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TECHNICAL APPROACH CONSENSUS DOCUMENT

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS

MATTHIESSEN AND HEGELER ZINC COMPANY SITE
LASALLE, ILLINOIS

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CONTENTS

Section **Page**

1.0 INTRODUCTION 1-1
1.1 SITE DESCRIPTION 1-2
1.2 SITE HABITATS AND WILDLIFE 1-4
1.2.1 Highly Disturbed Habitat 1-5
1.2.2 Disturbed Habitat with Vegetation 1-6
1.2.3 Savannah Habitat 1-6
1.2.4 Oak Hickory Woodland Habitat 1-7
1.2.5 LVR Riparian Habitat 1-7
1.2.6 LVR Riverine Habitat 1-7
1.2.7 Wildlife Species 1-8
1.3 REPORT ORGANIZATION 1-8
2.0 HUMAN HEALTH RISK ASSESSMENTS 2-1
2.1 CONCEPTUAL SITE MODEL 2-2
2.1.1 OU1 Preliminary CSM 2-2
2.1.2 OU2 Preliminary CSM 2-8
2.2 DATA EVALUATION AND COPC SELECTION 2-11
2.2.1 HHRA Datasets for OU1 and OU2 2-11
2.2.2 Data Validation 2-14
2.2.3 Constituents Excluded from Quantitative Evaluation 2-14
2.2.4 Approach to Duplicate Sample Data 2-14
2.2.5 Screening Process Overview 2-15
2.3 EXPOSURE ASSESSMENT 2-17
2.3.1 Calculation of Receptor Intakes 2-17
2.3.2 Exposure Point Concentrations 2-28
2.3.3 Modeling 2-28
2.3.4 Exposure Assumptions 2-29
2.4 TOXICITY ASSESSMENT 2-61
2.5 RISK CHARACTERIZATION 2-62
2.5.1 Calculation of Potential Cancer Risks 2-62
2.5.2 Calculation of Potential Non-Cancer Risks 2-63
2.5.3 Risk Evaluation for Lead 2-63
2.5.4 Risk Evaluation for Asbestos 2-63
3.0 ECOLOGICAL RISK ASSESSMENTS 3-1
3.1 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT 3-1
3.1.1 Problem Formulation 3-2
3.1.2 Screening-Level Exposure Estimates and Risk Calculations 3-6
3.2 BASELINE ECOLOGICAL RISK ASSESSMENT 3-7
3.2.1 Problem Formulation 3-8
3.2.2 Study Design and Risk Characterization 3-9
4.0 REFERENCES 4-1

FIGURES

1 Site Location
2 Site Layout
3 OU1 Habitat Types
4 OU2 Habitat Types
5 OU1 Human Health Exposure Areas
6 OU2 Human Health Exposure Areas
7 OU1 HHRA Conceptual Site Model
8 OU2 HHRA Conceptual Site Model
9 ERA Conceptual Site Model

ATTACHMENT 1

HHRA TABLES – OU1

1 Series:	Selection of Exposure Pathways, OU1
4 Series:	Values Used for Daily Intake Calculations
4.1	Current and Future Commercial/Industrial Worker
4.2	Current and Future Site-Specific Worker
4.3	Current and Future Utility Worker
4.4	Future Construction Worker
4.5	Current and Future Adolescent Trespasser
4.6	Current and Future Adult Trespasser
4.7	Future Child Recreationalist
4.8	Future Adolescent Recreationalist
4.9	Future Adult Recreationalist
4.10	Hypothetical Future Child Resident
4.11	Hypothetical Future Aggregate Resident
4.12	Current and Future Adolescent Recreational Fisherman
4.13	Current and Future Adult Recreational Fisherman
4.14	Current and Future Child Fish Consumer
4.15	Current and Future Adolescent Fish Consumer
4.16	Current and Future Adult Fish Consumer

ATTACHMENT 2

HHRA TABLES – OU2

1 Series:	Selection of Exposure Pathways, OU2
4 Series:	Values Used for Daily Intake Calculations
4.1	Future Commercial/Industrial Worker
4.2	Current and Future Utility Worker
4.3	Current and Future Construction Worker
4.4	Current and Future Adolescent Trespasser
4.5	Current and Future Adult Trespasser
4.6	Current and Future Child Recreationalist
4.7	Current and Future Adolescent Recreationalist
4.8	Current and Future Adult Recreationalist
4.9	Current and Future Child Resident
4.10	Current and Future Aggregate Resident

ACRONYMS AND ABBREVIATIONS

µg/L	Microgram per liter
$\mu g/m^3$	Microgram per cubic meter
ACM	Asbestos-containing material
ADAF	Age-dependent adjustment factor
AF	Soil-to-skin adherence factor
ALM	Adult Lead Model
ARAR	Applicable or relevant and appropriate requirement
AT	Averaging time for carcinogens
AT_c	Averaging time for carcinogens
AT_{nc}	Averaging time for non-carcinogens
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	Bioaccumulation factor
BERA	Baseline ecological risk assessment
bgs	Below ground surface
BW	Body weight
Carus	Carus Corporation and Carus Chemical Company
CDE	Chronic daily exposure
CDI	Chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
cm^2	Square centimeter
cm/hour	Centimeter per hour
cm^2-year/kg	Square centimeter-year per kilogram
COPC	Constituent of potential concern
COPEC	Constituent of potential ecological concern
Cr_{ag}	Consumption rate for aboveground produce
Cr_{bg}	Consumption rate for belowground produce
CSM	Conceptual site model
CTE	Central tendency exposure
CWA	Clean Water Act
DAF	Dermal absorption fraction
DW	Dry weight
Eco-SSL	Ecological Soil Screening Level
ED	Exposure duration
EF	Exposure frequency
ELCR	Excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ERA	Ecological risk assessment
ET	Exposure time
ETb	Exposure time bathing
ETod	Exposure time outdoors

ACRONYMS AND ABBREVIATIONS (Continued)

f/cc	Fiber per cubic centimeter
FCM	Food-chain model
FI	Fractional intake
FIELDS	Field Environmental Decision Support
Framework	"Framework for Investigating Asbestos-Contaminated Superfund Sites"
FS	Feasibility study
Geosyntec	Geosyntec Consultants, Inc.
GIabs	Gastrointestinal absorption
HEAST	Health Effects Assessment Summary Table
HI	Hazard index
HQ	Hazard quotient
HHRA	Human health risk assessment
HHRAP	Human Health Risk Assessment Protocol
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
IEUBK	Integrated Exposure Uptake Biokinetic
IPCB	Illinois Pollution Control Board
IRGW	Ingestion rate of groundwater
IRIS	Integrated Risk Information System
IRS	Ingestion rate of soil
IRSW	Ingestion rate of surface water
ISA	Integrated site assessment
IWQS	Illinois Water Quality Standard
kg/mg	Kilogram per milligram
K_p	Dermal permeability constant
L/cm^3	Liter per cubic centimeter
L/day	Liter per day
L-year/kg-day	Liter-year per kilogram-day
LOAEL	Lowest observed adverse effect level
LVR	Little Vermilion River
M&H	Matthiessen and Hegeler Zinc Company
MCL	Maximum contaminant level
MDL	Method detection limit
mg/µg	Milligram per microgram
mg/cm^2	Milligram per square centimeter
mg/day	Milligram per day
mg/kg	Milligram per kilogram
m^3/kg	Cubic meter per kilogram
mg/kg-day	Milligram per kilogram per day
mg/m^3	Milligram per cubic meter
mg-year/kg-day	Milligram-year per kilogram-day
MOU	Memorandum of Understanding

ACRONYMS AND ABBREVIATIONS (Continued)

MRL	Minimal risk level
NOAEL	No observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NWQS	National Water Quality Standards
ORNL	Oak Ridge National Laboratory
OU1	Operable Unit 1
OU2	Operable Unit 2
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PEF	Particulate emission factor
PPRTV	Provisional Peer Reviewed Toxicity Values
PRP	Potentially responsible party
QC	Quality control
Q/C	Soil dispersion particulate coefficient
RAC	Remedial Action Contract
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial action objective
RBA	Relative bioavailability
RDA	Recommended daily allowance
RfC	Reference concentration
RfD	Reference dose
RI	Remedial investigation
RMDP	Risk management decision point
RME	Reasonable maximum exposure
RPD	Relative percent difference
RPM	Remedial project manager
RSL	Regional screening level
SA	Skin surface area
SF	Slope factor
SLERA	Screening-level ecological risk assessment
SSI	Screening site inspection
SulTRAC	SulTRAC Inc.
TACO	Tiered Approach to Corrective Action Objectives
TCE	Trichloroethene
TRV	Toxicity reference value
UCL	Upper confidence limit
URF	Unit risk factor
U.S.C.	*United States Code*
USDA	U.S. Department of Agriculture

ACRONYMS AND ABBREVIATIONS (Continued)

USGS	U.S. Geological Survey
VDEQ	Virginia Department of Environmental Quality
VF	Volatilization factor
VOC	Volatile organic compound
WA	Work assignment
XRF	X-ray fluorescence

1.0 INTRODUCTION

Geosyntec Consultants, Inc. (Geosyntec), on behalf of Carus Corporation and the Carus Chemical Company (Carus), and SulTRAC Inc. (SulTRAC), on behalf of the U.S. Environmental Protection Agency (EPA), have jointly prepared this technical approach consensus document. This document describes a consensus approach between Geosyntec and SulTRAC on risk assessment methodology for the baseline human health risk assessments (HHRA), screening-level ecological risk assessments (SLERA), and baseline ecological risk assessments (BERA) for the Matthiessen and Hegeler Zinc Company (M&H) Site. The M&H Site is located in LaSalle, LaSalle County, Illinois, and borders the Little Vermilion River (LVR) (see Figure 1). The M&H Site is being addressed under three separate remedial investigation (RI) / feasibility study (FS) work assignments (WA). The work is being performed under (1) the EPA Remedial Action Contract (RAC) II for Region 5, Contract No. EP-S5-06-02, WA No. 032-RICO-B568, and (2) the Administrative Settlement Agreement and Order on Consent for RI/FS between EPA and Carus. SulTRAC currently is providing technical support for both the potentially responsible party (PRP)-lead RI/FS (WA No. 015-RSBD-B568) and the fund-lead RI/FS (WAs No. 016-RICO-B568 and 032-RICO-B568).

For the purposes of the RI, EPA has divided the M&H Site into two Operable Units – Operable Unit 1 (OU1) and Operable Unit 2 (OU2). OU1 consists of Carus Plant and areas to the east, including the Slag Pile and LVR. OU2 mainly consists of the former M&H facility (see Figure 2) but also includes an off-site residential area and an off-site mixed use area.

A comprehensive risk assessment document will be prepared and submitted as a companion document to the RI report. The purpose of this technical approach consensus document is to describe a consensus approach between Geosyntec and SulTRAC on the risk assessment methodology in order to develop harmonized risk metrics for all OU1 and OU2 risk assessments. The comprehensive risk assessment document will include the following risk assessments:

- OU1 HHRA: Evaluates current and future human health risks and hazards associated with exposure to site-related constituents at the Carus Plant and Slag Pile
- OU1 LVR HHRA: Evaluates current and future human health risks and hazards associated with exposure to site-related constituents in the LVR
- OU1 terrestrial SLERA: Evaluates potential current and future ecological risks associated with ecological exposure to site-related constituents in the terrestrial habitats of OU1

- OU1 LVR SLERA: Evaluates potential current and future ecological risks associated with ecological exposure to site-related constituents in the riparian/riverine habitats of OU1, and identifies potentially complete exposure pathways and constituents of potential ecological concern (COPEC) that require further evaluation in a BERA

- OU1 LVR BERA: Evaluates potential ecological exposure pathways and risks identified in the OU1 LVR SLERA as warranting further evaluation using a weight-of-evidence approach, which includes the results of the LVR community assessment

- OU2 HHRA: Evaluates current and future human health risks and hazards associated with exposure to site-related constituents at OU2 exposure areas (the Main Plant Area, Wooded Area – North, Wooded Area – Northeast, Building 100 Hot Spot, Rolling Mill Hot Spot, Rolling Mill Area, Off-Site Residential Area, and Off-Site Mixed Use Area)

- OU2 SLERA: Evaluates potential current and future ecological risks associated with exposure to site-related constituents in the terrestrial habitats of OU2, and identifies potentially complete exposure pathways and COPECs that require further evaluation in a BERA

- OU2 BERA: Evaluates potential ecological exposure pathways and risks identified in the OU2 SLERA as warranting further evaluation using a weight-of-evidence approach

Geosyntec will lead the effort to produce the OU1 risk assessments, and SulTRAC will lead the effort to produce the OU2 risk assessments. Geosyntec and SulTRAC will work together to summarize and synthesize the OU1 and OU2 risk assessments. Geosyntec, in cooperation with SulTRAC, will produce a comprehensive risk assessment encompassing all human health and ecological risk assessments (ERA) to be submitted as companion documents to the RI report.

The following sections provide the site description, discuss site habitats, and discuss the organization of this technical approach consensus document.

1.1 SITE DESCRIPTION

The entire M&H Site encompasses 160 acres in the City of LaSalle, Illinois (population 9,646). Figure 1 shows the site location, and Figure 2 shows the site layout. The M&H Site includes a former primary zinc smelting facility, a Rolling Mill, and the Carus Plant. The M&H Site is surrounded by the LVR on the north and east and by private residences on the south and west. North and east of the M&H Site and across the LVR are farmland and a limestone quarry, respectively. An abandoned and collapsed storm sewer line runs across OU2 and serves as a potential pathway that transports surface water runoff directly to the LVR, which then flows south into the Illinois River. A wetland is located approximately 0.5 mile upstream of the M&H Site on the LVR. Also, the Lake DePue Fish and Wildlife Area and the Spring Lake Heron Colony are located about 15 miles downstream of the M&H Site. The wildlife area and

colony provide breeding habitat for waterfowl and wading and migratory birds and are listed by the Illinois Department of Natural Resources (IDNR) as an Important Bird Area.

The M&H Site began operations in 1858. Raw materials such as zinc ore and various grades of coal were transported to the site in order to smelt zinc. Coal was provided by mines at the site. A Rolling Mill was built on the M&H Site in 1866 to produce zinc sheets. The furnace used produced gas as fuel, and any sulfur dioxide generated was recovered, converted into sulfuric acid, stored in on-site tanks, and sold. The M&H Site also had an ammonium sulfate fertilizer plant that used some of the sulfuric acid generated, but this plant operated only for a few years during the early 1950s. On-site coal mining was discontinued in 1937, and zinc smelting ceased in 1961. Sulfuric acid manufacture cased in 1968. From 1968 through 1978, when bankruptcy was declared, the facility performed only Rolling Mill operations.

In 1980, Fred and Cynthia Carus purchased the land where the Rolling Mill was located either directly or through a land trust, and the site became known as the LaSalle Rolling Mills. The LaSalle Rolling Mills, which occupied approximately 12 acres on the M&H Site, worked under contract to the U.S. Mint to generate metal blanks for pennies. In 2000, the LaSalle Rolling Mills declared bankruptcy and ceased operating on the site. In 2003, EPA conducted an emergency removal action at the LaSalle Rolling Mills to address cyanide contamination, the old plating line, and various other chemicals and storage tanks that remained on site. This emergency removal action has been completed.

Carus has been operating on all or a portion of its current plant since 1915. The Carus Plant is located on the southern portion of the M&H Site. The plant produces various chemicals, including potassium permanganate. Non-contact cooling water generated during the production of potassium permanganate is discharged to a holding pond and eventually to the LVR under a National Pollutant Discharge Elimination System (NPDES) permit. Solid wastes generated from manufacturing activities are transported off site to a permitted landfill used solely by Carus.

The M&H Site was listed on the National Priorities List (NPL) on September 29, 2003, pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 105, Title 42 of the *United States Code* (U.S.C.), Section 9605 (EPA 2003a). Two primary on-site sources were used to score the M&H Site for the NPL, Sources 1 and 2. Source 1 is a 6-acre Slag Pile located in the southeast portion of the former smelting facility property along the bank of the LVR at OU1. This Slag Pile is composed of material generated from the primary zinc smelting process. It is unknown when the pile began to accumulate, but slag has not been added to the pile since the primary smelter ceased operations in about 1961. Runoff from the Slag Pile flows directly into the LVR. Based on a 1988 aerial

photograph, photographs taken during a 1991 CERCLA screening site inspection (SSI) at the Carus property, and observations made during a December 1993 Illinois Environmental Protection Agency (IEPA) CERCLA integrated site assessment (ISA) sampling event, the Slag Pile (Source 1) has been in contact with the LVR since at least 1988 (IEPA 1991 and 1993). The Slag Pile had actually been in contact with the LVR for many years prior to 1988 because the Slag Pile resulted from the dumping of waste materials when the smelter was in operation. A portion of this slag is now located in the LVR.

During the December 1993 ISA, the IEPA collected three samples from the Slag Pile. The materials sampled consisted of slag by-product from the on-site smelting operations. The sample did not contain any soil and was described as "coarse, black, [and] coal-like." The maximum concentrations of potentially hazardous substances detected in these three samples included cadmium at 181 milligrams per kilogram (mg/kg); chromium at 43.3 mg/kg; copper at 4,340 mg/kg; lead at 1,370 mg/kg; nickel at 118 mg/kg; and zinc at 42,000 mg/kg (IEPA 1993).

The second source, Source 2, is a shallow waste pile located on the former smelter property at OU2. Contaminants detected in samples used to characterize Source 2 appear to have resulted from former zinc smelter and ancillary operations. The current limits of Source 2 were defined by five samples collected from portions of the former smelter property during the 1993 IEPA ISA. The material sampled consisted of black, cindery slag by-product of the on-site smelting operations. The maximum concentrations of potentially hazardous substances detected in the five samples included pentachlorophenol at 36 mg/kg; cadmium at 1,320 mg/kg; copper at 3,650 mg/kg; lead at 4,310 mg/kg; and zinc at 71,200 mg/kg. Some of the hazardous substances detected at the M&H Site may have migrated to the LVR. During the November 1991 CERCLA SSI and the 1993 ISA, IEPA concluded that an observed release to surface water was documented through chemical analysis because several sediment samples collected from the LVR contained elevated levels of cadmium, chromium, lead, nickel, and zinc (IEPA 1991 and 1993). Runoff from the shallow waste pile (Source 2) also flows into the LVR through natural drainage pathways and through a drainage pathway under OU2 that enters an abandoned and collapsed storm sewer line formerly used by the City of LaSalle.

1.2 SITE HABITATS AND WILDLIFE

In October 2007, Geosyntec conducted habitat evaluations of OU1, and in October 2008, SulTRAC conducted habitat evaluations of OU2. These evaluations were conducted in order to gather data necessary to identify potential ecological receptors and develop a conceptual site model (CSM) for the ERAs to be conducted for OU1 and OU2. Specifically, Geosyntec and SulTRAC evaluated the following

parameters for each OU: (1) water features and wetlands, (2) habitat types, (3) sensitive environments, (4) soils and land use, and (5) wildlife species.

SulTRAC observed several different water features in OU2, but these are not considered jurisdictional wetlands because no hydric soil characteristics were observed at any location. Furthermore, no soils mapped are classified as hydric soils. Most moist areas are present because the disturbed landscape contains numerous small depressions.

Aside from the LVR, Geosyntec observed water features in the uplands area of OU1 just east of the Carus Plant. These features are two man-made ponds constructed and operated to provide spill prevention and control for Clean Water Act (CWA) compliance associated with the daily operations of the plant. These ponds are not considered "waters of the United States" (that is, not jurisdictional). The U.S. Army Corps of Engineers states, "Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of the CWA … are not waters of the United States" (Title 33 of the *Code of Federal Regulations* [CFR], Section 328.3). These ponds are regulated under the NPDES program and are not included in the M&H Site ERAs.

The LVR does represent "waters of the State" of Illinois and of the United States, and based on observations made by Geosyntec, the LVR likely supports riparian "bed and bank" wetlands that should be considered jurisdictional.

SulTRAC identified five habitat types at OU2. Geosyntec confirmed that many of these habitat types were also present at OU1. Figures 3 and 4 show the locations of each habitat type at OU1 and OU2, respectively. The following sections discuss each habitat type and wildlife species observed at OU1 and OU2 during the habitat evaluations.

1.2.1 Highly Disturbed Habitat

In highly disturbed areas, little or no vegetation exists and the ground is often bare. These areas are concentrated around the former infrastructure remnants. Commonly, only slag piles and building debris are present, with no soil or organic matter to support vegetation. Thus, these areas have little habitat value in their current state.

The Carus Plant area is categorized as highly disturbed habitat. The plant is an active industrial facility supporting limited or no ecological habitats. This area includes the two previously discussed NPDES-permitted non-contact cooling water ponds located just east and southeast of the plant area. Immediately adjacent lands comprising the remaining upland terrestrial areas of OU1 are disturbed from historical

M&H Site operations primarily associated with the handling and placement of slag. These upland terrestrial areas consist of the "highly disturbed" Slag Pile itself, which has no soil and supports little if any vegetation. Portions of the Slag Pile are in the LVR.

Despite the presence of pollutants, physical alterations of the landscape in the highly disturbed portions of OU1 and OU2 have resulted in the presence of sparse and degraded habitat for ecological receptors. Importantly, these degraded areas support no critical habitat for state- or federally-protected species.

1.2.2 Disturbed Habitat with Vegetation

SulTRAC identified disturbed habitat with vegetation, including woodland-grassland areas that show some habitat recovery. Enough soil or organic material exists in these areas to support a mixture of woody and herbaceous species. The woody vegetation is typically young and predominantly consists of black locust (*Robinia pseudoacacia*), American elm (*Ulmus americana*), northern catalpa (*Catalpa speciosa*), big-tooth aspen (*Populus grandidentata*), smooth sumac (*Rhus glabra*), and Japanese honeysuckle (*Lonicera japonica*). Herbaceous vegetation mainly consists of big bluestem (*Andropogon gerardii*), tall goldenrod (*Solidago altissima*), and Kentucky bluegrass (*Poa pratensis*). Toward the northern boundary of OU2, the disturbed wooded area thickens and transitions into a more mature woodland. The woody species are similar, but the understory predominately consists of white snakeroot (*Ageratina altissima*).

Geosyntec also observed some disturbed habitat areas with vegetation in OU1 along the western fringes of the Slag Pile and east of the Carus Plant area (east of the ponds). Primarily woodlands with some grassy areas, the areas supported predominantly immature (and some mature) woody vegetation and grass species similar to those described above for OU2. Most mature woody species were observed in a small area in the extreme southeast portion of OU1 along the LVR near the Highway 6 Bridge.

Despite the presence of pollutants, physical alterations of the landscape in the disturbed habitat portions of OU1 and OU2 with vegetation have resulted in the presence of sparse and degraded habitat for ecological receptors. Importantly, these degraded areas support no critical habitat for state- or federally-protected species.

1.2.3 Savanna Habitat

Savanna habitat has formed on fairly disturbed ground located on topographic high points in portions of OU2. These areas typically contained big bluestem, switchgrass (*Panicum virgatum*), and Canada

wildrye (*Elymus canadensis*). Mature eastern cottonwoods (*Populus deltoides*) and smooth sumac occur along the savanna fringe as well as black locust and big-tooth aspen saplings.

Geosyntec observed no savanna habitats at OU1.

1.2.4 Oak Hickory Woodland Habitat

The mature oak-hickory woodlands habitat is located along the LVR valley slope and floodplain. The dominant species are burr oak (*Quercus macrocarpa*), white oak (*Quercus alba*), black oak (*Quercus velutina*), red oak (*Quercus rubra*), shingle oak (*Quercus imbricaria*), chinquapin oak (*Quercus muhlenbergii*), and bitternut hickory (*Carya cordiformis*). Also present in lesser quantities are American elm, big-tooth aspen, catalpa, and sugar maple (*Acer saccharum*). Close to the LVR, SulTRAC observed box elder and black willow. Within the woodland, SulTRAC found several small areas where water is seeping out of bedrock outcrops. Unidentified mosses and reed canarygrass (*Phalaris arundinacea*) were observed in these areas. Overall, these areas had good vegetative composition and age diversity, reflecting good terrestrial habitat conditions.

Geosyntec observed no oak hickory woodland habitats at OU1.

1.2.5 LVR Riparian Habitat

The near-bank (riparian) habitat along the LVR at both OU1 and OU2 supports a plant community adapted to periodic overbank flooding, particularly in the low-lying area directly north of the Carus property line at the Highway 6 Bridge. The relatively dense understory of this area is characterized by American sycamore (*Platanus occidentalis*), red maple (*Acer rubrum*), eastern cottonwood, Osage-orange (*Maclura pomifera*), catalpa, and birch. Shrub species including crabapple (*Malus* spp.), sumac (*Rhus* spp.), bush honeysuckle (*Lonicera maackii*), and common buckthorn (*Rhamnus cathartica*) were also observed in the bottomland mixed-hardwood forest habitat in the floodplain next to the LVR. Ground cover vegetation exhibits characteristics of both upland areas and low moist areas associated with the river and consists of grasses, herbaceous plants, poison ivy (*Toxicodendron radicans*), ferns, wildflower species, common reed, mosses, and other species adapted to moist conditions.

1.2.6 LVR Riverine Habitat

The riverine habitat associated with the LVR at OU1 has diversity created by the riffle/pool sequences that should provide sufficient habitat to support a variety of fish, macroinvertebrates, and mussel species. During normal flows below the dam located at the northern edge of the M&H Site, the LVR is 30 to 50

feet wide and less than 1 to 3 feet deep. The substrate appears diverse, with silts, gravels, cobbles, and some boulders. Large woody debris also was observed scattered about the stream. These features also provide habitat and refuge for aquatic species. The State of Illinois characterizes the LVR as a fishery with smallmouth bass (*Micropterus dolomieu*), bluegill (*Lepomis macrochirus*), sunfish (*Lepomis* spp.), crappie (*Pomoxis* spp.), channel catfish (*Ictalurus punctatus*), bullhead (*Ictalurus* spp.), carp (*Cyprinus carpio*), and drum (*Aplodinotus grunniens*) fish populations (EPA 2003a).

Geosyntec observed live and relic mussel species such as deertoe (*Truncilla truncata*), plain pocketbook (*Lampsilis cardium*), and white heelsplitter (*Lasmigona complanata*) in several areas of the LVR, particularly in shallow areas along the gravel and sand bar islands. The Illinois Natural History Survey indicates that other mussel species have been collected in the LVR within the project area, including the creek heelsplitter (*Lasmigona compressa*) and the ellipse (*Venustaconcha ellipsiformis*). Small gastropods (snails) also were observed in areas where the mussels were encountered. Specimens and egg cases of mayfly (*Ephemeroptera*) and caddisfly (*Trichoptera*) were found under large rocks and slag material in shallow areas of the LVR.

The LVR riverine habitat is part of OU1 (although a portion is next to OU2) and will be directly evaluated in the OU1 LVR SLERA and subsequent OU1 LVR BERA.

1.2.7 Wildlife Species

SulTRAC and Geosyntec documented wildlife species observed during the habitat evaluations of OU1 and OU2, including direct visual species observations or other species evidence such as tracks or scat. Mammals observed included white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), coyote (*Canis latrans*), beaver (*Castor canadensis*), and red fox (*Vulpes vulpes*). Birds identified included red-tailed hawk (*Buteo jamaicensis*), turkey vulture (*Cathartes aura*), cedar waxwings (*Bombycilla cedrorum*), great blue heron (*Ardea herodias*), American crow (*Corvus ossifragus*), wood duck (*Aix sponsa*), American robin (*Turdus migratorius*), and northern cardinal (*Cardinalis cardinalis*). Several other birds were also observed and heard but could not be identified. On October 22, 2008, SulTRAC also observed a large winter flock of blackbirds, grackles, and starlings within OU2.

1.3 REPORT ORGANIZATION

This technical approach consensus document consists of the sections summarized below.

- Section 1.0, Introduction, provides the project background and discusses the site description, site habitats and wildlife, and the report organization.

- Section 2.0, HHRA, discusses the CSMs, data evaluation and selection of constituents of potential concern (COPC), the exposure assessment, the toxicity assessment, and the risk characterization for the OU1 and OU2 HHRAs.
- Section 3.0, ERA, discusses the proposed SLERA and BERA approach.
- Section 4.0, References, lists the sources used to prepare this document.

Figures are presented after Section 4.0. This document also contains two attachments (Attachments 1 and 2) that present the HHRA tables for OU1 and OU2, respectively.

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2.0 HUMAN HEALTH RISK ASSESSMENTS

For the purposes of the HHRAs, OU1 will be divided into three human health exposure areas on the basis of habitat type, historical operations, current land use, and reasonably anticipated future land uses (see Figure 5). The OU1 areas include the following:

- Carus Plant
- Slag Pile
- LVR

Likewise, OU2 will be divided into the following eight human health exposure areas (see Figure 6):

- Main Plant Area
- Wooded Area – North
- Wooded Area – Northeast
- Building 100 Hot Spot
- Rolling Mill Hot Spot
- Rolling Mill Area
- Off-Site Residential Area
- Off-Site Mixed-Use Area

Consistent with standard risk assessment practice and EPA guidance, the elements summarized below will be included in the HHRA for each OU.

- ***Data Evaluation and Selection of Constituents of Potential Concern (COPC):*** The analytical data used in the HHRA will be summarized from the RI report. Summary statistics for each human health exposure area will be presented. COPCs in environmental media will be identified through comparisons of maximum detected concentrations to conservative, risk-based screening levels and, if relevant, background levels.

- ***Exposure Assessment:*** Current and reasonably anticipated future scenarios under which exposure to site-related constituents could occur will be qualitatively discussed for each OU and human health exposure area, and a set of exposure assumptions will be developed to quantitatively evaluate such scenarios by calculating future risks. Medium-specific exposure point concentrations (EPC) will be developed for each COPC in each human health exposure area, and conservative estimates of the intake of each COPC by each receptor through the selected pathways will be calculated.

- ***Toxicity Assessment:*** A characterization of the toxicity and dose-response characteristics of each COPC will be provided with regard to potential carcinogenic (including mutagenic) and non-carcinogenic effects.

- ***Risk Characterization:*** For each receptor and exposure scenario, the information provided by the exposure and toxicity assessments will be combined to yield quantitative risk estimates that characterize the relationship between hypothetical exposures and potential toxicity. Estimates for potential theoretical excess cancer risks and non-cancer hazards will be provided and discussed, both qualitatively and quantitatively. Uncertainties associated with the risk assessment also will be qualitatively discussed.

The selection of COPCs, EPCs, exposure assumptions, toxicity values, and calculated risks will be presented in tabular format in accordance with the Risk Assessment Guidance for Superfund (RAGS) Part D (EPA 2001). Applicable or relevant and appropriate requirements (ARAR) are outside the scope of the HHRA and therefore will be addressed in the RI report.

Risk management comprises a separate step in the project in which the magnitude of potential risks and the necessity of corrective actions to mitigate them are evaluated. Risk management measures, including remedial action objectives (RAO), will be addressed as part of the FSs.

The following sections discuss the CSMs for each OU, followed by each element of the HHRAs discussed above.

2.1 CONCEPTUAL SITE MODEL

Figures 7 and 8 present the CSMs for the OU1 and OU2 HHRAs, respectively. Sections 2.1.1 and 2.1.2 discuss the preliminary CSMs for OU1 and OU2, respectively.

2.1.1 OU1 Preliminary CSM

As defined in RAGS Part A (EPA 1989), the four elements necessary to form a complete exposure pathway for each OU include a source, transport mechanism, point of receptor contact, and exposure route. The following sections discuss the source and transport mechanisms, land and groundwater use, potential receptors and exposure points, and potential exposure routes for OU1. Figure 7 presents the CSM for OU1. The 1 Series tables in Attachment 1 summarize the selection of exposure pathways for OU1.

2.1.1.1 Source and Transport Mechanisms

At OU1, impacts to soil and groundwater primarily resulted from historic smelting operations. As described in Section 1.1, a 6-acre Slag Pile is located in the southeast portion of the former smelting facility along the bank of the LVR. Runoff from the Slag Pile can flow directly into the LVR. Incidental releases through spills and leaks or airborne transport of particulates during operations also have impacted soil, sediment, and surface water at OU1. Constituents deposited in soil may also leach to groundwater.

2.1.1.2 Land and Groundwater Use

Future uses of land and groundwater may affect the types and the frequency of potential exposures from any residual contamination at the M&H Site, which in turn may affect the remedies considered and chosen. In accordance with Section 6.2.2 of EPA RAGS Part A (EPA 1989), alternate future uses of land must be considered in the risk assessment process and to determine appropriate remediation techniques. Alternate future land uses should be chosen based on logical, reasoned judgment after an evaluation of all available information and consultation with the EPA Remedial Project Manager (RPM). Although risks associated with "reasonably possible" future uses should be evaluated, a risk assessment need not consider possibilities that are "exceedingly small" (EPA 1989). EPA states that for example, "future industrial land use is likely to be a reasonable assumption where a site is currently used for industrial purposes, is located in an area where the surroundings are zoned for industrial use, and the comprehensive plan predicts the site will continue to be used for industrial purposes" (EPA 1995b). Factors that may be relied upon to determine reasonably anticipated future land uses include the following:

- Current land uses and historical development patterns
- Local land use designations and the prospect for changes to those designations
- Local master development plans
- Local land use trends
- Population growth patterns and projections
- Existing or anticipated institutional controls

Carus has continuously operated its plant on all or a portion of the current Carus Plant site since approximately 1915. The plant is surrounded by residential areas to the south and west, the Slag Pile and the LVR to the east, and OU2 to the north. There is little or no vacant land surrounding the Carus Plant available for development, and land uses surrounding the plant site have been essentially unchanged for

several decades. The Carus Plant and former M&H Site are zoned for heavy industrial use, M-2, and the zoning designation has not changed since it was established in 1958. The City of LaSalle has a master development plan that does not reflect any planned development for the Carus Plant or former M&H Site properties. The City of LaSalle's population declined from 10,347 in 1980 to 9,717 in 1990 and then remained essentially stable at 9,796 through 2000 (Illinois Department of Commerce and Economic Opportunity 2005). The population in LaSalle County is estimated to have grown slower than that of the State of Illinois as a whole from 2000 to 2007 (1 percent versus 3.5 percent) (U.S. Census Bureau 2009). Because the City of LaSalle's population is expected to remain stable and because no development plans exist for the Carus Plant, the Carus Plant is not considered in demand for future residential development. The Carus Plant currently is a viable manufacturing facility, and the land use is anticipated to remain industrial. Carus also has indicated that it would accept an appropriate deed restriction on the Carus Plant to restrict it to commercial/industrial use.

No cultural resources, environmental justice issues, wetlands, floodplains, or critical habitats for threatened and endangered species have been identified for the Carus Plant that would limit the current industrial use from continuing in the future.

In addition, as part of its comprehensive water resource management plan, the City of LaSalle has enacted Ordinance 1755 and entered into a Memorandum of Understanding (MOU) with the IEPA. Ordinance 1755 prohibits the construction of any new private water system (for potable or other use) after September 12, 1994, within the city if a public water main is within 300 feet of the nearest property line of the property on which the private water system would be built. The MOU places certain obligations on the city so that Ordinance 1755 is acceptable for establishing environmental institutional controls (under Title 35 of the *Illinois Administrative Code* 742.320[d] and 742.1015) justifying the elimination of groundwater exposure pathways from consideration under Illinois law. Because a public water main serves the Carus Plant and no water supply wells are currently present on OU1, future use of groundwater on OU1 is prohibited.

Based on this information, the Carus Plant is anticipated to be used for industrial purposes only in the future, and future groundwater use is prohibited throughout OU1.

2.1.1.3 Potential Receptors and Exposure Points

Current and future receptors that are reasonably anticipated to be exposed to site-related constituents in environmental media were identified based on the information presented in Sections 2.1.1.1 and 2.1.1.2. These receptors are described below. Except for the current and future recreational fisherman, exposure

to sediment, surface water, and biota in the LVR is considered an incomplete or insignificant exposure pathway for on-site receptors. Likewise, exposure of fishermen to environmental media in terrestrial portions of OU1 is considered an incomplete exposure pathway.

- ***Current and Future Commercial/Industrial Worker:*** Portions of OU1 within the Carus Plant currently are used for commercial/industrial purposes. This use will likely continue. The Slag pile is not currently used for full-time commercial/industrial purposes. Future full-time commercial/industrial work at the Slag Pile is unlikely because of its uncertain geotechnical load-bearing capacity and its elevation differential compared to the current Carus Plant and other surrounding areas. However, such future use will be evaluated to support the consideration of related institutional controls, if necessary. A reduced-exposure commercial/industrial worker is more likely (see Site-Specific Worker description below). Therefore, current on-site commercial/ industrial workers could be exposed to site-related constituents in surface soil at the Carus Plant. Future commercial/industrial workers could be exposed to surface and subsurface soil at the Carus Plant and Slag Pile.

  In addition, current (Carus Plant only) and future commercial/industrial workers could be exposed to vapors in indoor air that migrate from sub-slab soil and groundwater through diffusion, advection, or as a result of heating and cooling systems. If warranted, this pathway will be evaluated using the Johnson and Ettinger (1991) model. However, based on the non-volatile nature of the primary COPCs in OU1 soil and groundwater, this exposure pathway is not expected to be significant. If volatile organic compounds (VOC) are not detected in a given medium, exposure to vapors will be considered an incomplete exposure pathway and will not be evaluated in the HHRA.

  Finally, despite the current prohibition regarding future groundwater use at OU1 because of the enactment of Ordinance 1755 (see Section 2.1.1.2), future commercial/industrial workers also will be assumed to ingest groundwater at OU1. Although this exposure pathway is not reasonably anticipated and is acknowledged as hypothetical, it will provide risk managers with information needed to evaluate the impact of any future changes in groundwater use at OU1 (EPA 1995b).

- ***Current and Future Site-Specific Worker:*** Based on the nature of the Slag Pile, significant commercial/industrial redevelopment probably will not occur. However, certain commercial/ industrial workers, such as environmental professionals, may periodically visit OU1. It was assumed that this receptor may be required to conduct semi-intrusive activities (such as sample collection). Therefore, current and future site-specific workers could be exposed to site-related constituents in surface soil and subsurface soil at the Slag Pile. Because commercial/industrial worker scenarios are considered protective of site-specific worker scenarios and because commercial/industrial land use is likely to continue at the Carus Plant, this receptor will not be quantitatively evaluated for the Carus Plant.

- ***Current and Future Utility Worker:*** Aboveground and underground utility and water lines currently are present at OU1 and are expected to remain on site under most future land-use scenarios. As a result, current and future on-site utility workers could be exposed to site-related constituents in surface and subsurface soil, and (if present) shallow groundwater (at less than 10 feet below ground surface [bgs], the limit of subsurface infrastructure) during low-frequency maintenance activities at the Carus Plant and Slag Pile. If VOCs are present in deeper groundwater (at 10 feet bgs or deeper), these VOCs could migrate into trench air. If VOCs are

detected in deeper groundwater, potential exposure through inhalation of trench air also will be evaluated (VDEQ 2008). If VOCs are not detected in groundwater regardless of depth, the groundwater-inhalation pathway will not be evaluated in the HHRA.

- ***Future Construction Worker*:** The future on-site construction worker could be exposed to site-related constituents in environmental media while performing short-duration construction related to possible site redevelopment. Therefore, the future on-site construction worker could be exposed to site-related constituents in surface and subsurface soil, and (if present) shallow groundwater (at less than 10 feet bgs, the limit of subsurface infrastructure) at the Carus Plant and Slag Pile. If VOCs are present in deeper groundwater (at 10 feet bgs or deeper), these VOCs may migrate into trench air. If VOCs are detected in deeper groundwater, potential exposure through inhalation of trench air also will be evaluated (VDEQ 2008). If VOCs are not detected in groundwater regardless of depth, the groundwater-inhalation pathway will not be evaluated in the HHRA. Future construction work at the Slag Pile is unlikely because of its uncertain geotechnical load-bearing capacity and its elevation differential compared to the current Carus Plant and other surrounding areas. However, such future use will be evaluated to support the consideration of related institutional controls, if necessary.

- ***Current and Future Trespasser:*** Perimeter fencing and a lack of "attractive nuisances" generally preclude trespassers at the Carus Plant. However, evidence of trespassers has been observed at the Slag Pile, and the northern portion of the Slag Pile has no current access restrictions. Therefore, current trespassers could be exposed to surface soil at the Slag Pile. If site redevelopment occurs, trespassers are not expected to be present at OU1. Therefore, current exposure conditions also are considered representative of future exposure conditions for the trespasser. Future recreationalist exposure assumptions are also considered protective of the trespasser (see below).

- ***Future Recreationalist:*** Although redevelopment of the Slag Pile for future recreational use is unlikely, the risk assessment will evaluate this possibility to support the selection of appropriate institutional controls or other remedial actions. Under this assumed scenario, future recreationalists could be exposed to surface and subsurface soil at the Slag Pile. Land use at the Carus Plant is expected to remain commercial/industrial. Therefore, this receptor was not evaluated for the Carus Plant.

- ***Hypothetical Future Resident:*** Future redevelopment from heavy industry (current zoning) to residential use and future use of groundwater for potable purposes are exceedingly small possibilities not reasonably anticipated at OU1. Of the three on-site OU1 exposure areas, the Carus Plant is the only area that could be redeveloped for residential use. However, this possibility is highly hypothetical. Nonetheless, in accordance with EPA's request and as a point of departure for making risk management decisions, a hypothetical future residential exposure scenario will be evaluated for the Carus Plant. Residents could be exposed to site-related constituents in surface soil, subsurface soil, and groundwater (shallow and deep) under this scenario.

- ***Current and Future LVR Fisherman:*** As discussed in Section 2.1.1.1, site-related constituents could be transported to the LVR by several mechanisms. Therefore, current and future fishermen could be exposed to site-related constituents in sediment and surface water while fishing in the LVR. Inhalation of particulates and vapors from sediment and surface water is not considered a significant exposure pathway. Therefore, this pathway will not be quantitatively evaluated in the HHRA.

- ***Current and Future Fish Consumer:*** Site-related constituents may be transported to the LVR by several mechanisms. Recreational anglers fishing in the LVR could be exposed to site-related constituents in fish tissue collected from the LVR. It was also conservatively assumed that recreational fishers would share fish caught in the LVR with family members (including children).

2.1.1.4 Potential Exposure Routes

The exposure routes that will be considered either quantitatively or qualitatively in the HHRAs for the various exposure scenarios described in Section 2.1.1.3 include the following:

- ***Current Commercial/Industrial Worker*:** Incidental ingestion of, dermal contact with, and inhalation of particulates and vapors in ambient air from surface soil, and inhalation of vapors in indoor air from sub-slab soil and groundwater at the Carus Plant

- ***Future Commercial/Industrial Worker*:** Incidental ingestion of, dermal contact with, and inhalation of particulates and vapors in ambient air from surface soil and subsurface soil, inhalation of vapors in indoor air from sub-slab soil and groundwater, and ingestion of groundwater (where present) at the Carus Plant and Slag Pile

- ***Current and Future Site-Specific Worker*:** Incidental ingestion of, dermal contact with, and inhalation of particulates and vapors in ambient air from surface soil and subsurface soil at the Slag Pile

- ***Current and Future Utility Worker*:** Incidental ingestion of, dermal contact with, and inhalation of particulates and vapors in ambient air from surface soil and subsurface soil, incidental ingestion of and dermal contact with shallow (less than 10 feet bgs) groundwater (if present), and inhalation of VOCs in ambient air from shallow and deeper (10 feet bgs or deeper) groundwater at the Carus Plant and Slag Pile

- ***Future Construction Worker*:** Incidental ingestion of, dermal contact with, and inhalation of particulates and vapors in ambient air from surface soil and subsurface soil, incidental ingestion of and dermal contact with shallow (less than 10 feet bgs) groundwater (if present), and inhalation of VOCs in ambient air from shallow and deeper (10 feet bgs or deeper) groundwater at the Carus Plant and Slag Pile

- ***Current and Future Trespasser:*** Incidental ingestion of, dermal contact with, and inhalation of particulates and vapors in ambient air from surface soil at the Slag Pile

- ***Future Recreationalist*:** Incidental ingestion of, dermal contact with, and inhalation of particulates and vapors in ambient air from surface soil and subsurface soil at the Slag Pile

- ***Hypothetical Future Resident:*** Incidental ingestion of, dermal contact with, inhalation of particulates and vapors in ambient and indoor (vapors only) air, ingestion of homegrown produce from surface and subsurface soil, and ingestion of, dermal contact with, inhalation of vapors in ambient and indoor air and as a result of household use from groundwater at the Carus Plant

- ***Current and Future LVR Fisherman:*** Incidental ingestion of and dermal contact with sediment and surface water in the LVR

- ***Current and Future Fish Consumer:*** Ingestion of fish tissue from the LVR

2.1.2 OU2 Preliminary CSM

As defined in RAGS Part A (EPA 1989), the four elements necessary to form a complete exposure pathway for each OU include a source, transport mechanism, point of receptor contact, and exposure route. The following sections discuss the source and transport mechanisms, land and groundwater use, potential receptors and exposure points, and potential exposure routes for OU2. Figure 8 presents the CSM for OU2. The 1 Series tables in Attachment 2 summarize the selection of exposure pathways for OU2.

2.1.2.1 Source and Transport Mechanisms

At OU2, impacts to soil, surface water, sediment, and groundwater primarily resulted from historical coal mining, zinc smelting, and rolling operations. Throughout OU2, especially in the Main Plant Area, multiple waste material and debris piles as well as sinter and slag piles are present. Runoff and erosion from these piles also have impacted surface soil and surface water and sediment at OU2 and have entered the abandoned storm sewer that discharges directly to the LVR. Historic stack and fugitive emissions from smelting and rolling operations and volatile and fugitive dusts from on-site piles have deposited onto OU2 surface soil, surface water, and sediment, and directly into the LVR. Constituents deposited in soil may also leach to groundwater.

For the purposes of the HHRA, soil beneath areas of standing water will be considered and referred to as sediment. This approach is warranted because of the expectation that wet or damp soil will adhere to exposed skin more like sediment than dry soil. However, this assumption does not imply that soil beneath areas of standing water will support benthic receptors. Habitat, or lack thereof, provided by these areas will be discussed as part of the habitat characterization.

2.1.2.2 Land and Groundwater Use

Future uses of land and groundwater may affect the types and the frequency of potential exposures from any residual contamination at the M&H Site, which in turn may affect the remedies considered and chosen. As discussed in Section 2.1.1.2, alternate future uses of land must be considered in the risk assessment process and to determine appropriate remediation techniques. Further, alternate future land uses selected for consideration in the HHRA should be chosen based on logical, reasoned judgment after an evaluation of all available information and need not consider possibilities that are “exceedingly small”

(EPA 1989). Factors that may be relied upon to determine reasonably anticipated future land uses are identified in Section 2.1.1.2.

As discussed in Section 2.1.1.2, with the enactment of Ordinance 1755 and the establishment of a MOU between the City of LaSalle and the State of Illinois, groundwater use for potable or other purposes at OU2 currently is prohibited. However, ordinances may change and MOU dissolved. As a result, risk managers require information regarding potential exposures, risks, and hazards if groundwater use at OU2 were to be allowed. This information will help document the need for institutional controls prohibiting groundwater use and will provide a basis for determining the need for and extent of groundwater remediation at OU2. Therefore, potential future groundwater use is evaluated for OU2.

2.1.2.3 Potential Receptors and Exposure Points

Current and future receptors that are reasonably anticipated to be exposed to site-related constituents in environmental media were identified based on the information presented in Sections 2.1.2.1 and 2.1.2.2. These receptors are described below.

- ***Future Commercial/Industrial Worker*:** A significant majority of OU2 currently is abandoned. Until late 2008, warehousing was conducted at the Rolling Mill. Similarly, neither of the off-site exposure areas currently is used for commercial/industrial purposes. Therefore, commercial/industrial workers will not be evaluated under current conditions. However, in the future, portions of OU2 could be redeveloped for commercial/industrial purposes. Specifically, all the on-site OU2 exposure areas except for the Wooded Area – Northeast could be developed for commercial/industrial purposes. Future commercial/industrial workers at these exposure areas could be exposed to site-related constituents in surface and subsurface soil. In addition, commercial/industrial workers could be exposed to vapors in indoor air that migrate from sub-slab soil and groundwater through diffusion, advection, or as a result of heating and cooling systems. Consistent with EPA guidance (EPA 2002a and 2004a), this pathway will be evaluated using the Johnson and Ettinger (1991) model. Finally, despite the current prohibition regarding future groundwater use at OU2 resulting from the enactment of Ordinance 1755 (see Section 2.1.1.2), commercial/industrial workers also will be assumed to ingest groundwater at OU2. This conservative approach is hypothetical but will provide risk managers with the information necessary to effectively evaluate any future changes in groundwater use at OU2.

- ***Current and Future Utility Worker:*** Currently, a limited number of active and operating above- and belowground utility and water lines are present at OU2. Current utilities include (1) aboveground high power lines along the west side of OU2, (2) "new" (less than 15 years old) underground storm sewers running west to east across OU2, and (3) an underground force main and power line paralleling the "new" storm sewer. The number of utilities is expected to increase in the future if the site is redeveloped. Utility and water lines also are present in the Off-Site Residential Area. As a result, current and future utility workers could be exposed to site-related constituents in surface and subsurface soil and (if present) shallow groundwater (less than 10 feet bgs, the limit of subsurface infrastructure) while performing low-frequency installation and maintenance activities at OU2 and in the Off-Site Residential Area. Utility workers also could be

- ***Current and Future Construction Worker*:** The future on-site construction worker could be exposed to site-related constituents in environmental media while performing short-duration construction related to possible site redevelopment. Therefore, the future on-site construction worker could be exposed to site-related constituents in surface soil, subsurface soil, and (if present) shallow groundwater (less than 10 feet bgs, the limit of subsurface infrastructure) at all five on-site OU2 exposure areas and in the Off-Site Residential Area. Construction workers also could be exposed to deeper groundwater (at 10 feet bgs or deeper) through the migration of VOCs from groundwater into trench air (VDEQ 2008). Construction workers also could be exposed in the Off-Site Residential Area but are not assumed to be exposed under both current and future land-use conditions at the Off-Site Mixed-Use Area.

- ***Current and Future Trespasser:*** Evidence of trespassing has been observed throughout OU2. Therefore, current trespassers could be exposed to site-related constituents in surface soil at all five on-site OU2 exposure areas. To the extent that trespassing continues in portions of OU2 developed in the future, current exposure conditions also are considered representative of future exposure conditions for the trespasser. Future recreationalist exposure assumptions also are considered protective of the trespasser (see below).

- ***Future Recreationalist:*** Similar to some portions of OU1, potential future land uses at OU2 include redevelopment as a recreational area. Similarly, the Off-Site Mixed Use Area may also be used for recreational purposes under current and future land-use conditions. A small cemetery is located in the Off-Site Mixed Use Area. The recreational receptor scenario is assumed to be protective of cemetery workers and visitors. Recreationalists could be exposed to site-related constituents in surface soil (current conditions) and to surface and subsurface soil (future conditions).

- ***Current and Future Resident:*** OU2 includes an Off-Site Residential Area located west of the M&H Site. Residential land use in this area is expected to continue in the future. Of the five on-site OU2 exposure areas, the Wooded Area – North is considered the most likely to be redeveloped for residential use in the future. This exposure area is next to the east edge of the Off-Site Residential Area. Therefore, utilities could easily be extended into this area and the Wooded Area – North is the only on-site OU2 exposure area that will be evaluated for potential future residential exposure. Residents could be exposed to site-related constituents in surface soil under current conditions in the Off-Site Residential Area and in surface and subsurface soil and groundwater (on-site exposure areas only) under future land-use conditions.

2.1.2.4 Potential Exposure Routes

The exposure routes that will be considered either quantitatively or qualitatively in the HHRAs for the various exposure scenarios described in Section 2.1.2.3 include the following:

- ***Future Commercial/Industrial Worker:*** Incidental ingestion of, dermal contact with, and inhalation of particulates and vapors from surface and subsurface soil and groundwater (ingestion and inhalation only) at all five on-site exposure areas at OU2

- ***Current and Future Utility Worker:*** Incidental ingestion of, dermal contact with, and inhalation of particulates and vapors from surface and subsurface soil at the Off-Site Residential Area and all five on-site exposure areas at OU2, and incidental ingestion of, dermal contact with, and inhalation of VOCs from OU2 groundwater (if present) at less than 10 feet bgs at all five on-site exposure areas at OU2

- ***Current and Future Construction Worker:*** Incidental ingestion of, dermal contact with, and inhalation of particulates and vapors from surface and subsurface soil at the Off-Site Residential Area and all five on-site exposure areas at OU2, and incidental ingestion of, dermal contact with, and inhalation of VOCs from OU2 groundwater (if present) at less than 10 feet bgs (incidental ingestion and dermal contact only) at all five on-site exposure areas at OU2; for the purposes of evaluating potential exposure to VOCs migrating from groundwater to air in construction trenches, groundwater at 10 feet bgs or deeper also will be considered (VDEQ 2008)

- ***Current and Future Trespasser:*** Incidental ingestion of, dermal contact with, and inhalation of particulates and vapors from surface soil and subsurface soil at all five on-site exposure areas at OU2

- ***Future Recreationalist:*** Incidental ingestion of, dermal contact with, and inhalation of particulates and vapors from surface and subsurface soil at all five on-site exposure areas at OU2

- ***Current and Future Resident:*** Incidental ingestion of, dermal contact with, inhalation of particulates and vapors from and produce grown in surface and subsurface soil at the Off-Site Residential Area and the Wooded Area – North on-site exposure area, and ingestion of, dermal contact with, and inhalation of VOCs from groundwater (Wooded Area – North on-site exposure area only)

2.2 DATA EVALUATION AND COPC SELECTION

This section presents the proposed approach for data evaluation and COPC selection for the HHRAs for OU1 and OU2. The following sections discuss the HHRA datasets for OU1 and OU2, data validation, constituents excluded from quantitative evaluation, the approach to duplicate sample data, and an overview of the screening process.

2.2.1 HHRA Datasets for OU1 and OU2

This section discusses the HHRA dataset for soil, slag, and sinter; groundwater; sediment, and surface water.

2.2.1.1 Soil, Slag, and Sinter

Analytical data collected from soil, slag, and sinter during Phases I and II of the comprehensive RI will be included in the evaluation of baseline risks associated with current (unremediated) conditions. Note; sinter data are available only for OU2. For the purposes of the HHRAs, soil, slag, and sinter samples (where present together) will be handled as a single dataset for each exposure area. Samples of building

materials also have been collected at OU2. However, there are difficulties and uncertainties associated with quantifying potential exposure to chemicals through direct contact with building materials. Therefore, although the building materials are considered potential source materials, the OU2 risk assessment will not quantify direct contact exposures to chemicals associated with building materials. Rather, the risk assessment will focus on potential exposures to other media (primarily soil) to which chemicals originally present on building materials may have migrated. It is also conservatively assumed that current concentrations of constituents in environmental media are representative of future conditions. For consistency in data quality, soil samples collected during the early 1990s will be excluded from the dataset. However, because the Phase I and II sampling plans were based on the results of earlier investigations, the use of only the most recent data should provide sufficient characterization of site conditions.

For the purposes of the HHRAs, soil samples collected from 2 feet bgs or less will be evaluated as surface soil samples and soil samples collected from 0 to 10 feet bgs will be evaluated as subsurface soil samples. Sampling depths (if any) that overlap the 2-foot-bgs interval will be evaluated as surface or subsurface soil on a case-by-case basis using best professional judgment, which will be documented in the risk assessment reports. Although subsurface soil is defined as discussed above, constituent concentrations in soil samples collected from 2 to 10 feet bgs will be compared to concentrations in surface soil as part of the uncertainty discussion. A limited number of samples were collected beneath pavement at the Carus Plant, which generally precludes access by current receptors. However, for the purposes of the HHRAs, samples collected from beneath the pavement will be evaluated under the current and future exposure scenarios.

EPA's Field Environmental Decision Support (FIELDS) group collected soil samples from the Off-Site Residential Area and the on-site exposure areas at OU2. These samples were analyzed using x-ray fluorescence (XRF) technology. A percentage of these samples also were analyzed at an off-site laboratory. The laboratory results will be used to correct or adjust the XRF results based on statistical correlations between the XRF and laboratory results. The corrected XRF data will be included in the soil dataset. EPA's FIELDS group also plans to collect soil samples from the Off-Site Mixed-Use Area in Spring and Summer 2009. These samples will be analyzed similarly. Analytical results from the soil samples collected and analyzed by EPA's FIELDS group also will be considered in evaluating current (unremediated) conditions at OU2 exposure areas.

2.2.1.2 Groundwater

Historical groundwater data are available. However, it cannot be determined if these data are representative of current or potential future conditions. Geosyntec has made several attempts to collect groundwater samples at OU1, but even after heavy precipitation events, not all groundwater wells have been productive, particularly at the Slag Pile. Groundwater samples have been collected throughout OU2 during Phases I and II of the comprehensive RI. Most of the OU2 wells have been productive, some to a lesser degree than others.

Where groundwater is not present, potential groundwater exposure will be considered an incomplete exposure pathway. If necessary, documentation for groundwater exclusion at any on-site OU1 or OU2 exposure area will be presented in the applicable HHRA report.

For the purposes of the HHRAs, shallow groundwater is defined as groundwater present at less than 10 feet bgs. Construction and utility worker exposure to groundwater through incidental ingestion and dermal contact is limited to shallow groundwater. This pathway will be considered incomplete if shallow groundwater is not present at a given exposure area. For the other potentially complete exposure pathways for groundwater (inhalation of vapors and hypothetical potable use), all available groundwater data will be considered regardless of depth. If VOCs are not present in groundwater at a given exposure area, the inhalation of vapors will be considered incomplete and excluded from evaluation in the HHRAs.

2.2.1.3 Sediment

Because of the limited quantity of sediment data, all available sediment data will be evaluated in the LVR HHRA (as part of OU1). Additional sediment data will be collected during the LVR ecological characterization and incorporated into the LVR SLERA and BERA. With regard to surface water features at OU2, all sediment data (and soil data collected in areas of standing surface water) collected as part of Phases I and II of the comprehensive RI will be considered in the HHRA.

2.2.1.4 Surface Water

Geosyntec recognizes that surface water conditions in the LVR are likely to vary temporally. Therefore, using only the most recent surface water data to characterize human health risks may not be appropriate. Before the OU1 HHRAs are conducted, surface water data collected from multiple data collection events will be qualitatively and quantitatively evaluated to identify potential sources of variability and to identify a dataset representative of current and future exposure conditions. The basis for the dataset used in the OU1 HHRAs will be documented in the risk assessment reports. With regard to surface water features at

OU2, all surface water data collected as part of Phases I and II of the comprehensive RI will be considered in the HHRA.

2.2.2 Data Validation

Data will be evaluated based on completeness, holding times, initial and continuing calibrations, surrogate recoveries, internal standards, compound identification, laboratory and field quality control (QC) procedures and results, reporting limits, documentation practices, and application of validation qualifiers (EPA 1992). Rejected (R-qualified) data will not be included in screening and risk estimation. Censored values (U- or UJ-qualified values) will be assigned the reported method detection limit (MDL). Statistical evaluations of non-detect results will be handled in accordance with EPA guidelines (for example, using ProUCL [EPA 2007a]). Uncertainties associated with the inclusion or exclusion of data based on the assigned data qualifiers will be discussed in the uncertainty sections of the risk assessment reports.

2.2.3 Constituents Excluded from Quantitative Evaluation

In accordance with EPA Superfund guidance, calcium, magnesium, potassium, and sodium are classified as essential nutrients and therefore will be eliminated from further quantitative evaluation (EPA 1989). However, values for these analytes will be qualitatively compared to U.S. Department of Agriculture (USDA) recommended daily allowance (RDA) values to ensure that they are not present at levels that could result in adverse effects as a result of exposure in environmental media. Analytical data results that are not chemical-specific (for example, total organic carbon and pH) also will be excluded from quantitative evaluation in the HHRAs.

2.2.4 Approach to Duplicate Sample Data

During the RI, field duplicate samples were collected at several of the sampling locations to be evaluated in the HHRAs. Before data analysis is conducted, duplicate sample results will be treated as summarized below.

- If a constituent was detected in both samples and the relative percent difference (RPD) between the results is less than 25 percent, the average concentration will be used.
- If a constituent is detected in both samples and the RPD between the results is more than 25 percent, the maximum concentration will be used.
- If a constituent is detected in one sample but not the other, the detected concentration will be used.
- If a constituent is not detected in either sample, the average MDL will be used.

2.2.5 Screening Process Overview

Consistent with EPA's approach for selecting chemical constituents for quantitative evaluation, maximum detected concentrations of constituents will be compared to conservative screening levels to assess the potential for adverse impacts to human health and to identify COPCs. This section discusses the proposed screening process, including screening levels, background screening, evaluation of carcinogenic polynuclear aromatic hydrocarbons (PAH), evaluation of infrequently detected constituents, and evaluation of non-detected constituents.

2.2.5.1 Screening Levels

If the maximum detected constituent concentration is less than its conservative screening criterion, the constituent will be eliminated as a COPC because the constituent will not contribute significantly to overall risk (EPA 1993). Exceedances of screening levels do not in themselves indicate that an unacceptable risk exists. Rather, the exceedance of a screening level indicates the need for further evaluation in the risk assessment. Screening levels for environmental media at the M&H Site are summarized below.

- ***Soil:*** EPA regional screening levels (RSL) for residential soil (EPA 2008b) will be used as the primary screening criteria to identify COPCs in surface soil (at less than 2 feet bgs) and subsurface soil (at 0 to 10 feet bgs) at OU1 and OU2. The RSLs are based on an excess cancer risk of 1.0×10^{-6} and a hazard quotient of 1.0 for non-cancer effects. For constituents without RSLs, IEPA's Tiered Approach to Corrective Action Objectives (TACO) Tier 1 residential soil remediation objectives will be used as secondary screening criteria (IPCB 2007). The IEPA's non-TACO objectives will be used as secondary screening criteria when TACO values are not available.

- ***Sediment:*** Sediment screening values for the protection of human health are generally not available. Therefore, EPA RSLs for residential soil will be used as the primary screening criteria to identify COPCs in sediment. IEPA's TACO and non-TACO objectives will be used as secondary screening criteria for sediment as described above for soil.

- ***Surface Water:*** Total and dissolved surface water data will be screened against the Illinois Water Quality Standards (IWQS) appropriate for the designated use of the LVR. If IWQS values are not available for a given chemical, surface water results will be screened against National Water Quality Standards (NWQS) (EPA 2009c) if available or tapwater RSLs (EPA 2008b) if NWQS values are not available.

- ***Groundwater:*** Maximum detected total and dissolved groundwater data (if present) will be compared to the most stringent of the following levels:

  - Federal maximum contaminant levels (MCL)

  - RSLs for tapwater

- Illinois Class I Groundwater Standards
- TACO Tier 1 groundwater remediation objectives and "Chemicals-Not-In-TACO-Class I Objectives"

Primary screening criteria may not be available for a limited number of constituents detected at the M&H Site. For these chemicals, surrogate screening values will be selected and documented based on structural similarities, potential toxicity, and health endpoints. If individual screening values are not available for Aroclors and certain groups of related pesticides listed in IEPA's letter dated April 10, 2009, screening will be conducted as specified in the letter (IEPA 2009). Polychlorinated biphenyls (PCB) and pesticides are not considered site-related constituents and are not expected to be detected on site.

2.2.5.2 Background Screening

After the comparison of maximum detected concentrations to the applicable screening levels, secondary screening of detected constituents will be performed using regional background concentrations when available. Screening against background concentrations ensures that constituents that may naturally occur at levels above the regulatory screening levels are not included as COPCs in the risk assessments. Regional background soil concentrations are documented in "Concentrations of Inorganic Chemicals in Background Soils – Counties Outside Metropolitan Statistical Areas (IPCB 2007) and "Average Concentrations of Elements in La Salle County, Illinois" (USGS 2007). The U.S. Geological Survey (USGS) source may also be used to provide regional background sediment concentrations. Background sediment concentrations will include background values obtained from the IEPA Bureau of Water's documents titled "Classification for Illinois Inland Lakes" and "Evaluation of Illinois Sieved Stream Sediment." Results relative to site-specific soil and sediment background levels will be discussed in the uncertainty sections of the risk assessments to provide information for risk management decisions. Site-specific soil background concentrations have not yet been identified for the M&H Site.

2.2.5.3 Evaluation of Carcinogenic PAHs

EPA has identified the carcinogenic PAHs benzo(a)pyrene and dibenzo(a,h)anthracene as potential mutagens. However, other less potent carcinogenic PAHs are not mutagens. In order to apply the age-dependent adjustment factors (ADAF) to account for mutagenic potential, these chemicals must be assessed independently. Therefore, rather than use the previously promulgated toxic equivalency approach to assessing carcinogenic PAHs, the HHRAs will assess each chemical independently at the screening level and in the risk calculation. However, the screening and toxicity levels in the RSL tables continue to be based on the sentinel chemical benzo(a)pyrene and toxic potency factors.

2.2.5.4 Evaluation of Infrequently Detected Constituents

The detection frequency, toxicity, and history of detected constituent concentrations also will be considered in the identification of COPCs. If a constituent is detected in less than 5 percent of the samples, the sample size is sufficiently large (greater than 30), and the maximum concentration is less than 10 times the screening level, the chemical will be eliminated as a COPC. Regardless of detection frequency, constituents classified as "known human carcinogens" (EPA Class A carcinogens) will be retained as COPCs.

2.2.5.5 Evaluation of Non-Detected Constituents

To ensure that elevated reporting limits do not result in the inappropriate exclusion of chemicals from further evaluation, one-half of the maximum MDL of a constituent not detected in a given medium will be compared to the appropriate screening level. Exceedances will be addressed on a case-by-case basis either qualitatively or quantitatively.

2.3 EXPOSURE ASSESSMENT

The RAGS Part D 4 Series tables list the exposure factors that will be used for OU1 (Attachment 1) and OU2 (Attachment 2) to estimate risks under both a reasonable maximum exposure (RME) scenario and an average or central tendency exposure (CTE) scenario to provide a range of risk estimates for use by risk managers. The RME is estimated by selecting values for exposure variables so that the combination of all variables results in the maximum exposure that can reasonably be expected to occur at a site. The CTE is estimated by selecting values so that the combination results in the typical (average) exposure that could occur at a site (EPA 1993). The tables list references used to select the exposure assumptions. As the tables show, exposure assumptions are based on a combination of standard default values from EPA guidance documents and best professional judgment considering site-specific information. The following sections present the rationales for the selection of exposure assumptions.

2.3.1 Calculation of Receptor Intakes

Ingested and dermally absorbed doses are presented in risk assessments as daily dose rates per unit of body weight (mg/kg-day). Chronic daily intake (CDI) is the general parameter used to quantify exposure doses for ingestion and dermal contact with site-related constituents. Chronic daily exposure (CDE) is the general parameter used to quantify exposure doses for inhalation of site-related constituents. For the inhalation pathway risk evaluation, receptor exposure concentrations are used in conjunction with concentration-based toxicity factors.

For scenarios involving receptors 0 to 16 years old, age-adjusted ingestion rates and age-adjusted dermal contact rates will be used to estimate exposure. These rates take into account differences in body weights, exposure durations, ingestion rates, skin surface areas, and adherence factors between various age groups. For mutagenic compounds, these rates also take into account the fact that susceptibility to mutagens generally decreases with age. For the inhalation pathway, exposure durations will be adjusted to account for mutagenic potential.

The following subsections present the equations for calculating the intake for each exposure pathway to be evaluated in the risk assessments.

2.3.1.1 Soil

Incidental Ingestion of COPCs in Soil

The CDI received through incidental ingestion of constituents in soil for children 0 to 16 years old (CDI_{0-16}) and adults (CDI_{16+}) will be calculated as follows:

$$CDI_{0-16} = \frac{EPC \times IRS(M)_{adj} \times RBA \ x \ FI \times EF \times CF}{AT}$$

$$CDI_{16+} = \frac{EPC \times IRS \times RBA \ x \ FI \times EF \times ED \times CF}{BW \times AT}$$

where

EPC	=	Exposure point concentration in soil (mg/kg)
IRS	=	Ingestion rate of soil (milligram per day [mg/day]; incorporated into $IRS[M]_{adj}$)
IRS_{adj}	=	Age-adjusted ingestion rate of soil (milligram-year per kilogram-day [mg-year/kg-day])
$IRS(M)_{adj}$	=	Age-adjusted ingestion rate of soil for mutagens (mg-year/kg-day)
RBA	=	Relative bioavailability (unitless; chemical specific)
FI	=	Fraction ingested from contaminated source
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years; incorporated into $IRS[M]_{adj}$)
CF	=	Conversion factor for soils (10^{-6} kilograms per milligram [kg/mg])

BW	=	Body weight (kg; incorporated into $IRS[M]_{adj}$)
AT	=	Averaging time (days)
		AT carcinogens = 70-year life-time × 365 days/year
		AT non-carcinogens = ED (years) × 365 days/year

The bioavailability of metals will be evaluated in accordance with EPA guidance, including "Guidance for Evaluating the Oral Bioavailability of Metals in Soils for Use in Human Health Risk Assessment" (EPA 2007b). EPA guidance recommends a tiered approach beginning with an assumption of 100 percent bioavailability, followed by use of default bioavailability values and continuing with development of site-specific bioavailability factors. As stated by EPA relative bioavailability (RBA) "refers to a comparison of absolute bioavailabilities" (EPA 2007b). At the M&H Site, it is particularly important to understand how the bioavailability of metals is affected (increases or decreases) with a change in the exposure matrix (for example, soil, slag, or sinter). Therefore, for both OU1 and OU2, the following RBA hierarchy will be followed for metals: (1) default RBA of 1.0 for all media (EPA 2007b), (2) default medium-specific RBAs then available (for example, the default medium-specific RBA for soil is 0.60) (EPA 2007b), and (3) site-specific medium-specific RBAs. After employing the first tier, subsequent tiers will be employed only if their use will result in significantly different results than those produced by the preceding tier.

Dermal Contact with COPCs in Soil

The CDI received through dermal contact with constituents in soil for children 0 to 16 years old ($CDI_{0\text{-}16}$) and adults (CDI_{16+}) will be calculated as follows:

$$CDI_{0-16} = \frac{EPC \times DAF \times DFS(M)_{adj} \times EF \times CF}{AT}$$

$$CDI_{16+} = \frac{EPC \times DAF \times SA \times AF \times EF \times ED \times CF}{BW \times AT}$$

where

EPC	=	Exposure point concentration of constituent in soil (mg/kg)
DAF	=	Dermal absorption fraction (unitless; chemical specific)

SA	=	Skin surface area exposed (square centimeter [cm^2]; incorporated into the $DFS[M]_{adj}$)
AF	=	Soil-skin adherence factor (mg/cm^2; incorporated into $DFS[M]_{adj}$)
DFS_{adj}	=	Age-adjusted dermal contact factor for soil (mg-year/kg-day)
$DFS(M)_{adj}$	=	Age-adjusted dermal contact factor for soil for mutagens (mg-year/kg-day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years; incorporated into $DFS[M]_{adj}$)
CF	=	Conversion factor for soils (10^{-6} kg/mg)
BW	=	Body weight (kg; incorporated into the $DFS[M]_{adj}$)
AT	=	Averaging time (days)
		AT carcinogens = 70-year life-time × 365 days/year
		AT non-carcinogens = ED (years) × 365 days/year

When available, dermal absorption fraction (DAF) values will be those reported in the EPA RSL tables (EPA 2008b). Additional DAFs will be the EPA Region 3-recommended values (EPA 1995a) and correspond to a value of 0.03 for volatile compounds and 0.01 for inorganic compounds. If a chemical-specific DAF cannot be identified, a default value of 0.1 will be used.

Inhalation of Volatiles and Airborne Particulates from Soil

Soil EPCs will be converted to air EPCs using the following equation:

$$C_a = \frac{C_s}{PEF + VF}$$

where

C_a	=	Concentration in air (milligrams per cubic meter [mg/m^3])
C_s	=	Concentration in soil (mg/kg)
PEF	=	Particulate emission factor (m^3/kg)
VF	=	Volatilization factor (m^3/kg)

To calculate a site-specific particulate emission factor (PEF) for the M&H Site, default parameters from the EPA 2008 "RSL User's Guide" (EPA 2008b) will be used except for the soil particulate dispersion coefficient (Q/C) term. For OU1, the default Q/C value will be replaced with a Q/C value for a 30-acre site (maximum acreage listed) in Chicago, Illinois, which geographically is the closest city with data available from EPA and therefore is more representative of regional conditions. For OU2, the default Q/C value will be replaced with a Q/C value based on exposure area-specific sized sites in Chicago, Illinois.

Site-specific volatilization factors (VF) will be calculated for volatile chemicals, which are defined as chemicals having a molecular weight less than 200 and a Henry's Law Constant greater than 1×10^{-5}. VFs will be calculated using the chemical- and site-specific parameters presented in the "RSL User's Guide" (EPA 2008b).

The potential exposure concentration for inhalation of particles or volatile constituents released from soil will be calculated using the following equations for non-carcinogens ($CDE_{Non\text{-}Cancer}$) and carcinogens/ mutagens (CDE_{Cancer}) based on consideration of EPA's recently finalized RAGS Part F guidance (EPA 2009a):

$$CDE_{Non-Cancer} = \frac{EPC_a \times EF \times ED \times ET \times CF_t}{AT_{nc}}$$

$$CDE_{Cancer} = \frac{EPC_a \times EF \times ED_{adj} \times ET \times CF_a \times CF_t}{AT_c}$$

where

EPC_a	=	Exposure point concentration in air (mg/m^3)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
ED_{adj}	=	Age-adjusted exposure duration for mutagens (Σ [ED_i*$ADAF_i$])
		ADAF = Age-dependent adjustment factor for mutagens (EPA 2005a)
		Age 0 to 2 years – 10 times
		Age 2 to 6 years – 3 times
		Age 6 to 16 years – 3 times

		Age 16 to 30 years – 1 time
ET	=	Exposure time (hours)
CF_t	=	Conversion factor (1/24 day/hours)
CF_a	=	Conversion factor (1×10^{-3} milligram per microgram [mg/µg])
AT	=	Averaging time (days)
		AT_c = Averaging time for carcinogens (70 years × 365 days/year)
		AT_{nc} = Averaging time for non-carcinogens (ED [years] × 365 days/year)

Homegrown Produce

The CDI received through ingestion of constituents in homegrown produce for children 0 to 16 years old ($Ihp_{0\text{-}16}$) and adults (Ihp_{16+}) will be calculated as recommended in EPA's "Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities"(EPA 2005b) with one exception. The uptake of COPCs from direct deposition onto plant surface will not be considered because EPA's HHRAP evaluates potential impacts from deposition from operational combustion units, and no such units are present at OU1 or OU2. Therefore, CDI will be calculated using the following equations:

$$Ihp_{0-16} = ((\mathrm{Pr} \times Cr_{ag}\ [M]_{adj}) + (\mathrm{Pr}_{bg} \times Cr_{bg}\ [M]_{adj}) \times FP$$

$$Ihp_{16+} = ((\mathrm{Pr} \times Cr_{ag}) + (\mathrm{Pr}_{bg} \times Cr_{bg})) \times FP$$

where

Ihp	=	Daily intake of COPC from homegrown produce (mg/kg-day dry weight [DW])
Pr	=	Aboveground exposed and protected produce concentration due to root uptake (mg/kg)
Pr_{bg}	=	Belowground produce concentration due to root uptake (mg/kg)
Cr_{ag}	=	Consumption rate of aboveground produce (kg DW/kg-day; incorporated into $Cr_{ag}[M]_{adj}$) (calculated as the sum of aboveground protected and unprotected produce)
$(Cr_{ag})_{adj}$	=	Age-adjusted aboveground produce ingestion rate (year * kg DW/kg-day)
$Cr_{ag}(M)_{adj}$	=	Age-adjusted aboveground produce ingestion rate for mutagens (year * kg DW/kg-day)

Cr_{bg}	=	Consumption rate of belowground produce (kg DW/kg-day; incorporated into $Cr_{bg}[M]_{adj}$)
$(Cr_{bg})_{adj}$	=	Age-adjusted belowground produce ingestion rate (year * kg DW/kg-day)
$Cr_{bg}(M)_{adj}$	=	Age-adjusted belowground produce ingestion rate for mutagens (year * kg DW/kg-day)
FP	=	Fraction homegrown produce ingested from contaminated source

$$Pr = EPC_{soil} \times Br_{ag}$$

$$Pr_{bg} = EPC_{soil} \times Br_{rootveg} \times VG_{rootveg}$$

where

EPC_{soil}	=	Soil exposure point concentration (mg/kg)
Br_{ag}	=	Plant-soil bioconcentration factor for aboveground produce ([mg COPC /kg DW plant]/[mg COPC/kg soil]) (from EPA 2005b)
$Br_{rootveg}$	=	Plant-soil bioconcentration factor for belowground produce ([mg COPC /kg DW plant]/[mg COPC/kg soil]) (from EPA 2005b)
$VG_{rootveg}$	=	Empirical correction factor for belowground produce (unitless) (from EPA 2005b)

Therefore, CDI from homegrown produce for children 0 to 16 years old ($CDIhp_{0\text{-}16}$) and adults ($CDIhp_{16+}$) will be calculated as follows:

$$CDIhp_{0-16} = \frac{Ihp(M)_{ADJ} \times EF \; x \; ED}{AT}$$

$$CDIhp_{16+} = \frac{Ihp \times EF \times ED \; x \; ED}{AT}$$

where

CDI_{hp}	=	Chronic daily intake of COPCs from homegrown produce (mg/kg-day)
Ihp	=	Daily intake of COPC from homegrown produce (mg/kg-day DW)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
AT	=	Averaging time (days)

2.3.1.2 Sediment

The dermal and ingestion equations presented in the previous sections for estimating COPC intake from soil also will be used to estimate intake of sediment from the LVR at OU1 and surface water features at OU2. Inhalation of sediment is considered an insignificant exposure pathway. Therefore, it will not be evaluated in the HHRAs.

2.3.1.3 Surface Water

Incidental Ingestion of COPCs in Surface Water

The CDI received through incidental ingestion of constituents in surface water for children 0 to 16 years old ($CDI_{0\text{-}16}$) and adults (CDI_{16+}) will be calculated as follows:

$$CDI_{0-16} = \frac{EPC_{SW} \times IRSW(M)_{adj} \times FI \times EF \times CF_{SW}}{AT}$$

$$CDI_{16+} = \frac{EPC_{SW} \times IRSW \times FI \times EF \times ED \times CF_{SW}}{BW \times AT}$$

where

EPC_{SW}	=	Exposure point concentration in surface water (µg/L)
IRSW	=	Ingestion rate of surface water (µg/L; incorporated into $IRSW[M]_{adj}$)
$IRSW_{adj}$	=	Age-adjusted ingestion rate of surface water (liter-year per kilogram-day [L-year/kg-day])
$IRSW(M)_{adj}$	=	Age-adjusted ingestion rate of surface water for mutagens (L-year/kg-day)
FI	=	Fraction ingested from contaminated source
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years; incorporated into $IRS[M]_{adj}$)
CF_{SW}	=	Conversion factor for surface water (10^{-3} mg/µg)
BW	=	Body weight (kg; incorporated into $IRS[M]_{adj}$)
AT	=	Averaging time (days)
		AT carcinogens = 70-year life-time × 365 days/year

AT non-carcinogens = ED (years) × 365 days/year

Dermal Contact with COPCs in Surface Water

The CDI received through dermal contact with constituents in surface water for children 0 to 16 years old ($CDI_{0\text{-}16}$) and adults (CDI_{16+}) will be calculated somewhat differently for inorganic and organic constituents. The equations used to calculate CDIs for inorganic constituents are presented first, followed by the equations used to calculate CDIs for organic constituents:

$$CDI_{0-16} = \frac{EPC_{SW} \times K_P \times DFSW(M)_{adj} \times EF \times EV \; x \; ET \times CF_{SW} \times CF_V}{AT}$$

$$CDI_{16+} = \frac{EPC_{SW} \times K_P \times SA_{SW} \times EF \times EV \; x \; ED \times ET \times CF_{SW} \times CF_V}{BW \times AT}$$

where

EPC_{SW}	=	Exposure point concentration of constituent in surface water (µg/L)
K_p	=	Dermal permeability constant (centimeter per hour [cm/hour])
SA_{SW}	=	Skin surface area exposed to surface water (cm^2; incorporated into $DFS[M]_{adj}$)
$DFSW_{adj}$	=	Age-adjusted dermal contact factor for surface water (square centimeter-year per kilogram [cm^2-year/kg])
$DFSW(M)_{adj}$	=	Age-adjusted dermal contact factor for mutagens (cm^2-year/kg)
EF	=	Exposure frequency (days/year)
EV	=	Event frequency (event/day)
ED	=	Exposure duration (years; incorporated into $DFS[M]_{adj}$)
ET	=	Exposure time (hours/day)
CF_{SW}	=	Conversion factor for surface water (10^{-3} mg/µg)
CF_V	=	Conversion factor for surface water volume (10^{-3} liter per cubic centimeter [L/cm^3])
BW	=	Body weight (kg; incorporated into $DFS[M]_{adj}$)
AT	=	Averaging time (days) AT carcinogens = 70-year life-time × 365 days/year AT non-carcinogens = ED (years) × 365 days/year

When available, dermal permeability constant (K_p) values expressed in units of cm/hour will be taken directly from the EPA RSL tables (EPA 2008b), which cite EPA's DERMWIN program and RAGS Part E (EPA 2004b). Dermal contact with groundwater or surface water is not anticipated to be a significant exposure pathway at OU1. However, if necessary, the primary literature will be reviewed to supplement K_p values.

The CDI received from dermal contact with constituents in surface water for children 0 to 16 years old ($CDI_{0\text{-}16}$) and adults (CDI_{16+})will be calculated as follows for organic constituents:

$$CDI_{0-16} = \frac{DAevent \times DFSW(M)_{adj} \times EV \ x \ EF}{AT}$$

$$CDI_{16+} = \frac{DAevent \times SA_{SW} \times EV \ x \ EF \ x \ ED}{BW \times AT}$$

where

DAevent	=	Absorbed dose per event (milligram per square centimeter [mg/cm^2]-event)
SA_{SW}	=	Skin surface area exposed to surface water (cm^2; incorporated into $DFS[M]_{adj}$)
$DFSW_{adj}$	=	Age-adjusted dermal contact factor for surface water (cm^2-year/kg)
$DFSW(M)_{adj}$	=	Age-adjusted dermal contact factor for mutagens (cm^2-year/kg)
EV	=	Event frequency (event/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years; incorporated into $DFS[M]_{adj}$)
BW	=	Body weight (kg; incorporated into $DFS[M]_{adj}$)
AT	=	Averaging time (days)
		AT carcinogens = 70-year life-time × 365 days/year
		AT non-carcinogens = ED (years) × 365 days/year

where

If tevent ≤ t*, then:

DAevent = 2 x FA x K_p x EPC_{SW} x CF_V x CF_{SW} ([6 x Taoevent x ET]/pi)^0.5

If tevent > t*, then:

$$DAevent = FA \times K_p \times EPC_{SW} \times CF_V \times CF_{SW} \times ((ET/[1 + B]) + 2 \times taoevent\ [(1 + 3B + 3B^2]/[1 + B]^2)$$

where

FA	=	Fraction absorbed water (dimensionless)
K_p	=	Dermal permeability constant (cm/hour)
EPC_{SW}	=	Exposure point concentration of constituent in surface water (µg/L)
CF_{SW}	=	Conversion factor for surface water (10^{-3} mg/ug)
CF_V	=	Conversion factor for surface water volume (10^{-3} L/cm^3)

Groundwater

As described in Sections 2.1.1.2 and 2.1.2.2, groundwater is not used at OU1 and OU2 for any purposes. Therefore, consumption of groundwater is an incomplete exposure pathway for current receptors at OU1 and OU2. According to Ordinance 1755, construction of any new private water system (for potable or other use) is prohibited at the M&H Site. Therefore, consumption of groundwater (as potable water) is likely to be an incomplete exposure pathway for future on-site receptors. In addition, several wells at OU1 have not been productive.

Notwithstanding these prohibitions on groundwater use, potentially complete exposure pathways exist for shallow groundwater (less than 10 feet bgs) for current (OU1 only) and future utility workers and future construction workers. These receptors could be exposed through incidental ingestion and dermal contact while conducting intrusive activities at the Carus Plant and Slag Pile and throughout the OU2 on-site exposure areas. Vapors from shallow groundwater and groundwater at depth (10 feet bgs or deeper) could migrate to indoor or ambient (for example, trench) air, where utility and construction workers (trench air only) and commercial/industrial workers could be exposed to VOCs in groundwater.

Based on the land use and previously discussed prohibitions on groundwater use, no other current or reasonably anticipated future groundwater exposure scenarios represent complete exposure pathways. However, as requested by EPA and as a point of departure for making risk management decisions, groundwater also was evaluated as a potable water source at the M&H Site. These scenarios are hypothetical and inconsistent with future land use and groundwater use plans for the M&H Site. Hypothetical exposure pathways for groundwater (regardless of depth) at the M&H Site include exposure of (1) future residents to groundwater through ingestion, dermal contact, inhalation of vapors in ambient

air, inhalation of vapors in indoor air, and inhalation of vapors during household use of groundwater, and (2) future commercial/industrial workers to groundwater through ingestion.

The ingestion and dermal equations presented in the sections above for estimating COPC intake from surface water also will be used to estimate intake of groundwater for these exposure routes. COPC concentrations in indoor air (through subsurface vapor transport) will be estimated using EPA's Johnson and Ettinger (1991) model (EPA 2004a). COPC concentrations in air within a construction trench or excavation will be estimated using the methodology developed by the Virginia Department of Environmental Quality (VDEQ) (VDEQ 2008). Inhalation equations similar to those presented in the previous sections for estimating COPC intake from inhalation of vapors and particulates from soil will be used to estimate the intake of vapors from groundwater. When shallow groundwater (less than 10 feet bgs) is not present, the utility and construction worker incidental ingestion and dermal contact pathways will not be evaluated. In addition, if VOCs are not present in groundwater, the inhalation of vapors will be considered an incomplete exposure pathway and excluded from evaluation in the HHRAs.

2.3.2 Exposure Point Concentrations

For RME and CTE, EPCs will be calculated as the 95 percent upper confidence limit (UCL) on the mean using EPA's ProUCL Version 4.00.00 statistical software package (EPA 2007a)[1]. The EPC will be the 95 percent UCL of the statistical method recommended by ProUCL. Statistical treatment will not be conducted for constituents with less than eight samples or less than 30 percent detections in a given dataset. Under these circumstances, the maximum detected concentration will be used as the EPC.

2.3.3 Modeling

Modeling will be used to generate medium-specific EPCs for media not sampled directly. Specifically, modeling will be used to estimate EPCs for blood lead, trench air, indoor air, and homegrown produce as discussed below.

2.3.3.1 Blood Lead

EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model and the Adult Lead Model (ALM) will be used to estimate blood-lead concentrations associated with exposure to lead at OU1 and OU2 for residents and non-residents, respectively (EPA 2009b).

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[1] Although ProUCL 4.00.02 has been publically released, an error for calculating H-UCL statistics was recently identified by Geosyntec. Therefore, the older version will be used.

2.3.3.2 Trench Air

The concentration of VOCs in air within a construction or utility trench will be estimated using a methodology developed by the VDEQ as part of its "Voluntary Remediation Program Risk Assessment Guidance" (VDEQ 2008). The methodology assumes a default trench 3 feet wide, 8 feet long, and 8 feet deep. Also, the methodology's algorithms can be modified depending on the depth to groundwater (greater than or less than 15 feet bgs). Because of the limited size of the assumed construction and utility trench and because VOCs may not be consistently present in groundwater throughout OU1 or OU2, for the purpose of modeling the VOC concentrations in trench air, the maximum VOC concentrations measured in groundwater for each OU-specific exposure area will be used.

2.3.3.3 Indoor Air

The migration of VOCs from underlying groundwater and soil into indoor air (subsurface vapor transport) will be evaluated consistent with EPA guidance, including "Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)" (EPA 2002a) and "User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings" (EPA 2004a). EPA's Johnson and Ettinger model (Version 3.1) also will be used. As described in Section 2.1.1.3, the primary COPCs at OU1 are non-volatile. Therefore, exposure to indoor air is not expected to be a significant pathway for receptors at OU1. However, the HHRAs will evaluate the potential risk associated with volatilization to indoor air. If VOCs are not detected in a given medium for OU1 and OU2, exposure to vapors in indoor air will be considered incomplete. Similarly, exposure to vapors in outdoor air also will be eliminated from evaluation in the HHRA if VOCs are not detected.

2.3.3.4 Homegrown Produce

The uptake of COPCs from soil into produce grown will be evaluated at OU1 and OU2 using COPC-specific uptake factors. Uptake into above- and belowground produce will be evaluated separately. To the extent possible, COPC-specific uptake factors will be calculated based on laboratory bioavailability tests of site soils and collection of site vegetation samples from areas with known soil contaminant levels. When site-specific COPC uptake factors cannot be calculated, the necessary uptake factors will be obtained from or calculated consistent with EPA's HHRAP (EPA 2005b).

2.3.4 Exposure Assumptions

Receptor-specific exposure assumptions are presented in the OU1- and OU2-specific RAGS Part D Series 4 tables presented in Attachments 1 and 2, respectively. The following sections summarize the bases for

the assumptions. Unless otherwise noted, the exposure assumptions presented below apply to both OU1 and OU2.

2.3.4.1 Current and Future Commercial/Industrial Worker Exposure Factors

The commercial/industrial worker receptor exposure scenarios include potential current exposure to site-related constituents in surface soil at the Carus Plant and potential future exposure to site-related constituents in surface soil and subsurface soil at the Carus Plant and Slag Pile at OU1 and the on-site exposure areas at OU2. The parameters used to estimate potential exposure are presented in Tables 4.1a.RME and 4.1a.CTE of Attachment 1 for OU1 and Tables 4.1a.RME and 4.1a.CTE of Attachment 2 for OU2 and are summarized below.

- The RME ingestion rate of soil (IRS) of 100 mg/kg is the EPA (2002a) default rate for an adult in an outdoor occupational exposure setting. The CTE IRS of 50 mg/day represents the EPA (2002b) recommended value for indoor workers.

- It was conservatively assumed that a commercial/industrial worker would receive all of his or her daily incidentally ingested soil and groundwater (OU2) from the site (fractional intake [FI] = 1).

- The RME soil-to-skin adherence factor (AF) of 0.2 mg/cm^2 is the EPA (2002b) default value for outdoor workers. The CTE AF of 0.02 mg/cm^2 is the EPA (2004b) CTE value for industrial workers.

- The skin surface area (SA) of 3,300 cm^2 is the EPA (2002b) default value for outdoor workers. The default SA assumes that a worker wears pants and a short-sleeved shirt while engaging in on-site activities and is calculated as the 50th percentile surface area occupied by one-third of the head, the forearms, and the hands for the average male and female.

- The RME and CTE exposure frequencies (EF) of 250 and 219 days per year, respectively, are the EPA default RME (EPA 1991) and CTE (EPA 1997b) values for commercial/industrial workers.

- The RME and CTE exposure durations (ED) of 25 and 9 years, respectively, are the EPA default RME (EPA 1991) and CTE (EPA 1997b) values for commercial/industrial workers.

- The exposure time (ET) for the RME and CTE scenarios was assumed to be 8 hours per day, or 40 hours per week over a period of 5 days.

- The commercial/industrial worker body weight (BW) of 70 kg is the EPA (1991) default value for adults.

- Consistent with EPA (1989) guidance, the averaging time for non-carcinogens (AT_{nc}) is equal to the ED and corresponds to a value of 9,125 days for the RME and 3,285 days for the CTE cases. The averaging time for carcinogens (AT_c) for both the RME and CTE scenarios represents an average 70-year lifetime and corresponds to 25,550 days.

For on-site exposure areas where groundwater is present, future commercial/industrial worker exposure through ingestion will be evaluated under the hypothetical assumption that under future land-use conditions, groundwater may be used as a potable water source. Also, volatile chemicals present in groundwater may migrate through the vadose zone and into buildings and the ambient atmosphere. Therefore, potential exposure through inhalation of volatile constituents in indoor and outdoor air also will be evaluated. The EF, ED, ET, BW, and AT parameters will be the same as those used to estimate potential exposure to soil constituents. The groundwater-specific exposure parameters are presented in Tables 4.1b.RME and 4.1b.CTE of Attachment 1 for OU1 and Tables 4.1b.RME and 4.1b.CTE of Attachment 2 for OU2 and are summarized below.

- The RME and CTE groundwater ingestion rate (IRGW) of 1 liter is the EPA (1991) default rate for a commercial/industrial worker. This value assumes that the worker ingests half of his or her daily intake (1 out of 2 liters) at work.

2.3.4.2 Current and Future Site-Specific Worker Exposure Factors

The site-specific worker receptor exposure scenarios include potential current and future exposure to site-related constituents in surface soil and subsurface soil at the Slag Pile (OU1) for an adult worker infrequently present on site. Except for the EF, the parameters used to estimate potential exposure are identical to those for the OU1 default commercial/industrial worker described above. For the RME case, the site-specific worker was assumed to be on site for 1 week every month (60 days per year). For the CTE case, the site-specific worker was assumed to be on-site for 1 week on a quarterly basis, (20 days per year). Tables 4.2.RME and 4.2.CTE of Attachment 1 present the exposure parameters for the site-specific worker. The site-specific worker will not be evaluated for OU2.

2.3.4.3 Current and Future Utility Worker Exposure Factors

The on-site utility worker receptor exposure scenarios include potential current and future exposure to surface soil and subsurface soil at the Carus Plant and Slag Pile at OU1 and future exposure to surface and subsurface soil at the on-site exposure areas at OU2. The off-site utility worker exposure scenarios include potential current and future exposure to soil at the Off-Site Residential Area (OU2). The parameters used to estimate potential exposure to soil are presented Tables 4.3a.RME and 4.3a.CTE of Attachment 1 for OU1 and Tables 4.2a.RME and 4.2a.CTE of Attachment 2 for OU2 and are summarized below.

- The RME IRS of 330 mg/day is the EPA (2002b) default value for a construction worker. The CTE IRS of 100 mg/day is the EPA (2002b) default value for an adult in an outdoor occupational setting.

- It was conservatively assumed that a utility worker would receive all of his or her daily incidentally ingested soil from the site (FI = 1).

- The RME AF of 0.3 mg/cm^2 is the EPA (2004b) default value for construction workers. The CTE AF of 0.1 mg/cm^2 is the EPA (2004b) mean weighted soil adherence factor for construction workers.

- The RME and CTE SA for contact with soil of 3,300 cm^2 is the EPA (2002b) default value for outdoor workers. The default SA assumes that a worker wears pants and a short-sleeved shirt while engaging in on-site activities and is calculated as the 50th percentile surface area occupied by one-third of the head, the forearms, and the hands for the average male and female.

- For a utility worker, exposure is expected to occur infrequently (less than once a month). RME and CTE EFs of 20 and 10 days were conservatively assumed based on best professional judgment.

- The RME and CTE EDs of 25 and 9 years, respectively, are the EPA default RME (EPA 1991) and CTE (EPA 1997b) values for commercial/industrial workers.

- The RME and CTE ET of 4 hours per day is based on the VDEQ model for trench work (VDEQ 2008).

- The utility worker BW of 70 kg is the EPA (1991) default value for adults.

- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the ED and corresponds to a value of 9,125 days for the RME and 2,409 days for CTE cases. The AT_c for both the RME and CTE scenarios represents an average 70-year lifetime and corresponds to 25,550 days.

If shallow groundwater (less than 10 feet bgs) is identified (the limit of subsurface infrastructure), utility worker exposure to groundwater while working in a trench will be evaluated. For non-volatile constituents, exposure primarily occurs through incidental ingestion and dermal contact. For volatile constituents, exposure primarily occurs through inhalation of vapors. Because of the limited extent of groundwater at OU1 and the non-volatile nature of the primary COPCs (metals), inhalation of groundwater vapors is not anticipated to be a significant exposure pathway. Therefore, inhalation risks likely will be evaluated qualitatively. If VOCs are detected at OU1, the methodology described below for OU2 will also be applied at OU1. On the other hand, volatile constituents have been detected in groundwater at OU2. Therefore, inhalation exposures will be evaluated quantitatively for OU2. Vapor concentrations in air inside a trench or excavation will be estimated using the trench model developed by VDEQ (2008) as discussed in Section 2.3.3.2. Risks resulting from incidental ingestion or dermal contact will be evaluated quantitatively for both OU1 and OU2. The EF, ED, ET, BW, and AT parameters are

the same as those used to estimate potential exposure to soil. The groundwater-specific exposure parameters are presented in Tables 4.3b.RME and 4.3b.CTE of Attachment 1 for OU1 and Tables 4.2b.RME and 4.2b.CTE of Attachment 2 for OU2 and are summarized below.

- For the RME incidental IRGW, it was assumed that a utility worker would ingest 0.05 liter per day (L/day) on one-fourth of the total days or on average, 0.0125 L/day. For the CTE incidental IRGW, it was assumed that a utility worker would ingest 0.03 L/day (about 1 ounce) of groundwater on one-fourth of the total days or on average, 0.0075 L/day.

- It was conservatively assumed that a utility worker would receive all of his or her daily incidentally ingested groundwater from the site (FI = 1).

- The RME and CTE SA for contact with groundwater of 2,129 cm^2 is the surface area occupied by the hands and feet of the average adult male and female (EPA 2004b).

2.3.4.4 Current and Future Construction Worker Exposure Factors

The future construction worker exposure scenarios include potential exposure to surface soil, subsurface soil, and groundwater at the Carus Plant and Slag Pile at OU1 and on-site exposure areas at OU2. The current off-site construction worker receptor was developed to represent potential exposure to surface soil at the Off-Site Residential Area at OU2. The parameters used to estimate potential exposure to chemicals in soil are presented in Tables 4.4a.RME and 4.4a.CTE of Attachment 1 for OU1 and Tables 4.3a.RME and 4.3a.CTE of Attachment 2 for OU2 and are summarized below.

- The RME IRS of 300 mg/day is the EPA (2002b) default value for a construction worker. The CTE IRS of 100 mg/day is the EPA (2002b) default value for an adult in an outdoor occupational setting.

- It was conservatively assumed that construction worker would receive all of his or her daily incidentally ingested soil from the site (FI = 1).

- The RME AF of 0.3 mg/cm^2 is the EPA (2004b) default value for construction workers. The CTE AF of 0.1 mg/cm^2 is the EPA (2004b) mean weighted soil adherence factor for construction workers.

- The RME and CTE SA for contact with soil of 3,300 cm^2 is the EPA (2002b) default value for outdoor workers. The default SA assumes that a worker wears pants and a short-sleeved shirt while engaging in on-site activities and is calculated as the 50th percentile surface area occupied by one-third of the head, the forearms, and the hands for the average male and female.

- Construction workers are assumed to be involved in short-duration redevelopment projects. For the RME case, construction workers were assumed to be present on-site for 5 days a week during the course of a 13-week redevelopment project, which corresponds to an RME EF of 65 days per year. The CTE EF of 30 days per year is the IPCB-recommended ED for construction projects (IPCB 2007).

- The RME and CTE ED of 1 year is the EPA (2002b) default value for construction workers.
- The ET for the RME and CTE soil exposure scenarios was assumed to be 8 hours per day, 40 hours per week over a period of 5 days.
- The construction worker BW of 70 kg is the EPA (1991) default value for adults.
- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the ED and corresponds to a value of 9,125 days for the RME and 2,409 days for CTE cases. The AT_c for both the RME and CTE scenarios represents an average 70-year lifetime and corresponds to 25,550 days.

If shallow groundwater (less than 10 feet bgs) is identified (the limit of subsurface infrastructure), utility worker exposure to groundwater while working in a trench will be evaluated. For non-volatile constituents, exposure primarily occurs through incidental ingestion and dermal contact. For volatile constituents, exposure primarily occurs through inhalation of vapors. Because of the limited extent of groundwater at OU1 and the non-volatile nature of the primary COPCs (metals), inhalation of groundwater vapors is not anticipated to be a significant exposure pathway. Therefore, inhalation risks likely will be evaluated qualitatively. If VOCs are detected at OU1, the methodology described below for OU2 will also be applied at OU1. As described above for utility workers, inhalation risks from groundwater vapors will be evaluated quantitatively at OU2. Risks resulting from incidental ingestion or dermal contact will be evaluated quantitatively for both OU1 and OU2. The EF, ED, ET, BW, and AT parameters are the same as those used to estimate potential exposure to soil. The groundwater-specific exposure parameters are presented in Tables 4.4b.RME and 4.4b.CTE of Attachment 1 for OU1 and Tables 4.3b.RME and 4.3b.CTE of Attachment 2 for OU2 and are summarized below.

- For the RME incidental IRGW, it was assumed that a construction worker would ingest 0.05 liter per day (L/day) on one-fourth of the total days or on average, 0.0125 L/day. For the CTE incidental IRGW, it was assumed that a construction worker would ingest 0.03 L/day (about 1 ounce) of groundwater on one-fourth of the total days or on average, 0.0075 L/day.
- It was conservatively assumed that a construction worker would receive all of his or her daily incidentally ingested groundwater from the site (FI = 1).
- The RME and CTE SA for contact with groundwater of 2,129 cm^2 is the surface area occupied by the hands and feet of the average adult male and female (EPA 2004b).

2.3.4.5 Current and Future Trespasser Exposure Factors

Evidence of trespassers has been observed at the Slag Pile, so the trespasser receptor applies to OU1. Assuming that the Slag Pile is not redeveloped for commercial/industrial or recreational purposes, current trespasser exposure scenarios are considered representative of future exposure scenarios. If site redevelopment occurs, trespassers are not expected to be present. Instead, more sensitive receptors, such as workers or recreationalists, are assumed. Therefore, the current and future trespasser exposure scenario includes potential exposure to surface soil at the Slag Pile at OU1.

Evidence of trespassers also has been observed at several of the on-site exposure areas at OU2, including observations of trespassers walking through the site, holes cut in the perimeter fence, tire tracks (likely from all-terrain vehicles), and a deer stand. It was conservatively assumed that trespassing may take place at all on-site OU2 exposure areas.

As noted above for OU1, in the future, it is assumed that each on-site exposure area will be redeveloped and that trespassing will not occur. If trespassing occurs in the future (for example, at a future industrial/commercial operation), the assumed future receptors will conservatively represent (be protective of) future trespassers. For OU2, trespassers also could be exposed to sediment and surface water. For OU1, potential exposure to sediment and surface water in the LVR is addressed for the shoreline fisherman receptor (see Section 2.3.4.8). As discussed below, two populations of current and future trespassers were evaluated: adolescents (6 to 16 years old) and adults (older than 16 years old).

Age-Adjusted Adolescent Trespasser Exposure Factors

As discussed in Section 2.2.5.3, for scenarios involving receptors 0 to 16 years old, age-adjusted values are used to estimate exposure. The age-adjusted adolescent trespasser soil exposure factors are presented in Tables 4.5.RME and 4.5.CTE of Attachment 1 for OU1 and Tables 4.4a.RME and 4.4a.CTE of Attachment 2 for OU2 and are summarized below.

- The RME age-adjusted ingestion rate of soil (IRS_{adj}) of 14.3 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRS_{adj} = \frac{ED_{6-16}(10\,years) \times IRS_{adult}(100mg/day)}{BW_{adult}(70kg)}$$

  The CTE IRS_{adj} of 7.1 mg-year/kg-day was calculated using above equation and, based on best professional judgment, an IRS of 50 mg/day (one-half of the RME IRS).

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects. The RME mutagenic IRS_{adj} ($IRS[M]_{adj}$) of 42.9 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRS(M)_{adj} = \frac{ED_{6-16}(10\,years) \times IRS_{adult}(100mg/day) \times 3}{BW_{adult}(70kg)}$$

  The CTE $IRS(M)_{adj}$ of 21.4 mg-year/kg-day was calculated using above equation and, based on best professional judgment, an IRS of 50 mg/day (one-half of the RME IRS).

- For adolescent trespassers, the RME and CTE FI term of 0.125 was selected based on best professional judgment. The FI term assumes that a trespasser has 16 total hours of activity time per day and will spend 2 of these hours on site.

- The RME age-adjusted dermal contact rate (DFS_{adj}) of 57 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$DFS_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{adult}(5{,}700cm^2) \times AF_{adult}(0.07mg/cm^2)}{BW_{adult}(70kg)}$$

  The CTE DFS_{adj} of 8.1 mg-year/kg-day was calculated using the above equation, but an AF of 0.01 mg/cm^2, which is the EPA (2004b) central tendency value for adult residents, was used.

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects. The RME mutagenic DFS_{adj} ($DFS[M]_{adj}$) of 171 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$DFS(M)_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{adult}(5{,}700cm^2) \times AF_{adult}(0.07mg/cm^2) \times 3}{BW_{adult}(70kg)}$$

  The CTE $DFS(M)_{adj}$ of 24 mg-year/kg-day was calculated using the above equation, but an AF of 0.01 mg/cm^2, which is the EPA (2004b) central tendency value for adult residents, was used.

- The RME EF of 43 days per year is based on best professional judgment and assumes an adolescent trespasser will visit the site 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks). For the CTE case, the adolescent trespasser is assumed to visit the site 1 day per week during the summer and biweekly (twice a month) during April, May, September, and October. These assumptions result in a CTE EF of 21 days per year.

- The adolescent trespasser ED is by default 10 years old (6 to 16 years old). The ED term is only included in the chronic daily exposure equation for inhalation.

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects (EPA 2008b). This assumption equates to an adjusted ED (ED_{adj}) for mutagenic effects of 30 years for the adolescent trespasser.

- The ET for RME and CTE soil exposure scenarios was assumed to be 2 hours per day. The ET term is only included in the chronic daily exposure equation for inhalation.

- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the ED and corresponds to a value of 3,650 days for the RME and CTE cases. The AT_c for both the RME and CTE scenarios represents an average 70-year lifetime and corresponds to 25,550 days.

Adolescent trespassers (6 to 16 years old) could be exposed to sediment and surface water at several locations at OU2: (1) a low-lying area at the east side of the Main Plant Area and (2) the small length of stream between the abandoned sewer outfall and the LVR. As with soil exposures, age-adjusted values are used to estimate exposure. The EF, ED, ET, FI, BW, and AT parameters are the same as those used to estimate potential exposure to soil. The age-adjusted adolescent trespasser sediment exposure factors are presented in Tables 4.4b.RME and 4.4b.CTE of Attachment 2 for OU2 and are summarized below. At OU1, potential sediment and surface water exposures are addressed as part of the shoreline fisherman receptor (see Section 2.3.4.8).

- The RME and CTE age-adjusted sediment ingestion rates ($IRSED_{adj}$) and mutagenic $IRSED_{adj}$ ($IRSED[M]_{adj}$) values are the same as the RME and CTE IRS_{adj} and $IRS(M)_{adj}$ values described above for soil.

- The RME and CTE age-adjusted dermal contact rate ($DFSED_{adj}$) of 70 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRSED_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{adult}(1{,}640\,cm^2) \times AF_{adult}(0.3\,mg/cm^2),}{BW_{adult}(70kg)}$$

  The SA value of 1,640 cm^2 represents the surface area of hands and feet (EPA 2004b). The AF of 0.3 mg/cm^2 is the EPA (2004b) value for reed gatherers.

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects. The RME and CTE mutagenic $DFSED_{adj}$ ($DFSED[M]_{adj}$) of 211 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRSED(M)_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{adult}(1{,}640\,cm^2) \times AF_{adult}(0.3\,mg/cm^2) \times 3}{BW_{adult}(70kg)}$$

The age-adjusted adolescent trespasser surface water exposure factors are presented in Tables 4.4c.RME and 4.4c.CTE of Attachment 2 for OU2 and are summarized below.

- The RME and CTE age-adjusted surface water ingestion rate ($IRSW_{adj}$) of 0.0018 L-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRSW_{adj} = \frac{ED_{6-16}(10\,years) \times IRSW(0.0125\,L/day)}{BW_{adult}(70kg)}$$

The ingestion rate of surface water (IRSW) value of 0.0125 L/day assumes, based on best professional judgment, an incidental ingestion rate of 0.05 L/day on one-fourth of the total days (0.05 L/day × 0.25).

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects. The RME and CTE mutagenic $IRSW_{adj}$ ($DFSED[M]_{adj}$) of 0.0054 L-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRSWM_{adj} = \frac{ED_{6-16}(10\,years) \times IRSW\,(0.0125\,L/day) \times 3}{BW_{adult}(70kg)}$$

- The RME and CTE age-adjusted dermal contact rates ($DFSW_{adj}$) of 304 cm^2-year/kg (surface water in low-lying area east of Main Plant Area) and 643 cm^2-year/kg (stream from abandoned sewer) are based on EPA (2008b) exposure inputs for residents 6 to 16 years old and were calculated as follows:

$$DFSW_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{adult}(2{,}129\,cm^2\,[4{,}499\,cm^2])}{BW_{adult}(70kg)}$$

The SA value of 2,129 cm^2 represents the average surface area of hands and feet for adults (EPA 2004b) and is used for the surface water at the low-lying area east of the Main Plant Area. The SA of 4,499 cm^2 represents the average surface area of hands, feet, and lower legs for adults (EPA 2004) for the deeper water in the stream discharging from the abandoned sewer.

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects. The RME and CTE mutagenic $DFSW_{adj}$ ($DFSW[M]_{adj}$) of 912 cm^2-year/kg (surface water in low-lying area east of Main Plant Area) and 1,928 cm^2-year/kg (stream from abandoned sewer) are based on EPA (2008b) exposure inputs for residents 6 to 16 years old and were calculated as follows:

$$DFSW(M)_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{adult}(2{,}129\,cm2\ [4{,}499\,cm^2]) \times 3}{BW_{adult}(70kg)}$$

Adult Trespasser Exposure Factors

The adult trespasser soil exposure factors are presented in Tables 4.6.RME and 4.6.CTE of Attachment 1 for OU1 and Tables 4.5a.RME and 4.5a.CTE of Attachment 2 for OU2 and are summarized below.

- An RME IRS of 100 mg/day was selected for the adult trespasser. This IRS is the EPA default rate for an adult in an outdoor occupational exposure setting (EPA 2002b) and was deemed representative of potential ingestion for the adult trespasser. The CTE IRS of 50 mg/day is based on best professional judgment and corresponds to one-half of the RME value.

- For adult trespassers, the RME and CTE FI term of 0.125 was selected based on best professional judgment. The FI term assumes that a trespasser has 16 total hours of activity time per day and will spend 2 of these hours on site.

- The RME AF of 0.07 mg/cm^2 is the EPA (2002b) default value for adult residents. The CTE AF of 0.01 mg/cm^2 is the EPA (2004b) central tendency value for adult residents.

- The RME and CTE SA of 5,700 cm^2 is the EPA (2002b) default value for adult residents.

- The RME EF of 43 days per year is based on best professional judgment and assumes an adult trespasser will visit the site 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks). For the CTE case, the adult trespasser is assumed to visit the site 1 day per week during the summer and biweekly (twice a month) during April, May, September, and October. These assumptions result in a CTE EF of 21 days per year.

- The EDs of 25 and 9 years are the EPA (1991) default RME and CTE values, respectively, for residents.

- The ET for RME and CTE soil exposure scenarios was assumed to be 2 hours per day. The ET term is only included in the chronic daily exposure equation for inhalation.

- The RME and CTE BW of 70 kg is the EPA (1989) default adult body weight.

- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the ED and corresponds to a value of 10,950 days for the RME and 3,285 days for the CTE cases. The AT_c for both the RME and CTE scenarios represents an average 70-year lifetime and corresponds to 25,550 days.

Adult trespassers could be exposed to sediment and surface water at several locations at OU2 as described above for adolescent trespassers. The FI, EF, ED, BW, and AT parameters are the same as those used to estimate potential exposure to soil. The adult trespasser sediment exposure factors are presented in Tables 4.5b.RME and 4.5b.CTE of Attachment 2 for OU2 and are summarized below. At OU1, potential sediment and surface water exposures are addressed as part of the shoreline fisherman receptor (see Section 2.3.4.8).

- The RME and CTE sediment ingestion rates (IRSED) are the same as the RME and CTE IRS values described above for soil.

- The RME and CTE SA of 2,129 cm^2 is based on the average skin surface area for the hands and feet of adult males and females (EPA 2004b).

- The RME and CTE sediment-to-skin adherence factor (AFsed) of 0.3 mg/cm^2 is the EPA (2004b) value for reed gatherers.

The adult trespasser surface water exposure factors are presented in Tables 4.5c.RME and 4.5c.CTE of Attachment 2 for OU2 and are summarized below.

- The RME and CTE IRSW of 0.0125 L/day is based on best professional judgment and assumes an incidental ingestion rate of 0.05 L/day on one-fourth of total days (0.05 L/day × 0.25).

- The RME and CTE SA value of 2,129 cm^2 (low-lying area east of Main Plant Area) represents the average surface area of hands and feet for adults (EPA 2004b). The skin surface area of 4,499 cm^2 (stream discharging the abandoned sewer) represents the average surface area of hands, feet, and lower legs of adults (EPA 2004b).

2.3.4.6 Future Recreationalist Exposure Factors

Although redevelopment of the Slag Pile area for future recreational use appears unlikely, the risk assessments will evaluate that possibility to support the selection of appropriate institutional controls or other remedial actions. Under this assumed scenario, the future recreationalist exposure scenarios include potential future exposure to surface soil and subsurface soil at the Slag Pile. Similarly, redevelopment of the Main Plant Area at OU2 for recreational use is less likely than for other portions of OU2. Nonetheless, the risk assessments will evaluate potential recreational land use at all on-site exposure areas at OU2. Also, for OU2, recreationalists could be exposed to sediment and surface water. For OU1, potential exposure to sediment and surface water in the LVR is addressed for the shoreline fisherman receptor (see Section 2.3.4.8). As discussed below, three populations of future recreationalists were evaluated for the Slag Pile (OU1) and all on-site exposure areas at OU2: children (0 to 6 years old), adolescents (6 to 16 years old), and adults (over 16 years old).

Age-Adjusted Child Recreationalist Exposure Factors

As described in Section 2.2.5.3, for scenarios involving receptors 0 to 16 years old, age-adjusted values are used to estimate exposure. The age-adjusted child recreationalist exposure factors are presented in Tables 4.7.RME and 4.7.CTE of Attachment 1 for OU1 and Tables 4.6a.RME and 4.6a.CTE of Attachment 2 for OU2 and are summarized below.

- The RME IRS_{adj} of 80 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 0 to 2 and 2 to 6 years old and was calculated as follows:

$$IRS_{adj} = \frac{ED_{0-2}(2\,years) \times IRS_{child}(200mg/day)}{BW_{child}(15kg)} + \frac{ED_{2-6}(4\,years) \times IRS_{child}(200mg/day)}{BW_{child}(15kg)}$$

  The CTE IRS_{adj} of 40 mg-year/kg-day was calculated using above equation and, based on best professional judgment, an IRS of 100 mg/day (one-half of the RME IRS).

- EPA assumes that children 0 to 2 years old are 10 times more susceptible to potential mutagenic effects and that children 2 to 6 years old are 3 times more susceptible to potential mutagenic effects (EPA 2008b). The RME $IRS(M)_{adj}$ of 427 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 0 to 2 and 2 to 6 years old and was calculated as follows:

$$IRS(M)_{adj} = \frac{ED_{0-2}(2\,years) \times IRS_{child}(200mg/day) \times 10}{BW_{child}(15kg)} + \frac{ED_{2-6}(4\,years) \times IRS_{child}(200mg/day) \times 3}{BW_{child}(15kg)}$$

The CTE $IRS(M)_{adj}$ of 213 mg-year/kg-day was calculated using above equation and, based on best professional judgment, an IRS of 100 mg/day (one-half of the RME IRS).

- For recreationalists, the RME and CTE FI term of 0.125 was selected based on best professional judgment. The FI term assumes that a recreationalist has 16 total hours of activity time per day and will spend 2 of these hours on site.

- The RME DFS_{adj} of 224 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 0 to 2 and 2 to 6 years old and was calculated as follows:

$$DFS_{adj} = \frac{ED_{0-2}(2\,years) \times SA_{child}(2{,}800\,cm^2) \times AF_{child}(0.2mg/cm^2)}{BW_{child}(15kg)} + \frac{ED_{2-6}(4\,yrs) \times SA_{child}(2{,}800\,cm^2) \times AF_{child}(0.2mg/cm^2)}{BW_{child}(15kg)}$$

The CTE DFS_{adj} of 44.8 mg-year/kg-day was calculated using the above equation, but an AF of 0.04 mg/cm^2, which is the EPA (2004b) central tendency value for child residents, was used.

- EPA assumes that children 0 to 2 years old are 10 times more susceptible to potential mutagenic effects and that children 2 to 6 years old are 3 times more susceptible to potential mutagenic effects (EPA 2008b). The RME $DFS(M)_{adj}$ of 1,195 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 0 to 2 and 2 to 6 years old and was calculated as follows:

$$DFS(M)_{adj} = \frac{ED_{0-2}(2\,years) \times SA_{child}(2{,}800cm^2) \times AF_{child}(0.2mg/cm^2) \times 10}{BW_{child}(15kg)} + \frac{ED_{2-6}(4\,years) \times SA_{child}(2{,}800cm^2) \times AF_{child}(0.2mg/cm^2) \times 3}{BW_{child}(15kg)}$$

The CTE $DFS(M)_{adj}$ of 239 mg-year/kg-day was calculated using the above equation, but an AF of 0.04 mg/cm^2, which is the EPA (2004b) central tendency value for child residents, was used.

- The RME EF of 43 days per year is based on best professional judgment and assumes that a recreationalist will visit the site 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks). For the CTE case, a recreationalist is assumed to visit the site 1 day per week during the summer and biweekly (twice a month) during April, May, September, and October. These assumptions result in a CTE EF of 21 days per year.

- The child recreationalist ED by default is 6 years old (0 to 6 years old). The ED term is only included in the chronic daily exposure equation for inhalation.

- EPA assumes that children 0 to 2 years old are 10 times more susceptible to potential mutagenic effects and that children 2 to 6 years old are 3 times more susceptible to potential mutagenic effects (EPA 2008b). These assumptions result in an ED_{adj} for mutagenic effects of 32 years ([2*10]+[4*3]).

- Based on best professional judgment, the ET for the RME and CTE soil exposure scenarios was assumed to be 2 hours per day. The ET term is only included in the chronic daily exposure equation for inhalation.

- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the exposure duration and corresponds to a value of 2,190 days for the RME and CTE cases. The AT_c for both the RME and CTE scenarios represents an average 70-year lifetime and corresponds to 25,550 days.

Child recreationalists (0 to 6 years old) could be exposed to sediment and surface water at several locations at OU2: (1) a low-lying area at the east side of the Main Plant Area and (2) the small length of stream between the abandoned sewer outfall and the LVR. As with soil exposures, age-adjusted values are utilized to estimate exposure. The EF, ED, and AT parameters are the same as those used to estimate potential exposure to soil. The age-adjusted child recreationalist sediment exposure factors are presented in Tables 4.6b.RME and 4.6b.CTE of Attachment 2 for OU2 and are summarized below. At OU1, potential sediment and surface water exposures are addressed as part of the shoreline fisherman scenario (see Section 2.3.4.8).

- The RME and CTE $IRSED_{adj}$ and $IRSED(M)_{adj}$ values are the same as the RME and CTE IRS_{adj} and $IRS(M)_{adj}$ values described above for soil.

- The RME and CTE $DFSED_{adj}$ of 97.1 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 0 to 2 and 2 to 6 years old and was calculated as follows:

$$DFSED_{adj} = \frac{ED_{0-2}(2years) \times SA_{child}(809cm^2) \times AF_{child}(0.3mg/cm^2)}{BW_{child}(15kg)} + \frac{ED_{2-6}(4years) \times SA_{child}(809cm^2) \times AF_{child}(0.3mg/cm^2)}{BW_{child}(15kg)}$$

  The SA represents the sum of hands and feet for children 0 to 6 years old (EPA 2004b). The AF of 0.3 mg/cm^2 is the EPA (2004b) value for reed gatherers.

- EPA assumes that children 0 to 2 years old are 10 times more susceptible to potential mutagenic effects and that children 2 to 6 years old are 3 times more susceptible to potential mutagenic effects (EPA 2008b). The RME $DFSED(M)_{adj}$ of 518 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 0 to 2 and 2 to 6 years old and was calculated as follows:

$$DFSED(M)_{adj} = \frac{ED_{0-2}(2years) \times SA_{child}(809cm^2) \times AF_{child}(0.3mg/cm^2) \times 10}{BW_{child}(15kg)} + \frac{ED_{2-6}(4years) \times SA_{child}(809cm^2) \times AF_{child}(0.3mg/cm^2) \times 3}{BW_{child}(15kg)}$$

The age-adjusted child trespasser surface water exposure factors are presented in Tables 4.6c.RME and 4.6c.CTE of Attachment 2 for OU2 and are summarized below.

- The RME and CTE $IRSW_{adj}$ of 0.003 L-year/kg-day is based on EPA (2008b) exposure inputs for residents 0 to 6 years old and was calculated as follows:

$$IRSW_{adj} = \frac{ED_{0-2}(2years) \times IRSW_{child}(0.0075L/day)}{BW_{child}(15kg)} + \frac{ED_{2-6}(4years) \times IRSW_{child}(0.0075L/day)}{BW_{child}(15kg)}$$

The IRSW value of 0.0075 L/day, assumes, based on best professional judgment, an incidental ingestion rate of 0.03 L/day (about 1 ounce) on one-fourth of the total days (0.03 L/day × 0.25).

- EPA assumes that children 0 to 2 years old are 10 times more susceptible to potential mutagenic effects and that children 2 to 6 years old are 3 times more susceptible to potential mutagenic effects (EPA 2008b). The RME and CTE $IRSW_{adj}$ of 0.016 L-year/kg-day is based on EPA (2008b) exposure inputs for residents 0 to 6 years old and was calculated as follows:

$$IRSW_{adj} = \frac{ED_{0-2}(2\,years) \times IRSW_{child}(0.0075\,L/day)\,x10}{BW_{child}(15kg)} + \frac{ED_{2-6}(4\,years) \times IRSW_{child}(0.0075\,L/day)\,x3}{BW_{child}(15kg)}$$

- The RME and CTE $DFSW_{adj}$ of 324 cm^2-year/kg (surface water in low-lying area east of Main Plant Area) and 584 cm^2-year/kg (stream from abandoned sewer) are based on EPA (2008b) exposure inputs for residents 0 to 6 years old and were calculated as follows:

$$DFSW_{adj} = \frac{ED_{0-2}(2\,years) \times SA_{child}(809\,cm^2\ [1{,}459\,cm^2])}{BW_{child}(15kg)} + \frac{ED_{2-6}(4\,years) \times SA_{child}(809\,cm^2\,[1{,}459\,cm^2])}{BW_{child}(15kg)}$$

The SA value of 809 cm^2 represents the average surface area of hands and feet for children 1 to 6 years old (EPA 2004b) and is used for surface water at the low-lying area east of the Main Plant Area. The SA of 1,459 cm^2 represents the average surface area of hands, feet, and lower legs for children 1 to 6 years old (EPA 2004b) for the deeper water in the stream discharging from the abandoned sewer.

- EPA assumes that children 0 to 2 and 2 to 6 are ten and three times more susceptible to potential mutagenic effects, respectively. The RME and CTE $DFSW(M)_{adj}$ of 1,726 cm^2-year/kg (surface water in low-lying area east of Main Plant Area) and 3,113 cm^2-year/kg (stream from abandoned sewer) are based on EPA (2008b) exposure inputs for residents 0 to 6 years old and were calculated as follows:

$$DFSW(M)_{adj} = \frac{ED_{0-2}(2\,years) \times SA_{child}(809\,cm^2\ [1{,}459\,cm^2])\,x10}{BW_{child}(15kg)} + \frac{ED_{2-6}(4\,years) \times SA_{child}(809\,cm^2\,[1{,}459\,cm^2])\,x3}{BW_{child}(15kg)}$$

Age-Adjusted Adolescent Recreationalist Exposure Factors

As discussed in Section 2.2.5.3, for scenarios involving receptors 0 to 16 years old, age-adjusted values are used to estimate exposure. The age-adjusted adolescent recreationalist exposure factors are presented in Tables 4.8.RME and 4.8.CTE of Attachment 1 for OU2 and Tables 4.7a.RME and 4.7a.CTE of Attachment 2 for OU2 and are summarized below.

- The RME IRS_{adj} of 14.3 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRS_{adj} = \frac{ED_{6-16}(10\,years) \times IRS_{adult}(100mg/day)}{BW_{adult}(70kg)}$$

The CTE IRS_{adj} of 7.1 mg-year/kg-day was calculated using above equation and, based on best professional judgment, an IRS of 50 mg/day (one-half of the RME IRS).

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects. The RME mutagenic IRS_{adj} ($IRS[M]_{adj}$) of 42.9 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRS(M)_{adj} = \frac{ED_{6-16}(10\,years) \times IRS_{adult}(100mg/day) \times 3}{BW_{adult}(70kg)}$$

The CTE $IRS(M)_{adj}$ of 21.4 mg-year/kg-day was calculated using above equation and, based on best professional judgment, an IRS of 50 mg/day (one-half of the RME IRS).

- For recreationalists, the RME and CTE FI term of 0.125 was selected based on best professional judgment. The FI term assumes that a recreationalist has 16 total hours of activity time per day and will spend 2 of these hours on site.

- The RME age-adjusted dermal contact rate (DFS_{adj}) of 57 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRS_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{adult}(5{,}700cm^2) \times AF_{adult}(0.07mg/cm^2)}{BW_{adult}(70kg)}$$

The CTE $DFS(M)_{adj}$ of 8.1 mg-year/kg-day was calculated using the above equation, but an AF of 0.01 mg/cm^2, which is the EPA (2004b) central tendency value for adult residents, was used.

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects. The RME mutagenic DFS_{adj} ($DFS[M]_{adj}$) of 171 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRS_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{adult}(5{,}700cm^2) \times AF_{adult}(0.07mg/cm^2) \times 3}{BW_{adult}(70kg)}$$

The CTE $DFS(M)_{adj}$ of 24 mg-year/kg-day was calculated using the above equation, but an AF of 0.01 mg/cm^2, which is the EPA (2004b) central tendency value for adult residents, was used.

- The RME EF of 43 days per year is based on best professional judgment and assumes that a recreationalist will visit the site 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks). For the CTE case, a recreationalist is assumed to visit the site 1 day per week during the summer and biweekly (twice a month) during April, May, September, and October. These assumptions result in a CTE EF of 21 days per year.

- The adolescent recreationalist ED by default is 10 years old (6 to 16 years old). The ED term is only included in the chronic daily exposure equation for inhalation.

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects (EPA 2008b). This assumption equates to an adjusted ED (ED_{adj}) for mutagenic effects of 30 years for the adolescent trespasser.

- Based on best professional judgment, the ET for RME and CTE soil exposure scenarios was assumed to be 2 hours per day. The ET term is only included in the chronic daily exposure equation for inhalation.

- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the ED and corresponds to a value of 3,650 days for the RME and CTE cases. The AT_c for both the RME and CTE scenarios represents an average 70-year lifetime and corresponds to 25,550 days.

Adolescent recreationalists (6 to 16 years old) could be exposed to sediment and surface water at several locations at OU2 as described above for child recreationalists. As with soil exposures, age-adjusted values are used to estimate exposure. The EF, ED, and AT parameters are the same as those used to estimate potential exposure to soil. The age-adjusted adolescent recreationalist sediment exposure factors are presented in Tables 4.7b.RME and 4.7b.CTE of Attachment 2 for OU2 and are summarized below. At OU1, potential sediment and surface water exposures are addressed as part of the shoreline fisherman scenario (see Section 2.3.4.8).

- The RME and CTE age-adjusted sediment ingestion rates ($IRSED_{adj}$) and mutagenic $IRSED_{adj}$ ($IRSED[M]_{adj}$) values are the same as the RME and CTE IRS_{adj} and $IRS(M)_{adj}$ values described above for soil.

- The RME and CTE age-adjusted $DFSED_{adj}$ of 91 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRSED_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{adult}(2{,}129\,cm^2) \times AF_{adult}(0.3\,mg/cm^2)}{BW_{adult}(70kg)}$$

  The skin surface area of 2,129 cm^2 represents the sum of hands and feet for adults (EPA 2004b). The AF of 0.3 mg/cm^2 is the EPA (2004b) value for reed gatherers.

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects (EPA 2008b). The RME and CTE $DFSED(M)_{adj}$ of 274 mg-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRSED(M)_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{adult}(2{,}129\,cm^2) \times AF_{adult}(0.3\,mg/cm^2) \times 3}{BW_{adult}(70kg)}$$

The age-adjusted adolescent recreationalist surface water exposure factors are presented in Tables 4.7c.RME and 4.7c.CTE of Attachment 2 for OU2 and summarized below.

- The RME and CTE $IRSW_{adj}$ of 0.0018 L-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRSW_{adj} = \frac{ED_{6-16}(10\,years) \times IRSW(0.0125\,L/day)}{BW_{adult}(70kg)}$$

  The IRSW value of 0.0125 L/day assumes, based on best professional judgment, an incidental ingestion rate of 0.05 L/day on one-fourth of the total days (0.05 L/day × 0.25).

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects. The RME and CTE mutagenic $IRSW_{adj}$ ($DFSED[M]_{adj}$) of 0.0054 L-year/kg-day is based on EPA (2008b) exposure inputs for residents 6 to 16 years old and was calculated as follows:

$$IRSWM_{adj} = \frac{ED_{6-16}(10\,years) \times IRSW\,(0.0125\,L/day) \times 3}{BW_{adult}(70kg)}$$

- The RME and CTE $DFSW_{adj}$ of 304 cm^2-year/kg (surface water in low-lying area east of Main Plant Area) and 643 cm^2-year/kg (stream from abandoned sewer) are based on EPA (2008b) exposure inputs for residents 6 to 16 years old and were calculated as follows:

$$DFSW_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{adult}(2{,}129\,cm^2\,[4{,}499\,cm^2])}{BW_{adult}(70kg)}$$

  The SA value of 2,129 cm^2 represents the average surface area of hands and feet for adults (EPA 2004b) and is used for the surface water at the low-lying area east of the Main Plant Area. The SA of 4,499 cm^2 represents the average surface area of hands, feet, and lower legs for adults (EPA 2004) for the deeper water in the stream discharging from the abandoned sewer.

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects. The RME and CTE $DFSW(M)_{adj}$ of 912 cm^2-year/kg (surface water in low-lying area east of Main Plant Area) and 1,928 cm^2-year/kg (stream from abandoned sewer) are based on EPA (2008b) exposure inputs for residents 6 to 16 years old and were calculated as follows:

$$DFSW(M)_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{adult}(2{,}129\,cm2\,[4{,}499\,cm^2]) \times 3}{BW_{adult}(70kg)}$$

Adult Recreationalist Exposure Factors

The adult recreationalist exposure factors are presented in Tables 4.9.RME and 4.9.CTE of Attachment 1 for OU1 and 4.8a.RME and 4.8a.CTE of Attachment 2 for OU2 and are summarized below.

- An RME IRS of 100 mg/day was selected for the adult recreationalist. This IRS is the EPA default rate for an adult in an outdoor occupational exposure setting (EPA 2002b) and was

deemed representative of potential ingestion for the adult trespasser. The CTE IRS of 50 mg/day is based on best professional judgment and corresponds to one-half of the RME value.

- For adult recreationalists, the RME and CTE FI term of 0.125 was selected based on best professional judgment. The FI term assumes that a recreationalist has 16 total hours of activity time per day and will spend 2 of these hours on site.

- The RME AF of 0.07 mg/cm^2 is the EPA (2002b) default value for adult residents. The CTE AF of 0.01 mg/cm^2 is the EPA (2004b) central tendency value for adult residents.

- The RME and CTE SA of 5,700 cm^2 is the EPA (2002b) default value for adult residents.

- The RME EF of 43 days per year is based on best professional judgment and assumes an adult recreationalist will visit the site 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks). For the CTE case, a recreationalist is assumed to visit the site 1 day per week during the summer and biweekly (twice a month) during April, May, September, and October. These assumptions correspond to a CTE EF of 21 days per year.

- The EDs of 25 and 9 years are the EPA (1991) default RME and CTE values, respectively, for residents.

- Based on best professional judgment, the ET for the RME and CTE soil exposure scenarios was assumed to be 2 hours per day. The ET term is only included in the chronic daily exposure equation for inhalation.

- The RME and CTE BW of 70 kg is the EPA (1989) default adult body weight.

- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the ED and corresponds to a value of 10,950 days for the RME and 3,285 days for the CTE cases. The AT_c for both the RME and CTE scenarios represents an average 70-year lifetime and corresponds to 25,550 days.

Adult recreationalists could be exposed to sediment and surface water at several locations at OU2 as described above for child recreationalists. The FI, EF, ED, BW, and AT parameters are the same as those used to estimate potential exposure to soil. The adult recreationalist sediment exposure factors are presented in Tables 4.8b.RME and 4.8b.CTE of Attachment 2 for OU2 and are summarized below. At OU1, potential sediment and surface water exposures are addressed as part of the shoreline fisherman scenario (see Section 2.3.4.8).

- The RME and CTE IRSED are the same as the RME and CTE IRS values described above for soil.

- The RME and CTE SA of 2,129 cm^2 is based on the average skin surface area for the hands and feet of adult males and females (EPA 2004b).

- The RME and CTE AFsed of 0.3 mg/cm^2 is the EPA (2004b) value for reed gatherers.

The adult recreationalist surface water exposure factors are presented in Tables 4.8c.RME and 4.8c.CTE of Attachment 2 for OU2 and are summarized below.

- The RME and CTE IRSW of 0.0125 L/day is based on best professional judgment and assumes an incidental ingestion rate of 0.05 L/day on one-fourth of total days (0.05 L/day × 0.25).
- The RME and CTE SA value of 2,129 cm^2 (low-lying area east of Main Plant Area) represents the average surface area of hands and feet for adults (EPA 2004b). The skin surface area of 4,499 cm^2 (stream discharging the abandoned sewer) represents the average surface area of hands, feet, and lower legs of adults (EPA 2004b).

2.3.4.7 Current and Future Residential Exposure Factors

The current resident receptor exposure scenarios include potential exposure to surface soil and groundwater at the Off-Site Residential Area at OU2. The future on-site resident exposure scenarios include potential exposure to surface soil, subsurface soil, and groundwater at the Carus Plant (OU1) and at the Wooded Area – North exposure area OU2. As discussed below, two populations, child and aggregate residents, were considered in the exposure assessment. The method for calculating risk for aggregate resident populations used age-adjusted ingestion, dermal, and inhalation factors to take into account the difference in daily ingestion and surface area, body weights, and exposure durations for children 0 to 6 years old and others 7 to 30 years old.

Child Resident Exposure Factors

Because non-carcinogenic risk is an event-driven phenomenon and not a result of exposure over a lifetime, the child resident scenario was deemed more conservative and appropriate for the evaluation of potential non-carcinogenic risk. As described in Section 2.3.1, for scenarios involving receptors 0 to 16 years old, age-adjusted soil ingestion and dermal contact rates are used to estimate exposure. The child resident exposure factors for potential soil exposures are presented in Tables 4.10a.RME and 4.10a.CTE of Attachment 1 for OU1 and 4.9a.RME and 4.9a.CTE of Attachment 2 for OU2 and are discussed below.

- The RME IRS of 200 mg/day is the EPA (1991) recommended upper-bound soil intake value for children in a residential exposure setting. The CTE IRS of 100 mg/day is the mean daily soil ingestion rate for children (EPA,1997b).
- It was conservatively assumed that a resident would receive all of his or her daily incidentally ingested soil from the site (FI = 1).
- The RME AF of 0.2 mg/cm^2 is the EPA (2002b) default RME value for a child resident. The CTE AF of 0.04 mg/cm^2 is the EPA (2002b) default CTE value for a child resident.

- The SA of 2,800 cm^2 is the EPA (2002b) default value for a child resident.
- The EF of 350 days per year is the EPA (1989) default value for residents.
- By default, the ED for the child resident is 6 years (0 to 6 years old)
- Residents are assumed to be on site continuously. Therefore, the ET is 24 hours per day (EPA 1989).
- The BW of 15 kg is the EPA (1989) default child body weight.
- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the ED and corresponds to a value of 2,190 days for the RME and CTE cases. Carcinogenic effects for residents are evaluated in the aggregate resident scenario only.
- The RME and CTE consumption rate for aboveground produce (Cr_{ag}) of 2.27×10^{-3} kg/kg-day DW (sum of exposed and protected aboveground produce) is the EPA (2005b) recommended aboveground produce ingestion rate for residential children.
- The RME and CTE consumption rate for belowground produce (Cr_{bg}) of 2.3×10^{-4} kg/kg-day DW is the EPA (2005b) recommended belowground produce ingestion rate for residential children.
- The RME FP value of 1 is the EPA (2005b) recommended upper-bound value for homegrown produce. The CTE FP value of 0.5 is based on best professional judgment.

Based on the previously discussed prohibitions on groundwater use, potable use is not reasonably anticipated. However, as requested by EPA and as a point of departure for making risk management decisions, groundwater also was evaluated as a potable water source at the M&H Site for hypothetical future residential receptors. Hypothetical exposure pathways for groundwater (regardless of depth) at the site include exposure of future residents to groundwater through ingestion, dermal contact, and inhalation during household use. Also, potential exposure through inhalation of indoor and outdoor air will be evaluated to assess risks from volatile chemicals present in groundwater that may migrate through the vadose zone and into buildings and ambient air. The EF, ED, ET, FI, BW, and AT parameters are the same as those used to estimate potential exposure to soil. The groundwater-specific exposure parameters are presented in Tables 4.10.b RME and 4.10b.CTE of Attachment 1 for OU1 and Tables 4.9b.RME and 4.9b.CTE of Attachment 2 for OU2 and are summarized below.

- The RME and CTE IRGW of 1 L/day is the recommended default ingestion rate for residential children (EPA 1991).
- The RME and CTE SA of 6,600 cm^2 is the EPA (2004b) recommended default skin surface area for residential children exposed during bathing.

- The RME exposure time outdoors (ETod) of 24 hours/day is the default ET for residents (EPA 2008b). The CTE ETod of 3 hours/day is the amount of time spent outdoors at a residence by a child 0 to 6 years old based on the EPA (1997b) recommendation of 2 hours/day for residents of all ages.

- The RME exposure time bathing (ETb) value of 1 hour/day is the EPA (2004b) recommended upper-bound duration of bathing activities for residential children. The CTE ETb value of 0.33 hour/day is the EPA (2004b) recommended mean duration of bathing activities for residential children.

Aggregate Resident Exposure Factors

Because potential carcinogenic risk is estimated over the lifetime of an individual, the aggregate resident scenario was used to evaluate potential carcinogenic (and mutagenic) risk to a future resident. As described in Section 2.2.5.3, for scenarios involving receptors 0 to 16 years old, age-adjusted soil ingestion and dermal contact rates are used to estimate exposure. The age-adjusted aggregate resident (0 to 30 years old) exposure factors for potential soil exposures are presented in Tables 4.11a.RME and 4.11a.CTE of Attachment 1 for OU1 and 4.10a.RME and 4.10a.CTE of Attachment 2 for OU2 and are discussed below.

- The IRS_{adj} for the aggregate resident is based on EPA (2008b) exposure inputs and the equation presented below. The resulting RME and CTE IRS_{adj} for are 114 and 42.1 mg-year/kg-day, respectively.

$$IRS_{adj} = \frac{ED_{0-2} \times IRS_{child}}{BW_{child}} + \frac{ED_{2-6} \times IRS_{child}}{BW_{child}} + \frac{ED_{6-16} \times IRS_{adult}}{BW_{adult}} + \frac{ED_{16-30} \times IRS_{adult}}{BW_{adult}}$$

  - The total RME ED of 30 years is based on the 90th percentile for time at one residence (EPA 1997b). The total CTE ED of 9 years is an EPA recommended value for CTE and represents the national median time spent at one residence (EPA 1989). For the RME and CTE cases, the youngest receptors were assumed for the EDs because the early years generally are the most sensitive to exposure (0 to 30 years old for the RME case and 0 to 9 years old for the CTE case).

  - The RME IRS corresponds to the EPA recommended soil intake values for residential exposure of 200 mg/day for children and 100 mg/day for adults (EPA 2002b). For CTE, the IRS corresponds to a value of 100 mg/day for children and 50 mg/day for adults.

  - EPA default body weight values for child and adult receptors of 15 and 70 kg, respectively, were used for the aggregate resident (EPA 2002b).

- To account for potential mutagenic effects during early life exposure (before age 16), EPA applies an ADAF to each of the four residential age groups identified above (0 to 2, 2 to 6, 6 to 16, and 16 to 30 years old). Thus, for mutagenic compounds, the IRS_{adj} equation is modified as presented below. The resulting RME and CTE $IRS(M)_{adj}$ are 489.5 and 220 mg-year/kg-day, respectively.

$$IRS(M)_{adj} = \frac{ED_{0-2} \times IRS_{child} \times ADAF_{0-2}}{BW_{child}} + \frac{ED_{2-6} \times IRS_{child} \times ADAF_{2-6}}{BW_{child}} + \frac{ED_{6-16} \times IRS_{adult} \times ADAF_{6-16}}{BW_{adult}} + \frac{ED_{16-30} \times IRS_{adult} \times ADAF_{16-30}}{BW_{adult}}$$

- For the ages 0 to 2 years old (ED of 2 years for RME and CTE cases), the ADAF is 10.
- For the ages 2 to 6 years old (ED of 4 years for RME and CTE cases), the ADAF is 3.
- For the ages 6 to 16 years old (EDs of 10 years for RME and 3 years for CTE cases), the ADAF is 3.
- For the ages 16 to 30 years old (EDs of 14 years for RME and 0 years for CTE cases), the ADAF is 1.

- It was conservatively assumed that a resident would receive all of his or her daily incidentally ingested soil from the site (FI = 1).
- The DFS_{adj} for the aggregate residents is based on EPA (2008b) exposure inputs and the equation presented below. The resulting RME and CTE DFS_{adj} for are 361 and 241 mg-year/kg-day, respectively.

$$DFS_{adj} = \frac{ED_{0-2} \times SA_{child} \times AF_{child}}{BW_{child}} + \frac{ED_{2-6} \times SA_{child} \times AF_{child}}{BW_{child}} + \frac{ED_{6-16} \times SA_{adult} \times AF_{adult}}{BW_{adult}} + \frac{ED_{16-30} \times SA_{adult} \times AF_{adult}}{BW_{adult}}$$

- The total RME ED of 30 years is based on the 90th percentile for time at one residence (EPA 1997b). The total CTE ED of 9 years is an EPA recommended value for CTE and represents the national median time spent at one residence (EPA 1989). For the RME and CTE cases, the youngest receptors were assumed for the EDs because the early years generally are the most sensitive to exposure (0 to 30 years old for the RME case and 0 to 9 years old for the CTE case).
- Child and adult SAs are the EPA (2002b) default values of 2,800 and 5,700 cm^2, respectively.
- Child and adult AFs are the EPA (2002b) default values of 0.2 and 0.07 mg/cm^2, respectively.
- Child and adult BWs are the EPA (1989) default values of 15 and 70 kg, respectively.

- EPA assumes that children 0 to 2 years old are 10 times more susceptible to mutagenic effects, children 2 to 6 years old are 3 time more susceptible, and adolescents 6 to 16 years old also are 3 times more susceptible (EPA 2008b). The RME $DFS(M)_{adj}$ for the aggregate resident is based on EPA (2008b) exposure inputs described above and was calculated as follows:

$$DFS(M)_{adj} = \frac{ED_{0-2} \times SA_{child} \times AF_{child} \times 10}{BW_{child}} + \frac{ED_{2-6} \times IRS_{child} \times AF_{child} \times 3}{BW_{child}} + \frac{ED_{6-16} \times IRS_{adult} \times AF_{adult} \times 3}{BW_{adult}} + \frac{ED_{16-30} \times IRS_{adult} \times AF_{adult} \times 1}{BW_{adult}}$$

The resulting RME and CTE $DFS(M)_{adj}$ are 1,445 and 1,246 mg-year/kg-day, respectively.

- The EF of 350 days per year is the EPA (1989) default value for residents.

- The total RME ED of 30 years is based on the 90th percentile for time at one residence (EPA 1997b). The CTE ED of 9 years is an EPA recommended value that represents the national median time spent at one residence (EPA 1989). Because age-adjusted rates account for body weight and exposure duration, these terms are not included in the ingestion and dermal intake equations for the future aggregate resident.

- The $CRag_{adj}$ for the aggregate resident is based on EPA (2008b) exposure inputs and the equation presented below. The resulting RME and CTE $IRag_{adj}$ are 3.59×10^{-2} and 1.64×10^{-2} kg/kg-day DW.

$$Crag_{adj} = (ED_{0\text{-}2} \times CRag_{child}) + (ED_{2\text{-}6} \times CRag_{child}) + (ED_{7\text{-}16} \times CRag_{adult}) + (ED_{17\text{-}30} \times CRag_{adult})$$

  - The total RME ED of 30 years is based on the 90th percentile for time at one residence (EPA 1997b). The total CTE ED of 9 years is an EPA recommended value and represents the national median time spent at one residence (EPA 1989). For the RME and CTE cases, the youngest receptors were assumed for the EDs because the early years generally are the most sensitive to exposure (0 to 30 years old for the RME case and 0 to 9 years old for the CTE case).

  - The RME and CTE $Crag_{child}$ of 2.27×10^{-3} kg/kg-day DW (sum of exposed and protected aboveground produce) is the EPA (2005b) recommended aboveground produce ingestion rate for residential children.

  - The RME and CTE Crag of 9.3×10^{-4} kg/kg-day DW (sum of exposed and protected aboveground produce) is the EPA (2005b) recommended aboveground produce ingestion rate for residential adults.

- The $CRbg_{adj}$ for the aggregate residents is based on EPA (2008b) exposure inputs and the equation presented below. The resulting RME and CTE $CRbg_{adj}$ are 4.74×10^{-3} and 1.8×10^{-3} kg/kg-day DW.

$$Crbg_{adj} = (ED_{0\text{-}2} \times CRbg_{child}) + (ED_{2\text{-}6} \times CRbg_{child}) + (ED_{7\text{-}16} \times CRbg_{adult}) + (ED_{17\text{-}30} \times CRbg_{adult})$$

  - The total RME ED of 30 years is based on the 90th percentile for time at one residence (EPA 1997b). The total CTE ED of 9 years is an EPA recommended value and represents the national median time spent at one residence (EPA 1989). For the RME and CTE cases, the youngest receptors were assumed for the EDs because the early years generally are the most sensitive to exposure (0 to 30 years old for the RME case and 0 to 9 years old for the CTE case).

  - The RME and CTE $Crbg_{child}$ of 2.3×10^{-4} kg/kg-day DW is the EPA (2005b) recommended belowground produce ingestion rate for residential children.

  - The RME and CTE Crbg of 1.4×10^{-4} kg/kg-day DW is the EPA (2005b) recommended belowground produce ingestion rate for residential adults.

- To account for potential mutagenic effects during early life exposure (before 16 years old), EPA applies an ADAF to each of the four residential age groups identified above. Thus, for mutagenic

compounds, the $Crag(M)_{adj}$ and $CRbg(M)_{adj}$ are modified as presented below. The resulting RME and CTE $Crag(M)_{adj}$ are 1.14×10^{-1} and 8.1×10^{-2} kg/kg-day DW, respectively.

$$Crag(M)_{adj} = (ED_{0\text{-}2} \times CRag_{child} \times ADAF_{0\text{-}2}) + (ED_{2\text{-}6} \times CRag_{child} \times ADAF_{2\text{-}6}) + (ED_{6\text{-}16} \times CRag_{adult} \times ADAF_{6\text{-}16}) + (ED_{17\text{-}30} \times CRag_{adult} \times ADAF_{16\text{-}30})$$

- For the ages 0 to 2 years old (ED of 2 years for RME and CTE cases), the ADAF is 10.
- For the ages 2 to 6 years old (ED of 4 years for RME and CTE cases), the ADAF is 3.
- For the ages 6 to 16 years old (EDs of 10 years for RME and 3 years for CTE cases), the ADAF is 3.
- For the ages 16 to 30 years old (EDs of 14 years for RME and 0 years for CTE cases), the ADAF is 1.

- The RME and CTE $CRbg(M)_{adj}$ were calculated as summarized below and are 1.35×10^{-2} and 8.6×10^{-3} kg/kg-day DW, respectively.

$$Crbg(M)_{adj} = (ED_{0\text{-}2} \times CRbg_{child} \times ADAF_{0\text{-}2}) + (ED_{2\text{-}6} \times CRbg_{child} \times ADAF_{2\text{-}6}) + (ED_{6\text{-}16} \times CRbg_{adult} \times ADAF_{6\text{-}16}) + (ED_{17\text{-}30} \times CRbg_{adult} \times ADAF_{16\text{-}30})$$

- EPA assumes that children 0 to 2 years old are 10 times more susceptible to potential mutagenic effects, children 2 to 6 years old are 3 times more susceptible to potential mutagenic effects, and adolescents 6 to 16 years old also are 3 times more susceptible to potential mutagenic effects (EPA 2008). These assumptions result in an ED_{adj} for mutagenic effects of 76 years for the RME case ([2*10]+[4*3]+[10*3]+[14*1]) and 41 years for the CTE case ([2*10]+[4*3]+[3*3]).

- Based on best professional judgment, the ET for the RME and CTE soil exposure scenarios was assumed to be 2 hours per day. The ET term is only included in the chronic daily exposure equation for inhalation.

- Consistent with EPA (1989) guidance, the AT_c for both the RME and CTE cases represents an average 70-year lifetime and corresponds to 25,550 days. Non-carcinogenic effects for residents are evaluated in the child resident scenario only.

As described in the previous section, groundwater will be evaluated as a potable water source at the site for hypothetical future residential receptors. Hypothetical exposure pathways for groundwater (regardless of depth) at the site include exposure of future residents to groundwater through ingestion, dermal contact, and inhalation during household use. Also, potential exposure through inhalation of indoor and outdoor air will be evaluated to assess risks from volatile chemicals present in groundwater that could migrate through the vadose zone and into buildings and ambient air. The EF, ED, ET, FI, BW, and AT parameters are the same as those used to estimate potential exposure to soil. The age-adjusted groundwater-specific exposure parameters are presented in Tables 4.11b.RME and 4.11b.CTE of Attachment 1 for OU1 and Tables 4.10b.RME and 4.10b.CTE of Attachment 2 for OU2 and are summarized below.

- The RME and CTE $IRGW_{adj}$ for the aggregate residents is based on EPA (2008) exposure inputs and the equation presented below. The resulting RME and CTE $IRGW_{adj}$ values are 1.09 and 0.49 mg-year/kg-day, respectively.

$$IRGW_{adj} = \frac{ED_{0-2} \times IRGW_{child}}{BW_{child}} + \frac{ED_{2-6} \times IRGW_{child}}{BW_{child}} + \frac{ED_{6-16} \times IRGW_{adult}}{BW_{adult}} + \frac{ED_{16-30} \times IRGW_{adult}}{BW_{adult}}$$

  - The total RME ED of 30 years is based on the 90th percentile for time at one residence (EPA 1997b). The total CTE ED of 9 years is an EPA recommended value for CTE and represents the national median time spent at one residence (EPA 1989). For the RME and CTE cases, the youngest receptors were assumed for the EDs because the early years generally are the most sensitive to exposure (0 to 30 years old for the RME case and 0 to 9 years old for the CTE case).

  - The RME and CTE IRGW values for adults (2 L/day) and children (1 L/day) correspond to the EPA (1991) recommended tap water ingestion rates for adult and child residents, respectively.

- To account for potential mutagenic effects during early life exposure (before 16 years old), EPA applies an ADAF to each of the four residential age groups identified above. Thus, for mutagenic compounds, the $IRGW_{adj}$ equation is modified as presented below. The resulting RME and CTE $IRGW(M)_{adj}$ are 3.39 and 2.39 mg-year/kg-day, respectively.

$$IRGW(M)_{adj} = \frac{ED_{0-2} \times IRGW_{child} \times ADAF_{0-2}}{BW_{child}} + \frac{ED_{2-6} \times IRGW_{child} \times ADAF_{2-6}}{BW_{child}} + \frac{ED_{6-16} \times IRGW_{adult} \times ADAF_{6-16}}{BW_{adult}} + \frac{ED_{16-30} \times IRGW_{adult} \times ADAF_{16-30}}{BW_{adult}}$$

  - For the ages 0 to 2 years old (ED of 2 years for RME and CTE cases), the ADAF is 10.

  - For the ages 2 to 6 years old (ED of 4 years for RME and CTE cases), the ADAF is 3.

  - For the ages 6 to 16 years old (EDs of 10 years for RME and 3 years for CTE cases), the ADAF is 3.

  - For the ages 16 to 30 years old (EDs of 14 years for RME and 0 years for CTE cases), the ADAF is 1.

- The $DFGW_{adj}$ for the aggregate residents is based on EPA (2008b) exposure inputs and the equation presented below. This parameter is used to estimate exposures to inorganic constituents in groundwater. The resulting RME and CTE $DFGW_{adj}$ are 6,219 and 2,414 cm^2-hour-year/kg-day, respectively.

$$DFGW_{adj} = \frac{ED_{0-2} \times SA_{child} \times ET_{child}}{BW_{child}} + \frac{ED_{2-6} \times SA_{child} \times ET_{child}}{BW_{child}} + \frac{ED_{6-16} \times SA_{adult} \times ET_{adult}}{BW_{adult}} + \frac{ED_{16-30} \times SA_{adult} \times ET_{adult}}{BW_{adult}}$$

  - The total RME ED of 30 years is based on the 90th percentile for time at one residence (EPA 1997b). The total CTE ED of 9 years is an EPA recommended value for CTE and represents the national median time spent at one residence (EPA 1989). For the RME and CTE cases, the youngest receptors were assumed for the EDs because the early years generally are the

most sensitive to exposure (0 to 30 years old for the RME case and 0 to 9 years old for the CTE case).

- Child and adult SAs are the EPA (2004b) default values for bathing of 6,600 and 18,000 cm^2, respectively.

- The RME adult and child ETs are the EPA (2004) recommended upper-bound bathing times of 0.58 and 1 hour/day, respectively. The CTE adult and child ETs are the EPA (2004b) mean bathing times of 0.33 and 0.25 hour/day, respectively.

- EPA assumes that children 0 to 2 years old are 10 times more susceptible to mutagenic effects, children 2 to 6 years old are 3 times more susceptible, and adolescents 6 to 16 years old also are 3 times more susceptible (EPA 2008b). The RME $DFS(M)_{adj}$ for the aggregate resident is based on EPA (2008b) exposure inputs as described above and calculated as follows (this parameter is used to estimate exposures to inorganic constituents in groundwater):

$$DFGW(M)_{adj} = \frac{ED_{0-2} \times SA_{child} \times ET_{child} \times 10}{BW_{child}} + \frac{ED_{2-6} \times SA_{child} \times ET_{child} \times 3}{BW_{child}} + \frac{ED_{6-16} \times SA_{adult} \times ET_{adult} \times 3}{BW_{adult}} + \frac{ED_{16-30} \times SA_{adult} \times ET_{adult} \times 1}{BW_{adult}}$$

The resulting RME and CTE $DFS(M)_{adj}$ are 20,642 and 5,225 mg-year/kg-day, respectively.

- The $DFGW_{adjo}$ for the aggregate residents is based on EPA (2008b) exposure inputs and the equation presented below. This parameter is used to estimate exposures to organic constituents in groundwater. The resulting RME and CTE $DFGW_{adjo}$ are 7,330 and 4,591 cm^2-hour-year/kg-day, respectively.

$$DFGW_{adjo} = \frac{ED_{0-2} \times SA_{child} \times \sqrt{ET_{child}}}{BW_{child}} + \frac{ED_{2-6} \times SA_{child} \times \sqrt{ET_{child}}}{BW_{child}} + \frac{ED_{6-16} \times SA_{adult} \times \sqrt{ET_{adult}}}{BW_{adult}} + \frac{ED_{16-30} \times SA_{adult} \times \sqrt{ET_{adult}}}{BW_{adult}}$$

- EPA assumes that children 0 to 2 years old are 10 times more susceptible to mutagenic effects, children 2 to 6 years old are 3 times more susceptible, and adolescents 6 to 16 years old also are 3 times more susceptible (EPA 2008b). The RME $DFS(M)_{adjo}$ for the aggregate resident is based on EPA (2008b) exposure inputs as described above and calculated as follows (this parameter is used to estimate exposures to organic constituents in groundwater):

$$DFGW(M)_{adjo} = \frac{ED_{0-2} \times SA_{child} \times \sqrt{ET_{child}} \times 10}{BW_{child}} + \frac{ED_{2-6} \times SA_{child} \times \sqrt{ET_{child}} \times 3}{BW_{child}} + \frac{ED_{6-16} \times SA_{adult} \times \sqrt{ET_{adult}} \times 3}{BW_{adult}} + \frac{ED_{16-30} \times SA_{adult} \times \sqrt{ET_{adult}} \times 1}{BW_{adult}}$$

The resulting RME and CTE $DFS(M)_{adjo}$ are 22,679 and 9,183 mg-year/kg-day, respectively.

2.3.4.8 Current and Future Shoreline Fisherman Exposure Factors

As discussed below, two ages of populations, adolescents (6 to 16 years old) and adults (more than 16 years old) were evaluated for fishing along the LVR shoreline for OU1. No fishable water bodies are present at OU2.

Age-Adjusted Adolescent Fisherman Exposure Factors

As discussed in Section 2.2.5.3, for scenarios involving receptors 0 to 16 years old, age-adjusted values are used to estimate exposure. The age-adjusted adolescent fisherman exposure factors for OU1 are presented in Attachment 1 in Tables 4.12a.RME and 4.12a.CTE for sediment and Tables 4.12b.RME and 4.12b.CTE for surface water and are summarized below.

- The RME age-adjusted sediment ingestion rate ($IRSED_{adj}$) of 14.3 mg-year/kg-day is conservatively based on EPA (2008b) exposure inputs for calculating age-adjusted rates for residents 6 to 16 years old exposed to soil and was calculated as follows:

$$IRSED_{adj} = \frac{ED_{6-16}(10\,years) \times IRSED_{adult}(100mg/day)}{BW_{adult}(70kg)}$$

  The CTE $IRSED_{adj}$ of 7.1 mg-year/kg-day was calculated using above equation but assuming a CTE IRSED of 50 mg/day (one-half of the RME IRSED).

- EPA assumes that adolescents 6 to 16 year old are three times more susceptible to potential mutagenic effects (EPA 2008b). The RME $IRSED_{adj}$ for mutagens ($IRSED[M]_{adj}$) of 42.9 mg-year/kg-day is based on the $IRSED_{adj}$ exposure inputs and an ADAF value of 3 and was calculated as follows:

$$IRSED(M)_{adj} = \frac{ED_{6-16}(10\,years) \times IRSED_{adult}(100mg/day) \times 3}{BW_{adult}(70kg)}$$

  The CTE $IRSED(M)_{adj}$ of 21.4 mg-year/kg-day was calculated using above equation but assuming a CTE IRSED of 50 mg/day (one-half of the RME IRSED).

- The RME and CTE sediment FI term of 0.125 was selected based on best professional judgment. The FI term assumes that a fisherman has 16 total hours of activity time per day and will spend 2 of these hours on site.

- The RME and CTE age-adjusted sediment dermal contact rate ($DFSED_{adj}$) of 70 mg-year/kg-day is based on the default ED and BW values used to calculate age-adjusted rates for residents 6 to 16 years old (EPA 2008b) exposed to soil, a site-specific SA that assumes exposure of the hands and feet to sediment, and an AF based on reed-gathering (EPA 2004b). The $DFSED_{adj}$ was calculated as follows:

$$DFSED_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{site-specific}(1{,}640cm^2) \times AF_{reed-gatherer}(0.3mg/cm^2)}{BW_{adult}(70kg)}$$

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects (EPA 2008b). The RME and CTE $DFSED_{adj}$ for mutagens ($DFSED[M]_{adj}$) of 211 mg-year/kg-day is based on the above exposure inputs and an ADAF value of 3 and was calculated as follows:

$$DFSED(M)_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{site-specific}(1{,}640cm^2) \times AF_{reed-gatherer}(0.3mg/cm^2) \times 3}{BW_{adult}(70kg)}$$

- The RME age-adjusted incidental surface water ingestion rate ($IRSW_{adj}$) of 0.0018 L-year/kg-day assumes a fisherman will incidentally ingest 0.05 L/day on one-fourth of the total days. The BW and ED are the EPA (2008b) default values for calculating age-adjusted rates for residents 6 to 16 years old. The $IRSW_{adj}$ was calculated as follows:

$$IRSW_{adj} = \frac{ED_{6-16}(10\,years) \times IRSW_{site-specific}(0.0125L/day)}{BW_{adult}(70kg)}$$

  The CTE $IRSW_{adj}$ of 0.0011 L-year/kg-day was calculated using above equation but assuming a CTE IRSW of 0.03 L/day (about 1 ounce) on one-fourth of total days.

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects (EPA 2008b). The $IRSW_{adj}$ for mutagens ($IRSW[M]_{adj}$) of 0.0054 L-year/kg-day is based on the $IRSW_{adj}$ exposure assumptions and an ADAF value of 3. The $IRSW(M)_{adj}$ was calculated as follows:

$$IRSW(M)_{adj} = \frac{ED_{6-16}(10\,years) \times IRSW_{site-specific}(0.0125L/day) \times 3}{BW_{adult}(70kg)}$$

  The CTE $IRSW(M)_{adj}$ 0.0032 L-year/kg-day was calculated using above equation but assuming a CTE IRSW of 0.03 L/day (about 1 ounce) on one-fourth of total days.

- The RME and CTE surface water FI term conservatively assumes that 100 percent of incidental surface water ingestion occurs on site.

- The RME and CTE age-adjusted surface water dermal contact rate ($DFSW_{adj}$) of 643 cm^2-year/kg is based on the default ED and BW values used to calculate age-adjusted rates for residents 6 to 16 years old (EPA 2008b) and a site-specific SA that assumes exposure of the hands, feet, and lower legs to surface water (EPA 2004b). The $DFSW_{adj}$ was calculated as follows:

$$DFSW_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{site-specific}(4{,}499cm^2)}{BW_{adult}(70kg)}$$

- EPA assumes that adolescents 6 to 16 years old are three times more susceptible to potential mutagenic effects (EPA 2008b). The RME and CTE $DFSW_{adj}$ for mutagens ($DFSW[M]_{adj}$) of 1,928 cm^2-year/kg is based on the $DFSW_{adj}$ exposure inputs and an ADAF value of 3 and was calculated as follows:

$$DFSW(M)_{adj} = \frac{ED_{6-16}(10\,years) \times SA_{site-specific}(4{,}499cm^2) \times 3}{BW_{adult}(70kg)}$$

- The RME EF of 43 days per year is based on best professional judgment and assumes a fisherman will fish at the site 2 days per week during the summer (13 weeks) and 1 day per week during

April, May, September, and October (17 weeks). For the CTE case, a fisherman is assumed to fish at the site 1 day per week during the summer and biweekly (twice a month) during April, May, September, and October. These assumptions result in a CTE EF of 21 days per year.

- The RME and CTE ET of 2 hours per day is based on best professional judgment. This variable is only used to estimate dermal exposure to surface water.

- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the ED and corresponds to a value of 3,650 days for the RME and CTE cases. The AT_c for both the RME and CTE cases represents an average 70-year lifetime and corresponds to 25,550 days.

Adult Fisherman Exposure Factors

The adult fisherman exposure factors for OU1 are presented in Attachment 1 in Tables 4.13a.RME and 4.13a.CTE for sediment and Tables 4.13b.RME and 4.13b.CTE for surface water and are summarized below.

- An RME IRSED of 100 mg/day was selected for the adult fisherman. This IRSED is the EPA default rate for residential adult soil exposure. Therefore, this value is considered a conservative estimate of IRSED. The CTE IRSED of 50 mg/day is based on best professional judgment and corresponds to one-half of the RME value.

- For fishermen, the RME and CTE sediment FI term of 0.125 was selected based on best professional judgment. The FI term assumes that a fisherman has 16 total hours of activity time per day and will spend 2 of these hours on site.

- The RME and CTE sediment AF of 0.3 mg/cm^2 is the EPA (2002b) value for reed gatherers.

- It was assumed that the hands and feet are potentially exposed to sediment during fishing. The RME and CTE sediment SA of 2,129 cm^2 is the average skin surface area of the hands and feet of adult males and females.

- An RME IRSW of 0.0125 L/day was selected for the adult fisherman. A fisherman is assumed to incidentally ingest 0.05 L/day on one-fourth of total days. For the CTE case, the IRSW of 0.0075 L/day assumes a fisherman ingests 0.03 L/day (about 1 ounce) on one-fourth of total days.

- It was conservatively assumed that 100 percent of surface water ingestion occurs on site (FI = 1).

- It was assumed that the hands, feet, and lower legs are potentially exposed to surface water during fishing. The RME and CTE surface water SA of 4,499 cm^2 is the average skin surface area of the hands, feet, and lower legs of adult males and females.

- The RME EF of 43 days per year is based on best professional judgment and assumes a fisherman will visit the site 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks). For the CTE case, a fisherman is assumed to visit the site 1 day per week during the summer and biweekly (twice a month) during April, May, September, and October. These assumptions result in a CTE EF of 21 days per year.

- The EDs of 25 and 9 years are the EPA (1991) default RME and CTE values, respectively, for residents.

- Based on best professional judgment, the ET for the RME and CTE surface water exposure scenarios was assumed to be 2 hours per day. The ET term is only included in the chronic daily surface water exposure equation for dermal contact.

- The RME and CTE BW of 70 kg is the EPA (1989) default adult body weight.

- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the ED and corresponds to a value of 10,950 days for the RME and 3,285 days for CTE cases. The AT_c for both the RME and CTE scenarios represents an average 70-year lifetime and corresponds to 25,550 days.

2.3.4.9 Current and Future Fish Consumer

As discussed below, three ages of populations, children (3 to 6 years old), adolescents (6 to 16 years old), and adults (more than 16 years old) could consume fish caught in the LVR at OU1.

Current and Future Child Fish Consumer

As discussed in Section 2.2.5.3, for scenarios involving receptors 0 to 16 years old, age-adjusted values are used to estimate exposure. The age-adjusted child consumer of fish exposure factors are presented for OU1 in Tables 4.14.RME and 4.14.CTE of Attachment 1 and are summarized below.

- The RME age-adjusted fish ingestion rate (IRF_{adj}) of 0.0024 kg-year/kg-day was calculated as follows, where the RME fish ingestion rate (IRF) of 0.0012 kg/day is the 95th percentile per capita freshwater fish intake rate for children 3 to 6 years old (EPA 2008d):

$$IRF_{adj} = \frac{ED_{3-6}(3years) \times IRF_{3-6}(0.012kg/day)}{BW_{child}(15kg)}$$

  The CTE IRF_{adj} of 0.00044 kg-year/kg-day was calculated using above equation but assuming a CTE IRF of 0.0022 kg/day, which is the mean per capita freshwater fish intake rate for children 3 to 6 years old (EPA 2008d).

- EPA assumes that children 3 to 6 years old are three times more susceptible to potential mutagenic effects (EPA 2008b). The RME IRF_{adj} for mutagens ($IRF[M]_{adj}$) of 0.0072 kg-year/kg-day is based on the IRF_{adj} exposure inputs and an ADAF value of 3 and was calculated as follows:

$$IRF(M)_{adj} = \frac{ED_{3-6}(3years) \times IRF_{3-6}(0.012kg/day) \times 3}{BW_{child}(15kg)}$$

  The CTE $IRF(M)_{adj}$ of 0.0013 kg-year/kg-day was calculated using above equation but assuming a CTE IRF of 0.0022 kg/day, which is the mean per capita freshwater fish intake rate for children 3 to 6 years old (EPA 2008d).

- The RME and CTE fish consumption FI term of 0.25 was selected based on best professional judgment. The FI term assumes 25 percent of fish ingested are from the site.

- The RME and CTE EF of 350 days per year is the EPA (1991) default value for fish consumption.

- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the ED and corresponds to a value of 1,095 days for the RME and CTE cases. The AT_c for both the RME and CTE scenarios represents an average 70-year lifetime and corresponds to 25,550 days.

Current and Future Adolescent Fish Consumer

As described in Section 2.2.5.3, for scenarios involving receptors 0 to 16 years old, age-adjusted values are used to estimate exposure. The age-adjusted adolescent consumer of fish exposure factors for OU1 are presented in Tables 4.15.RME and 4.15.CTE of Attachment 1 and are summarized below.

- The RME IRF_{adj} of 0.0028 kg-year/kg-day was calculated as follows, where the RME IRF of 0.0195 kg/day is the average of the 95th percentile per capita freshwater fish intake rate for children 6 to 11 years old (0.013 kg/day) and adolescents 11 to 16 years old (0.026 kg/day) (EPA 2008d) and the body weight is the EPA (2008b) recommended value for calculating age-adjusted rates for residents 6 to 16 years old:

$$IRF_{adj} = \frac{ED_{6-16}(10 years) \times IRF_{6-16}(0.0195 kg/day)}{BW_{adult}(70 kg)}$$

  The CTE IRF_{adj} of 0.00052 kg-year/kg-day was calculated using above equation but assuming a CTE IRF of 0.00365 kg/day, which is the average of the mean per capita freshwater fish intake rate for children 6 to 11 years old (0.003 kg/day) and children 11 to 16 years old (0.0043 kg/day) (EPA 2008d).

- EPA assumes that children 6 to 11 years old are three times more susceptible to potential mutagenic effects (EPA 2008). The RME $IRF(M)_{adj}$ of 0.0084 kg-year/kg-day is based on the IRF_{adj} exposure inputs and an ADAF value of 3 and was calculated as follows:

$$IRF(M)_{adj} = \frac{ED_{6-16}(10 years) \times IRF_{6-16}(0.0195 kg/day) \times 3}{BW_{adult}(70 kg)}$$

  The CTE $IRF(M)_{adj}$ of 0.0016 kg-year/kg-day was calculated using above equation but assuming a CTE IRF of 0.00365 kg/day, which is the average of the mean per capita freshwater fish intake rate for children 6 to 11 years old (0.003 kg/day) and children 11 to 16 years old (0.0043 kg/day) (EPA 2008d).

- The RME and CTE fish consumption FI term of 0.25 was selected based on best professional judgment. The FI term assumes 25 percent of fish ingested are from the site.

- The RME and CTE EF of 350 days per year is the EPA (1991) default value for fish consumption.

- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the ED and corresponds to a value of 3,650 days for the RME and CTE cases. The AT_c for both the RME and CTE scenarios represents an average 70-year lifetime and corresponds to 25,550 days.

Current and Future Adult Fish Consumer

The adult consumer of fish exposure factors for OU1 are presented in Tables 4.16.RME and 4.16.CTE of Attachment 1 and are summarized below.

- The RME IRF of 0.025 kg-day is the 95th percentile fish intake rate for adult recreational anglers (EPA 1997b). The CTE IRF of 0.008 kg-day is the mean fish intake value for adult recreational anglers (EPA 1991).
- The RME and CTE fish consumption FI term of 0.25 was selected based on best professional judgment. The FI term assumes 25 percent of fish ingested are from the site.
- The RME and CTE EF of 350 days per year is the EPA (1991) default value for fish consumption.
- Consistent with EPA (1989) guidance, the AT_{nc} is equal to the ED and corresponds to a value of 3,650 days for the RME and CTE cases. The AT_c for both the RME and CTE scenarios represents an average 70-year lifetime and corresponds to 25,550 days.
- The EDs of 25 and 9 years are the EPA (1991) default RME and CTE values, respectively, for residents.
- The RME and CTE BW of 70 kg is the EPA (1989) default adult body weight.

Consistent with EPA (1989) guidance, the averaging time ATnc is equal to the exposure duration and corresponds to a value of 10,950 days for RME and 3,285 days for CTE; the ATc for both RME and CTE represents an average 70-year lifetime and corresponds to 25,550 days.

2.4 TOXICITY ASSESSMENT

The risk assessment will use the default toxicity values presented in the EPA RSL tables (EPA 2008b). The default values were obtained from the following sources in the order in which they are presented below:

- Integrated Risk Information System (IRIS) on-line database (EPA 2008a)
- Provisional Peer Reviewed Toxicity Values (PPRTV) derived by EPA's Superfund Health Risk Technical Support Center for the EPA Superfund program
- The Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk levels (MRL)

- The California Environmental Protection Agency/Office of Environmental Health Hazard Assessment's toxicity values
- The EPA Superfund program's Health Effects Assessment Summary Tables (HEAST)

Toxicity criteria are typically only available for oral (reference dose [RfD] or slope factor [SF]) and inhalation (reference concentration [RfC] or unit risk factor [URF]) exposures. For the risk assessments, dermal RfDs and SFs will be extrapolated from oral RfDs and SFs using the constituent-specific gastrointestinal absorption (GIabs) factor (unitless) recommended in RAGS, Part E, Supplemental Guidance for Dermal Risk Assessment (EPA 2004b). Specifically, extrapolations will be conducted only for chemicals with GIabs factors less than 50 percent (EPA 2004b). For all other chemicals, oral RfDs or SFs will be used to characterize hazards and risks from dermal exposures. Route-to-route extrapolation from oral to inhalation toxicity values will not be conducted. Use of surrogate toxicity values for non-carcinogens will be conducted on a case-by-case basis. Surrogate toxicity values will not be used for carcinogens because of the variability in carcinogenic mode of action between seemingly similar chemicals.

2.5 RISK CHARACTERIZATION

This section discusses the calculation of potential cancer risks, calculation of potential non-cancer risks, the risk evaluation for lead, and the risk evaluation for asbestos.

2.5.1 Calculation of Potential Cancer Risks

Excess lifetime cancer risks (ELCR) will be estimated using the exposure assumptions and toxicity factors described in the previous sections and the following general equation for estimating chemical-specific cancer risks:

$$ELCR = CDI \times SF \text{ or}$$

$$ELCR = CDE \times URF$$

where

ELCR	=	Theoretical excess lifetime cancer risk (unitless)
CDI	=	Chronic daily intake (mg/kg-day)
CDE	=	Chronic daily exposure (microgram per cubic meter [$\mu g/m^3$])
SF	=	Cancer slope factor (risk per mg/kg body weight-day)
URF	=	Inhalation unit risk factor ($\mu g/m^3$)

Cumulative ELCRs for each receptor will be summed across all exposure pathways. The EPA acceptable cancer risk range of 1 in 1 million to 1 in 10,000 (1×10^{-6} to 1×10^{-4}) (EPA 1989) will be used as the benchmark for identifying potentially unacceptable risks at the M&H Site. Individual constituents that contribute greater than a 1×10^{-6} cancer risk to a cumulative cancer risk greater than 1×10^{-4} for a given receptor-exposure scenario will be identified as constituents of concern and addressed in the FSs.

2.5.2 Calculation of Potential Non-Cancer Risks

Potential non-cancer risks for individual COPCs will be expressed as hazard quotients (HQ) (EPA 1989). HQs will be calculated using the exposure assumptions and toxicity factors described in the previous sections and the following general equations for estimating chemical-specific non-cancer hazards:

$$HQ = CDI / RfD \text{ or}$$

$$HQ = CDE / RfC$$

where

HQ	=	Hazard quotient (unitless)
CDI	=	Chronic daily intake (mg/kg-day)
CDE	=	Chronic daily exposure (mg/m^3)
RfD	=	Reference dose (hazard per mg/kg body weight-day)
RfC	=	Inhalation reference concentration (mg/m^3)

The HQs will be summed to yield a multiple-chemical hazard index (HI) and a target-organ-specific HQ. EPA's benchmark value of 1 for groups of chemicals that affect the same target organ (EPA 1989) will be used to identify potentially unacceptable risks associated with the M&H Site.

2.5.3 Risk Evaluation for Lead

The EPA IEUBK model and ALM will be used for assessing potential risks associated with exposure to lead at the M&H Site for residents and non-residents, respectively (EPA 2009b).

2.5.4 Risk Evaluation for Asbestos

Friable asbestos has been detected throughout OU2, especially in the Main Plant Area. Potential exposure is expected to occur through inhalation. Historically, potential risks associated with exposure to asbestos-contaminated soils were qualitatively evaluated by comparing site-specific asbestos

concentrations in soil to a level of greater than 1 percent asbestos, the definition of "asbestos-containing material" (ACM) as defined in the National Emission Standards for Hazardous Air Pollutants (40 CFR Part 61). However, EPA now believes that "the 1% definition may not be reliable for assessing potential human health hazards from asbestos contaminated soils at Superfund sites" (EPA 2008c). EPA's current guidance for assessing Superfund sites contaminated with asbestos is presented in its "Framework for Investigating Asbestos-Contaminated Superfund Sites" (Framework) (EPA 2008c). Potential exposure to asbestos-contaminated soil at OU2 will be evaluated consistent with EPA's Framework, which presents an asbestos decision framework of six steps and two risk management decision points (RMDP). The steps and RMDPs are listed below, along with the status of each as applicable.

- **Step 1 – Review all available site information.** ACMs (for example, insulation in the form of wrappings and tiles) were used throughout the Main Plant area.
- **Step 2 – Has there been (or is there a threat of) a release?** ACM-building debris is present throughout OU2, especially in the Main Plant Area.
- **Step 3 – Are human exposure pathways currently present and complete?** Trespassing currently occurs at OU2. Receptor-specific exposure through inhalation could be occurring.
- **Step 4 – Preliminary environmental sampling.** EPA's Framework recommends activity-based sampling "at a location with high source level and under conditions of high-end disturbance." To date, only static air samples have been collected and analyzed for asbestos. Air samples were collected under ambient conditions without simulation of a "high-end soil disturbance," for example, EPA's recommended generic "raking scenario." Asbestos has not been detected in any air samples collected at OU2.
- **RMDP 1** – This RMDP has not been made and will be made based on HHRA results for OU2. The primary question is whether asbestos is present in air at concentrations that represent a level of concern. EPA has generated a series of generic activity-specific levels of concern (remediation goals) ranging from 0.00043 fibers per cubic centimeter (f/cc) (lifetime exposure) to 0.053 f/cc (jogging). As noted under Step 4, results for all air samples collected at OU2 have been non-detect for asbestos.
- **Step 5 – More detailed environmental sampling.** The need for more detailed environmental sampling will depend on result of RMDP 1. One outcome could be the collection of air samples under high-end soil disturbance conditions (the raking scenario).
- **RMDP 2** – This RMDP has not been made and will be made based on any additional environmental sampling.
- **Step 6 – Implement response action or institutional controls.** This step will take place as part of the site-specific FS.

In summary, potential exposure to asbestos-contaminated soil will be evaluated in accordance with EPA's Framework using all available soil and air sampling results for asbestos (EPA 2008c). Activity-based asbestos air sampling will be conducted at OU2 in late spring or early summer. The results of the activity-based air sampling will be used as the primary basis for assessing the potential exposure to asbestos by human receptors and characterizing the potential risks posed by such exposures.

3.0 ECOLOGICAL RISK ASSESSMENTS

As described in Section 1.0, SulTRAC is currently providing technical support for both the PRP-lead RI/FS (WA No. 015-RSBD-B568) and the fund-lead RI/FS (Was No. 016-RICO-B568 and 032-RICO-B568). As part of the RI/FS, an ERA will be performed for the M&H Site inclusive of all OUs based on data collected during the Phase I and II field activities. On October 22 and 23, 2008, SulTRAC personnel conducted field investigations as part of the Phase I RI to evaluate ecological habitats at OU2 of the M&H Site (EPA No. IL0000064782). In October 2007, Carus' contractor, Geosyntec, conducted field investigations to evaluate ecological habitats at OU1 of the M&H Site. SulTRAC and Geosyntec compared and discussed the results of their investigations to ensure that the entire M&H Site was addressed.

Formulation of this technical approach was based on information from field investigations conducted in October 2007 and the results of the Phase I RI activities conducted during Summer and Fall 2007 that encompassed field and other activities to characterize and identify contamination at OU1 and OU2. Additional data collected by SulTRAC during Phase II in Summer and Fall 2008 provides further support for the risk assessments, as will data from the Phase II activities to be conducted by Geosyntec scheduled for Summer and Fall 2009.

Sections 1.1 and 1.2 of this document include brief site and habitat descriptions to provide a context for the technical approach. Descriptions of approaches to the SLERA and BERA are presented below. Although OU1 and OU2 are being evaluated under separate RIs, the technical approach and methodology for conducting the ERAs is generally the same, and SulTRAC and Geosyntec have coordinated and closely collaborated on these issues. However, there may be slight deviations from the approach presented herein as the ERAs are conducted.

3.1 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT

The SLERA will be conducted consistent with EPA ERA guidance for Superfund sites (EPA 1997a). Two steps are involved in conducting a SLERA: (1) problem formulation and (2) screening level exposure estimate and risk calculation. Upon completion of Steps 1 and 2, there is a scientific management decision point (SMDP) with one of the three possible decisions as summarized below.

1. There is enough information to conclude that potential ecological risks are very low or nonexistent and therefore no further action is warranted at the site on the basis of ecological risk.

2. The information is not adequate to make a decision at this point, and the ERA process will proceed to a BERA (Steps 3 through 8).

3. The information indicates a potential for adverse ecological effects, and a more thorough study is necessary (a BERA).

The following sections discuss problem formulation and screening-level exposure estimates and risk calculations for the SLERA.

3.1.1 Problem Formulation

The objective of the problem formulation step is to collect sufficient information concerning the M&H Site to develop a CSM. The CSM will include a fate and transport diagram that traces the contaminants' movements through the ecosystem and identifies potential exposure pathways and receptors. One of the major goals of the CSM is to identify complete exposure pathways and receptors at potential risk. As noted in Section 1.0, previously collected information on the environmental setting has led to identification of the M&H Site's sources of contamination and preliminary characterization of the ecological habitats. For the purposes of the RI, EPA has divided the M&H Site into two OUs, OU1 and OU2. For the purposes of the ERA, each OU has been subdivided into exposure areas on the basis of habitat cover type, current land use, and anticipated future redevelopment. As shown in Figure 3, OU1 exposure areas and their dominant habitat types are as follows:

- Carus Plant (highly disturbed)
- Slag Pile (highly disturbed)
- Areas adjacent to the Slag Pile (disturbed with vegetation)
- LVR (riverine)

As shown in Figure 4, at OU2 the exposure areas and their dominant habitat types are as follows:

- Main Plant Area (highly disturbed);
- Areas adjacent to the Main Plant Area (disturbed with vegetation; woodlands-grasslands);
- Savanna
- Oak Hickory Woodland

Constituents of interest at the M&H Site were identified based on historical operations and previous investigations. The data collected during the RI Phase I provide a general understanding of contaminants

present in the various media at OU1 and OU2 and concentration levels. Additional data will be collected during Phase II to fill the data gaps identified after the available data are evaluated. The major COPECs currently identified in OU1 and OU2 include metals (cadmium, copper, lead, mercury, and zinc) and PAHs. Trichloroethene (TCE) and PCBs have also been identified as COPECs in OU2. All the available data will be reviewed to identify all contaminants detected at each OU1 and OU2 exposure area and to identify definitive COPECs for the SLERA.

Soil is the major contaminated medium identified for uplands at the M&H Site. Impacts to soil are primarily the result of historical coal mining and smelting operations. In addition, a 6-acre Slag Pile is located in the southeast portions of the former smelting property at OU1 along the bank of the LVR. Surface water runoff from OU1 and Slag Pile flows directly into the LVR, potentially transporting site-related materials to sediment, surface water, and biota in the LVR. Surface water at OU2 is limited to depressions that collect surface water runoff. Constituents deposited in soil also could leach to groundwater, and groundwater is believed to discharge to the LVR.

During the ecological habitat evaluation, a variety of receptors were observed at the M&H Site, and other receptors, although not observed directly, are likely present. This information has been used to develop preliminary CSMs for the ERA for the Site (OU1 and OU2) (Figure 9). If necessary, the CSM will be reviewed and modified after reception and review of the Phase II data. The CSM notes a number of complete exposure pathways for terrestrial receptors, including plants, invertebrates, avians, and mammals in the terrestrial portions of the M&H Site, and benthic invertebrates, fish, reptiles, amphibians, avians, and mammals associated with the LVR.

Endpoints for a screening level assessment are any adverse effects on ecological receptors. For the upland terrestrial portions of OU1 (the Carus Plant, Slag Pile, and disturbed areas next to the Slag Pile) and OU2, the focus will be on plant, invertebrate, avian, and mammalian receptors. For the aquatic portions of OU1 (the LVR), the focus will be on benthic, aquatic (fish), and upper-trophic level, semi-aquatic avian and mammalian receptors. The general ecological management goal that will guide selection of assessment endpoints is summarized below.

- Ensure adequate protection of ecological systems within the impacted areas of the M&H Site by protecting them from the deleterious effects of acute and chronic exposures to site-related COPECs.

The specific assessment endpoints for the SLERA are summarized below.

- Ensure adequate protection of terrestrial plant and soil communities, including native plant communities, by protecting them from the deleterious effects of acute and chronic exposures to site-related COPECs.

- Ensure adequate protection of mammal and bird populations by protecting them from the deleterious effects of acute and chronic exposures to site-related COPECs.

- Ensure adequate protection of threatened and endangered species (including candidate species) and species of special concern and their habitats by protecting them from the deleterious effects of acute and chronic exposures to site-related COPECs.

- Ensure adequate protection of the aquatic communities in LVR by protecting them from the deleterious effects of acute and chronic exposures to site-related COPECs due to surface water and groundwater discharges.

- Ensure adequate protection of the aquatic-dependent avian and mammalian populations along the shoreline of the LVR by protecting them from the deleterious effects of acute and chronic exposures to site-related COPECs due to biotic uptake of COPECs in sediment and surface water.

"Adequate protection" generally is defined as protection of the growth, reproduction, and survival of local populations. That is, the focus is on ensuring the sustainability of the local population rather than on protection of every individual in the population, although federal- and state-identified threatened and endangered species will be considered.

It is anticipated that exposure will occur through direct contact, ingestion, and, to a lesser degree, dermal contact and inhalation. Several potential sources were reviewed to identify appropriate screening levels for the ERA, including those recommended in IEPA's comment letter dated April 10, 2009 (IEPA 2009). Based on this review, the endpoint measures for the terrestrial communities at OU1 and OU2 will be soil screening levels available from the sources listed below. These sources will be used in the order of preference as they are listed below. This approach is consistent with IEPA guidance (IEPA 2009) and appropriate for the contaminant sources present at the M&H Site. Therefore, it is believed that this approach will provide a conservative screening level estimate of potential ecological risks.

1. EPA. 2008. Ecological Soil Screening Levels (Eco-SSLs). Last Updated May 21, 2008. On-line Address: http://www.epa.gov/ecotox/ecossl/

2a. Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory (ORNL), Oak Ridge, TN. 128 Pages. ES/ER/TM-85/R3. On-line Address: http://www.esd.ornl.gov/programs/ecorisk/documents/tm85r3.pdf

2b. Efroymson, R.A., M.E Will, and G.W. Suter II. 1997. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic

Processes: 1997 Revision. ORNL, Oak Ridge TN. ES/ER/TM-126/R2. On-line Address: http://www.esd.ornl.gov/programs/ecorisk/documents/tm126r21.pdf

2c. Efroymson, R.A., G.W. Suter, II, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals for Ecological Endpoints. ORNL, Oak Ridge, TN. 50 Pages. ES/ER/TM-162/R2. On-line Address: http://www.esd.ornl.gov/programs/ecorisk/documents/tm162r2.pdf

3a. Crommentuijn, T, D.F. Kalf, M.D. Polder, R. Posthumus, and E. J. van de Plassche. 1997. Maximum Permissible Concentrations and Negligible Concentrations for Pesticides. RIVM Report No. 601501002. On-line Address: http://www.contaminatedland.co.uk/std-guid/dutch-l.htm

3b. Crommentuijn, T, M. D. Polder, and E. J. van de Plassche. 1997. Maximum Permissible Concentrations and Negligible Concentrations for Metals, Taking Background Concentrations into Account. RIVM Report No. 601501001. On-line Address: http://www.contaminatedland.co.uk/std-guid/dutch-l.htm

4. EPA. 2003. Region 5 Ecological Screening Levels. On-line Address: http://www.epa.gov/reg5rcra/ca/edql.html/

Screening-level concentrations protective for each of the major terrestrial receptor groups noted above will be identified.

The endpoint measures for the aquatic communities of OU1 and OU2 will be aquatic life water quality standards for the State of Illinois (IPCB 2008). For the aquatic community, the water concentrations will be compared to the Illinois Water Quality Standards (IWQS) for chronic and acute exposures (IPCB 2008). If the ratio is greater than 1, a potential risk will be considered indicated. When constituent-specific criteria are not provided by the IWQS criteria provided in EPA's National Recommended Water Quality Criteria will be used to evaluate potential risks. Finally, when constituent-specific criteria are not provided by these sources, EPA Region 5's Eco-SSLs (EPA 2003b) will be used. Constituents for which no aquatic life criteria are available from the sources identified above will be carried forward into the BERA, as applicable, for further risk evaluation.

Because sediment has no federal or state standards, the sediment constituent concentrations will be compared to several sources for guidelines or criteria. The sediment metals concentrations will be compared to the threshold effects concentrations from MacDonald, Ingersoll, and Berger (2000), and PAH screening levels will be determined following EPA (2005c) guidance. For all other constituents, screening levels will be obtained from EPA Region 5 Eco-SSLs (EPA 2003b). Illinois-specific sediment background criteria also are available from IEPA's Bureau of Water documents titled "Classification for Illinois Inland Lakes" and "Evaluation of Illinois Sieved Stream Sediment Data." These criteria will be

considered in the interpretation of the sediment screening level evaluation and in the selection of constituents carried forward into the BERA.

3.1.2 Screening-Level Exposure Estimates and Risk Calculations

As noted in Section 3.1.1, OU1 consists of three unique habitats: (1) highly disturbed (the Carus Plant and Slag Pile), (2) disturbed with vegetation (areas associated with and next to the Slag Pile) and (2) riverine (the LVR). OU2 consists of four unique terrestrial habitats: (1) highly disturbed (Main Plant Area), (2) disturbed with vegetation (Main Plant Area), (3) savanna, and (4) oak hickory woodland. The assessment will focus on the most biologically active portion of the surface soils from 0 to 12 inches bgs. The soil dataset will be segregated by each exposure area and evaluated to identify the maximum detected concentration for each contaminant. This concentration will be used as the screening level exposure estimate. It will be assumed that the area use factor is 1, that all contaminants are 100 percent bioavailable, and that the most sensitive life stage will be exposed. These assumptions will be used in conjunction with the screening levels noted above to assess potential risks. An HQ will be calculated for each contaminant for each receptor group by determining the ratio of the exposure concentrations to the screening levels for each receptor group. If the HQ is greater than 1, a potentially unacceptable risk will be considered identified. For habitats that do not have a COPEC HQ that exceeds 1, the HQs for COPECs with the same toxic mechanism will be added to determine the HI for the habitat. If this HI is greater than 1, a potentially unacceptable risk will be considered identified. HIs exceeding 1 likely will be limited to PAH- or dioxin-like chemicals.

Based on a preliminary review of the available data, each habitat is expected to show HQs greater than 1 for at least one and likely several receptor groups. Based on these results, it is anticipated that management will recommend a BERA for selected OU1 and OU2 exposure areas.

One of the final objectives of the SLERA is to identify potential ecological risks that should be further characterized and refined in the BERA. This objective is accomplished through collection of additional data and development of more refined and realistic exposure assumptions to estimate exposures, toxicities, and related risks. In order to effectively evaluate the ecological risks associated with a site, understanding the ecological management goals for that site is important. Significant portions of the M&H Site, including OU1 and OU2, have been used solely for industrial operations since the mid-1800s. Land use for portions of OU1 is not anticipated to change in the future. Long-term land use associated with OU2 is less certain, although a portion of OU2 likely will remain industrial or commercial in use for the foreseeable future.

The ecological evaluation identified two habitats, disturbed and disturbed with vegetation, that represent OU1 and OU2 areas used for past industrial purposes and that now contain the highest levels of contamination. In some of these areas, the SLERA is expected to result in HQs greater than 500. The highly disturbed and disturbed area habitat quality is very low, in part because of the soils composition (or lack of soils), which limits the ability to support vegetation. The soils in these habitats are composed primarily of slag, sinter, and, in OU2, building debris from the smelting operation in this area. The disturbed area with vegetation habitat quality is slightly better, as indicated by its ability to support limited vegetation. The composition of the soil is still dominated by slag and sinter. This situation has resulted in a sparse and degraded habitat for ecological receptors.

SulTRAC and Geosyntec recommend excluding from the BERA the two habitats at OU1 and OU2 classified as highly disturbed and disturbed with vegetation. The current high levels of contamination and the physical nature of the soil identified for these two habitat types clearly represent a degraded habitat capable only of supporting limited growth of opportunistic species and that presents no value as foraging habitat for wildlife.

The SLERA will clearly result in HQs greater than 1, and further evaluation will not provide significant additional refinement of potential risks or contribute useful information for the FSs for remedial actions. The highly disturbed and disturbed with vegetation habitats at the M&H Site have a long history of industrial use, and their status is not likely to change because of their proximity to the current industrial operations at OU1, which likewise supports highly disturbed habitats and disturbed habitats with vegetation. Thus, the ecological management goal for these habitats at OU1 and OU2 will likely continue to be industrial use. The information collected during the SLERA will be sufficient to identify an unacceptable ecological risk for these areas to support a management decision to remediate the site or place an institutional control on the site limiting its use to industrial or commercial land use. The focus of the BERA will be risks associated with contamination identified in the LVR (OU1) and the savanna and oak hickory woodland at OU2. These habitats have the highest quality at the M&H Site and represent the most valuable ecological resources at the site.

3.2 BASELINE ECOLOGICAL RISK ASSESSMENT

A BERA will be conducted on the riverine habitat of the LVR (OU1), the savanna habitat of OU2, and the oak hickory woodland habitat of OU2 consistent with EPA's ERA guidance for Superfund sites (EPA 1997a). Each step involved in conducting a BERA is discussed below (problem formulation and study design and risk characterization).

3.2.1 Problem Formulation

The objective of problem formulation for a BERA is to establish the risk assessment goals and focus, characterize potential ecological effects, update the CSM, refine exposure pathways, and establish assessment endpoints.

As stated in Section 3.1.2, the focus of the BERA will be the two habitats of highest quality at OU2, savanna and oak hickory woodland, and the riverine habitat associated with the LVR at OU1. As an initial step in BERA problem formulation, COPECs identified during the SLERA will be re-evaluated to determine if it is appropriate for the BERA to focus on a reduced number of COPECs. The COPECs not carried forward into the BERA may include constituents that pose a negligible risk based on their maximum concentrations or that were detected in a very low percentage of samples (less than 5 percent) and therefore that do not represent a hot spot.

General ecological effects of COPECs will be described in the SLERA problem formulation discussion. SulTRAC and Geosyntec will collectively review the toxicity literature for the COPECs included in the BERA to identify toxicity reference values (TRV) based on the no observed adverse effect level (NOAEL) and the lowest observed adverse effect level (LOAEL). The toxicity mechanism and function (acute or chronic) for each TRV also will be identified.

Potentially complete exposure pathways will have been identified in the SLERA. Part of the next phase of the problem formulation will be to refine the CSM based on site-specific conditions. The fate and transport of each COPEC significantly affects potential exposures at the site and potential toxicity response. Metals are anticipated to be one of the prominent contaminant groups at OU1 and OU2, and several major fate and transport factors may influence their movement at the M&H Site. The overriding concern associated with the fate and transport of metals is their bioavailability and ultimate movement within and through the food chain. Soil oxidation-reduction conditions and pH impact the solubility and bioavailability of metals. Also, soil matrix conditions and how tightly the metals are bound within the slag materials will impact bioavailability. These factors will be reflected in the bioaccumulation of contaminants in soil invertebrates and plants.

To complete the CSM for the problem formulation step, endpoints to be evaluated in the risk assessments will be identified. The assessment endpoints evaluated in the SLERA will be reviewed and modified as needed based on additional data collected during the RI Phase II. The BERA endpoints will focus on specific exposure pathways for a variety of receptors. In the upland terrestrial portions of OU2, these endpoints may include the following:

- Function and viability of the terrestrial plant community
- Function and viability of the soil invertebrates community
- Function and viability of the herbivorous mammalian community
- Function and viability of the soil invertebrate-consuming mammalian community
- Function and viability of the omnivorous mammalian community
- Function and viability of the carnivorous mammalian community
- Function and viability of the soil invertebrate-consuming avian community
- Function and viability of the omnivorous avian community
- Function and viability of the carnivorous avian community

In the riverine habitats of the LVR (OU1), these endpoints may include the following:

- Function and viability of the aquatic community
- Function and viability of the omnivorous mammalian community along the shoreline
- Function and viability of the piscivorous avian community along the shoreline

3.2.2 Study Design and Risk Characterization

The next step in the BERA will be to prepare a study design based on the problem formulation. The design will clearly identify the lines of evidence and the endpoint measures to verify achievement and maintenance of assessment endpoints. The following sections discuss the aquatic habitat study design, the terrestrial habitat study design, and the food-chain model (FCM).

3.2.2.1 Aquatic Habitat Study Design (LVR – OU1)

To assess the function and viability of the aquatic community within the LVR, a biological community assessment will be conducted during Phase II of the RI currently scheduled for Summer and Fall 2009. Field studies targeting fish and benthic macroinvertebrates (aquatic insects and mollusks) will be conducted in accordance with IEPA- and IDNR-established sampling and bioassessment protocols. This approach will yield an indication of the biotic integrity of the aquatic community in the LVR bordering OU1 and OU2.

IDNR and IEPA have developed protocols for determining the biological integrity of Illinois streams based on biological community data collected in the field. IDNR has developed the fish community "Index of Biotic Integrity," and IEPA has developed the "Stream Condition Index" based on macroinvertebrate community structure. Both indices are used by IEPA to help assess attainment of Aquatic Life Use in Illinois streams in the context of CWA compliance (i.e., Section 303[d] impairment determinations).

Both the biotic integrity and stream condition indices employ a "multi-metric" scoring approach that places a value on a specific metric's deviation from an expected value. The lower the deviation, the greater the score for the metric. The metrics serve as useful indicators of the effect of human influences on the environment (in this case, potential site-related impacts to the aquatic community of the LVR).

The results of this effort will be used during the risk characterization phase as a weight-of-evidence approach. The approach will qualitatively integrate the exposure profile and stress-response analysis (community assessment).

To assess the function and viability of the omnivorous mammalian and piscivorous avian communities along the shoreline of the LVR, Geosyntec will use an FCM (see Section 3.2.2.3) to estimate exposures and compare these exposure doses to high and low TRVs. The risk to each representative species will be characterized using an HQ based on this comparison. Medium-specific EPCs will be calculated using EPA's ProUCL Version 4.00.00 statistical program (EPA 2007a)[2]. Both the median and 95 percent UCL values will be identified and used in the BERA risk calculations. Median and maximum values will be used if the number of samples or detected values are insufficient to perform statistical analyses.

To make the LVR FCM more site-specific, Geosyntec will collect biotic tissue data from one prey fish species, one freshwater mussel species, and one predator sportfish species. Target species will be subject to availability, but based on review of historical data, are anticipated to include the following:

- Prey fish species
  - Hornyhead chub (*Nocomis biguttatus*)
  - Spotfin shiner (*Cyprinella spiloptera*)
  - Central stoneroller (*Campostoma anomalum*) (alternate)

[2]Although ProUCL 4.00.02 has been publically released, an error for calculating H-UCL statistics was recently identified by Geosyntec. Therefore, the older version will be used.

- Bluntnose minnow (*Pimephales notatus*) (alternate)

- Predator sportfish species
  - Smallmouth bass (*Micropterus dolomieu*)
  - Largemouth bass (*M. salmoides*) (alternate)
- Freshwater mussel species
  - Unknown at this time; the most abundant, non-protected species will be selected in the field

Biotic samples will be collected from several transect locations within the LVR, and every effort will be made to retain the same species across sample reaches.

The biotic tissue information will be used to more accurately characterize the movement of sediment and surface water COPECs up the food chain and provide a better estimate of potential exposure for upper trophic-level receptors.

Sediment and surface water analytical data collected during Phase I and II of the RI also will be incorporated into the FCM to account for incidental ingestion that may occur during feeding.

3.2.2.2 Terrestrial Habitat Study Design (OU2)

For the plants and soil invertebrates, SulTRAC will compare the soil concentration data to screening levels. Medium-specific EPCs will be calculated using EPA's ProUCL Version 4.00.00 (EPA 2007a)[3] statistical program. Both the median and 95 percent UCL values will be identified and used in the BERA. An HQ based on soil concentration and screening values will be determined for each COPEC and receptor group to assess potential impacts.

To assess the potential impacts to other terrestrial receptors, SulTRAC will use an FCM to estimate the potential exposures. The terrestrial receptors will include primary consumers, omnivores, and carnivores. The FCM will focus on mammalian and avian receptors. SulTRAC will collect additional information as part of the Phase II RI to properly characterize the movements of some of the contaminants from soil up the food chain. To make the FCM more site-specific, SulTRAC will collect information on the uptake of soil-bound COPECs into vegetation, a significant food source for a number of site receptors. This information will be used to more accurately characterize potential exposures to receptors in the FCM.

---

[3] Although ProUCL 4.00.02 has been publically released, an error for calculating H-UCL statistics was recently identified by Geosyntec. Therefore, the older version will be used.

SulTRAC also will conduct laboratory soil bioaccumulation tests with earthworms and collect vegetation samples from areas with a range of known soil contamination levels.

Soil samples will be collected from several locations within each habitat of concern and sent to a laboratory for 28-day bioaccumulation tests with earthworms. SulTRAC also will identify locations at OU2 with elevated contamination and collect native herbaceous vegetation samples from these locations. The relevant part(s) of the browsed portions will be sampled. Each plant collected will be divided into two separate portions, aboveground and belowground, and each portion will be analyzed separately to determine COPEC concentrations in the roots and leafy parts of the plant. These data will provide an understanding of the bioaccumulation of COPECs in soil, their potential to move within the food chain, and food source contamination. Because some of the terrestrial receptors at OU2 are expected also to use the LVR as a food source, SulTRAC will obtain the biotic tissue contamination data collected by Geosyntec from the LVR within OU1, and this information will be used in the food chain model explained in the following section.

3.2.2.3 Food Chain Model

As described in previous sections, risks to upper-trophic level avian and mammalian species will be assessed using an FCM. The FCM assumes exposure to COPECs primarily through ingestion of contaminated environmental media (soil, sediment, and surface water) and prey. Exposure models estimate the mass of a COPEC internalized daily by a receptor per kilogram of body weight per day (the daily COPEC dosage). Estimates of exposure generally are based on knowledge of the spatial and temporal distribution of both COPECs and receptors, and on specific natural and life history characteristics that influence exposure to COPECs. Results for surface soil samples collected from 0 to 1 foot bgs will be used in FCMs to estimate doses to avian and mammalian receptors.

Daily doses will be estimated for each COPEC and representative receptor when adequate data are available and these models are appropriate. These doses will then be compared with high and low TRVs to estimate the potential adverse biological effects on the receptor. The risk to each representative species will be characterized using an HQ approach based on this comparison.

The total exposure from ingestion for each receptor of concern will be calculated as the sum of the dietary exposure estimates. The following generic equation was adapted for each representative receptor:

$$\text{Dose}_{\text{total}} = \frac{([\text{IR}_{\text{prey}} \times \text{C}_{\text{prey}}] + [\text{IR}_{\text{soil}} \times \text{C}_{\text{soil}}]) \times \text{SUF}}{\text{BW}}$$

where

$Dose_{total}$	=	Estimated dose from ingestion (mg/kg-day)
IR_{prey}	=	Ingestion rate of prey (kg/day)
C_{prey}	=	Concentration in DW of COPEC in prey (mg/kg)
IR_{soil}	=	Ingestion rate of soil (kg/day)
C_{soil}	=	Concentration in DW of COPEC in soil (mg/kg)
SUF	=	Site use factor (unitless)
BW	=	Adult body weight (kg)

The risk estimates will ensure that the assessment does not indicate little or no risk when a risk actually exists. Therefore, conservative assumptions will be used in this analysis in the absence of site- or species-specific data. Exposure will be assessed within the context of the following linear food chains to evaluate potential ecological effects on secondary consumer birds and mammals:

- Soil → Plants and Invertebrates → American Robin
- Soil → Small Mammals → American Kestrel
- Soil → Plants → Meadow Vole
- Soil → Plants and Invertebrates → Deer Mouse
- Soil → Small Mammals → Red Fox
- Soil → Plants, Invertebrates, Small Mammals and Aquatic Life → Raccoon
- Sediment → Benthos and Aquatic Life → Mink or River Otter
- Sediment → Benthos and Aquatic Life → Great Blue Heron or Kingfisher

Site-specific prey data may not be not available for use in the dose calculation described above. Therefore, bioaccumulation models will be used to estimate the concentrations of COPECs in prey tissue based on the concentrations of COPECs in soil or sediment. Soil-to-biota or sediment-to-biota bioaccumulation models for small mammals may be used, either as simple bioaccumulation factors (BAF) that can be multiplied by the concentration in the soil or sediment or as regression models that incorporate the concentration in soil or sediment to estimate the COPEC concentration in prey.

Updated ecological soil and sediment screening level (Eco-SSL) BAFs and regressions will be used whenever available (EPA 2005b). Additional regression models and simple BAFs (Bechtel-Jacobs Company, LLC 1998; ORNL 2008; Sample and Arenal 1999; Sample, Opresko, and Suter 1996; Baes, Sharp, Sjoreen, and Shor 1984) will be chosen if no Eco-SSL regression is available. A regression model will be applied only if the model is significant (the slope differs significantly [$p < 0.05$] from 0) and the coefficient of determination (R2) is greater than or equal to 0.6. If these criteria are not met, another regression model or BAF will be selected to estimate bioaccumulation. The Eco-SSL (EPA 2005b) BAFs will be retained instead of default BAFs for chemicals without any alternative invertebrate BAFs. A default value of 1 will be used for chemicals without any available BAFs.

The overall risks to the ecological receptors will be presented using a weight-of-evidence approach. This approach considers the various COPECs present, the uncertainties associated with the data collection methods, toxicity data, and risk estimation methods. It will also evaluate the laboratory and field data and the consistency between them, and how the field and laboratory data support the estimated risks. Presentation of the estimated risks based on both NOAEL and LOAEL TRVs will provide risk managers with an understanding of the potential range of risks for the ecological receptors. This understanding may also be used to develop site-specific remediation goals that could depend on the quality of the habitat to be protected or rehabilitated.

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FIGURES

1 Site Location
2 Site Layout
3 OU1 Habitat Types
4 OU2 Habitat Types
5 OU1 Human Health Exposure Areas
6 OU2 Human Health Exposure Areas
7 OU1 HHRA Conceptual Site Model
8 OU2 HHRA Conceptual Site Model
9 ERA Conceptual Site Model

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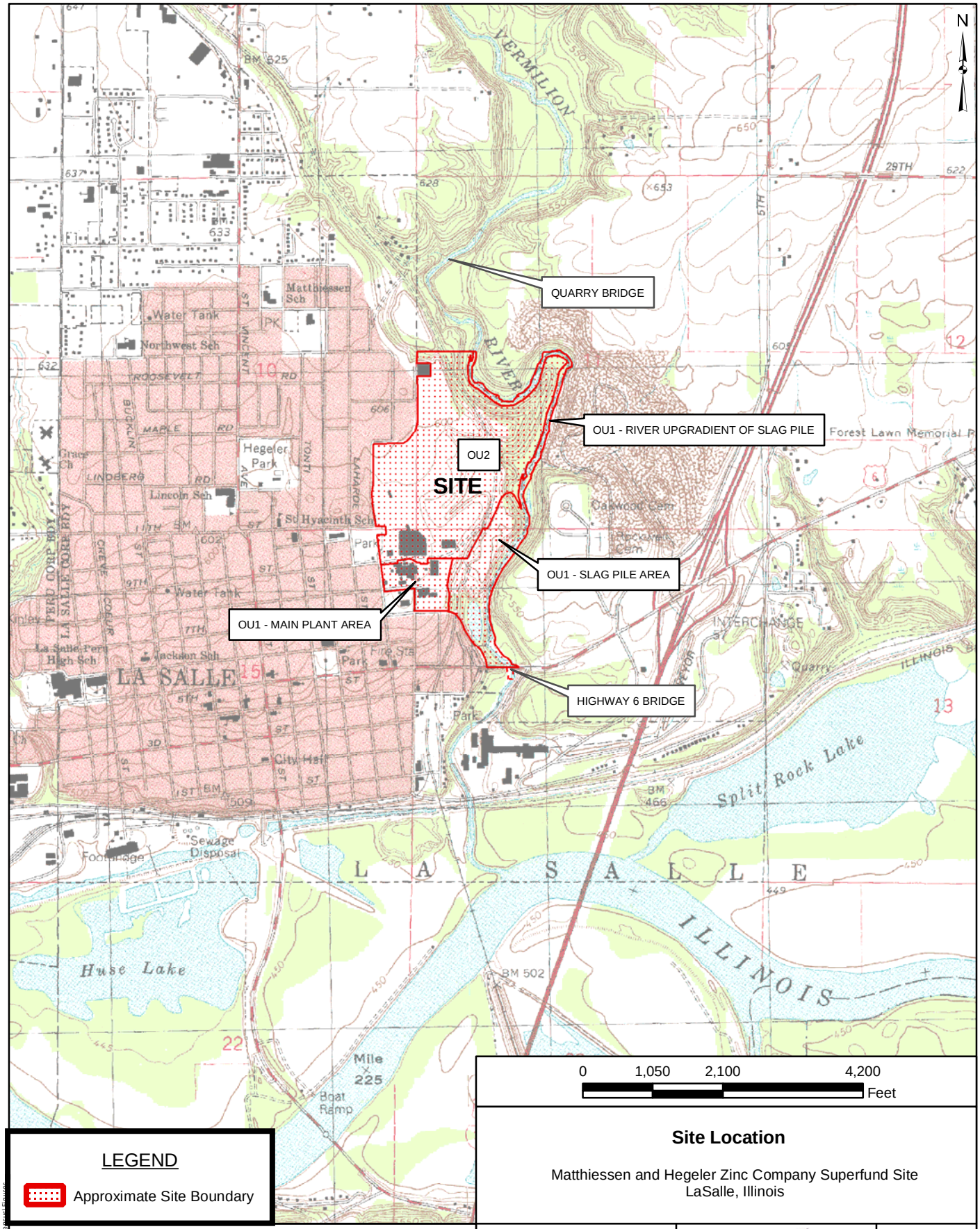

LEGEND

Approximate Site Boundary

Site Location

Matthiessen and Hegeler Zinc Company Superfund Site
LaSalle, Illinois

Note:

Basemap Source:
USGS 7.5 min Series, LaSalle Quadrangle (1994)

Geosyntec consultants

Jacksonville, FL

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Figure 1

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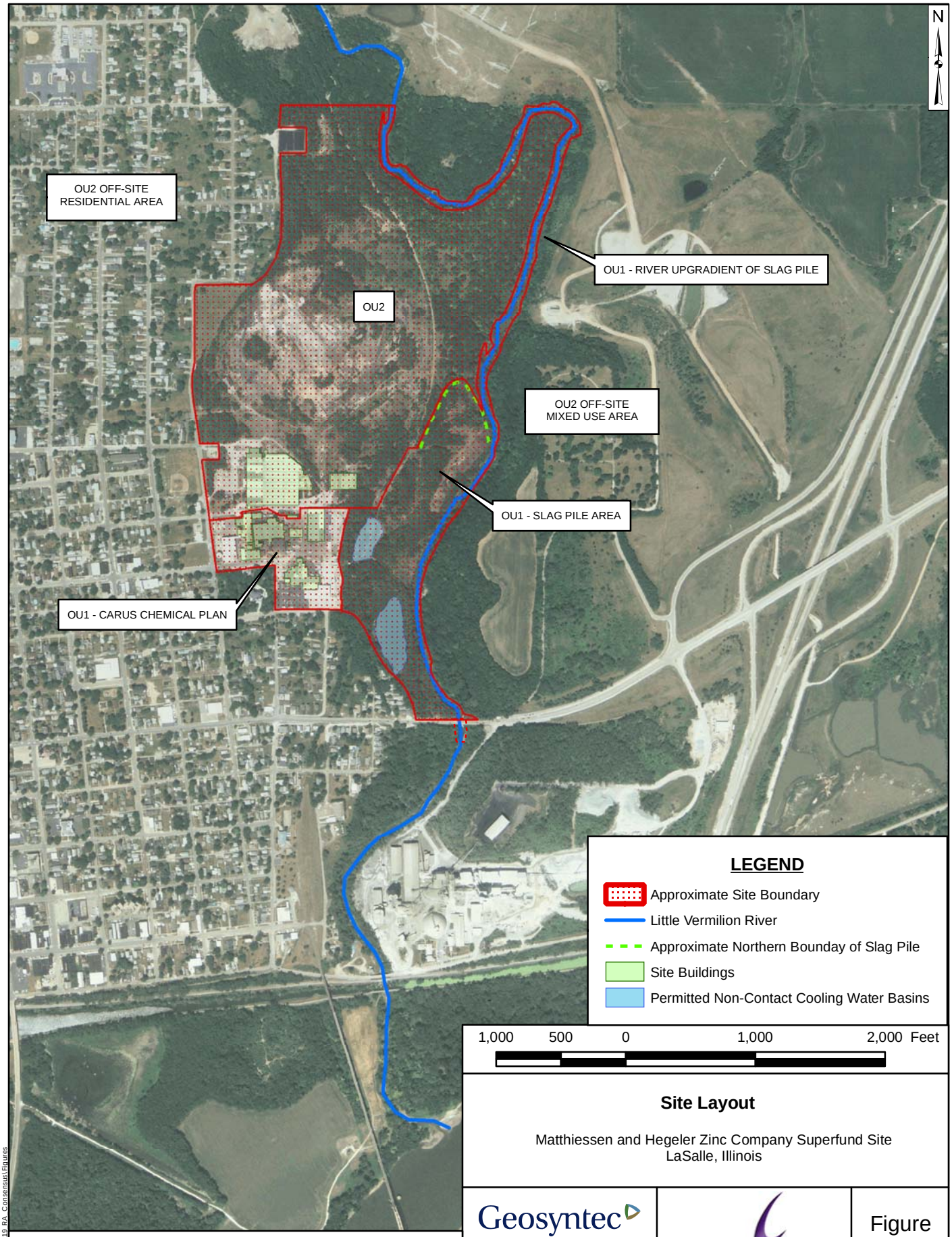

Note:
Basemap Source:
USDA NAIP, 2007

Site Layout

Matthiessen and Hegeler Zinc Company Superfund Site
LaSalle, Illinois

Geosyntec consultants

Jacksonville, FL

CARUS

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Figure
2

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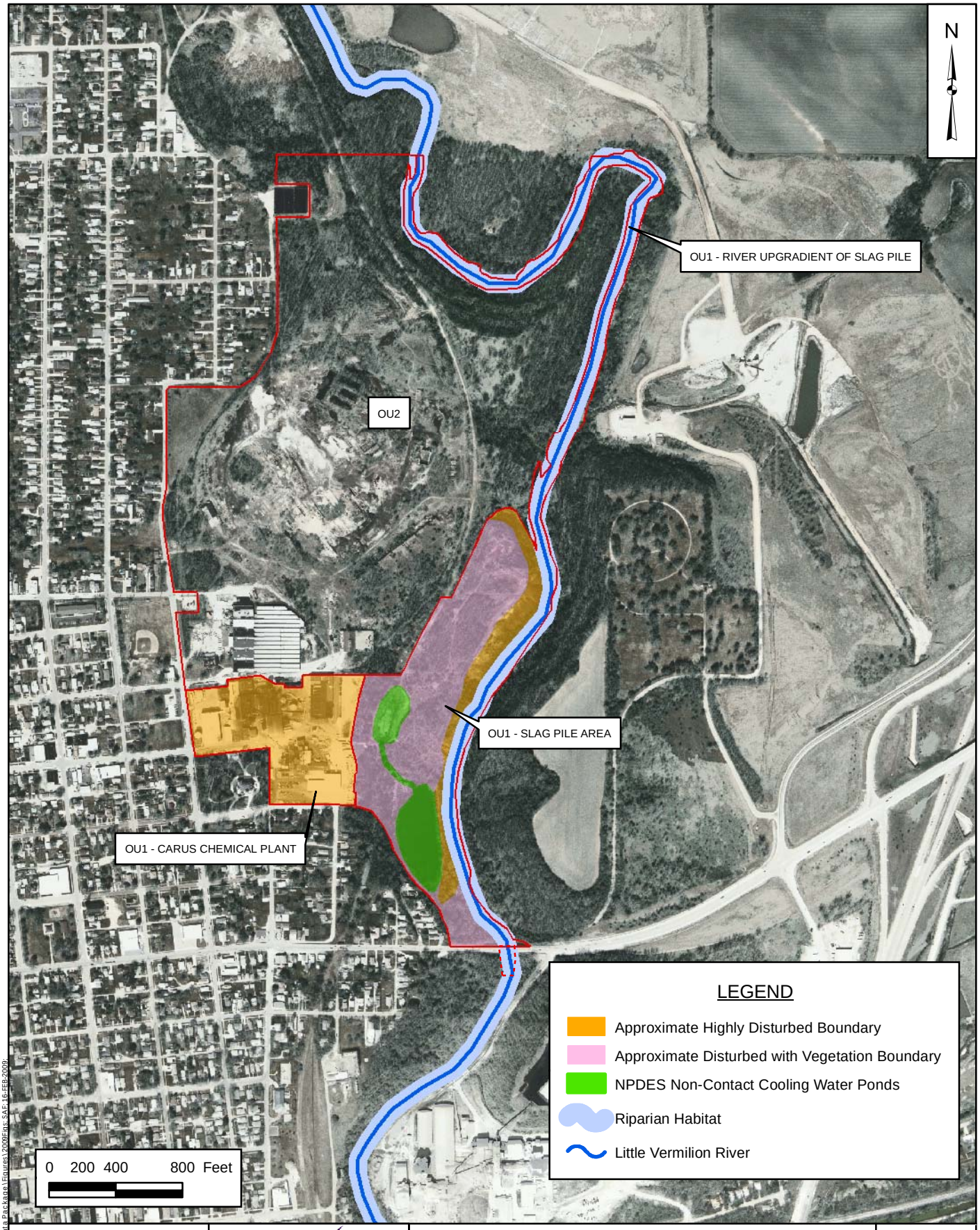

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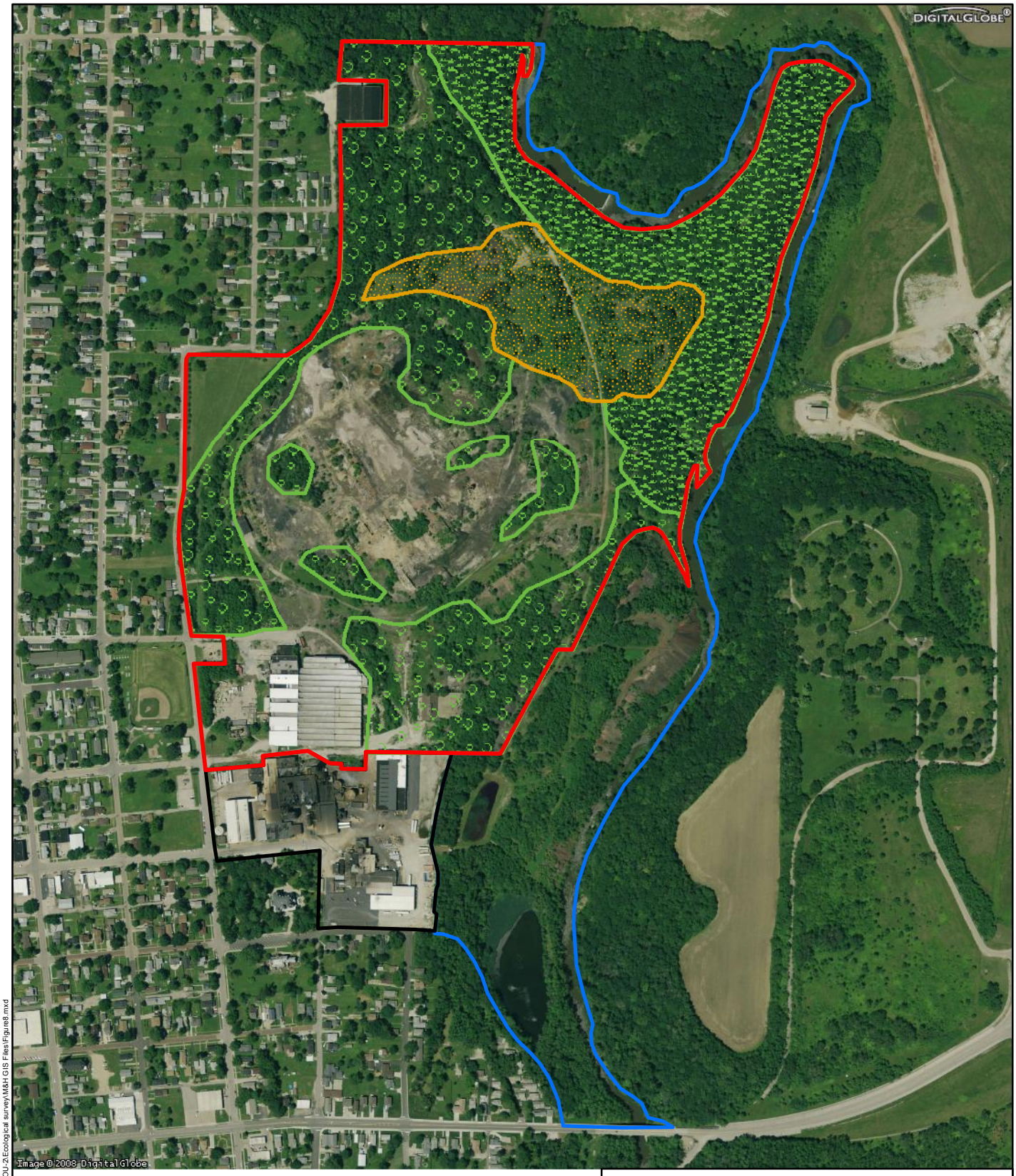
Geosyntec consultants	CARUS®	**OU1 Habitat Types** Matthiesen and Hegeler Zinc Company Site, OU1 LaSalle, Illinois	Figure **3**
Jacksonville, FL	30-APR-2009		



Legend

- Main Plant Area
- Riverine
- OU2 Boundary
- Savannah
- Disturbed Woodland-Grassland
- Oak-Hickory Woodland

N W E S

0 300 600
Feet

Source: 2006 USDA National Agriculture Imagery Program, LaSalle County, Illinois

Matthiessen & Hegeler Zinc Company
LaSalle, Illinois

Figure 4
OU2 Habitat Types

SulTRAC

Date: 05/28/08 Drawn By: Bill Spiking Project No: G9021016.103

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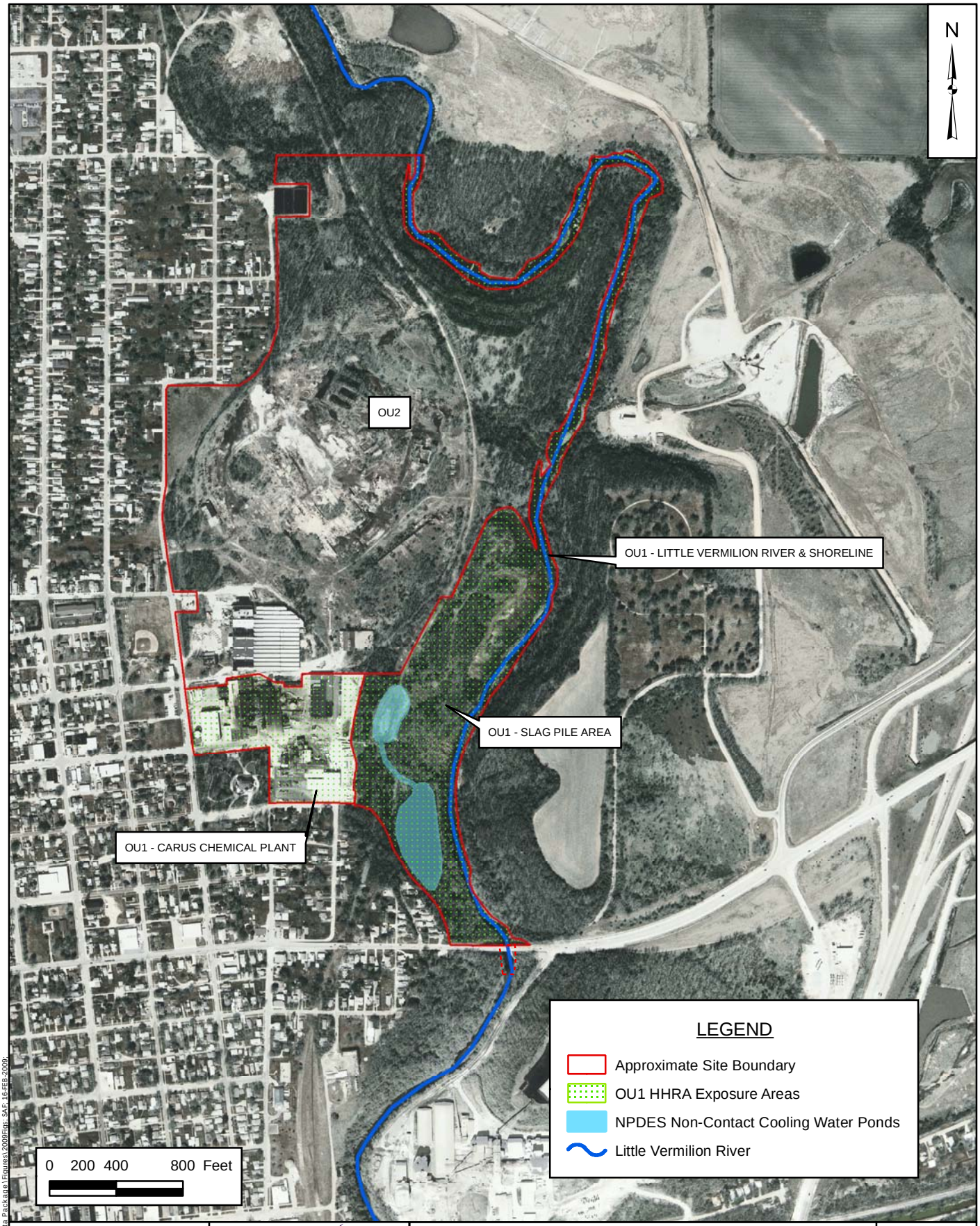

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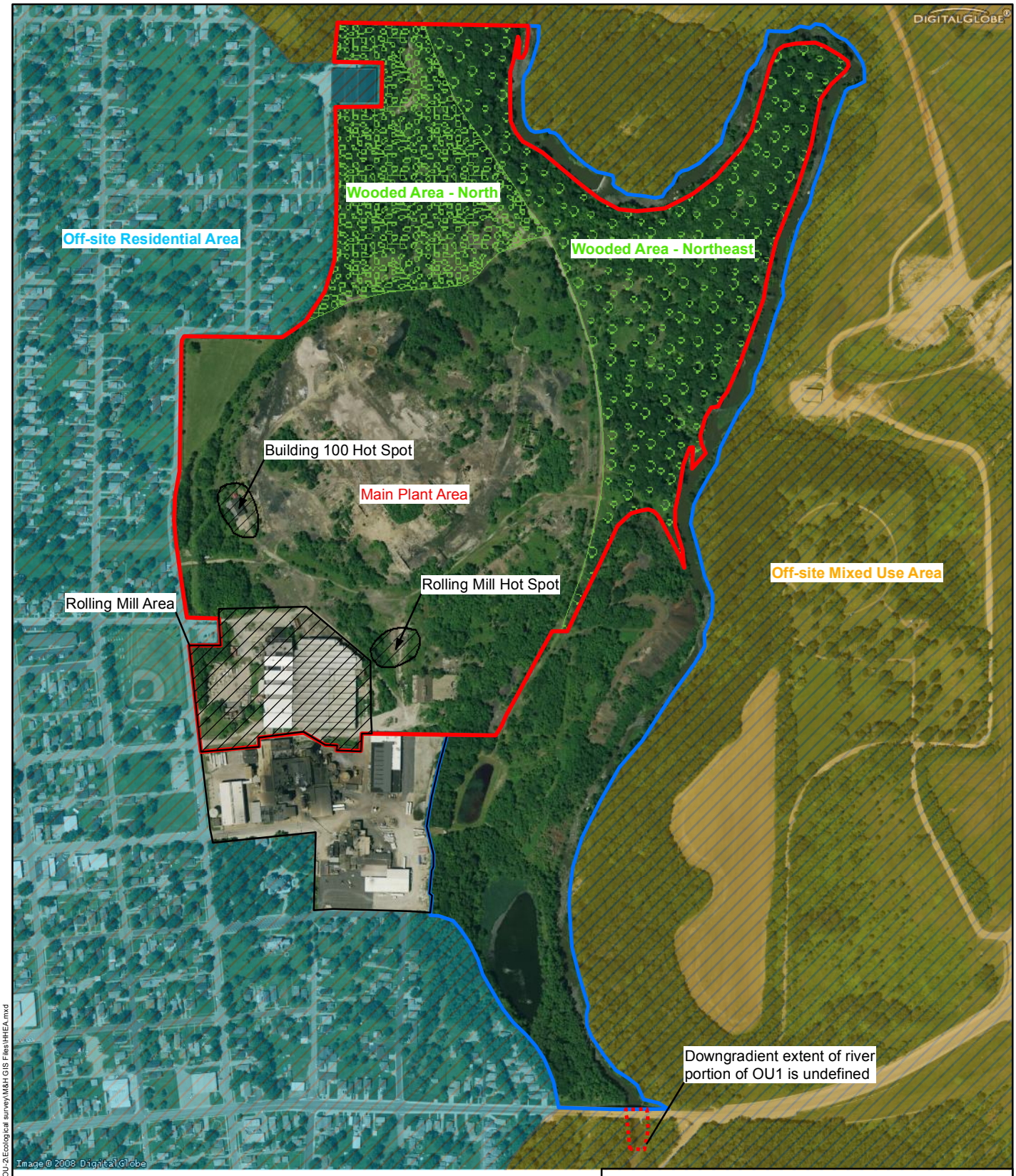
Geosyntec consultants	CARUS®	**OU1 Human Health Exposure Areas** Matthiesen and Hegeler Zinc Company Site, OU1 LaSalle, Illinois	Figure **5**
Jacksonville, FL	30-APR-2009		



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Source: 2006 USDA National Agriculture Imagery Program, LaSalle County, Illinois

Matthiessen & Hegeler Zinc Company
LaSalle, Illinois

Figure 6
OU2 Human Health Exposure Areas

SulTRAC

Date: 04/10/09 Drawn By: Bill Spiking Project No: G9021016.103

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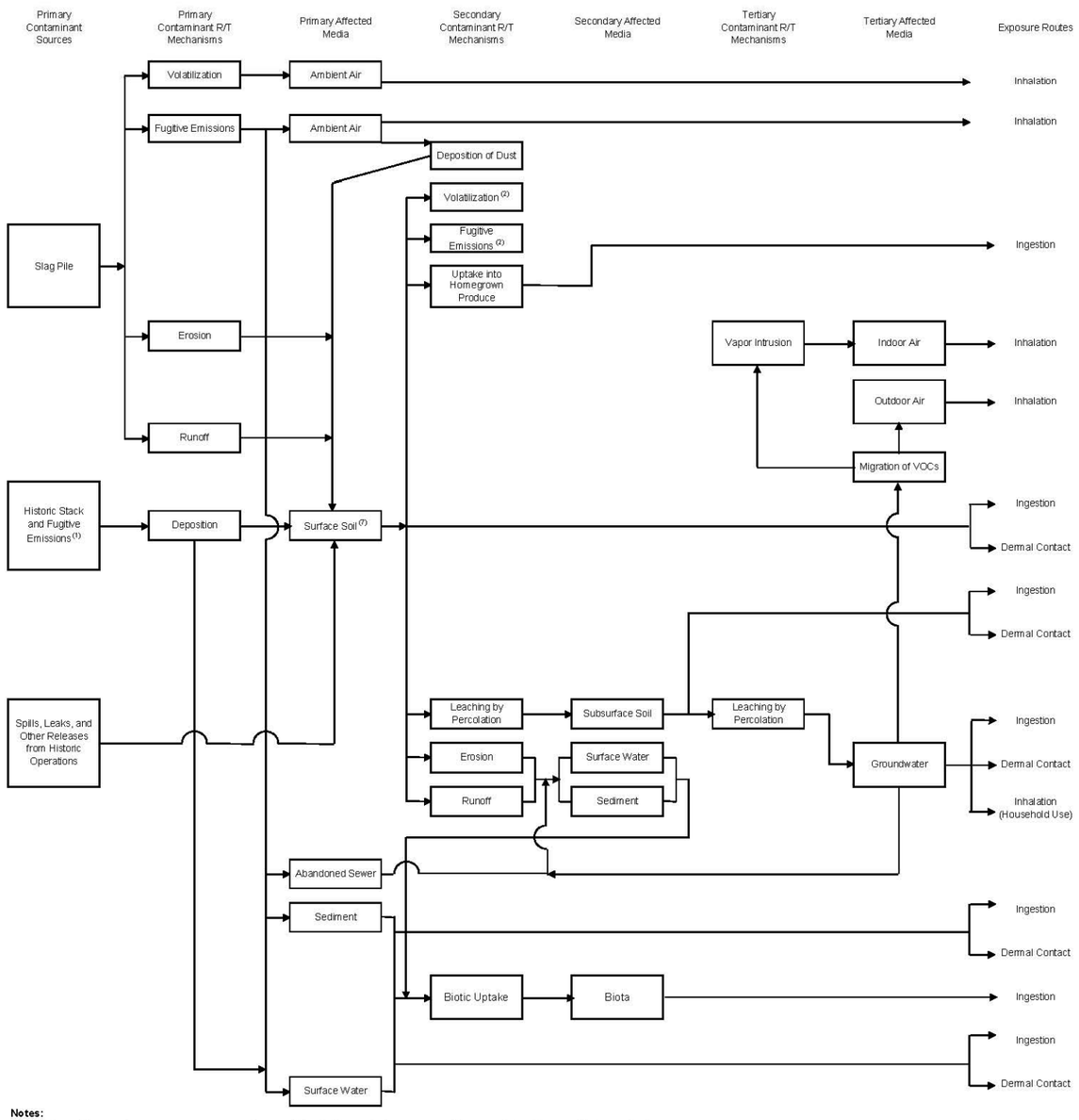

Potential Current and Future On-Site Receptors [3]						Potential Future On-Site Receptors [3]		
Commercial/ Industrial Worker [a,b,d]	Site-Specific Worker [c,d]	Utility Worker [a,b,c,d]	Trespasser [a,b,c,d]	Shoreline Fisherman [e,f]	Fish Consumer [e,f]	Recreationalist [d]	Construction Worker [b,d]	Hypothetical Resident [b]
●	●	●	●	--	--	●	●	●
●	●	●	●	--	--	●	●	●
--	--	--	--	--	--	--	--	●
●[4]	--	--	--	--	--	--	--	●[4]
●[4]	○	●[4]	--	--	--	--	●[4]	●[4]
●	●	●	●	--	--	●	●	●
●	●	●	●	--	--	●	●	●
●[5]	●[5]	●[5]	●[5]	--	--	●	●	●
●[5]	●[5]	●[5]	●[5]	--	--	●	●	●
●[5]	--	●[6]	--	--	--	--	●[6]	●
○[5]	--	●[6]	--	--	--	--	●[6]	●
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--	--	--	--	●	--	--	--	--

Notes:

R/T = Release/Transport
LVR = Little Vermilion River
OU = Operable Unit

● = Potentially complete exposure pathway - retained for quantitative analysis
○ = Potentially complete, but insignificant, exposure pathway - will not be retained for quantitative analysis
-- = Incomplete or Insignificant Exposure Pathway - will not be retained for quantitative analysis

1. Emissions were expected to be in vapor, particulate, and particle-bound forms.
2. As shown under primary R/T mechanisms.
3. Time-Frame Exposure Scenarios assumed to occur as follows:
   a. Current Exposure - Carus Chemical Plant
   b. Future Exposure - Carus Chemical Plant
   c. Current Exposure - Slag Pile
   d. Future Exposure - Slag Pile
   e. Current Exposure - LVR
   f. Future Exposure - LVR
4. If VOCs are not detected in a given media, exposure to soil/groundwater vapors in indoor air and groundwater vapors in outdoor air will not be evaluated.
5. Applies to future scenarios only.
6. Applies to groundwater less than 10 feet below ground surface.
7. Secondary R/T mechanisms originating from surface soil also apply to subsurface soil that is brought t other surface as the result of excavation and landscaping activities in the future.

OU1 HHRA Conceptual Site Model

Matthiessen and Hegeler Zinc Company Superfund Site
LaSalle, Illinois

Geosyntec consultants

CARUS

Jacksonville, FL

30-APR-2009

Figure 7

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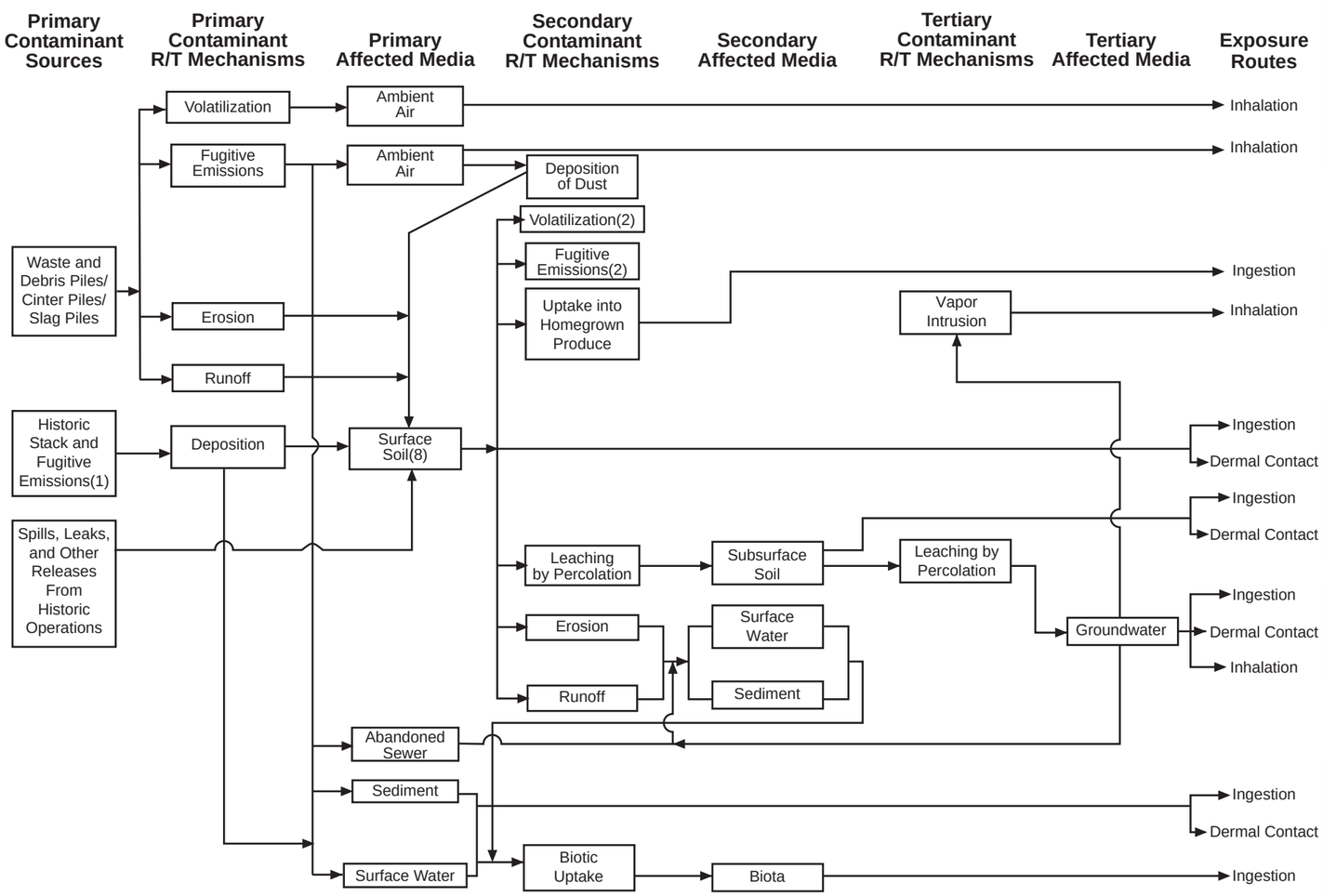

Current	Current and Future			Future(5)			
On-Site Adult and Youth Trespassers	Off-Site Adult/Child Resident(3)	Off-Site Adult Utility and Construction Workers(3)	Off-Site Adult/Youth/Child Recreationalist(4)	On-Site Adult/Child Resident	On-Site Adult//Youth/Child Recreationalist	On-Site Adult Commercial/ Industrial Workers	On-Site Adult Utility and Construction Workers
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Notes:

R/T = Release/Transport
LVR = Little Vermillion River
OU = Operable unit

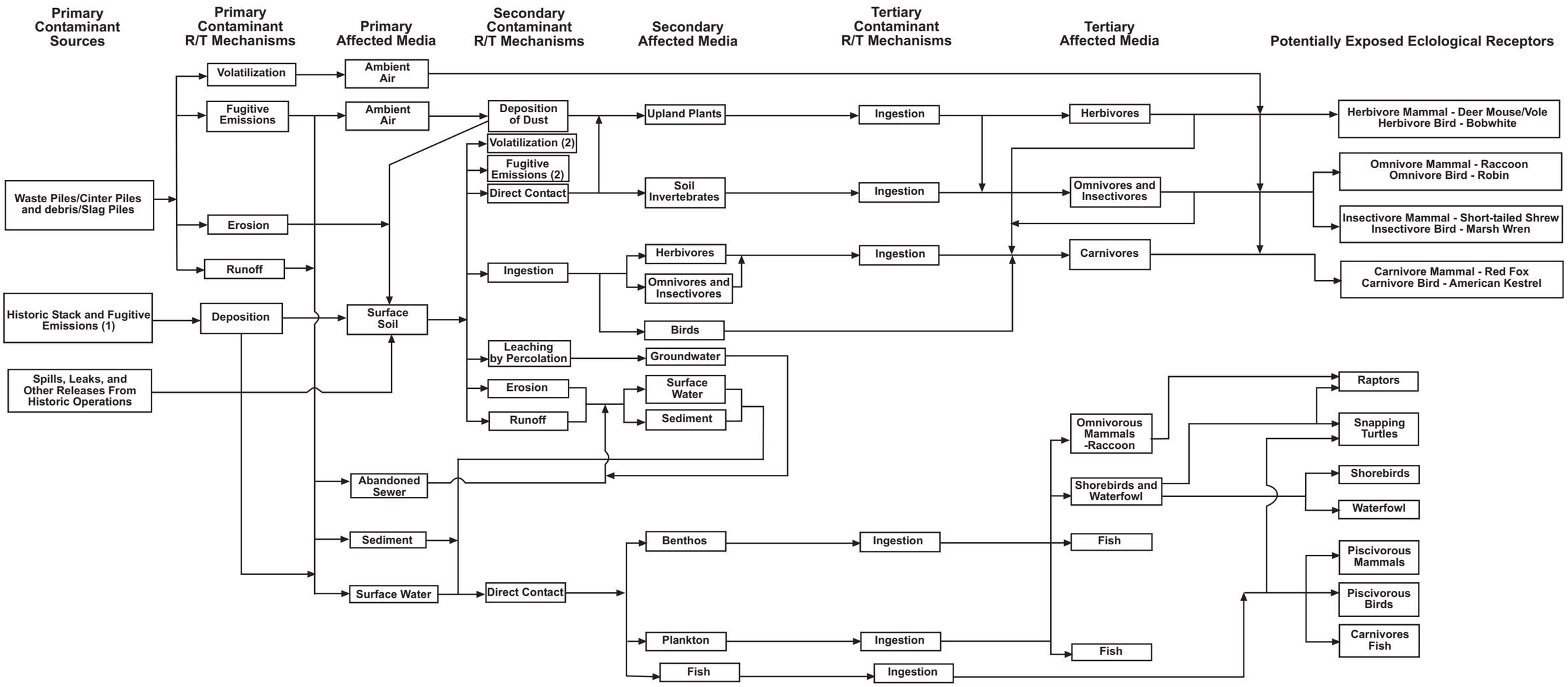
● = Potentially complete exposure pathway -- retained for quantitative analysis.
○ = Potentially complete, but insignificant, exposure pathway -- will not be retained for quantitative analysis.
-- = Incomplete exposure pathway -- will not be retained for quantitative analysis.

1. Emissions were expected to be in vapor, particulate and particle-bound forms.
2. As shown under primary contaminant R/T mechanisms.
3. Exposures assumed to occur in existing residential area west of OU2.
4. Exposures assumed to occur across (east) of the LVR.
5. Future on-site exposures assumed to occure in the following exposure areas: adult/child residents -- wooded area north of main plant area; adult/youth/child recreationalist -- all on-site exposure areas; adult commercial/industrial worker -- all on-site exposure areas except for the wooded area north east of main plant area and adjacent to the LVR; adult utility and construction worker -- same as commercial/industrial worker.
6. Potential exposure to subsurface soil assumed to occur if subsurface soil brought to surface and mixed with surface soil as the result of site development.
7. Potential exposures through incidental ingestion and dermal contact with LVR surface water and sediment and ingestion of aquatic life (mammals, fish caught in the LVR will be addressed as part of the OU1 HHRA.
8. Secondary R/T mechanisms originating from surface soil also apply to subsurface soil that is brought to the surface as the result of excavation and landscaping activities in the future.

Matthiessen & Hegeler Zinc Company
LaSalle, Illinois

Figure 8
OU2 HHRA Conceptual Site Model

SulTRAC



Note:
R/T = Release/Transport
1. Emissions were expected to be in vapor, particulate and particle-bound forms.
2. As shown under primary contaminant R/T Mechanisms.

Matthiessen & Hegeler Zinc Company
LaSalle, Illinois

Figure 9
ERA Conceptual Site Model

SulTRAC

S:\PROJECTS\RAC Region5\Matthiessen & Hegeler Zinc\OU-2\Conceptual Site Model\FH10

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ATTACHMENT 1

HHRA TABLES – OU1

1 Series:	Selection of Exposure Pathways, OU1
4 Series:	Values Used for Daily Intake Calculations
4.1	Current and Future Commercial/Industrial Worker
4.2	Current and Future Site-Specific Worker
4.3	Current and Future Utility Worker
4.4	Future Construction Worker
4.5	Current and Future Adolescent Trespasser
4.6	Current and Future Adult Trespasser
4.7	Future Child Recreationalist
4.8	Future Adolescent Recreationalist
4.9	Future Adult Recreationalist
4.10	Hypothetical Future Child Resident
4.11	Hypothetical Future Aggregate Resident
4.12	Current and Future Adolescent Recreational Fisherman
4.13	Current and Future Adult Recreational Fisherman
4.14	Current and Future Child Fish Consumer
4.15	Current and Future Adolescent Fish Consumer
4.16	Current and Future Adult Fish Consumer

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TABLE 1a
SELECTION OF EXPOSURE PATHWAYS, OU1 - CARUS CHEMICAL PLANT
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection of Exposure Pathway
Current/Future	Surface Soil	Surface Soil	Surface Soil at the Carus Chemical Plant	Commercial/ Industrial Worker	Adult	Ingestion	Quantitative	Current/future commercial/industrial workers may incidentally ingest surface soil.
						Dermal Contact		Current/future commercial/industrial workers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air at the Carus Chemical Plant	Commercial/ Industrial Worker	Adult	Inhalation	Quantitative	Current/future commercial/industrial workers may inhale particulates and vapors that migrate from surface soil to outdoor air.
	Sub-Slab Surface Soil Sub-Slab Subsurface Soil	Vapors	Indoor Air at the Carus Chemical Plant	Commercial/ Industrial Worker	Adult	Inhalation	J&E Model	Current/future commercial/industrial workers may inhale vapors that migrate from surface/subsurface soil beneath buildings/structures to indoor air via diffusion, advection, or as a result of heating and ventilation systems.
	Groundwater	Vapors	Indoor Air at the Carus Chemical Plant	Commercial/ Industrial Worker	Adult	Inhalation	J&E Model	Current/future commercial/industrial workers may inhale vapors that migrate from groundwater beneath buildings/structures to indoor air via diffusion, advection, or as a result of heating and ventilation systems.
			Outdoor Air at the Carus Chemical Plant	Commercial/ Industrial Worker	Adult	Inhalation	Quantitative	Current/future commercial/industrial workers may inhale vapors that migrate from groundwater to outdoor air.
Future	Subsurface Soil	Subsurface Soil	Subsurface Soil at the Carus Chemical Plant	Commercial/ Industrial Worker	Adult	Ingestion	Quantitative	Future commercial/industrial workers may incidentally ingest subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment.
						Dermal Contact		Future commercial/industrial workers may have exposed skin come into contact with subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment..
		Particulates and Vapors	Outdoor Air at the Carus Chemical Plant	Commercial/ Industrial Worker	Adult	Inhalation	Quantitative	Future commercial/industrial workers may inhale particulates and vapors that migrate from subsurface soil to outdoor air if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment.
	Groundwater	Groundwater	Groundwater at the Carus Chemical Plant	Commercial/ Industrial Worker	Adult	Ingestion	Quantitative	Future commercial/industrial workers may ingest groundwater from the site.
Current/Future	Surface Soil	Surface Soil	Surface Soil at the Carus Chemical Plant	Utility Worker	Adult	Ingestion	Quantitative	Current/future utility workers may incidentally ingest surface soil.
						Dermal Contact		Current/future utility workers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air at the Carus Chemical Plant	Utility Worker	Adult	Inhalation	Quantitative	Current/future utility workers may inhale particulates and vapors that migrate from surface soil to outdoor air.
	Subsurface Soil	Subsurface Soil	Subsurface Soil at the Carus Chemical Plant	Utility Worker	Adult	Ingestion	Quantitative	Current/future utility workers may incidentally ingest subsurface soil.
						Dermal Contact		Current/future utility workers may have exposed skin come into contact with subsurface soil.
		Particulates and Vapors	Outdoor Air at the Carus Chemical Plant	Utility Worker	Adult	Inhalation	Quantitative	Current/future utility workers may inhale particulates and vapors that migrate from subsurface soil to outdoor air.
	Groundwater	Groundwater	Groundwater at the Carus Chemical Plant	Utility Worker	Adult	Ingestion	Quantitative	Current/future utility workers may incidentally ingest groundwater <10 feet below ground surface while conducting intrusive activities.
						Dermal Contact		Current/future utility workers may have exposed skin come into contact with groundwater <10 feet below ground surface while conducting intrusive activities.
		Vapors	Outdoor Air (Trenches) at the Carus Chemical Plant	Utility Worker	Adult	Inhalation	Quantitative	Current/future utility workers may inhale vapors that migrate from groundwater to trench air.

TABLE 1a (continued)
SELECTION OF EXPOSURE PATHWAYS, OU1 - CARUS CHEMICAL PLANT
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection of Exposure Pathway
Future	Surface Soil	Surface Soil	Surface Soil at the Carus Chemical Plant	Construction Worker	Adult	Ingestion	Quantitative	Future construction workers may incidentally ingest surface soil.
						Dermal Contact		Future construction workers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air at the Carus Chemical Plant	Construction Worker	Adult	Inhalation	Quantitative	Future construction workers may inhale particulates and vapors that migrate from surface soil to outdoor air.
	Subsurface Soil	Subsurface Soil	Subsurface Soil at the Carus Chemical Plant	Construction Worker	Adult	Ingestion	Quantitative	Future construction workers may incidentally ingest subsurface soil.
						Dermal Contact		Future construction workers may have exposed skin come into contact with subsurface soil.
		Particulates and Vapors	Outdoor Air at the Carus Chemical Plant	Construction Worker	Adult	Inhalation	Quantitative	Future construction workers may inhale particulates and vapors that migrate from subsurface soil to outdoor air.
	Groundwater	Groundwater	Groundwater at the Carus Chemical Plant	Construction Worker	Adult	Ingestion	Quantitative	Future construction workers may incidentally ingest groundwater <10 feet below ground surface while conducting intrusive activities.
						Dermal Contact		Future construction workers may have exposed skin come into contact with groundwater <10 feet below ground surface while conducting intrusive activities.
		Vapors	Outdoor Air (Trenches) at the Carus Chemical Plant	Construction Worker	Adult	Inhalation	Quantitative	Future construction workers may inhale vapors that migrate from groundwater to trench air.
Future	Surface Soil	Surface Soil	Surface Soil at the Carus Chemical Plant	Hypothetical Future Resident	Child 0-6 Aggregate 0-30	Ingestion	Quantitative	Hypothetical future residents may incidentally ingest surface soil.
						Dermal Contact		Hypothetical future residents may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air at the Carus Chemical Plant	Hypothetical Future Resident	Child 0-6 Aggregate 0-30	Inhalation	Quantitative	Hypothetical future residents may inhale particulates and vapors that migrate from surface soil to outdoor air.
		Homegrown Produce	Homegrown Produce at the Carus Chemical Plant	Hypothetical Future Resident	Child 0-6 Aggregate 0-30	Ingestion	Quantitative	Hypothetical future residents may ingest produce grown in surface soil.
	Subsurface Soil	Subsurface Soil	Subsurface Soil at the Carus Chemical Plant	Hypothetical Future Resident	Child 0-6 Aggregate 0-30	Ingestion	Quantitative	Hypothetical future residents may incidentally ingest subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment.
						Dermal Contact		Hypothetical future residents may have exposed skin come into contact with subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment.
		Particulates and Vapors	Outdoor Air at the Carus Chemical Plant	Hypothetical Future Resident	Child 0-6 Aggregate 0-30	Inhalation	Quantitative	Hypothetical future residents may inhale particulates and vapors that migrate from subsurface soil to outdoor air if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment.
		Homegrown Produce	Homegrown Produce at the Carus Chemical Plant	Hypothetical Future Resident	Child 0-6 Aggregate 0-30	Ingestion	Quantitative	Hypothetical future residents may ingest produce grown in subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment.
	Sub-Slab Surface Soil / Sub-Slab Subsurface Soil	Vapors	Indoor Air at the Carus Chemical Plant	Hypothetical Future Resident	Child 0-6 Aggregate 0-30	Inhalation	J&E Model	Hypothetical future residents may inhale vapors that migrate from surface/subsurface soil beneath buildings/structures to indoor air via diffusion, advection, or as a result of heating and ventilation systems.
	Groundwater	Groundwater	Groundwater at the Carus Chemical Plant	Hypothetical Future Resident	Child 0-6 Aggregate 0-30	Ingestion	Quantitative	Hypothetical future residents may ingest groundwater from the site.
						Dermal Contact	Quantitative	Hypothetical future residents may have exposed skin come into contact with groundwater at the site.
		Vapors	Outdoor Air at the Carus Chemical Plant	Hypothetical Future Resident	Child 0-6 Aggregate 0-30	Inhalation	Quantitative	Hypothetical future residents may inhale vapors that migrate from groundwater to outdoor air.
		Vapors	Indoor Air at the Carus Chemical Plant	Hypothetical Future Resident	Child 0-6 Aggregate 0-30	Inhalation	Quantitative	Hypothetical future residents may inhale vapors that migrate from groundwater to indoor air during household use (e.g., washing dishes).
		Vapors	Indoor Air at the Carus Chemical Plant	Hypothetical Future Resident	Child 0-6 Aggregate 0-30	Inhalation	J&E Model	Hypothetical future residents may inhale vapors that migrate from groundwater beneath buildings/structures to indoor air via diffusion, advection, or as a result of heating and ventilation systems.

TABLE 1b
SELECTION OF EXPOSURE PATHWAYS, OU1 - SLAG PILE
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection of Exposure Pathway
Future	Surface Soil	Surface Soil	Surface Soil at the Slag Pile	Commercial/ Industrial Worker	Adult	Ingestion	Quantitative	Future commercial/industrial workers may incidentally ingest surface soil.
						Dermal Contact		Future commercial/industrial workers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air at the Slag Pile	Commercial/ Industrial Worker	Adult	Inhalation	Quantitative	Future commercial/industrial workers may inhale particulates and vapors that migrate from surface soil to outdoor air.
	Subsurface Soil	Subsurface Soil	Subsurface Soil at the Slag Pile	Commercial/ Industrial Worker	Adult	Ingestion	Quantitative	Future commercial/industrial workers may incidentally ingest subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment.
						Dermal Contact		Future commercial/industrial workers may have exposed skin come into contact with subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment..
		Particulates and Vapors	Outdoor Air at the Slag Pile	Commercial/ Industrial Worker	Adult	Inhalation	Quantitative	Future commercial/industrial workers may inhale particulates and vapors that migrate from subsurface soil to air if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment.
	Sub-Slab Surface Soil Sub-Slab Subsurface Soil	Vapors	Indoor Air at the Slag Pile	Commercial/ Industrial Worker	Adult	Inhalation	J&E Model	Future commercial/industrial workers may inhale vapors that migrate from surface/subsurface soil beneath buildings/structures to indoor air via diffusion, advection, or as a result of heating and ventilation systems.
	Groundwater	Groundwater	Groundwater at the Slag Pile	Commercial/ Industrial Worker	Adult	Ingestion	Quantitative	Future commercial/industrial workers may ingest groundwater from the site.
		Vapors	Indoor Air at the Slag Pile	Commercial/ Industrial Worker	Adult	Inhalation	J&E Model	Future commercial/industrial workers may inhale vapors that migrate from groundwater beneath buildings/structures to indoor air via diffusion, advection, or as a result of heating and ventilation systems.
			Outdoor Air at the Slag Pile	Commercial/ Industrial Worker	Adult	Inhalation	Quantitative	Future commercial/industrial workers may inhale vapors that migrate from groundwater to outdoor air.
Current/Future	Surface Soil	Surface Soil	Surface Soil at the Slag Pile	Site-Specific Worker	Adult	Ingestion	Quantitative	Current/future site-specific workers may incidentally ingest surface soil.
						Dermal Contact		Current/future site-specific workers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air at the Slag Pile	Site-Specific Worker	Adult	Inhalation	Quantitative	Current/future site-specific workers may inhale particulates and vapors that migrate from surface soil to outdoor air.
	Subsurface Soil	Subsurface Soil	Subsurface Soil at the Slag Pile	Site-Specific Worker	Adult	Ingestion	Quantitative	Current/future site-specific workers may incidentally ingest subsurface soil.
						Dermal Contact		Current/future site-specific workers may have exposed skin come into contact with subsurface soil.
		Particulates and Vapors	Outdoor Air at the Slag Pile	Site-Specific Worker	Adult	Inhalation	Quantitative	Current/future site-specific workers may inhale particulates and vapors that migrate from subsurface soil to outdoor air.
Current/Future	Surface Soil	Surface Soil	Surface Soil at the Slag Pile	Utility Worker	Adult	Ingestion	Quantitative	Current/future utility workers may incidentally ingest surface soil.
						Dermal Contact		Current/future utility workers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air at the Slag Pile	Utility Worker	Adult	Inhalation	Quantitative	Current/future utility workers may inhale particulates and vapors that migrate from surface soil to outdoor air.
	Subsurface Soil	Subsurface Soil	Subsurface Soil at the Slag Pile	Utility Worker	Adult	Ingestion	Quantitative	Current/future utility workers may incidentally ingest subsurface soil.
						Dermal Contact		Current/future utility workers may have exposed skin come into contact with subsurface soil.
		Particulates and Vapors	Outdoor Air at the Slag Pile	Utility Worker	Adult	Inhalation	Quantitative	Current/future utility workers may inhale particulates and vapors that migrate from subsurface soil to outdoor air.
	Groundwater	Groundwater	Groundwater at the Slag Pile	Utility Worker	Adult	Ingestion	Quantitative	Current/future utility workers may incidentally ingest groundwater <10 feet below ground surface while conducting intrusive activities.
						Dermal Contact		Current/future utility workers may have exposed skin come into contact with groundwater <10 feet below ground surface while conducting intrusive activities.
		Vapors	Outdoor Air (Trenches) at the Slag Pile	Utility Worker	Adult	Inhalation	Quantitative	Current/future utility workers may inhale vapors that migrate from groundwater to trench air.

TABLE 1b (continued)
SELECTION OF EXPOSURE PATHWAYS, OU1 - SLAG PILE
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection of Exposure Pathway
Future	Surface Soil	Surface Soil	Surface Soil at the Slag Pile	Construction Worker	Adult	Ingestion	Quantitative	Future construction workers may incidentally ingest surface soil.
						Dermal Contact	Quantitative	Future construction workers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air at the Slag Pile	Construction Worker	Adult	Inhalation	Quantitative	Future construction workers may inhale particulates and vapors that migrate from surface soil to outdoor air.
	Subsurface Soil	Subsurface Soil	Subsurface Soil at the Slag Pile	Construction Worker	Adult	Ingestion	Quantitative	Future construction workers may incidentally ingest subsurface soil.
						Dermal Contact		Future construction workers may have exposed skin come into contact with subsurface soil.
		Particulates and Vapors	Outdoor Air at the Slag Pile	Construction Worker	Adult	Inhalation	Quantitative	Future construction workers may inhale particulates and vapors that migrate from subsurface soil to outdoor air.
	Groundwater	Groundwater	Groundwater at the Slag Pile	Construction Worker	Adult	Ingestion	Quantitative	Future construction workers may incidentally ingest groundwater <10 feet below ground surface while conducting intrusive activities.
						Dermal Contact		Future construction workers may have exposed skin come into contact with groundwater <10 feet below ground surface while conducting intrusive activities.
		Vapors	Outdoor Air (Trenches) at the Slag Pile	Construction Worker	Adult	Inhalation	Quantitative	Future construction workers may inhale vapors that migrate from groundwater to trench air.
Current/Future	Surface Soil	Surface Soil	Surface Soil at the Slag Pile	Trespasser	Adolescent 6-16 Adult 16+	Ingestion	Quantitative	Current/future trespassers may incidentally ingest surface soil.
						Dermal Contact	Quantitative	Current/future trespassers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air at the Slag Pile	Trespasser	Adolescent 6-16 Adult 16+	Inhalation	Quantitative	Current/future trespassers may inhale particulates and vapors that migrate from surface soil to outdoor air.
Future	Surface Soil	Surface Soil	Surface Soil at the Slag Pile	Recreator	Child 0-6 Adolescent 6-16 Adult 16+	Ingestion	Quantitative	Future recreationalists may incidentally ingest surface soil.
						Dermal Contact	Quantitative	Future recreationalists may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air at the Slag Pile	Recreator	Child 0-6 Adolescent 6-16 Adult 16+	Inhalation	Quantitative	Future recreationalists may inhale particulates and vapors that migrate from surface soil to air.
	Subsurface Soil	Subsurface Soil	Subsurface Soil at the Slag Pile	Recreator	Child 0-6 Adolescent 6-16 Adult 16+	Ingestion	Quantitative	Future recreationalists may incidentally ingest subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment.
						Dermal Contact	Quantitative	Future recreationalists may have exposed skin come into contact with subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment.
		Particulates and Vapors	Outdoor Air at the Slag Pile	Recreator	Child 0-6 Adolescent 6-16 Adult 16+	Inhalation	Quantitative	Future recreationalists may inhale particulates and vapors that migrate from subsurface soil to outdoor air if subsurface soil is brought to the surface and mixed with surface soil as the result of site redevelopment.

TABLE 1c
SELECTION OF EXPOSURE PATHWAYS, OU1 - LITTLE VERMILION RIVER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection of Exposure Pathway
Current/Future	Sediment	Sediment	Sediment in the LVR	Shoreline Fisherman	Adolescent 6-16 Adult 16+	Ingestion	Quantitative	Shoreline fisherman may incidentally ingest sediment.
						Dermal Contact		Shoreline fisherman may have exposed skin come into contact with sediment.
Current/Future	Surface Water	Surface Water	Surface Water in the LVR	Shoreline Fisherman	Adolescent 6-16 Adult 16+	Ingestion	Quantitative	Shoreline fisherman may incidentally ingest surface water.
						Dermal Contact		Shoreline fisherman may have exposed skin come into contact with surface water.
Current/Future	Fish Tissue	Fish Tissue	Fish at the LVR	Fish Consumer	Child 3-6 Adolescent 6-16 Adult 16+	Ingestion	Quantitative	Fish consumers may ingest fish from the site which have been impacted by site-related constituents.

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TABLE 4.1a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE COMMERCIAL/INDUSTRIAL WORKER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Commercial/ Industrial Worker	Adult	C: SS at Carus Chemical Plant F: SS/SB at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	100	mg/day	EPA, 2002 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	250	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	25	years	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future On-Site Commercial/ Industrial Worker	Adult	C: SS at Carus Chemical Plant F: SS/SB at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.2	mg/cm^2	EPA, 2002 (8)	BW x AT
				EF	Exposure Frequency	250	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	25	years	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Commercial/ Industrial Worker	Adult	C: SS/SB P&V in Outdoor Air at Carus Chemical Plant C/F: SS/SB P&V in Outdoor Air at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	250	days/year	EPA, 1991 (3)	ATc
				ED	Exposure Duration	25	years	EPA, 1991 (4)	
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Default soil ingestion rate for outdoor workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Default exposure frequency for outdoor workers.
(4) ED: Default exposure duration for workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: Default soil-to-skin adherence factor for outdoor workers.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(10) ET: Assumes 40-hour work week (5 days per week).

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:

BPJ= Best Professional Judgment.
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TABLE 4.1a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE COMMERCIAL/INDUSTRIAL WORKER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Commercial/ Industrial Worker	Adult	C: SS at Carus Chemical Plant F: SS/SB at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	50	mg/day	EPA, 2002 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	219	days/year	EPA, 1997 (3)	
				ED	Exposure Duration	9	years	EPA, 1997 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future On-Site Commercial/ Industrial Worker	Adult	C: SS at Carus Chemical Plant F: SS/SB at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.02	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	219	days/year	EPA, 1997 (3)	
				ED	Exposure Duration	9	years	EPA, 1997 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Commercial/ Industrial Worker	Adult	C: SS/SB P&V in Outdoor Air at Carus Chemical Plant C/F: SS/SB P&V in Outdoor Air at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	219	days/year	EPA, 1997 (3)	ATc
				ED	Exposure Duration	9	years	EPA, 1997 (4)	
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Default soil ingestion rate for indoor workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Default exposure frequency for indoor workers.
(4) ED: Recommended central tendency exposure duration for industrial scenarios.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: Default central tendency soil-to-skin adherence factor for industrial workers.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(10) ET: Assumes 40-hour work week (5 days per week).

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.1b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE COMMERCIAL/INDUSTRIAL WORKER - GROUNDWATER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Commercial/ Industrial Worker	Adult	F: GW at Carus Chemical Plant & Slag Pile	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
				IRgw	Groundwater Ingestion Rate	1	L/day	EPA, 1991 (1)	CDI (mg/kg-day) =
				FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCgw x IRgw x FI x EF x ED x CFgw
				EF	Exposure Frequency	250	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	25	years	EPA, 1989 (4)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Commercial/ Industrial Worker	Adult	C/F: GW Vapors in Outdoor Air at Carus Chemical Plant & Slag Pile	EPCgw	Exposure Point Concentration - Groundwater	See Table 3s	mg/L	See Table 3s	
				EF	Exposure Frequency	250	days/year	BPJ (3)	CDE_C ($\mu g/m^3$) =
				ED	Exposure Duration	25	years	EPA, 1989 (4)	EPCgw x (1/VFwamb) x EF x ED x ET x CFa x CFt
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	ATc
				VF_{wamb}	Volatilization factor, Water to Ambient Air	See Table XX	m^3/L	See Table XX	
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCgw x (1/VFwamb) x EF x ED x ET x CFt
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	ATnc
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Commercial/ Industrial Worker	Adult	C/F: GW Vapors in Indoor Air at Carus Chemical Plant & Slag Pile	EPCia	Chemical Concentration in Indoor Air	Calculated	$\mu g/m^3$	See Table XX	CDE_C ($\mu g/m^3$) =
				EF	Exposure Frequency	250	days/year	BPJ (3)	EPCia x EF x ED x ET x CFt
				ED	Exposure Duration	25	years	EPA, 1989 (4)	ATc
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCia x EF x ED x ET x CFa x CFt
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	ATnc
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRgw: Assumes that a commercial/industrial worker ingests one-half of daily water intake (2 liters) at work.
(2) FI: Assumes 100% of incidental groundwater ingestion occurs on-site.
(3) EF: Default exposure frequency for indoor workers.
(4) ED: Default exposure duration for workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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TABLE 4.1b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE COMMERCIAL/INDUSTRIAL WORKER - GROUNDWATER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Commercial/ Industrial Worker	Adult	F: GW at Carus Chemical Plant & Slag Pile	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
				IRgw	Groundwater Ingestion Rate	1	L/day	EPA, 1991 (1)	CDI (mg/kg-day) =
				FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCgw x IRgw x FI x EF x ED x CFgw
				EF	Exposure Frequency	219	days/year	IPCB, 2007 (3)	BW x AT
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Commercial/ Industrial Worker	Adult	C/F: GW Vapors in Outdoor Air at Carus Chemical Plant & Slag Pile	EPCgw	Exposure Point Concentration - Groundwater	See Table 3s	mg/L	See Table 3s	
				EF	Exposure Frequency	219	days/year	BPJ (3)	CDE_C ($\mu g/m^3$) =
				ED	Exposure Duration	9	years	EPA, 1989 (4)	EPCgw x (1/VFwamb) x EF x ED x ET x CFa x CFt
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	ATc
				VF_{wamb}	Volatilization factor, Water to Ambient Air	See Table XX	m^3/L	See Table XX	
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCgw x (1/VFwamb) x EF x ED x ET x CFt
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	ATnc
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Commercial/ Industrial Worker	Adult	C/F: GW Vapors in Indoor Air at Carus Chemical Plant & Slag Pile	EPCia	Chemical Concentration in Indoor Air	Calculated	$\mu g/m^3$	See Table XX	CDE_C ($\mu g/m^3$) =
				EF	Exposure Frequency	219	days/year	BPJ (3)	EPCia x EF x ED x ET x CFt
				ED	Exposure Duration	9	years	EPA, 1989 (4)	ATc
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCia x EF x ED x ET x CFa x CFt
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	ATnc
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRgw: Assumes that a commercial/industrial worker would incidentally ingest 0.03 L/day (about one ouunce) on one-fourth of the total days or, on average, 0.0075 L/day.
(2) FI: Assumes 100% of incidental groundwater ingestion occurs on-site.
(3) EF: Default exposure frequency for indoor workers.
(4) ED: Recommended central tendency exposure duration for industrial scenarios.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 1 year ED.

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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TABLE 4.2.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE SITE-SPECIFIC WORKER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Site-Specific Worker	Adult	C/F: SS/SB at Slag Pile	EPC	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	100	mg/day	EPA, 1997 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	60	days/year	BPJ (3)	
				ED	Exposure Duration	25	years	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future On-Site Site-Specific Worker	Adult	C/F: SS/SB at Slag Pile	EPC	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.2	mg/cm^2	EPA, 2002 (8)	BW x AT
				EF	Exposure Frequency	60	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	25	years	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Site-Specific Worker	Adult	C/F: SS/SB P&V in Outdoor Air at Slag Pile	EPC	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	60	days/year	EPA, 1991 (3)	ATc
				ED	Exposure Duration	25	years	EPA, 1991 (4)	
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Default soil ingestion rate for outdoor workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Assumes 1 week per month.
(4) ED: Default exposure duration for workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: Default soil-to-skin adherence factor for outdoor workers.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(10) ET: Assumes 40-hour work week (5 days per week).

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
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EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.2.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE SITE-SPECIFIC COMMERCIAL/INDUSTRIAL WORKER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Site-Specific Worker	Adult	C/F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	100	mg/day	EPA, 1997 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	20	days/year	BPJ (3)	
				ED	Exposure Duration	25	years	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future On-Site Site-Specific Worker	Adult	C/F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.02	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	20	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	25	years	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Site-Specific Worker	Adult	C/F: SS/SB P&V in Outdoor Air at Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	20	days/year	EPA, 1991 (3)	ATc
				ED	Exposure Duration	25	years	EPA, 1991 (4)	
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Default soil ingestion rate for outdoor workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Assumes 5 days per week on a quarterly basis.
(4) ED: Default exposure duration for workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: Default central tendency soil-to-skin adherence factor for industrial workers.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(10) ET: Assumes 40-hour work week (5 days per week).

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
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EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.3a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE UTILITY WORKER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Utility Worker	Adult	C/F: SS/SB at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	330	mg/day	EPA, 2002 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	20	days/year	BPJ (3)	
				ED	Exposure Duration	25	years	EPA, 2002 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 2002 (4)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future On-Site Utility Worker	Adult	C/F: SS/SB at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.3	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	20	days/year	BPJ (3)	
				ED	Exposure Duration	25	years	EPA, 2002 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Utility Worker	Adult	C/F: SS/SB P & V in Outdoor Air at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	20	days/year	BPJ (3)	ATc
				ED	Exposure Duration	25	years	EPA, 2002 (4)	
				ET	Exposure Time	4	hrs/day	VDEQ, 2008 (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Recommended soil ingestion rate for construction workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Assumes 20 days per year.
(4) ED: Default exposure duration for workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: 95th percentile weighted soil adherence factor for construction workers.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(10) ET: Based on Virginia Department of Environmental Quality (VDEQ) model for trench work.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
VDEQ. (Virginia Department of Environmental Quality). 2008. "Voluntary Remediation Program Risk Assessment Guidance." On-Line Address: http://www.deq.virginia.gov/vrprisk/raguide.html

TABLE 4.3a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE UTILITY WORKER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Utility Worker	Adult	C/F: SS/SB at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	100	mg/day	EPA, 2002 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	10	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 2002 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 2002 (4)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future On-Site Utility Worker	Adult	C/F: SS/SB at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.1	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	10	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 2002 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Utility Worker	Adult	C/F: SS/SB P & V in Outdoor Air at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	10	days/year	BPJ (3)	ATc
				ED	Exposure Duration	9	years	EPA, 2002 (4)	
				ET	Exposure Time	4	hrs/day	VDEQ, 2008 (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Recommended soil ingestion rate for outdoor workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Assumes 10 days per year.
(4) ED: Recommended central tendency exposure duration for industrial scenarios.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: Mean weighted soil adherence factor for construction workers.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(10) ET: Based on Virginia Department of Environmental Quality (VDEQ) model for trench work.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
VDEQ. (Virginia Department of Environmental Quality). 2008. "Voluntary Remediation Program Risk Assessment Guidance." On-Line Address: http://www.deq.virginia.gov/vrprisk/raguide.html

TABLE 4.3b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE UTILITY WORKER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Utility Worker	Adult	C/F: GW at the Water Table at Carus Chemical Plant & Slag Pile	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
				IRgw	Groundwater Ingestion Rate (Incidental)	0.0125	L/day	BPJ (1)	CDI (mg/kg-day) =
				FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCgw x IRgw x FI x EF x ED x CFgw
				EF	Exposure Frequency	20	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	25	years	EPA, 1989 (4)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future On-Site Utility Worker	Adult	C/F: GW at the Water Table at Carus Chemical Plant & Slag Pile	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	For Inorganics:
				SA	Skin Surface Area	2,129	cm^2	EPA, 2004 (7)	CDI (mg/kg-day) =
				EF	Exposure Frequency	20	days/year	BPJ (3)	EPCgw x Kp x SA x EF x ED x ET x CFgw x CFv
				ED	Exposure Duration	25	years	EPA, 1989 (4)	BW x AT
				ET	Exposure Time	4	hrs/day	VDEQ, 2008 (8)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	For Organics:
				BW	Body Weight	70	kg	EPA, 1989 (5)	CDI (mg/kg-day) =
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	DAevent x EV x EF x SA x ED
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	BW x AT
				B	Ratio of Permeability Coefficient of a Compound	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
					Through the Corneum Relative to its Permeability	--	--	--	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
					Coefficient Across the Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	If tevent > t*, then:
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	DAevent = FA x Kp x EPCgw x CFv x CFgw x sqrt [ET/(1+B) + 2 x τevent
				EV	Event Frequency	1	event/day	EPA, 2004	x ({1+3B+3B^2}/{1+B}^{2})]
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	day	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Utility Worker	Adult	C/F: GW Vapors in Outdoor Air (Trenches) at Carus Chemical Plant & Slag Pile	CAtrench	Chemical Concentration in Trench	Calculated	$\mu g/m^3$	See Table B.2	
				CFa	Conversion Factor - Air	1.0E-03	mg/µg	--	CDEc ($\mu g/m^3$) =
				ET	Exposure Time	4	hrs/day	VDEQ, 2008 (8)	CAtrench x EF x ET x ED x CFt
				EF	Exposure Frequency	20	days/year	BPJ (3)	ATc
				ED	Exposure Duration	25	years	EPA, 1989 (4)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	CDEnc (mg/m^3) =
				ATnc	Average Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	CAtrench x EF x ET x ED x CFt x CFa
				ATc	Averaging Time - Carcinogens	25,550	day	EPA, 1989 (6)	ATnc

Notes:
(1) IRgw: Assumes that a utility worker would incidentally ingestion 0.05 L/day on one-fourth of the total days or, on average, 0.0125 L/day.
(2) FI: Assumes 100% of incidental groundwater ingestion occurs on-site.
(3) EF: Assumes 20 days per year.
(4) ED: Default exposure duration for workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.
(7) SA: Average surface area of hands and feet for adult males and females.
(8) ET: Based on Virginia Department of Environmental Quality (VDEQ) model for trench work.

Definitions:
GW = Groundwater

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
VDEQ. (Virginia Department of Environmental Quality). 2008. "Voluntary Remediation Program Risk Assessment Guidance." On-Line Address: http://www.deq.virginia.gov/vrprisk/raguide.html

TABLE 4.3b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE UTILITY WORKER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
Ingestion	Current and Future On-Site Utility Worker	Adult	C/F: GW at the Water Table at Carus Chemical Plant & Slag Pile	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRgw	Groundwater Ingestion Rate (Incidental)	0.0075	L/day	BPJ (1)	EPCgw x RBA x IRgw x FI x EF x ED x CFgw / BW x AT
				FI	Fractional Intake	1.0	unitless	BPJ (2)	
				EF	Exposure Frequency	10	days/year	IPCB, 2007 (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFgw	Conversion Factor - Groundwater	1.0E-06	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	
Dermal	Current and Future On-Site Utility Worker	Adult	C/F: GW at the Water Table at Carus Chemical Plant & Slag Pile	Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	For Inorganics:
				SA	Skin Surface Area	2,129	cm^2	EPA, 2004 (7)	CDI (mg/kg-day) =
				EF	Exposure Frequency	10	days/year	IPCB, 2007 (3)	EPCgw x Kp x SA x EF x ED x ET x CFgw x CFv / BW x AT
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				ET	Exposure Time	4	hrs/day	VDEQ, 2008 (8)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	For Organics:
				BW	Body Weight	70	kg	EPA, 1989 (5)	CDI (mg/kg-day) =
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	DAevent x EV x EF x SA x ED / BW x AT
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	
				B	Ratio of Permeability Coefficient of a Compound	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
					Through the Corneum Relative to its Permeability	--	--	--	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
					Coefficient Across the Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	If tevent > t*, then:
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	DAevent = FA x Kp x EPCgw x CFv x CFgw x sqrt [ET/(1+B) + 2 x τevent x ({1+3B+3B^2}/{1+B})^2)]
				EV	Event Frequency	1	event/day	EPA, 2004	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	day	EPA, 1989 (6)	
				CAtrench	Chemical Concentration in Trench	Calculated	$\mu g/m^3$	See Table B.2	
Inhalation	Current and Future On-Site Utility Worker	Adult	C/F: GW Vapors in Outdoor Air (Trenches) at Carus Chemical Plant & Slag Pile	CFa	Conversion Factor - Air	1.0E-03	mg/µg	--	CDEc ($\mu g/m^3$) =
				ET	Exposure Time	4	hours/day	BPJ (8)	CAtrench x EF x ET x ED x CFt / ATc
				EF	Exposure Frequency	10	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	CDEnc (mg/m^3) =
				ATnc	Average Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	CAtrench x EF x ET x ED x CFt x CFa / ATnc
				ATc	Averaging Time - Carcinogens	25,550	day	EPA, 1989 (6)	

Notes:
(1) IRgw: Assumes that a utility worker would incidentally ingestion 0.03 L/day (about one ouunce) on one-fourth of the total days or, on average, 0.0075 L/day.
(2) FI: Assumes 100% of incidental groundwater ingestion occurs on-site.
(3) EF: Assumes 10 days per year.
(4) ED: Recommended central tendency exposure duration for industrial scenarios.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 1 year ED.
(7) SA: Average surface area of hands and feet for adult males and females.
(8) ET: Based on Virginia Department of Environmental Quality (VDEQ) model for trench work.

Definitions:
GW = Groundwater

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
VDEQ. (Virginia Department of Environmental Quality). 2008. "Voluntary Remediation Program Risk Assessment Guidance." On-Line Address: http://www.deq.virginia.gov/vrprisk/raguide.html

TABLE 4.4a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE CONSTRUCTION WORKER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Construction Worker	Adult	F: SS/SB at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	330	mg/day	EPA, 2002 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	65	days/year	BPJ (3)	
				ED	Exposure Duration	1	years	EPA, 2002 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Future On-Site Construction Worker	Adult	F: SS/SB at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.3	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	65	days/year	BPJ (3)	
				ED	Exposure Duration	1	years	EPA, 2002 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Future On-Site Construction Worker	Adult	F: SS/SB P & V in Outdoor Air at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	65	days/year	BPJ (3)	ATc
				ED	Exposure Duration	1	years	EPA, 2002 (4)	
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Recommended soil ingestion rate for construction workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Assumes 5 days per week for a 13-week construction project.
(4) ED: Recommended exposure duration for construction workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 1 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: 95th percentile weighted soil adherence factor for construction workers.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(10) ET: Assumes 40-hour work week (5 days per week).

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.4a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE CONSTRUCTION WORKER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Construction Worker	Adult	F: SS/SB at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	100	mg/day	EPA, 2002 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	30	days/year	IPCB, 2007 (3)	
				ED	Exposure Duration	1	years	EPA, 2002 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Future On-Site Construction Worker	Adult	F: SS/SB at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.1	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	30	days/year	IPCB, 2007 (3)	
				ED	Exposure Duration	1	years	EPA, 2002 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Future On-Site Construction Worker	Adult	F: SS/SB P & V in Outdoor Air at Carus Chemical Plant & Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	30	days/year	IPCB, 2007 (3)	ATc
				ED	Exposure Duration	1	years	EPA, 2002 (4)	
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Recommended soil ingestion rate for outdoor workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Illinois Pollution Control Board recommended exposure duration for construction projects.
(4) ED: Recommended exposure duration for construction workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 1 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: Mean weighted soil adherence factor for construction workers.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(10) ET: Assumes 40-hour work week (5 days per week).

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.4b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE CONSTRUCTION WORKER - GROUNDWATER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
Ingestion	Future On-Site Construction Worker	Adult	F: GW at the Water Table at Carus Chemical Plant & Slag Pile	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRgw	Groundwater Ingestion Rate (Incidental)	0.0125	L/day	BPJ (1)	EPCgw x RBA x IRgw x FI x EF x ED x CFgw
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	65	days/year	BPJ (3)	
				ED	Exposure Duration	1	years	EPA, 1989 (4)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	
Dermal	Future On-Site Construction Worker	Adult	F: GW at the Water Table at Carus Chemical Plant & Slag Pile	Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	For Inorganics:
				SA	Skin Surface Area	2,129	cm^2	EPA, 2004 (7)	CDI (mg/kg-day) =
				EF	Exposure Frequency	65	days/year	BPJ (3)	EPCgw x Kp x SA x EF x ED x ET x CFgw x CFv
				ED	Exposure Duration	1	years	EPA, 1989 (4)	BW x AT
				ET	Exposure Time	4	hrs/day	VDEQ, 2008 (8)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	For Organics:
				BW	Body Weight	70	kg	EPA, 1989 (5)	CDI (mg/kg-day) =
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	DAevent x EV x EF x SA x ED
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	BW x AT
				B	Ratio of Permeability Coefficient of a Compound	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
					Through the Corneum Relative to its Permeability	--	--	--	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
					Coefficient Across the Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	If tevent > t*, then:
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	DAevent = FA x Kp x EPCgw x CFv x CFgw x sqrt [ET/(1+B) + 2 x τevent
				EV	Event Frequency	1	event/day	EPA, 2004	x ({1+3B+3B^2}/{1+B}^{2})]
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				CAtrench	Chemical Concentration in Trench	Calculated	$\mu g/m^3$	See Table B.2	
Inhalation	Future On-Site Construction Worker	Adult	C/F: GW Vapors in Outdoor Air (Trenches) at Carus Chemical Plant & Slag Pile	CFa	Conversion Factor - Air	4	hrs/day	VDEQ, 2008 (8)	CDEc ($\mu g/m^3$) =
				ET	Exposure Time	65	days/year	BPJ (3)	CAtrench x EF x ET x ED x CFt
				EF	Exposure Frequency	1	years	EPA, 1989 (4)	ATc
				ED	Exposure Duration	1.0E-03	mg/ug	--	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	CDEnc (mg/m^3) =
				ATnc	Average Time - Noncarcinogens	365	days	EPA, 1989 (6)	CAtrench x EF x ET x ED x CFt x CFa
				ATc	Averaging Time - Carcinogens	25,550	day	EPA, 1989 (6)	ATnc

Notes:
(1) IRgw: Assumes that a construction worker would incidentally ingestion 0.05 L/day on one-fourth of the total days or, on average, 0.0125 L/day.
(2) FI: Assumes 100% of incidental groundwater ingestion occurs on-site.
(3) EF: Assumes 5 days per week for a 13-week construction project.
(4) ED: Recommended exposure duration for construction workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 1 year ED.
(7) SA: Average surface area of hands and feet for adult males and females.
(8) ET: Based on the Virginia Department of Environmental Protection trench exposure model.

Definitions:
GW = Groundwater

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.

TABLE 4.4b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE CONSTRUCTION WORKER - GROUNDWATER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
Ingestion	Future On-Site Construction Worker	Adult	F: GW at the Water Table at Carus Chemical Plant & Slag Pile	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRgw	Groundwater Ingestion Rate (Incidental)	0.0075	L/day	BPJ (1)	EPCgw x RBA x IRgw x FI x EF x ED x CFgw / BW x AT
				FI	Fractional Intake	1.0	unitless	BPJ (2)	
				EF	Exposure Frequency	30	days/year	IPCB, 2007 (3)	
				ED	Exposure Duration	1	years	EPA, 1989 (4)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	
Dermal	Future On-Site Construction Worker	Adult	F: GW at the Water Table at Carus Chemical Plant & Slag Pile	Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	For Inorganics:
				SA	Skin Surface Area	2,129	cm^2	EPA, 2004 (7)	CDI (mg/kg-day) =
				EF	Exposure Frequency	30	days/year	IPCB, 2007 (3)	EPCgw x Kp x SA x EF x ED x ET x CFgw x CFv / BW x AT
				ED	Exposure Duration	1	years	EPA, 1989 (4)	
				ET	Exposure Time	4	hrs/day	VDEQ, 2008 (8)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	For Organics:
				BW	Body Weight	70	kg	EPA, 1989 (5)	CDI (mg/kg-day) =
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	DAevent x EV x EF x SA x ED / BW x AT
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	
				B	Ratio of Permeability Coefficient of a Compound	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
					Through the Corneum Relative to its Permeability	--	--	--	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
					Coefficient Across the Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	If tevent > t*, then:
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	DAevent = FA x Kp x EPCgw x CFv x CFgw x sqrt [ET/(1+B) + 2 x τevent
				EV	Event Frequency	1	event/day	EPA, 2004	x ({1+3B+3B^2}/{1+B}^{2})]
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				CAtrench	Chemical Concentration in Trench	Calculated	$\mu g/m^3$	See Table B.2	
Inhalation	Future On-Site Construction Worker	Adult	C/F: GW Vapors in Outdoor Air (Trenches) at Carus Chemical Plant & Slag Pile	CFa	Conversion Factor - Air	4	hours/day	BPJ (8)	CDEc ($\mu g/m^3$) =
				ET	Exposure Time	30	days/year	IPCB, 2007 (3)	CAtrench x EF x ET x ED x CFt / ATc
				EF	Exposure Frequency	1	years	EPA, 1989 (4)	
				ED	Exposure Duration	1.0E-03	mg/ug	--	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	CDEnc (mg/m^3) =
				ATnc	Average Time - Noncarcinogens	365	days	EPA, 1989 (6)	CAtrench x EF x ET x ED x CFt x CFa / ATnc
				ATc	Averaging Time - Carcinogens	25,550	day	EPA, 1989 (6)	

Notes:
(1) IRgw: Assumes that a construction worker would incidentally ingestion 0.03 L/day (about one ouunce) on one-fourth of the total days or, on average, 0.0075 L/day.
(2) FI: Assumes 100% of incidental groundwater ingestion occurs on-site.
(3) EF: Illinois Pollution Control Board recommended exposure duration for construction projects.
(4) ED: Recommended exposure duration for construction workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 1 year ED.
(7) SA: Average surface area of hands and feet for adult males and females.
(8) ET: Based on the Virginia Department of Environmental Protection trench exposure model.

Definitions:
GW = Groundwater

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.

TABLE 4.5.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADOLESCENT TRESPASSER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Soil
Exposure Medium: Surface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Trespasser	Adolescent Age 6-16	C/F: SS at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	14.3	mg-year/kg-day	EPA, 2008 (1)	EPC x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	42.9	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future On-Site Trespasser	Adolescent Age 6-16	C/F: SS at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	57	mg-year/kg-day	EPA, 2008 (6)	EPC x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	171	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPJ (8)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Current and Future On-Site Trespasser	Adolescent Age 6-16	C/F: SS P&V in Outdoor Air at Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	EPC x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				EF	Exposure Frequency	43	days/year	BPJ (4)	ATc
				ED	Exposure Duration	10	years	--	
				EDadj	Mutagenic ED	30	years	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				ET	Exposure Time	2	hrs/day	BPJ (11)	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	ATnc
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for trespassers ages 6 to 16 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for trespassers ages 6 to 16 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]

(5) ATc:365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for trespassers ages 6 to 16 calculated as:
DFSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5700 cm^2) x AF_{adult} (0.07 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for trespassers ages 6 to 16 calculated as:
DFSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5700 cm^2) x AF_{adult} (0.07 mg/cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Site-specific PEF calculate

(9) ED: Assumes 10 years (ages 6 to 16).

(10) EDadj: For ages 6 to 16, an age-dependent adjustment factor of 3 is applied to ED to account for mutagenic effects via inhalation [(3*10)=30].

(11) ET: Assumes a 2 hour Site visit.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.5.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADOLESCENT TRESPASSER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Soil
Exposure Medium: Surface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Trespasser	Adolescent Age 6-16	C/F: SS at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	7.1	mg-year/kg-day	EPA, 2008 (1)	EPC x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	21.4	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future On-Site Trespasser	Adolescent Age 6-16	C/F: SS at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	8.1	mg-year/kg-day	EPA, 2008 (6)	EPC x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	24	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	21	days/year	BPJ (8)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Current and Future On-Site Trespasser	Adolescent Age 6-16	C/F: SS P&V in Outdoor Air at Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	EPC x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				EF	Exposure Frequency	21	days/year	BPJ (4)	ATc
				ED	Exposure Duration	10	years	--	
				EDadj	Mutagenic ED	30	years	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				ET	Exposure Time	2	hrs/day	BPJ (11)	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	ATnc
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for trespassers ages 6 to 16 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (50 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for trespassers ages 6 to 16 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (50 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21]

(5) ATc:365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for trespassers ages 6 to 16 calculated as:
DFSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5700 cm^2) x AFadult-cte (0.01 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Adult Resident CTE (EPA, 2004) Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for trespassers ages 6 to 16 calculated as:
DFSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5700 cm^2) x AFadult-cte (0.01 mg/cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Adult Resident CTE (EPA, 2004) Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.

(9) ED: Assumes 10 years (ages 6 to 16).

(10) EDadj: For ages 6 to 16, an age-dependent adjustment factor of 3 is applied to ED to account for mutagenic effects via inhalation [(3*10)=30].

(11) ET: Assumes a 2 hour Site visit.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.6.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADULT TRESPASSER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Soil
Exposure Medium: Surface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Trespasser	Adult	C/F: SS at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	100	mg/day	EPA, 1997 (1)	EPC x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future On-Site Trespasser	Adult	C/F: SS at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	5,700	cm^2	EPA, 2002 (7)	EPC x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.07	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Trespasser	Adult	C/F: SS P&V in Outdoor Air at Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	43	days/year	BPJ (3)	ATc
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				ET	Exposure Time	2	hrs/day	BPJ (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Recommended soil ingestion rate for adult residents.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]
(4) ED: Default exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 30 year ED.
(7) SA: Default skin surface area for adult residents.
(8) AF: Default soil-to-skin adherence factor for adult residents.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(11) ET: Assumes a 2 hour Site visit.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.6.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADULT TRESPASSER - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Soil
Exposure Medium: Surface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Trespasser	Adult	C/F: SS at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	50	mg/day	EPA, 1997 (1)	EPC x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future On-Site Trespasser	Adult	C/F: SS at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	5,700	cm^2	EPA, 2002 (7)	EPC x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.01	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Trespasser	Adult	C/F: SS P&V in Outdoor Air at Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	43	days/year	BPJ (3)	ATc
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				ET	Exposure Time	2	hrs/day	BPJ (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Mean soil ingestion rate for adults.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21]
(4) ED: Default central tendency exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 9 year ED.
(7) SA: Default skin surface area for adult residents.
(8) AF: Default central tendency soil-to-skin adherence factor for adult residents.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(11) ET: Assumes a 2 hour Site visit.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.7.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE CHILD RECREATIONALIST - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Child Age 0-6	F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	80	mg-year/kg-day	EPA, 2008 (1)	EPC x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	427	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future On-Site Recreationalist	Child Age 0-6	F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	224	mg-year/kg-day	EPA, 2008 (6)	EPC x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	1,195	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPJ (8)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Future On-Site Recreationalist	Child Age 0-6	F: SS/SB P&V in Outdoor Air at Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	EPC x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				EF	Exposure Frequency	43	days/year	BPJ (4)	ATc
				ED	Exposure Duration	6	years	--	
				EDadj	Mutagenic ED	32	years	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				ET	Exposure Time	2	hrs/day	BPJ (11)	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFa	Conversion Factor - Air	1.00E+03	ug/mg	--	ATnc
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for Recreationalists ages 0 to 6 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (200 mg/day) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x IRS_{child} (200 mg/day) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for Recreationalists ages 0 to 6 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (200 mg/day) x $ADAF_{0-2}$ (10) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x IRS_{child} (200 mg/day) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 6 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for Recreationalists ages 0 to 6 calculated as:
DFSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2)/ BW_{child} (15kg)) + (ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2)/ BW_{child} (15kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for Recreationalists ages 0 to 6 calculated as:
DFSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2) x $ADAF_{0-2}$ (10) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.

(9) ED: Assumes 6 years (ages 0 to 6).

(10) EDadj: To account for potential mutagenic effects via inhalation an age-dependent adjustment factor (ADAF) of 10 is applied to the ED for ages 0 to 2 and an ADAF of 3 is applied to the ED for ages 2 to 6 [(2x10)+(4x3)=32].

(11) ET: Assumes a 2 hour Site visit.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.7.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE CHILD RECREATIONALIST - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Child Age 0-6	F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	40	mg-year/kg-day	EPA, 2008 (1)	EPC x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	213	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future On-Site Recreationalist	Child Age 0-6	F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	44.8	mg-year/kg-day	EPA, 2008 (6)	EPC x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	239	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	21	days/year	BPJ (8)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Future On-Site Recreationalist	Child Age 0-6	F: SS/SB P&V in Outdoor Air at Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	EPC x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				EF	Exposure Frequency	21	days/year	BPJ (4)	ATc
				ED	Exposure Duration	6	years	--	
				EDadj	Mutagenic ED	32	years	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				ET	Exposure Time	2	hrs/day	BPJ (11)	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFa	Conversion Factor - Air	1.00E+03	ug/mg	--	ATnc
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for Recreationalists ages 0 to 6 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (100 mg/day) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x IRS_{child} (100 mg/day) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for Recreationalists ages 0 to 6 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (100 mg/day) x $ADAF_{0-2}$ (10) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x IRS_{child} (100 mg/day) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21].

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 6 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for Recreationalists ages 0 to 6 calculated as:
DFSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.04 mg/cm^2)/ BW_{child} (15kg)) + (ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.04 mg/cm^2)/ BW_{child} (15kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Child Resident CTE (EPA, 2004) Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for Recreationalists ages 0 to 6 calculated as:
DFSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.04 mg/cm^2) x $ADAF_{0-2}$ (10) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.04 mg/cm^2) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Child resident CTE (EPA, 2004) Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.

(9) ED: Assumes 6 years (ages 0 to 6).

(10) EDadj: To account for potential mutagenic effects via inhalation an age-dependent adjustment factor (ADAF) of 10 is applied to the ED for ages 0 to 2 and an ADAF of 3 is applied to the ED for ages 2 to 6 [(2x10)+(4x3)=32].

(11) ET: Assumes a 2 hour Site visit.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.8.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE ADOLESCENT RECREATIONALIST - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Adolescent Age 6-16	F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	14.3	mg-year/kg-day	EPA, 2008 (1)	EPC x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	42.9	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future On-Site Recreationalist	Adolescent Age 6-16	F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	57	mg-year/kg-day	EPA, 2008 (6)	EPC x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	171	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPJ (8)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Future On-Site Recreationalist	Adolescent Age 6-16	F: SS/SB P&V in Outdoor Air at Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	EPC x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				EF	Exposure Frequency	43	days/year	BPJ (4)	Atc
				ED	Exposure Duration	10	years	--	
				EDadj	Mutagenic ED	30	years	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				ET	Exposure Time	2	hrs/day	BPJ (11)	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	ATnc
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for Recreationalists ages 6 to 16 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for Recreationalists ages 6 to 16 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for Recreationalists ages 6 to 16 calculated as:
DFSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5,700 cm^2) x AF_{adult} (0.07 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for Recreationalists ages 6 to 16 calculated as:
DFSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5,700 cm^2) x AF_{adult} (0.07 mg/cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.

(9) ED: Assumes 10 years (ages 6 to 16).

(10) EDadj: To account for potential mutagenic effects via inhalation an age-dependent adjustment factor of 3 is applied to the ED for ages 6 to 16 [3x10=30].

(11) ET: Assumes a 2 hour Site visit.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.8.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE ADOLESCENT RECREATIONALIST - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Adolescent Age 6-16	F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	7.1	mg-year/kg-day	EPA, 2008 (1)	EPC x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	21.4	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future On-Site Recreationalist	Adolescent Age 6-16	F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	8.1	mg-year/kg-day	EPA, 2008 (6)	EPC x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	24	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	21	days/year	BPJ (8)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Future On-Site Recreationalist	Adolescent Age 6-16	F: SS/SB P&V in Outdoor Air at Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	EPC x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				EF	Exposure Frequency	21	days/year	BPJ (4)	Atc
				ED	Exposure Duration	10	years	--	
				EDadj	Mutagenic ED	30	years	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				ET	Exposure Time	2	hrs/day	BPJ (11)	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	ATnc
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for Recreationalists ages 6 to 16 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (50 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for Recreationalists ages 6 to 16 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (50 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21].

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for Recreationalists ages 6 to 16 calculated as:
DFSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5,700 cm^2) x AF_{adult} (0.01 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Adult Resident CTE (EPA, 2004) Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for Recreationalists ages 6 to 16 calculated as:
DFSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5,700 cm^2) x AF_{adult} (0.01 mg/cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Adult Resident CTE (EPA, 2004) Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.

(9) ED: Assumes 10 years (ages 6 to 16).

(10) EDadj: To account for potential mutagenic effects via inhalation an age-dependent adjustment factor of 3 is applied to the ED for ages 6 to 16 [3x10=30].

(11) ET: Assumes a 2 hour Site visit.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.9.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE ADULT RECREATIONALIST - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Adult	F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	100	mg/day	EPA, 1997 (1)	EPC x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Future On-Site Recreationalist	Adult	F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	5,700	cm^2	EPA, 2002 (7)	EPC x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.07	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Future On-Site Recreationalist	Adult	F: SS/SB P&V in Outdoor Air at Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	43	days/year	BPJ (3)	ATc
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				ET	Exposure Time	2	hrs/day	BPJ (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Recommended soil ingestion rate for adult residents.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+(1*17)=43]
(4) ED: Default exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 30 year ED.
(7) SA: Default skin surface area for adult residents.
(8) AF: Default soil-to-skin adherence factor for adult residents.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(11) ET: Assumes a 2 hour Site visit.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.9.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE ADULT RECREATIONALIST - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Adult	F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	50	mg/day	EPA, 1997 (1)	EPC x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Future On-Site Recreationalist	Adult	F: SS/SB at Slag Pile	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	5,700	cm^2	EPA, 2002 (7)	EPC x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.01	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Future On-Site Recreationalist	Adult	F: SS/SB P&V in Outdoor Air at Slag Pile	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	21	days/year	BPJ (3)	ATc
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				ET	Exposure Time	2	hrs/day	BPJ (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Mean soil ingestion rate for adults.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21]
(4) ED: Default central tendency exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 9 year ED.
(7) SA: Default skin surface area for adult residents.
(8) AF: Default central tendency soil-to-skin adherence factor for adult residents.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(11) ET: Assumes a 2 hour Site visit.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Table 4.10a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
HYPOTHETICAL FUTURE CHILD RESIDENT - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V, Homegrown Produce

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Hypothetical Future On-Site Resident	Child Age 0-6	F: SS/SB at Carus Chemical Plant	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI_{NC} (mg/kg-day) =
				IRS	Soil Ingestion Rate	200	mg/day	EPA, 1991 (1)	EPC x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x ATnc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	6	years	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	15	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Dermal	Hypothetical Future On-Site Resident	Child Age 0-6	F: SS/SB at Carus Chemical Plant	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI_{NC} (mg/kg-day) =
				SA	Skin Surface Area	2,800	cm^2	EPA, 2002 (7)	EPC x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.2	mg/cm^2	EPA, 2002 (8)	BW x ATnc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	6	years	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	15	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Inhalation	Hypothetical Future On-Site Resident	Child Age 0-6	F: SS/SB P&V in Outdoor Air at Carus Chemical Plant	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_{NC} (mg/m^3) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFt
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	ATnc
				ED	Exposure Duration	6	years	EPA, 1991 (4)	
				ET	Exposure Time	24	hrs/day	EPA, 2008 (10)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Ingestion	Hypothetical Future On-Site Resident	Child Age 0-6	F: Produce Grown in SS/SB at Carus Chemical Plant	Prag	Aboveground Exposed and Protected Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (11)	
				EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	See Table 3 Series	CDI_{NC} (mg/kg-day) =
				Brag	Plant-Soil Bioconcentration Factor for Aboveground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (12)	IHP x EF x ED
				PRbg	Belowground Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (11)	ATnc
				BRrootveg	Plant-Soil Bioconcentration Factor for Belowground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (12)	where:
				VGrootveg	**Empirical Correction Factor for Belowground Produce**	**0.01 or 1.0**	**unitless**	**EPA, 2005 (13)**	**IHP (mg/kg-day) =**
				IHP	Daily Intake From Homegrown Produce	site-specific	mg/kg-day	EPA, 2008 (14)	((Prag x Crag) + (Prbg x CRbg)) x Fp
				Crag	Aboveground Produce Ingestion Rate	2.27E-03	kg DW/kg-day	EPA, 2005 (15)	and
				CRbg	Belowground Produce Ingestion Rate	2.30E-04	kg DW/kg-day	EPA, 2005 (16)	Prag = EPCs x Brag
				Fp	Fraction of Homegrown Produce Ingested From Contaminated Source	1	unitless	BPJ (17)	Prbg = EPCs x Brrootveg x VGrootveg
				EF	Exposure Frequency	350	days/year	EPA, 2005 (3)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 2005 (6)	

Notes:
(1) IRS: Default soil ingestion rate for children.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Default exposure frequency for residents.
(4) ED: Default exposure duration for child residents.
(5) BW: Default child body weight.
(6) ATnc: 365 days/year x 6 year ED; note, carcinogenic effects for residents were evaluated using the more-sensitive aggregate resident receptor only.
(7) SA: Default skin surface area for children.
(8) AF: Default soil-to-skin adherence factor for children.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(10) ET: Default exposure time for residents.
(11) Prag: Consistent with EPA (2005), calculated using equation presented.
(12) Brag and Brrootveg: Chemical-specific values will be obtained from the HHRAP Comparison Database (ACCESS) or calculated using the procedures presented in Appendix A-2 of EPA (2005).
(13) VGrootveg: Default empirical correction factors for belowground produce. A VGrootveg value of 0.01 will be used for chemicals with a logKow > 4, and a VGrootveg value of 1.0 will be used for chemicals with a logKow ≤ 4.
(14) IHP: Consistent with EPA (2005), this parameter was calculated using the equation presented.
(15): Crag: The RME aboveground produce ingestion rate for resident children ages 0 to 6 was calculated as the sum of default exposed and protected aboveground produce ingestion rates.
(16) Crbg: Default belowground ingestion rate for resident children ages 0 to 6.
(17) Fp: Default fraction of homegrown produce ingested from contaminated source.

Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2005. "Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities". OSWER. EPA-530-R-05-006. September.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Table 4.10a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
HYPOTHETICAL FUTURE CHILD RESIDENT - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V, Homegrown Produce

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Hypothetical Future On-Site Resident	Child Age 0-6	F: SS/SB at Carus Chemical Plant	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI_{NC} (mg/kg-day) =
				IRS	Soil Ingestion Rate	100	mg/day	EPA, 1997 (1)	EPC x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x ATnc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	6	years	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	15	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Dermal	Hypothetical Future On-Site Resident	Child Age 0-6	F: SS/SB at Carus Chemical Plant	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI_{NC} (mg/kg-day) =
				SA	Skin Surface Area	2,800	cm^2	EPA, 2002 (7)	EPC x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.04	mg/cm^2	EPA, 2004 (8)	BW x ATnc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	6	years	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	15	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Inhalation	Hypothetical Future On-Site Resident	Child Age 0-6	F: SS/SB P&V in Outdoor Air at Carus Chemical Plant	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_{NC} (mg/m^3) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPC x (1/PEF + 1/VF) x EF x ED x ET x CFt
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	ATnc
				ED	Exposure Duration	6	years	EPA, 1991 (4)	
				ET	Exposure Time	24	hrs/day	EPA, 2008 (10)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Ingestion	Hypothetical Future On-Site Resident	Child Age 0-6	F: Produce Grown in SS/SB at Carus Chemical Plant	Prag	Aboveground Exposed and Protected Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (11)	
				EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	See Table 3 Series	CDI_{NC} (mg/kg-day) =
				Brag	Plant-Soil Bioconcentration Factor for Aboveground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (12)	IHP x EF x ED
				PRbg	Belowground Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (11)	ATnc
				BRrootveg	Plant-Soil Bioconcentration Factor for Belowground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (12)	where:
				VGrootveg	Empirical Correction Factor for Belowground Produce	0.01 or 1.0	unitless	EPA, 2005 (13)	IHP (mg/kg-day) =
				IHP	Daily Intake From Homegrown Produce	site-specific	mg/kg-day	EPA, 2008 (14)	((Prag x Crag) + (Prbg x CRbg)) x Fp
				Crag	Aboveground Produce Ingestion Rate	2.27E-03	kg DW/kg-day	EPA, 2005 (15)	and
				CRbg	Belowground Produce Ingestion Rate	2.30E-04	kg DW/kg-day	EPA, 2005 (16)	Prag = EPCs x Brag
				Fp	Fraction of Homegrown Produce Ingested From Contaminated Source	0.5	unitless	EPA, 2005 (17)	Prbg = EPCs x Brrootveg x VGrootveg
				EF	Exposure Frequency	350	days/year	EPA, 2005 (3)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 2005 (6)	

Notes:
(1) IRS: Mean daily soil ingestion rate for children.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Default exposure frequency for residents.
(4) ED: Default exposure duration for child residents.
(5) BW: Default child body weight.
(6) ATnc: 365 days/year x 6 year ED; note, carcinogenic effects for residents were evaluated using the more-sensitive aggregate resident receptor only.
(7) SA: Default skin surface area for children.
(8) AF: Default central tendency soil-to-skin adherence factor for children.
(9) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(10) ET: Default exposure time for residents.
(10) ET: CTE exposure time outdoors at residence for residential child age 0 to 6 based on BPJ and EPA recommendation for residents of all ages.
(11) Prag: Consistent with EPA (2005), calculated using equation presented.
(12) Brag and Brrootveg: Chemical-specific values will be obtained from the HHRAP Comparison Database (ACCESS) or calculated using the procedures presented in Appendix A-2 of EPA (2005).
(13) VGrootveg: Default empirical correction factors for belowground produce. A VGrootveg value of 0.01 will be used for chemicals with a logKow > 4, and a VGrootveg value of 1.0 will be used for chemicals with a logKow ≤ 4.
(14) IHP: Consistent with EPA (2005), this parameter was calculated using the equation presented.
(15): Crag: The CTE aboveground produce ingestion rate for resident children ages 0 to 6 was calculated as the sum of default exposed and protected aboveground produce ingestion rates.
(16) Crbg: Default belowground ingestion rate for resident children ages 0 to 6.
(17) Fp: The CTE values is equal to 50 percent of the RME value based on best professional judgment.

Definitions:
Definitions:
SS = Surface Soil
SB = Subsurface Soil
P & V = Particulates and Vapors

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.10b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
HYPOTHETICAL FUTURE CHILD RESIDENT - GROUNDWATER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Hypothetical Future On-Site Resident	Child Age 0-6	F: Potable GW at Carus Chemical Plant	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
				IRgw	Tapwater Ingestion Rate	1	L/day	EPA, 1991 (1)	CDI_{NC} (mg/kg-day) =
				FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCgw x IRgw x FI x EF x ED x CFw
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	BW x ATnc
				ED	Exposure Duration	6	years	EPA, 1991 (4)	
				CFdw	Conversion Factor - Water	1.0E+03	mg/ug	--	
				BW	Body Weight	15	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Dermal	Hypothetical Future On-Site Resident	Child Age 0-6	F: Potable GW at Carus Chemical Plant	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	EPCgw x Kp x DFGW[M]adj x EF x ET x CFgw x CFv
				DFGWadj	Age-Adjusted Dermal Contact Factor - Groundwater	2,640	cm^2-year/kg	EPA ,2008 (7)	AT
				DFGWMadj	Mutagenic DFGWadj	14,080	cm^2-year/kg	EPA, 2008 (8)	For Organics:
				ET	Exposure Time	1	hr/day	EPA, 2004 (9)	CDI (mg/kg-day) =
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	DAevent x EV x EF x DFGW[M]adj
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
				B	Ratio of Permeability Coefficient of a Compound Through the	chemical-specific	unitless	See Table 5 & 6 Series	
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	
					Viable Epidermis	--	--	--	If tevent > t*, then:
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	DAevent = FA x Kp x EPCgw x CFv x CFgw x sqrt [ET/(1+B) + 2 x τevent
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	x ({1+3B+$3B^2$)/{1+B})^2)]
				EV	Event Frequency	1	event/day	EPA, 2004	
				ATnc	Average Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Inhalation	Hypothetical Future On-Site Resident	Child Age 0-6	F: GW Vapors in Outdoor Air at Carus Chemical Plant	EPCair	Exposure Point Concentration - Air	Calculated	mg/m^3	Calculated	
				EPCgw	Exposure Point Concentration - Groundwater	See Table 3s	mg/L	See Table 3s	CDE (mg/m^3) =
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	EPCair x EF x ED x ETod x CFt
				ED	Exposure Duration	6	years	EPA, 1991 (4)	AT
				ETod	Exposure Time - Outdoors	24	hours/day	EPA, 2008 (9)	
				CFt	Conversion Factor, Time (1/24)	0.042	day/hrs	--	where EPCair =
				VF_{wamb}	Volatilization Factor, Water to Ambient Air	See Table XX	m^3/L	See Table XX	EPCgw
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	VFwamb
Inhalation	Hypothetical Future On-Site Resident	Child Age 0-6	F: GW Vapors in Indoor Air at Carus Chemical Plant (Vapor Intrusion)	EPCia	Chemical Concentration in Indoor Air	See Table XX	mg/m^3	See Table XX	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	CDE (mg/m^3) =
				ED	Exposure Duration	6	years	EPA, 1991 (4)	EPCia x EF x ED
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	AT
Inhalation	Hypothetical Future On-Site Resident	Child Age 0-6	F: GW Vapors in Indoor Air at Carus Chemical Plant (Household Use)	EPCgw	Exposure Point Concentration - Groundwater	See Table XX	µg/L	See Table XX	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	CDE (mg/m^3) =
				ED	Exposure Duration	6	years	EPA, 1991 (4)	EPCgw x VFw x EF x ED x ETb x CFt x CFgw
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	AT
				ETb	Exposure Time - Bathing	1	hr/day	EPA, 2004 (10)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				VF_W	Volatilization Factor, Domestic Use	0.5	L/m^3	EPA 1991	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	

Notes:
(1) IRgw: Default water ingestion rate for children.
(2) FI: Assumes 100% of groundwater ingestion occurs at the Site.
(3) EF: Default exposure frequency for residents.
(4) ED: Default exposure duration for child residents.
(5) BW: Default child body weight.
(6) ATnc: 365 days/year x 6 year ED; note, carcinogenic effects for residents were evaluated using the more-sensitive aggregate resident receptor only.
(7) DFGWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rate for residential children age 0 to 6 is calculated as:
DFGWadj (cm^2-year/kg) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) / BW_{child} (15 kg)) + ((ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of Residential Child (cm^2); BW = Body Weight (kg)
(8) DFGWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rate for residential children age 0 to 6 is calculated as:
DFGWMadj (cm^2-year/kg) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x $ADAF_{0-2}$ (10) / BW_{child} (15 kg)) + ((ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x ADAF2-6 (3) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of Residential Child (cm^2); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)
(9): ET/ETod: Default exposure time for residents.
(10): Etb: Default RME time spent bathing by a residential child.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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TABLE 4.10b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
HYPOTHETICAL FUTURE CHILD RESIDENT - GROUNDWATER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Hypothetical Future On-Site Resident	Child Age 0-6	F: Potable GW at Carus Chemical Plant	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
				IRgw	Tapwater Ingestion Rate	1	L/day	EPA, 1991 (1)	CDI_{NC} (mg/kg-day) =
				FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCgw x IRgw x FI x EF x ED x CFw
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	BW x ATnc
				ED	Exposure Duration	6	years	EPA, 1991 (4)	
				CFdw	Conversion Factor - Water	1.0E+03	mg/ug	--	
				BW	Body Weight	15	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Dermal	Hypothetical Future On-Site Resident	Child Age 0-6	F: Potable GW at Carus Chemical Plant	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	EPCgw x Kp x DFGW[M]adj x EF x ET x CFgw x CFv
				DFGWadj	Age-Adjusted Dermal Contact Factor - Groundwater	2,640	cm^2-year/kg	EPA ,2008 (7)	AT
				DFGWMadj	Mutagenic DFGWadj	14,080	cm^2-year/kg	EPA, 2008 (8)	For Organics:
				ET	Exposure Time	0.33	hrs/day	EPA, 2004 (9)	CDI (mg/kg-day) =
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	DAevent x EV x EF x DFGW[M]adj
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
				B	Ratio of Permeability Coefficient of a Compound Through the	chemical-specific	unitless	See Table 5 & 6 Series	
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	
					Viable Epidermis	--	--	--	If tevent > t*, then:
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	DAevent = FA x Kp x EPCgw x CFv x CFgw x sqrt [ET/(1+B) + 2 x τevent
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	x ({1+3B+$3B^2$}/{1+B}^{2})]
				EV	Event Frequency	1	event/day	EPA, 2004	
				ATnc	Average Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Inhalation	Hypothetical Future On-Site Resident	Child Age 0-6	F: GW Vapors in Outdoor Air at Carus Chemical Plant	EPCair	Exposure Point Concentration - Air	Calculated	mg/m^3	Calculated	
				EPCgw	Exposure Point Concentration - Groundwater	See Table 3s	mg/L	See Table 3s	CDE (mg/m^3) =
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	EPCair x EF x ED x ETod x CFt
				ED	Exposure Duration	6	years	EPA, 1991 (4)	AT
				ETod	Exposure Time - Outdoors	3	hrs/day	EPA, 1997 (9)	
				CFt	Conversion Factor, Time (1/24)	0.042	day/hrs	--	where EPCair =
				VF_{wamb}	Volatilization Factor, Water to Ambient Air	See Table XX	m^3/L	See Table XX	EPCgw
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	VFwamb
Inhalation	Hypothetical Future On-Site Resident	Child Age 0-6	F: GW Vapors in Indoor Air at Carus Chemical Plant (Vapor Intrusion)	EPCia	Chemical Concentration in Indoor Air	See Table XX	mg/m^3	See Table XX	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	CDE (mg/m^3) =
				ED	Exposure Duration	6	years	EPA, 1991 (4)	EPCia x EF x ED
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	AT
Inhalation	Hypothetical Future On-Site Resident	Child Age 0-6	F: GW Vapors in Indoor Air at Carus Chemical Plant (Household Use)	EPCgw	Exposure Point Concentration - Groundwater	See Table XX	mg/L	See Table XX	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	CDE (mg/m^3) =
				ED	Exposure Duration	6	years	EPA, 1991 (4)	EPCgw x VFw x EF x ED x ETb x CFt x CFgw
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	AT
				ETb	Exposure Time - Bathing	0.33	hr/day	EPA, 2004 (10)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				VF_W	Volatilization Factor, Domestic Use	0.5	L/m^3	EPA 1991	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	

Notes:
(1) IRgw: Default water ingestion rate for children.
(2) FI: Assumes 100% of groundwater ingestion occurs at the Site.
(3) EF: Default exposure frequency for residents.
(4) ED: Default exposure duration for child residents.
(5) BW: Default child body weight.
(6) ATnc: 365 days/year x 6 year ED; note, carcinogenic effects for residents were evaluated using the more-sensitive aggregate resident receptor only.
(7) DFGWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rate for residential children age 0 to 6 is calculated as:
DFGWadj (cm^2-year/kg) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) / BW_{child} (15 kg)) + ((ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of Residential Child (cm^2); BW = Body Weight (kg)
(8) DFGWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rate for residential children age 0 to 6 is calculated as:
DFGWMadj (cm^2-year/kg) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x $ADAF_{0-2}$ (10) / BW_{child} (15 kg)) + ((ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x ADAF2-6 (3) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of Residential Child (cm^2); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)
(9): ET/ETod: Default exposure time for residents.
(10): Etb: Default RME time spent bathing by a residential child.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
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TABLE 4.11a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
HYPOTHETICAL FUTURE AGGREGATE RESIDENT - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V, Homegrown Produce

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: SS/SB at Carus Chemical Plant	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI_C (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	114.3	mg-year/kg-day	EPA, 2008 (1)	EPC x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	489.5	mg-year/kg-day	EPA, 2008 (2)	ATc
				FI	Fractional Intake	1.0	unitless	BPJ (3)	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: SS/SB at Carus Chemical Plant	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI_C (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	361	mg-year/kg-day	EPA, 2008 (6)	EPC x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	1445	mg-year/kg-day	EPA, 2008 (7)	ATc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: SS/SB P & V in Outdoor Air at Carus Chemical Plant	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	EPC x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	ATc
				ED	Exposure Duration	30	years	EPA, 1991 (9)	
				EDadj	Mutagenic ED	76	years	EPA, 2008 (10)	
				ET	Exposure Time	24	hrs/day	EPA, 1991 (11)	
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Ingestion	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: Produce Grown in SS/SB at Carus Chemical Plant	Prag	Aboveground Exposed and Protected Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (12)	
				EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	See Table 3 Series	CDI_C (mg/kg-day) =
				Brag	Plant-Soil Bioconcentration Factor for Aboveground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (13)	IHP[M]adj x EF x ED
				Pbg	Belowground Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (12)	ATc
				BRrootveg	Plant-Soil Bioconcentration Factor for Belowground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (13)	
				VGrootveg	Empirical Correction Factor for Belowground Produce	0.01 or 1.0	unitless	EPA, 2005 (14)	where:
				IHPadj	Age-Adjusted Daily Intake From Homegrown Produce	site-specific	yr-kg DW/kg-day	EPA, 2008 (15)	IHP[M]adj (yr-kg DW/kg-day) =
				IHP[M]adj	Age-Adjusted Daily Intake From Homegrown Produce for Mutagens	site-specific	yr-kg DW/kg-day	EPA, 2008 (15)	((Prag x Crag[M]adj) + (Prbg x Crbg [M]adj)) x Fp
				Cragadj	Age-Adjusted Aboveground Produce Ingestion Rate	3.59E-02	yr-kg DW/kg-day	EPA, 2008 (16)	
				Crag[M]adj	Age-Adjusted Aboveground Produce Ingestion Rate for Mutagens	1.14E-01	yr-kg DW/kg-day	EPA, 2008 (17)	and
				Crbgadj	Age-Adjusted Belowground Produce Ingestion Rate	4.74E-03	yr-kg DW/kg-day	EPA, 2008 (18)	Prag = EPCs x Brag
				Crbg[M]adj	Age-Adjusted Belowground Produce Ingestion Rate for Mutagens	1.35E-02	yr-kg DW/kg-day	EPA, 2008 (19)	Prbg = EPCs x Brrootveg x VGrootveg
				Fp	Fraction of Homegrown Produce Ingested From Contaminated Source	1	unitless	EPA, 2005 (20)	
				EF	Exposure Frequency	350	days/year	EPA, 2005 (3)	
				ATc	Average Time - Carcinogens	25,550	days	EPA, 2005 (6)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted soil ingestion rates for aggregate residents were calculated as:
IRSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (200 mg/day) / BW_{child} (15kg))+(ED_{2-6} (4 yr) x IRS_{child} (200 mg/day) / BW_{child} (15kg)) + (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg)) + (ED_{16-30} (14 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted soil ingestion rates for mutagens for aggregate residents were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (200 mg/day) x $ADAF_{0-2}$ (10)/ BW_{child} (15kg))+(ED_{2-6} (4 yr) x IRS_{child} (200 mg/day) x $ADAF_{2-6}$ (3) / BW_{child} (15kg)) + (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg)) + (ED_{16-30} (14 yr) x IRS_{adult} (100 mg/day) x $ADAF_{16-30}$ (1) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(3) FI: Assumes 100% of soil ingestion occurs at the Site.

(4) EF: Default exposure frequency for residents.

(5) ATc: Assumes 365 days per year over a 70-year lifetime. Note that non-carcinogenic effects for residents were evaluated using the more-sensitive child receptor.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for aggregate residents were calculated as:
(ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2)/ BW_{child} (15kg))+(ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2) / BW_{child} (15kg)) + (ED_{6-16} (10 yr) x SA_{adult} (5700 cm^2) x AF_{adult} (0.07 mg/cm^2) / BW_{adult} (70kg)) + (ED_{16-30} (14 yr) x SA_{adult} (5700 cm^2) x AF_{adult} (0.07 mg/cm^2) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for mutagens for aggregate residents were calculated as:
(ED_{0-2} (2 yr) x SA_{child} (2,800 cm^2) x AF_{child} (0.2 mg/cm^2) x $ADAF_{0-2}$ (10)/ BW_{child} (15kg))+(ED_{2-6} (4 yr) x SA_{child} (2,800 cm^2) x AF_{child} (0.2 mg/cm^2) x $ADAF_{2-6}$ (3) / BW_{child} (15kg)) +
(ED6-16 (10 yr) x SAadult (5,700 cm2) x AFadult (0.07 mg/cm2) x ADAF6-16 (3) / BWadult (70kg)) + (ED16-30 (14 yr) x SAadult (5,700 cm2) x AFadult (0.07 mg/cm2) x ADAF16-30 (1) / BWadult (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.

(9) ED: Default exposure duration for residents.

account for

(11) Default exposure time for residents.

(12) Prag: Consistent with EPA (2005), calculated using equation presented.

(13) Brag and Brrootveg: Chemical-specific values will be obtained from the HHRAP Comparison Database (ACCESS) or calculated using the procedures presented in Appendix A-2 of EPA (2005).

(14) VGrootveg: Default empirical correction factors for belowground produce. A VGrootveg value of 0.01 will be used for chemicals with a logKow > 4, and a VGrootveg value of 1.0 will be used for chemicals with a logKow ≤ 4.

(15) IHPadj and IHP[M]adj: Consistent with EPA (2005), these parameters were calculated using the equation presented.

(16): Cragadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted RME aboveground produce ingestion rates for residents age 0 to 30 were calculated as:
Cragadj (yr-kg DW/kg-day) = (ED_{0-2} (2 yrs) x $IHP_{ap-child}$ (2.27E-03 kg DW/kg-day)) + (ED_{2-6} (4 yrs) x $IHP_{ap-child}$ (2.27E-03 kg DW/kg-day)) + (ED_{6-16} (10 yrs) x $IHP_{ap-adult}$ (9.3E-04 kg DW/kg-day)) + (ED_{16-30} (14 yrs) x $IHP_{ap-adult}$ (9.3E-04 kg DW/kg-day))
Where: ED = Exposure Duration (yrs); IHPag-child and IHPag-adult = Ingestion Rate of Aboveground Produce - Sum of Exposed and Protected Aboveground Produce (EPA 2005).

(17): Crag[M]adj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted RME aboveground produce ingestion rates for mutagens for residents age 0 to 30 were calculated as:
Crag[M]adj (yr-kg DW/kg-day) = (ED_{0-2} (2 yrs) x $IHP_{ap-child}$ (2.27E-03 kg DW/kg-day) x $ADAF_{0-2}$ (10)) + (ED_{2-6} (4 yrs) x $IHP_{ap-child}$ (2.27E-03 kg DW/kg-day) x $ADAF_{2-6}$ (3)) + (ED_{6-16} (10 yrs) x $IHP_{ap-adult}$ (9.3E-04 kg DW/kg-day) x $ADAF_{6-16}$ (3)) + (ED_{16-30} (14 yrs) x $IHP_{ap-adult}$ (9.3E-04 kg DW/kg-day) x $ADAF_{16-30}$ (1))
Where: ED = Exposure Duration (yrs); IHPag-child and IHPag-adult = Ingestion Rate of Aboveground Produce - Sum of Exposed and Protected Aboveground Produce (EPA 2005); ADAF = Age-Dependent Adjustment Factor (unitless)

(18) Crbgadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted RME belowground produce ingestion rates for residents age 0 to 30 were calculated as:
Crbgadj (yr-kg DW/kg-day) = (ED_{0-2} (2 yrs) x $IHPb_{g-child}$ (2.3E-04 kg DW/kg-day)) + (ED_{2-6} (4 yrs) x $IHPb_{g-child}$ (2.3E-04 kg DW/kg-day)) + (ED_{6-16} (10 yrs) x $IHPb_{g-adult}$ (1.4E-04 kg DW/kg-day)) + (ED_{16-30} (14 yrs) x $IHPb_{g-adult}$ (1.4E-04 kg DW/kg-day))
Where: ED = Exposure Duration (yrs); IHPbg-child and IHPbg-adult = Ingestion Rate of Belowground Produce (EPA 2005).

(19): Crbg[M]adj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted RME belowground produce ingestion rates for mutagens for residents age 0 to 30 were calculated as:
Crbg[M]adj (yr-kg DW/kg-day) = (ED_{0-2} (2 yrs) x $IHPb_{g-child}$ (2.3E-04 kg DW/kg-day) x $ADAF_{0-2}$ (10)) + (ED_{2-6} (4 yrs) x $IHPb_{g-child}$ (2.3E-04 kg DW/kg-day) x $ADAF_{2-6}$ (3)) + (ED_{6-16} (10 yrs) x $IHPb_{g-adult}$ (1.4E-04 kg DW/kg-day) x $ADAF_{6-16}$ (3)) + (ED_{16-30} (14 yrs) x $IHPb_{g-adult}$ (1.4E-04 kg DW/kg-day) x $ADAF_{16-30}$ (1))
Where: ED = Exposure Duration (yrs); IHPbg-child and IHPbg-adult = Ingestion Rate of Belowground Produce (EPA 2005); ADAF = Age-Dependent Adjustment Factor (unitless)

(20) Fp: Default fraction of homegrown produce ingested from contaminated source.

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.11a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
HYPOTHETICAL FUTURE AGGREGATE RESIDENT - SOIL
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, P & V, Homegrown Produce

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
Ingestion	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: SS/SB at Carus Chemical Plant	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI_C (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	42.1	mg-year/kg-day	EPA, 2008 (1)	EPC x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	220	mg-year/kg-day	EPA, 2008 (2)	ATc
				FI	Fractional Intake	1.0	unitless	BPJ (3)	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
Dermal Contact	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: SS/SB at Carus Chemical Plant	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI_C (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	241	mg-year/kg-day	EPA, 2008 (6)	EPC x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	1246	mg-year/kg-day	EPA, 2008 (7)	ATc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
				EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
Inhalation	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: SS/SB P & V in Outdoor Air at Carus Chemical Plant	VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	EPC x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	ATc
				ED	Exposure Duration	9	years	EPA, 1991 (9)	
				EDadj	Mutagenic ED	41	years	EPA, 2008 (10)	
				ET	Exposure Time	24	hrs/day	EPA, 1991 (11)	
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
				Prag	Aboveground Exposed and Protected Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (12)	
Ingestion	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: Produce Grown in SS/SB at Carus Chemical Plant	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	See Table 3 Series	CDI_C (mg/kg-day) =
				Brag	Plant-Soil Bioconcentration Factor for Aboveground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (13)	IHP[M]adj x EF x ED
				Pbg	Belowground Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (12)	ATc
				BRrootveg	Plant-Soil Bioconcentration Factor for Belowground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (13)	
				VGrootveg	Empirical Correction Factor for Belowground Produce	0.01 or 1.0	unitless	EPA, 2005 (14)	where:
				IHPadj	Age-Adjusted Daily Intake From Homegrown Produce	site-specific	yr-kg DW/kg-day	EPA, 2008 (15)	IHP[M]adj (yr-kg DW/kg-day) =
				IHP[M]adj	Age-Adjusted Daily Intake From Homegrown Produce for Mutagens	site-specific	yr-kg DW/kg-day	EPA, 2008 (15)	((Prag x Crag[M]adj) + (Prbg x Crbg [M]adj)) x Fp
				Cragadj	Age-Adjusted Aboveground Produce Ingestion Rate	3.59E-02	yr-kg DW/kg-day	EPA, 2008 (16)	
				Crag[M]adj	Age-Adjusted Aboveground Produce Ingestion Rate for Mutagens	1.14E-01	yr-kg DW/kg-day	EPA, 2008 (17)	and
				Crbgadj	Age-Adjusted Belowground Produce Ingestion Rate	4.74E-03	yr-kg DW/kg-day	EPA, 2008 (18)	Prag = EPCs x Brag
				Crbg[M]adj	Age-Adjusted Belowground Produce Ingestion Rate for Mutagens	1.35E-02	yr-kg DW/kg-day	EPA, 2008 (19)	Prbg = EPCs x Brrootveg x VGrootveg
				Fp	Fraction of Homegrown Produce Ingested From Contaminated Source	0.5	unitless	EPA, 2005 (20)	
				EF	Exposure Frequency	350	days/year	EPA, 2005 (3)	
				ATc	Average Time - Carcinogens	25,550	days	EPA, 2005 (6)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted central tendency exposure (CTE) soil ingestion rates for aggregate residents were calculated as follows (assumes the default CTE ED of 9 years occurs during the most sensitive ages (0 to 9):
IRSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (100 mg/day) / BW_{child} (15kg))+(ED_{2-6} (4 yr) x IRS_{child} (100 mg/day) / BW_{child} (15kg)) + (ED_{6-9} (3 yr) x IRS_{adult} (50 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)
(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted CTE soil ingestion rates for mutagens for aggregate residents were calculated as follows (assumes the default CTE ED of 9 years occurs during the most sensitive ages (0 to 9):
IRSMadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (100 mg/day) x $ADAF_{0-2}$ (10)/ BW_{child} (15kg))+(ED_{2-6} (4 yr) x IRS_{child} (100 mg/day) x $ADAF_{2-6}$ (3) / BW_{child} (15kg)) + (ED_{6-9} (3 yr) x IRS_{adult} (50 mg/day) x $ADAF_{6-9}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)
(3) FI: Assumes 100% of soil ingestion occurs at the Site.
(4) EF: Default exposure frequency for residents.
(5) ATc: Assumes 365 days per year over a 70-year lifetime. Note that non-carcinogenic effects for residents were evaluated using the more-sensitive child receptor.
(6) IRSadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for aggregate residents were calculated as follows (assumes the default CTE ED of 9 years occurs during the most sensitive ages (0 to 9):
(ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2)/ BW_{child} (15kg))+(ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2) / BW_{child} (15kg)) + (ED_{6-9} (3 yr) x SA_{adult} (5700 cm^2) x AF_{adult} (0.07 mg/cm^2) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)
(7) IRS<adj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for mutagens for aggregate residents were calculated as follows (assumes the default CTE ED of 9 years occurs during the most sensitive ages (0 to 9):
(ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2) x $ADAF_{0-2}$ (10)/ BW_{child} (15kg))+(ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2) x $ADAF_{2-6}$ (3) / BW_{child} (15kg)) + (ED_{6-9} (3 yr) x SA_{adult} (5700 cm^2) x AF_{adult} (0.07 mg/cm^2) x $ADAF_{6-9}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm2); AF = Soil-to-skin Adherence Factor (mg/cm2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)
(8) PEF: Site-specific PEF calculated using EPA, 2008 Guidance based on a 30-acre Site in Chicago, Illinois.
(9) ED: Default CT exposure duration for residents.
(10) EDadj: To account for potential mutagenic effects via inhalation an age-dependent adjustment factor (ADAF) of 10 is applied to the ED for ages 0 to 2, an ADAF of 3 is applied to the ED for ages 2 to 6, and an ADAF of 3 is applied to the ED for ages 6 to 9 [(2x10)+(4x3)+(3*3)=41].
(11) Default exposure time for residents.
(12) Prag: Consistent with EPA (2005), calculated using equation presented.
(13) Brag and Brrootveg: Chemical-specific values will be obtained from the HHRAP Comparison Database (ACCESS) or calculated using the procedures presented in Appendix A-2 of EPA (2005).
(14) VGrootveg: Default empirical correction factors for belowground produce. A VGrootveg value of 0.01 will be used for chemicals with a logKow > 4, and a VGrootveg value of 1.0 will be used for chemicals with a logKow ≤ 4.
(15) IHPadj and IHP[M]adj: Consistent with EPA (2005), these parameters were calculated using the equation presented.
(16): Cragadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted CTE aboveground produce ingestion rates for residents age 0 to 30 were calculated as:
Cragadj (yr-kg DW/kg-day) = (ED_{0-2} (2 yrs) x $IHP_{ag-child}$ (2.27E-03 kg DW/kg-day)) + (ED_{2-6} (4 yrs) x $IHP_{ag-child}$ (2.27E-03 kg DW/kg-day)) + (ED_{6-16} (10 yrs) x $IHP_{ag-adult}$ (9.3E-04 kg DW/kg-day)) + (ED_{16-30} (14 yrs) x $IHP_{ag-adult}$ (9.3E-04 kg DW/kg-day))
Where: ED = Exposure Duration (yrs); IHPag-child and IHPag-adult = Ingestion Rate of Aboveground Produce - Sum of Exposed and Protected Aboveground Produce (EPA 2005).
(17): Crag[M]adj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted CTE aboveground produce ingestion rates for mutagens for residents age 0 to 30 were calculated as:
Crag[M]adj (yr-kg DW/kg-day) = (ED_{0-2} (2 yrs) x $IHP_{ag-child}$ (2.27E-03 kg DW/kg-day) x $ADAF_{0-2}$ (10)) + (ED_{2-6} (4 yrs) x $IHP_{ag-child}$ (2.27E-03 kg DW/kg-day) x $ADAF_{2-6}$ (3)) + (ED_{6-16} (10 yrs) x $IHP_{ag-adult}$ (9.3E-04 kg DW/kg-day) x $ADAF_{6-16}$ (3)) + (ED_{16-30} (14 yrs) x $IHP_{ag-adult}$ (9.3E-04 kg DW/kg-day) x $ADAF_{16-30}$ (1))
Where: ED = Exposure Duration (yrs); IHPag-child and IHPag-adult = Ingestion Rate of Aboveground Produce - Sum of Exposed and Protected Aboveground Produce (EPA 2005); ADAF = Age-Dependent Adjustment Factor (unitless)
(18) Crbgadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted CTE belowground produce ingestion rates for residents age 0 to 30 were calculated as:
Crbgadj (yr-kg DW/kg-day) = (ED_{0-2} (2 yrs) x $IHPb_{g-child}$ (2.3E-04 kg DW/kg-day)) + (ED_{2-6} (4 yrs) x $IHPb_{g-child}$ (2.3E-04 kg DW/kg-day)) + (ED_{6-16} (10 yrs) x $IHPb_{g-adult}$ (1.4E-04 kg DW/kg-day)) + (ED_{16-30} (14 yrs) x $IHPb_{g-adult}$ (1.4E-04 kg DW/kg-day))
Where: ED = Exposure Duration (yrs); IHPbg-child and IHPbg-adult = Ingestion Rate of Belowground Produce (EPA 2005).
(19): Crbg[M]adj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted CTE belowground produce ingestion rates for mutagens for residents age 0 to 30 were calculated as:
Crbg[M]adj (yr-kg DW/kg-day) = (ED_{0-2} (2 yrs) x $IHPb_{g-child}$ (2.3E-04 kg DW/kg-day) x $ADAF_{0-2}$ (10)) + (ED_{2-6} (4 yrs) x $IHPb_{g-child}$ (2.3E-04 kg DW/kg-day) x $ADAF_{2-6}$ (3)) + (ED_{6-16} (10 yrs) x $IHPb_{g-adult}$ (1.4E-04 kg DW/kg-day) x $ADAF_{6-16}$ (3)) + (ED_{16-30} (14 yrs) x $IHPb_{g-adult}$ (1.4E-04 kg DW/kg-day) x $ADAF_{16-30}$ (1))
Where: ED = Exposure Duration (yrs); IHPbg-child and IHPbg-adult = Ingestion Rate of Belowground Produce (EPA 2005); ADAF = Age-Dependent Adjustment Factor (unitless)
(20) Fp: The CTE value is assumed to be 50 percent of the RME value based on best professional judgment.

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.11b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
HYPOTHETICAL FUTURE AGGREGATE RESIDENT - GROUNDWATER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: Potable GW at Carus Chemical Plant	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
				IRGWadj	Age-Adjusted Tapwater Ingestion Rate	1.1	mg-year/kg-day	EPA, 2008 (1)	CDIC (mg/kg-day) =
				IRGW[M]adj	Mutagenic IRGWadj	3.4	mg-year/kg-day	EPA, 2008 (2)	EPCgw x IRGWadj x FI x EF x CFw
				FI	Fractional Intake	1	unitless	BPJ (3)	ATc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				CFw	Conversion Factor - Water	1.0E-06	kg/mg	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: Potable GW at Carus Chemical Plant	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFGWadj	Age-Adjusted Dermal Contact Factor - Groundwater	6,219	cm^2-hr-yr/kg-day	EPA, 2008 (6)	
				DFGW[M]adj	Mutagenic DFGWadj	20,642	cm^2-hr-yr/kg-day	EPA, 2008 (7)	
				DFGWadjo	Age-Adjusted Dermal Contact Factor for Organics - Groundwater	7,330	cm^2-hr-yr/kg-day	EPA, 2008 (8)	EPCgw x Kp x DFGW[M]adj x EF x ET x CFgw x CFv
				DFGW[M]adjo	Mutagenic DFGWadjo	22,679	cm^2-hr-yr/kg-day	EPA, 2008 (9)	AT
				EF	Exposure Frequency	350	days/year	BPJ (4)	For Organics:
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x DFGW[M]adjo
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	AT
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	If tevent < or = t*, then:
				B	Ratio of Permeability Coefficient of a Compound Through the Corneum Relative to its Permeability Coefficient Across the Viable Epidermis	chemical-specific --	unitless --	See Table 5 & 6 Series --	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	If tevent > t*, then:
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	DAevent = FA x Kp x EPCgw x CFv x CFgw x [1/{1+B}] + (FA x Kp x
				ATnc	Average Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	EPCgw x CFv x CFgw x [2 x tevent x {(1+3B+$3B^2$)/(1+B)^2}]
				ATc	Averaging Time - Carcinogens	25,550	day	EPA, 1989 (5)	
Inhalation	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: GW Vapors in Outdoor Air at Carus Chemical Plant	EPCair	Exposure Point Concentration - Air	Calculated	$\mu g/m^3$	Calculated	
				EPCgw	Exposure Point Concentration - Groundwater	See Table 3s	µg/L	See Table 3s	CDE ($\mu g/m^3$) =
				EF	Exposure Frequency	350	days/year	BPJ (4)	EPCair x EF x EDadj x ET x CFt
				ED	Exposure Duration	30	years	EPA, 1989 (4)	ATc
				ET	Exposure Time - Outdoors	24	hrs/day	EPA, 2008 (11)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	where EPCair =
				VFwamb	Volatilization factor, Water to Ambient Air	See Table XX	m^3/L	See Table XX	EPCgw
				EDadj	Mutagenic ED	76	yrs	EPA, 1989 (10)	VFwamb
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: GW Vapors in Indoor Air at Carus Chemical Plant (Vapor Intrusion)	EPCia	Chemical Concentration in Indoor Air	See Table XX	$\mu g/m^3$	See Table XX	
				EDadj	Mutagenic ED	76	yrs	EPA, 1989 (10)	CDE ($\mu g/m^3$) =
				EF	Exposure Frequency	350	days/year	BPJ (4)	EPCia x EF x EDadj x ET x CFt
				ED	Exposure Duration	30	years	EPA, 1989 (4)	ATc
				ET	Exposure Time - Outdoors	24	hrs/day	EPA, 2008 (11)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: GW Vapors in Indoor Air at Carus Chemical Plant (Household Use)	EPCgw	Exposure Point Concentration - Groundwater	See Table XX	µg/L	See Table XX	
				EDadj	Mutagenic ED	76	yrs	EPA, 1989 (10)	CDE ($\mu g/m^3$) =
				EF	Exposure Frequency	350	days/year	BPJ (4)	EPCgw x VFw x EF x ETb[M]adj x CFt
				ED	Exposure Duration	30	years	EPA, 1989 (4)	BW x Atc
				ETbadj	Age-Adjusted Exposure Time	19.9	yr-hr/day	EPA, 2008 (12)	
				ETb[M]adj	Mutagenic ETbadj	57.5	yr-hr/day	EPA, 2008 (13)	
				VF_w	Volatilization factor, Domestic Use	0.5	L/m^3	EPA 1991	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRGWadj: Consistent with the EPA (2008) RSL User's Guide, an age-adjusted tapwater ingestion rate for aggregate residents calculated as:
IRGWadj (L-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (1 L/day) / BW_{child} (15 kg))+(ED_{2-6} (4 yr) x IRS_{child} (1 L/day) / BW_{child} (15 kg)) + (ED_{6-16} (10 yr) x IRS_{adult} (2 L/day) / BW_{adult} (70 kg)) + (ED_{16-30} (14 yr) x IRS_{adult} (2 L/day) / BW_{adult} (70 kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Tap water (L/day); BW = Body Weight (kg) EPA (2008) recommended value for calculating age-adjusted rates.

(2) IRGW[M]adj: Consistent with the EPA (2008) RSL User's Guide, an age-adjusted tapwater ingestion rate for mutagens for aggregate residents calculated as:
IRSMadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (1 L/day) x $ADAF_{0-2}$ (10)/ BW_{child} (15 kg))+(ED_{2-6} (4 yr) x IRS_{child} (1 L/day) x $ADAF_{2-6}$ (3) / BW_{child} (15 kg)) + (ED_{6-16} (10 yr) x IRS_{adult} (2 L/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70 kg)) + (ED_{16-30} (14 yr) x IRS_{adult} (2 L/day) x $ADAF_{16-30}$ (1) / BW_{adult} (70 kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Tap water (L/day); BW = Body Weight (kg) EPA (2008) recommended value for calculating age-adjusted rates; ADAF = Age-Dependent Adjustment Factor (unitless)

(3) FI: Assumes 100% of groundwater ingestion occurs at the Site.

(4) EF and ED: Default exposure frequency and exposure duration for residents.

(5) ATc: Assumes 365 days per year over a 70-year lifetime. Note that non-carcinogenic effects for residents were evaluated using the more-sensitive child receptor.

(6) DFGWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the RME age-adjusted dermal contact rate for residents age 0 to 30 is calculated as:
DFGWadj (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x ET child (1 hr) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x ETchild (1 hr) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x SAadult (18,000 cm^2) x sqrt ETadult (0.58 hr) / BWadult (70 kg)) + (ED_{16-30} (14 yrs) x SAadult (18,000 cm^2) x ETadult (0.58 hr) / BWadult (70 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg)

(7) DFGW[M]adj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the RME age-adjusted dermal contact rate for mutagens for residents age 0 to 30 is calculated as:
DFGW[M]adj (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x ETchild (1 hr) x $ADAF_{0-2}$ (10) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x ETchild (1 hr) x $ADAF_{2-6}$ (3) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x
SAadult (18,000 cm^2) x ETadult (0.58 hr) x ADAF6-16 (3) / BWadult (70 kg)) + (ED16-30 (14 yrs) x SAadult (18,000 cm^2) x ETadult (0.58 hr) x ADAF16-30 (1) / BWadult (70 kg)
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)

(8) DFGWadjo: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the RME age-adjusted dermal contact rate for organics for residents age 0 to 30 is calculated as:
DFGWadjo (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (1) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (1) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x SAadult (18,000 cm^2) x sqrt [ETadult] (0.76) / BWadult (70 kg)) + (ED_{16-30} (14 yrs) x SAadult (18,000 cm^2) x sqrt [ETadult] (0.76) / BWadult (70 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg)

(9) DFGW[M]adjo: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the RME age-adjusted dermal contact rate for organic mutagens for residents age 0 to 30 is calculated as:
DFGW[M]adjo (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (1) x $ADAF_{0-2}$ (10) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^5) x sqrt [ETchild] (1) x $ADAF_{2-6}$ (3) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x
SAadult (18,000 cm^2) x sqrt [ETadult] (0.76) x ADAF6-16 (3) / BWadult (70 kg)) + (ED16-30 (14 yrs) x SAadult (18,000 cm2) x sqrt [ETadult] (0.76) x ADAF16-30 (1) / BWadult (70 kg)
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor

(10) EDadj: To account for potential mutagenic effects via inhalation, age-dependent factors of 10, 3, 3, and 1 were applied to the EDs for ages 0-2, 2-6, 6-16, and 16-30 years, respectively.

(11) ET: Default exposure time for residents.

(12) ETbadj: Consistent with the EPA (2008) RSL User's Guide, the RME age-adjusted exposure time for bathing for residents 0 to 30 years was calculated as:
ETbadj (yr-hr/day) = ((ED_{0-2} (2 yrs) x ETbchild (1 hr/day) + (ED_{2-6} (4 yrs) x ETbchild (1 hr/day)) + (ED_{6-16} (10 yrs) x ETbadult (0.58 hr)) + (ED_{16-30} (14 yrs) x ETbadult (0.58 hr/day))
Where: ED = Exposure Duration (years); ETb = Exposure Time - Bathing (hr/day)

(13) Etb[M]adj: Consistent with the EPA (2008) RSL User's Guide, the RME age-adjusted exposure time for bathing for mutagens for residents 0 to 30 years was calculated as:
Etb[M]adj (yr-hr/day) = ((ED_{0-2} (2 yrs) x ETbchild (1 hr/day) x $ADAF_{0-2}$ (10) + (ED_{2-6} (4 yrs) x ETbchild (1 hr/day)) $ADAF_{2-6}$ (3) + (ED_{6-16} (10 yrs) x ETbadult (0.58 hr)) x $ADAF_{6-16}$ (3) + (ED_{16-30} (14 yrs) x ETbadult (0.58 hr/day) x $ADAF_{16-30}$ (1))
Where: ED = Exposure Duration (years); ETb = Exposure Time - Bathing (hr/day); Age-Dependent adjustment factor (unitless)

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.11b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
HYPOTHETICAL FUTURE AGGREGATE RESIDENT - GROUNDWATER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: Potable GW at Carus Chemical Plant	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
				IRGWadj	Age-Adjusted Tapwater Ingestion Rate	0.49	mg-year/kg-day	EPA, 2008 (1)	CDIC (mg/kg-day) =
				IRGW[M]adj	Mutagenic IRGWadj	2.39	mg-year/kg-day	EPA, 2008 (2)	EPCgw x IRGWadj x FI x EF x CFw
				FI	Fractional Intake	1	unitless	BPJ (3)	ATc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				CFw	Conversion Factor - Water	1.0E-06	kg/mg	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: Potable GW at Carus Chemical Plant	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFGWadj	Age-Adjusted Dermal Contact Factor - Groundwater	2,414	cm^2-hr-yr/kg-day	EPA, 2008 (6)	
				DFGW[M]adj	Mutagenic DFGWadj	7,475	cm^2-hr-yr/kg-day	EPA, 2008 (7)	
				DFGWadjo	Age-Adjusted Dermal Contact Factor for Organics - Groundwater	4,591	cm^2-hr-yr/kg-day	EPA, 2008 (8)	EPCgw x Kp x DFGW[M]adj x EF x ET x CFgw x CFv
				DFGW[M]adjo	Mutagenic DFGWadjo	9,183	cm^2-hr-yr/kg-day	EPA, 2008 (9)	AT
				EF	Exposure Frequency	350	days/year	BPJ (3)	For Organics:
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x DFGW[M]adjo
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	AT
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	If tevent < or = t*, then:
				B	Ratio of Permeability Coefficient of a Compound Through the Corneum Relative to its Permeability Coefficient Across the Viable Epidermis	chemical-specific --	unitless --	See Table 5 & 6 Series --	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	If tevent > t*, then:
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	DAevent = FA x Kp x EPCgw x CFv x CFgw x [1/(1+B)] + (FA x Kp x
				ATnc	Average Time - Noncarcinogens	3,285	days	EPA, 1989 (5)	EPCgw x CFv x CFgw x [2 x tevent x {(1+3B+$3B^2$)/(1+B)^2}]
				ATc	Averaging Time - Carcinogens	25,550	day	EPA, 1989 (5)	
Inhalation	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: GW Vapors in Outdoor Air at Carus Chemical Plant	EPCair	Exposure Point Concentration - Air	Calculated	$\mu g/m^3$	Calculated	
				EPCgw	Exposure Point Concentration - Groundwater	See Table 3s	µg/L	See Table 3s	CDE ($\mu g/m^3$) =
				EF	Exposure Frequency	350	days/year	BPJ (3)	EPCair x EF x EDadj x ET x CFt
				ED	Exposure Duration	9	years	EPA, 1989 (4)	ATc
				ET	Exposure Time - Outdoors	3	hrs/day	EPA, 1997 (11)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	where EPCair =
				VFwamb	Volatilization factor, Water to Ambient Air	See Table XX	m^3/L	See Table XX	EPCgw
				EDadj	Mutagenic ED	76	yrs	EPA, 1989 (10)	VFwamb
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: GW Vapors in Indoor Air at Carus Chemical Plant (Vapor Intrusion)	EPCia	Chemical Concentration in Indoor Air	See Table XX	mg/m^3	See Table XX	
				EDadj	Mutagenic ED	76	yrs	EPA, 1989 (10)	CDE ($\mu g/m^3$) =
				EF	Exposure Frequency	350	days/year	BPJ (3)	EPCia x EF x EDadj x ET x CFt
				ED	Exposure Duration	9	years	EPA, 1989 (4)	ATc
				ET	Exposure Time - Outdoors	3	hrs/day	EPA, 1997 (11)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Hypothetical Future On-Site Resident	Aggregate Child/Adult Age 0-30	F: GW Vapors in Indoor Air at Carus Chemical Plant (Household Use)	EPCgw	Exposure Point Concentration - Groundwater	See Table XX	µg/L	See Table XX	
				EDadj	Mutagenic ED	76	yrs	EPA, 1989 (10)	CDE ($\mu g/m^3$) =
				EF	Exposure Frequency	350	days/year	BPJ (3)	EPCgw x VFw x EF x ETb[M]adj x CFt
				ED	Exposure Duration	9	years	EPA, 1989 (4)	BW x Atc
				ETbadj	Age-Adjusted Exposure Time	7.98	yr-hr/day	EPA, 2008 (12)	
				ETb[M]adj	Mutagenic ETbadj	21.56	yr-hr/day	EPA, 2008 (13)	
				VF_w	Volatilization factor, Domestic Use	0.5	L/m^3	EPA 1991	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRGWadj: Consistent with the EPA (2008) RSL User's Guide, an age-adjusted tapwater ingestion rate for aggregate residents calculated as:
IRGWadj (L-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (1 L/day) / BW_{child} (15 kg))+(ED_{2-6} (4 yr) x IRS_{child} (1 L/day) / BW_{child} (15 kg)) + (ED_{6-16} (10 yr) x IRS_{adult} (2 L/day) / BW_{adult} (70 kg)) + (ED_{16-30} (14 yr) x IRS_{adult} (2 L/day) / BW_{adult} (70 kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Tap water (L/day); BW = Body Weight (kg) EPA (2008) recommended value for calculating age-adjusted rates.

(2) IRGWadj: Consistent with the EPA (2008) RSL User's Guide, an age-adjusted tapwater ingestion rate for mutagens for aggregate residents calculated as:
IRSMadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (1 L/day) x $ADAF_{0-2}$ (10)/ BW_{child} (15kg))+(ED_{2-6} (4 yr) x IRS_{child} (1 L/day) x $ADAF_{2-6}$ (3) / BW_{child} (15kg)) + (ED_{6-16} (10 yr) x IRS_{adult} (2 L/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg)) + (ED_{16-30} (14 yr) x IRS_{adult} (2 L/day) x $ADAF_{16-30}$ (1) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Tap water (L/day); BW = Body Weight (kg) EPA (2008) recommended value for calculating age-adjusted rates; ADAF = Age-Dependent Adjustment Factor (unitless)

(3) FI: Assumes 100% of groundwater ingestion occurs at the Site.

(4) EF: Default exposure frequency for residents.

(5) ATc: Assumes 365 days per year over a 70-year lifetime. Note that non-carcinogenic effects for residents were evaluated using the more-sensitive child receptor.

(6) DFGWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the CTE age-adjusted dermal contact rate for residents age 0 to 30 is calculated as:
DFGWadj (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x ET child (0.33 hr) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x ETchild (0.33 hr) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x SAadult (18,000 cm^2) x sqrt ETadult (0.25 hr) / BWadult (70 kg)) + (ED_{16-30} (14 yrs) x SAadult (18,000 cm^2) x ETadult (0.25 hr) / BWadult (70 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg)

(7) DFGW[M]adj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the CTE age-adjusted dermal contact rate for mutagens for residents age 0 to 30 is calculated as:
DFGW[M]adj (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x ETchild (0.33 hr) x $ADAF_{0-2}$ (10) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x ETchild (0.33 hr) x $ADAF_{2-6}$ (3) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x
SAadult (18,000 cm^2) x ETadult (0.25 hr) x ADAF6-16 (3) / BWadult (70 kg)) + (ED16-30 (14 yrs) x SAadult (18,000 cm2) x ETadult (0.25 hr) x ADAF16-30 (1) / BWadult (70 kg)
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)

(8) DFGWadjo: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the CTE age-adjusted dermal contact rate for organics for residents age 0 to 30 is calculated as:
DFGWadjo (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (0.57) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (0.57) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x SAadult (18,000 cm^2) x sqrt [ETadult] (0.50) / BWadult (70 kg)) + (ED_{16-30} (14 yrs) x SAadult (18,000 cm^2) x sqrt [ETadult] (0.50) / BWadult (70 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg)

(9) DFGW[M]adjo: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the CTE age-adjusted dermal contact rate for organic mutagens for residents age 0 to 30 is calculated as:
DFGW[M]adjo (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (0.57) x $ADAF_{0-2}$ (10) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (0.57) x $ADAF_{2-6}$ (3) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x
SAadult (18,000 cm^2) x sqrt [ETadult] (0.50) x ADAF6-16 (3) / BWadult (70 kg)) + (ED16-30 (14 yrs) x SAadult (18,000 cm2) x sqrt [ETadult] (0.50) x ADAF16-30 (1) / BWadult (70 kg)
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor

(10) EDadj: To account for potential mutagenic effects via inhalation, age-dependent factors of 10, 3, 3, and 1 were applied to the EDs for ages 0-2, 2-6, 6-16, and 16-30 years, respectively.

(11) ET: Default exposure time for residents.

(12) ETbadj: Consistent with the EPA (2008) RSL User's Guide, the CTE age-adjusted exposure time for bathing for residents 0 to 30 years was calculated as:
ETbadj (yr-hr/day) = ((ED_{0-2} (2 yrs) x ETbchild (0.33 hr/day) + (ED_{2-6} (4 yrs) x ETbchild (0.33 hr/day)) + (ED_{6-16} (10 yrs) x ETbadult (0.25 hr)) + (ED_{16-30} (14 yrs) x ETbadult (0.25 hr/day))
Where: ED = Exposure Duration (years); ETb = Exposure Time - Bathing (hr/day)

(13) Etb[M]adj: Consistent with the EPA (2008) RSL User's Guide, the CTE age-adjusted exposure time for bathing for mutagens for residents 0 to 30 years was calculated as:
Etb[M]adj (yr-hr/day) = ((ED_{0-2} (2 yrs) x ETbchild (0.33 hr/day) x $ADAF_{0-2}$ (10) + (ED_{2-6} (4 yrs) x ETbchild (0.33 hr/day)) $ADAF_{2-6}$ (3) + (ED_{6-16} (10 yrs) x ETbadult (0.25 hr)) x $ADAF_{6-16}$ (3) + (ED_{16-30} (14 yrs) x ETbadult (0.25 hr/day) x $ADAF_{16-30}$ (1))
Where: ED = Exposure Duration (years); ETb = Exposure Time - Bathing (hr/day); ADAF = Age-Dependent adjustment factor (unitless)

Sources:

BPJ= Best Professional Judgment.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.

EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.

EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.12a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADOLESCENT RECREATIONAL FISHERMAN - SEDIMENT
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Recreational Fisherman	Adolescent Age 6-16	C/F: Sediment in the LVR	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSEDadj	Age-Adjusted Sediment Ingestion Rate	14.3	mg-year/kg-day	EPA, 2008 (1)	EPCsed x RBA x IRS(M)adj x FI x EF x CFs
				IRSEDMadj	Mutagenic IRSadj	42.9	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future Recreational Fisherman	Adolescent Age 6-16	C/F: Sediment in the LVR	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSEDadj	Age-Adjusted Dermal Contact Factor - Sediment	70	mg-year/kg-day	EPA, 2008 (6)	EPCsed x DAF x DFS(M)adj x EF x CFs
				DFSEDMadj	Mutagenic DFSEDadj	211	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPJ (8)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSEDadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted sediment ingestion rates for fishermen ages 6 to 16 were calculated as:
IRSEDadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSEDMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted sediment ingestion rates for mutagens for fishermen ages 6 to 16 were calculated as:
IRSEDMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSEDadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for fishermen ages 6 to 16 were calculated as:
DFSEDadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (1,640 cm^2) x $AF_{reed\ gatherer}$ (0.3 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of feet and hands (cm^2); AF = Soil-to-skin Adherence Factor (EPA, 2004) (mg/cm^2); BW = Body Weight (kg)

(7) DFSEDMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for fishermen ages 6 to 16 calculated as:
DFSEDMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (1,640 cm^2) x $AF_{reed\ gatherer}$ (0.3 mg/cm^2) * $ADAF_{6-16}$ (3)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of feet and hands (cm^2); AF = Soil-to-skin Adherence Factor (EPA, 2004) (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

Sources:

BPJ= Best Professional Judgment.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.12a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADOLESCENT RECREATIONAL FISHERMAN - SEDIMENT
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Recreational Fisherman	Adolescent Age 6-16	C/F: Sediment in the LVR	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSEDadj	Age-Adjusted Sediment Ingestion Rate	7.1	mg-year/kg-day	EPA, 2008 (1)	EPCsed x RBA x IRS(M)adj x FI x EF x CFs
				IRSEDMadj	Mutagenic IRSadj	21.4	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future Recreational Fisherman	Adolescent Age 6-16	C/F: Sediment in the LVR	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSEDadj	Age-Adjusted Dermal Contact Factor - Sediment	70	mg-year/kg-day	EPA, 2008 (6)	EPCsed x DAF x DFS(M)adj x EF x CFs
				DFSEDMadj	Mutagenic DFSEDadj	211	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	21	days/year	BPJ (8)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSEDadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted central tendency exposure (CTE) sediment ingestion rates for fishermen ages 6 to 16 were calculated as:
IRSEDadj (mg-year/kg-day) = ($ED_{6\text{-}16}$ (10 yr) x IRS_{adult} (50 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSEDMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted CTE sediment ingestion rates for mutagens for fishermen ages 6 to 16 were calculated as:
IRSEDMadj (mg-year/kg-day) = ($ED_{6\text{-}16}$ (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6\text{-}16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 1 days per week during the summer (13 weeks) and 2 day per month during April, May, September, and October (13 + (2*4)=21]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSEDadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for fishermen ages 6 to 16 were calculated as:
DFSEDadj (mg-year/kg-day) = ($ED_{6\text{-}16}$ (10 yr) x $SA_{site\text{-}specific}$ (1,640 cm^2) x $AF_{reed\ gatherer}$ (0.3 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of feet and hands (cm^2); AF = Soil-to-skin Adherence Factor assumes feet and hands (EPA, 2004) (mg/cm^2); BW = Body Weight (kg)

(7) DFSEDMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for fishermen ages 6 to 16 calculated as:
DFSEDMadj (mg-year/kg-day) = ($ED_{6\text{-}16}$ (10 yr) x $SA_{site\text{-}specific}$ (1,640 cm^2) x $AF_{reed\ gatherer}$ (0.3 mg/cm^2) * $ADAF_{6\text{-}16}$ (3)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of feet and hands (cm^2); AF = Soil-to-skin Adherence Factor assumes feet and hands (EPA, 2004) (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

Sources:

BPJ= Best Professional Judgment.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.12b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADOLESCENT RECREATIONAL FISHERMAN - SURFACE WATER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Recreational Fisherman	Adolescent Age 6-16	C/F: Surface Water in the LVR	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSWadj	Age-Adjusted Surface Water Ingestion Rate (Incide	0.0018	L-year/kg-day	EPA, 2008; BPJ (1)	EPCsw x RBA x IRSW(M)adj x FI x EF x CFsw
				IRSWMadj	Mutagenic IRSWadj (Incidental)	0.0054	L-year/kg-day	EPA, 2008; BPJ (2)	AT
				FI	Fractional Intake	1.0	unitless	BPJ (3)	
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future Recreational Fisherman	Adolescent Age 6-16	C/F: Surface Water in the LVR	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSWadj	Age-Adjusted Dermal Contact Factor - Surface Wat	643	cm^2-year/kg	EPA, 2008 (6)	EPCsw x Kp x DFS(M)adj x EF x ET x CFsw x CFv
				DFSWMadj	Mutagenic DFSWadj	1,928	cm^2-year/kg	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPL (4)	
				ET	Exposure Time	2	hrs/day	BPJ (8)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	ug/mg	--	
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental surface water ingestion rate for recreational fishermen ages 6 to 16 calculated as:
IRSWadj (L-year/kg-day) = (ED_{6-16} (10 yr) x IRSW (0.0125 L/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Surface Water (L/day); BW = Body Weight (kg)
RME IRS assumes an incidental ingestion rate of 0.05 L/day on one-fourth of total days (0.05 x 0.25).

(2) IRSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental surface water ingestion rates for mutagens for recreational fishermen ages 6 to 16 calculated as:
IRSMadj (L-year/kg-day) = (ED_{6-16} (10 yr) x IRSW (0.01253 L/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Surface Water (L/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)
RME IRS assumes an incidental ingestion rate of 0.05 L/day on one-fourth of total days (0.05 x 0.25).

(3) FI: Conservatively assuems 100% of incidntal surface water ingestion occurs at the Site.

(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for trespassers ages 6 to 16 calculated as:
DFSWadj (cm^2-year/kg) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (4,499 cm^2) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet, hands, and lower legs (EPA, 2004); BW = Body Weight (kg)

(7) DFSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for mutagens for trespassers ages 6 to 16 calculated as:
DFSWMadj (cm^2-year/kg) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (4,499 cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet, hands, and lower legs (EPA, 2004); ADAF = Age-Dependent Adjustement Factor (unitless); BW = Body Weight (kg)

(8) ET: Assumes a 2 hour Site visit.

Sources:

BPJ= Best Professional Judgment.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.12b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADOLESCENT RECREATIONAL FISHERMAN - SURFACE WATER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Recreational Fisherman	Adolescent Age 6-16	C/F: Surface Water in the LVR	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSWadj	Age-Adjusted Surface Water Ingestion Rate (Incide	0.0011	L-year/kg-day	EPA, 2008; BPJ (1)	EPCsw x RBA x IRSW(M)adj x FI x EF x CFsw
				IRSWMadj	Mutagenic IRSWadj (Incidental)	0.0032	L-year/kg-day	EPA, 2008; BPJ (2)	AT
				FI	Fractional Intake	1.0	unitless	BPJ (3)	
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future Recreational Fisherman	Adolescent Age 6-16	C/F: Surface Water in the LVR	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSWadj	Age-Adjusted Dermal Contact Factor - Surface Wat	643	cm^2-year/kg	EPA, 2008 (6)	EPCsw x Kp x DFS(M)adj x EF x ET x CFsw x CFv
				DFSWMadj	Mutagenic DFSWadj	1,928	cm^2-year/kg	EPA, 2008 (7)	AT
				EF	Exposure Frequency	21	days/year	BPL (4)	
				ET	Exposure Time	2	hrs/day	BPJ (8)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	ug/mg	--	
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental surface water ingestion rate for recreational fishermen ages 6 to 16 calculated as:
IRSWadj (L-year/kg-day) = (ED_{6-16} (10 yr) x IRSW (0.0075 L/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Surface Water (L/day); BW = Body Weight (kg)
CTE IRS assumes an incidental ingestion rate of 0.03 L/day (about 1 ounce) on one-fourth of total days (0.03 x 0.25).

(2) IRSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental surface water ingestion rates for mutagens for recreational fishermen ages 6 to 16 calculated as:
IRSMadj (L-year/kg-day) = (ED_{6-16} (10 yr) x IRSW (0.0075 L/day) x $ADAF_{6-16}$ (3)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Surface Water (L/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)
CTE IRS assumes an incidental ingestion rate of 0.03 L/day (about 1 ounce) on one-fourth of total days (0.03 x 0.25).

(3) FI: Conservatively assuems 100% of incidntal surface water ingestion occurs at the Site.

(4) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for trespassers ages 6 to 16 calculated as:
DFSWadj (cm^2-year/kg) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (4,499 cm^2) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet, hands, and lower legs (EPA, 2004); BW = Body Weight (kg)

(7) DFSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for mutagens for trespassers ages 6 to 16 calculated as:
DFSWMadj (cm^2-year/kg) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (4,499 cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet, hands, and lower legs (EPA, 2004); ADAF = Age-Dependent Adjustement Factor (unitless); BW = Body Weight (kg)

(8) ET: Assumes a 2 hour Site visit.

Sources:

BPJ= Best Professional Judgment.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.13a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADULT RECREATIONAL FISHERMAN - SEDIMENT
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Recreational Fisherman	Adult	C/F: Sediment in the LVR	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSED	Sediment Ingestion Rate	100	mg/day	EPA, 1997 (1)	EPCsed x RBA x IRSED x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future Recreational Fisherman	Adult	C/F: Sediment in the LVR	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	2,129	cm^2	EPA, 2002 (7)	EPCsed x DAF x SA x AFsed x EF x ED x CFs
				AFsed	Sediment-to-Skin Adherence Factor	0.3	mg/cm^2	EPA, 2002 (8)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRSED: Recommended soil ingestion rate for adult residents.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]
(4) ED: Default exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 30 year ED.
(7) SA: Average skin surface areas of hands and feet for adult males and females.
(8) AFsed: Sediment-to-skin adherence factor for reed gatherers.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.

TABLE 4.13a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADULT RECREATIONAL FISHERMAN - SEDIMENT
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Recreational Fisherman	Adult	C/F: Sediment in the LVR	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSED	Sediment Ingestion Rate	50	mg/day	EPA, 1997 (1)	EPCsed x RBA x IRSED x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future Recreational Fisherman	Adult	C/F: Sediment in the LVR	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	2,129	cm^2	EPA, 2002 (7)	EPCsed x DAF x SA x AFsed x EF x ED x CFs
				AFsed	Sediment-to-Skin Adherence Factor	0.3	mg/cm^2	EPA, 2002 (8)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRSED: CT assumed to be 1/2 recommended soil ingestion rate for adult residents.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 1 day per week during the summer (13 weeks) and 2 day per month during April, May, September, and October [(1*13)+8=21]
(4) ED: Default CT exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 9 year ED.
(7) SA: Average skin surface areas of hands and feet for adult males and females.
(8) AFsed: Soil-to-skin adherence factor for reed gatherers.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.

TABLE 4.13b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADULT RECREATIONAL FISHERMAN - SURFACE WATER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Recreational Fisherman	Adult	C/F: Surface Water in the LVR	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSW	Surface Water Ingestion Rate (Incidental)	0.0125	L/day	EPA, 1997 (1)	EPCsw x RBA x IRSW x FI x EF x ED x CFsw
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future Recreational Fisherman	Adult	C/F: Surface Water in the LVR	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	4,499	cm^2	EPA, 2004 (7)	EPCsw x Kp x SA x EF x ED x ET x CFsw x CFv
				EF	Exposure Frequency	43	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				ET	Exposure Time	2	hrs/day	BPJ (8)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRSW: Based on best professional judgment; assumes an incidental ingestion rate of 0.05 L/day on one-fourth of total days.
(2) FI: Conservatively assuems 100% of incidntal surface water ingestion occurs at the Site.
(3) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]
(4) ED: Default exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 30 year ED.
(7) SA: Average skin surface area of feet, hands, and lower legs for adult males and females.
(8) ET: Assumes a 2 hour Site visit.

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

TABLE 4.13b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADULT RECREATIONAL FISHERMAN - SURFACE WATER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Recreational Fisherman	Adult	C/F: Surface Water in the LVR	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSW	Surface Water Ingestion Rate (Incidental)	0.0075	L/day	EPA, 1997 (1)	EPCsw x RBA x IRSW x FI x EF x ED x CFsw
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future Recreational Fisherman	Adult	C/F: Surface Water in the LVR	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	4,499	cm^2	EPA, 2004 (7)	EPCsw x Kp x SA x EF x ED x ET x CFsw x CFv
				EF	Exposure Frequency	21	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				ET	Exposure Time	2	hrs/day	BPJ (8)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRSW: Based on best professional judgment; assumes an incidental ingestion rate of 0.03 L/day (about one ounce) on one-fourth of total days.
(2) FI: Conservatively assuems 100% of incidntal surface water ingestion occurs at the Site.
(3) EF: Assumes 1 days per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+8=21]
(4) ED: Default CT exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 9 year ED.
(7) SA: Average skin surface area of feet, hands, and lower legs for adult males and females.
(8) ET: Assumes a 2 hour Site visit.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

TABLE 4.14.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE CHILD FISH CONSUMER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Fish
Exposure Medium: Fish Tissue

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Fish Consumer	Child Age 3-6	C/F: Fish from the LVR	EPC_F	Exposure Point Concentration - Fish Tissue	medium-specific	mg/kg	See Table 3 Series	
				IRFadj	Age-Adjusted Fish Ingestion Rate	0.0024	kg-year/kg-day	EPA, 2008a,b (1)	CDI (mg/kg-day) =
				IRFMadj	Mutagenic IRF	0.0072	kg-year/kg-day	EPA, 2008a,b (2)	$\frac{EPC_F \times IR(M)_F \times FI \times EF \times CFs}{AT}$
				FI	Fractional Intake	0.25	unitless	BPJ (3)	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				ATnc	Averaging Time - Noncarcinogens	1,095	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:
(1) IRFadj: Consistent with the methodology presented in the EPA (2008a) RSL User's Guide and, an age-adjusted fish ingestion rate for children ages 3 to 6 was calculated as:
IRFadj (kg-year/kg-day) = (ED_{3-6} (3 yr) x IRF_{3-6} (0.012 kg/day) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRF = Ingestion Rate of Fish (kg/day); BW = Body Weight (kg)
For RME the IRF is the 95th percentile per capita freshwater fish intake rate as reported in the EPA Child-Specific Exposures Factor Handbook (CSEFH - 2008b.)
(2) IRM_F: Consistent with the methodology presented in the EPA (2008a) RSL User's Guide and, an age-adjusted fish ingestion rate for mutagens for children ages 3 to 6 was calculated as:
IRMFadj (kg-year/kg-day) = (ED_{3-6} (3 yr) x IRF_{3-6} (0.012 kg/day) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRF = Ingestion Rate of Fish (kg/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)
For RME the IRF is the 95th percentile per capita freshwater fish intake rate as reported in the EPA Child-Specific Exposures Factor Handbook (CSEFH - 2008b.)
(3) FI: Assumes 25% of fish ingested are from the Site.
(4) EF: Default value for residents.
(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 6 year ED.

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
EPA. 2008a. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
EPA. 2008b. "Child-Specific Exposure Factors Handbook (Final Report)." National Center for Environmental Assessment (NCEA). EPA/600/R-06/096F. September.

TABLE 4.14.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE CHILD FISH CONSUMER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Fish
Exposure Medium: Fish Tissue

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Fish Consumer	Child Age 3-6	C/F: Fish from the LVR	EPC_F	Exposure Point Concentration - Fish Tissue	medium-specific	mg/kg	See Table 3 Series	
				IRFadj	Age-Adjusted Fish Ingestion Rate	0.00044	kg-year/kg-day	EPA, 2008a,b (1)	CDI (mg/kg-day) =
				IRFMadj	Mutagenic IRF	0.0013	kg-year/kg-day	EPA, 2008a,b (2)	$\frac{EPC_F \times IR(M)_F \times FI \times EF \times CFs}{AT}$
				FI	Fractional Intake	0.25	unitless	BPJ (3)	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				ATnc	Averaging Time - Noncarcinogens	1,095	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:
(1) IRFadj: Consistent with the methodology presented in the EPA (2008a) RSL User's Guide and, a CTE age-adjusted fish ingestion rate for children ages 3 to 6 was calculated as:
IRFadj (kg-year/kg-day) = (ED_{3-6} (3 yr) x IRF_{3-6} (0.0022 kg/day) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRF = Ingestion Rate of Fish (kg/day); BW = Body Weight (kg)
For CTE the IRF is the mean per capita freshwater fish intake rate as reported in the EPA Child-Specific Exposures Factor Handbook (CSEFH - 2008b.)
(2) IRFMadj: Consistent with the methodology presented in the EPA (2008a) RSL User's Guide and, an age-adjusted fish ingestion rate for mutagens for children ages 3 to 6 was calculated as:
IRFMadj (kg-year/kg-day) = (ED_{3-6} (3 yr) x IRF_{3-6} (0.0022 kg/day) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRF = Ingestion Rate of Fish (kg/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)
For CTE the IRF is the mean per capita freshwater fish intake rate as reported in the EPA Child-Specific Exposures Factor Handbook (CSEFH - 2008b.)
(3) FI: Assumes 25% of fish ingested are from the Site.
(4) EF: Default value for residents.
(5) ATc:365 days per year x 70-year lifetime. ATnc: 365 days per year x ED (6 years)

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
EPA. 2008a. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
EPA. 2008b. "Child-Specific Exposure Factors Handbook (Final Report)." National Center for Environmental Assessment (NCEA). EPA/600/R-06/096F. September.

TABLE 4.15.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADOLESCENT FISH CONSUMER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Fish
Exposure Medium: Fish Tissue

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Fish Consumer	Adolescent Age 6-16	C/F: Fish from the LVR	EPC_F	Exposure Point Concentration - Fish Tissue	medium-specific	mg/kg	See Table 3 Series	
				IRFadj	Age-Adjusted Fish Ingestion Rate	0.0028	kg-year/kg-day	EPA, 2008a,b (1)	CDI (mg/kg-day) =
				IRFMadj	Mutagenic IRF	0.0084	kg-year/kg-day	EPA, 2008a,b (2)	$\frac{EPC_F \times IR(M)_F \times FI \times EF \times CFs}{AT}$
				FI	Fractional Intake	0.25	unitless	BPJ (3)	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:
(1) IRF: Consistent with the methodology presented in the EPA (2008a) RSL User's Guide, an age-adjusted fish ingestion rate for adolescents ages 6 to 16 calculated as:
IRF (kg-year/kg-day) = (ED_{6-16} (10 yr) x IRF_{6-16} (0.0195 kg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRF = Ingestion Rate of Fish (kg/day); BW = Body Weight (kg) recommended for calculating age-adjusted rates for residents ages 6 to 16 (EPA, 2008a)
For RME the IRF is the average of the 95th percentile per capita freshwater fish intake rates for children 6 to 11 (0.013 kg/day) and children 11 to 16 (0.026 kg/day) as reported in the EPA Child-Specific Exposures Factor Handbook (CSEFH - 2008b.)
(2) IRFMadj: Consistent with the methodology presented in the EPA (2008a) RSL User's Guide, an age-adjusted fish ingestion rate for mutagens for recreational fishermen ages 6 to 16 calculated as:
IRFMadj(kg-year/kg-day) = (ED_{6-16} (10 yr) x IRF_{6-16} (0.0195 kg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRF = Ingestion Rate of Fish (kg/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg) recommended for calculating age-adjusted rates for residents ages 6 to 16 (EPA, 2008a)
For RME the IRF is the average of the 95th percentile per capita freshwater fish intake rates for children 6 to 11 (0.013 kg/day) and children 11 to 16 (0.026 kg/day) as reported in the EPA Child-Specific Exposures Factor Handbook (CSEFH - 2008b.)
(3) FI: Assumes 25% of fish ingested are from the Site.
(4) EF: Default value for residents.
(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
EPA. 2008a. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
EPA. 2008b. "Child-Specific Exposure Factors Handbook (Final Report)." National Center for Environmental Assessment (NCEA). EPA/600/R-06/096F. September.

TABLE 4.15.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADOLESCENT FISH CONSUMER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Fish
Exposure Medium: Fish Tissue

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Fish Consumer	Adolescent Age 6-16	C/F: Fish from the LVR	EPC_F	Exposure Point Concentration - Fish Tissue	medium-specific	mg/kg	See Table 3 Series	
				IRFadj	Age-Adjusted Fish Ingestion Rate	0.00052	kg-year/kg-day	EPA, 2008 (1)	CDI (mg/kg-day) =
				IRFMadj	Mutagenic IRF	0.0016	kg-year/kg-day	EPA, 2008 (1)	$\frac{EPC_F \times IR(M)_F \times FI \times EF \times CFs}{AT}$
				FI	Fractional Intake	0.25	unitless	BPJ (3)	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:
(1) IRF: Consistent with the methodology presented in the EPA (2008a) RSL User's Guide, an age-adjusted fish ingestion rate for adolescents ages 6 to 16 calculated as:
IRFadj (kg-year/kg-day) = (ED_{6-16} (10 yr) x IRF_{6-16} (0.00365 kg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRF = Ingestion Rate of Fish (kg/day); BW = Body Weight (kg) recommended for calculating age-adjusted rates for residents ages 6 to 16 (EPA, 2008a)
For CTE the IRF is the average of the mean per capita freshwater fish intake rates for children 6 to 11 (0.003 kg/day) and children 11 to 16 (0.0043 kg/day) as reported in the EPA Child-Specific Exposures Factor Handbook (CSEFH - 2008b.)
(2) $IRFM_{adj}$: Consistent with the methodology presented in the EPA (2008a) RSL User's Guide, an age-adjusted fish ingestion rate for mutagens for recreational fishermen ages 6 to 16 calculated as:
IRFMadj (kg-year/kg-day) = (ED_{6-16} (10 yr) x IRF_{6-16} (0.00365 kg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRF = Ingestion Rate of Fish (kg/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg) recommended for calculating age-adjusted rates for residents ages 6 to 16 (EPA, 2008a)
For CTE the IRF is the average of the mean per capita freshwater fish intake rates for children 6 to 11 (0.003 kg/day) and children 11 to 16 (0.0043 kg/day) as reported in the EPA Child-Specific Exposures Factor Handbook (CSEFH - 2008b.)
(3) FI: Assumes 25% of fish ingested are from the Site.
(4) EF: Default value for residents.
(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
EPA. 2008a. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
EPA. 2008b. "Child-Specific Exposure Factors Handbook (Final Report)." National Center for Environmental Assessment (NCEA). EPA/600/R-06/096F. September.

TABLE 4.16.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADULT FISH CONSUMER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Fish
Exposure Medium: Edible Fish Tissue

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Fish Consumer	Adult	C/F: Fish from the LVR	EPC_F	Exposure Point Concentration - Fish Tissue	medium-specific	mg/kg	See Table 3 Series	
				IRF	Fish Ingestion Rate	0.025	kg/day	EPA, 1997 (1)	CDI (mg/kg-day) =
				FI	Fractional Intake	0.25	unitless	BPJ (2)	$\frac{EPC_F \times IR_F \times FI \times EF \times ED \times CFs}{BW \times AT}$
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRF: 95th percentile value for recreational anglers.
(2) FI: Assumes 25% of fish ingested are from the Site.
(3) EF: Default value for residents.
(4) ED: Default exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 30 year ED.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.

TABLE 4.16.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADULT FISH CONSUMER
Matthiessen and Hegeler Zinc Company Site, OU1 - LaSalle, Illinois

Timeframe: Current and Future
Medium: Fish
Exposure Medium: Edible Fish Tissue

Exposure Route	Receptor	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)
Ingestion	Current and Future Fish Consumer	Adult	C/F: Fish from the LVR	EPC_F	Exposure Point Concentration - Fish Tissue	medium-specific	mg/kg	See Table 3 Series	
				IRF	Fish Ingestion Rate	0.008	kg/day	EPA, 1991 (1)	CDI (mg/kg-day) =
				FI	Fractional Intake	0.25	unitless	BPJ (2)	$\frac{EPC_F \times IR_F \times FI \times EF \times ED \times CFs}{BW \times AT}$
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRF: Mean value for recreational anglers.
(2) FI: Assumes 25% of fish ingested are from the Site.
(3) EF: Default value for residents.
(4) ED: Default CT exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 9 year ED.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.

ATTACHMENT 2

HHRA TABLES – OU2

1 Series:	Selection of Exposure Pathways, OU2
4 Series:	Values Used for Daily Intake Calculations
4.1	Future Commercial/Industrial Worker
4.2	Current and Future Utility Worker
4.3	Current and Future Construction Worker
4.4	Current and Future Adolescent Trespasser
4.5	Current and Future Adult Trespasser
4.6	Current and Future Child Recreationalist
4.7	Current and Future Adolescent Recreationalist
4.8	Current and Future Adult Recreationalist
4.9	Current and Future Child Resident
4.10	Current and Future Aggregate Resident

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TABLE 1
SELECTION OF EXPOSURE PATHWAYS
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Surface Soil	Surface Soil	Surface Soil	On-Site Trespasser	Adult	Ingestion	Quant.	Trespassers may incidentally ingest surface soil.
						Dermal	Quant.	Trespassers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air	On-Site Trespasser	Adult	Inhalation	Quant.	Trespassers may inhale volatiles and fugitive dust that migrate from surface soil to air.
	Surface Soil	Surface Soil	Surface Soil	On-Site Trespasser	Adolescent (6-16 years)	Ingestion	Quant.	Trespassers may incidentally ingest surface soil.
						Dermal	Quant.	Trespassers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air	On-Site Trespasser	Adolescent (6-16 years)	Inhalation	Quant.	Trespassers may inhale volatiles and fugitive dust that migrate from surface soil to air.
	Sediment	Sediment	Sediment	On-Site Trespasser	Adult	Ingestion	Quant.	Trespassers may incidentally ingest on-site sediment.
						Dermal	Quant.	Trespassers may have exposed skin come into contact with on-site sediment.
					Adolescent (6-16 years)	Ingestion	Quant.	Trespassers may incidentally ingest on-site sediment.
						Dermal	Quant.	Trespassers may have exposed skin come into contact with on-site sediment.
	Surface Water	Surface Water	Surface Water	On-Site Trespasser	Adult	Ingestion	Quant.	Trespassers may incidentally ingest on-site surface water.
						Dermal	Quant.	Trespassers may have exposed skin come into contact with on-site surface water.
					Adolescent (6-16 years)	Ingestion	Quant.	Trespassers may incidentally ingest on-site surface water.
						Dermal	Quant.	Trespassers may have exposed skin come into contact with on-site surface water.
Current/Future	Surface Soil	Surface Soil	Surface Soil	Off-Site Resident	Adult	Ingestion	Quant.	Off-site residents in the existing residential area west of OU2 may incidentally ingest surface soil.
						Dermal	Quant.	Off-site residents in the existing residential area west of OU2 may have exposed skin come into contact with surface soil.
		Particulates	Outdoor Air	Off-Site Resident	Adult	Inhalation	Quant.	Off-site residents in the existing residential area west of OU2 may inhale fugitive dust that migrates from surface soil to air. Inhalation of volatiles from surface soils is expected to be insignificant for off-site residents.
	Surface Soil	Surface Soil	Surface Soil	Off-Site Resident	Child	Ingestion	Quant.	Off-site residents in the existing residential area west of OU2 may incidentally ingest surface soil.
						Dermal	Quant.	Off-site residents in the existing residential area west of OU2 may have exposed skin come into contact with surface soil.
		Particulates	Outdoor Air	Off-Site Resident	Child	Inhalation	Quant.	Off-site residents in the existing residential area west of OU2 may inhale fugitive dust that migrates from surface soil to air. Inhalation of volatiles from surface soils is expected to be insignificant for off-site residents.
	Surface Soil	Homegrown Produce	Homegrown Produce	Off-Site Resident	Adult	Ingestion	Quant.	Off-site residents in the existing residential area west of OU2 may ingest homegrown produce that have taken up contaminants from surface soil.
					Child	Ingestion	Quant.	Off-site residents in the existing residential area west of OU2 may ingest homegrown produce that have taken up contaminants from surface soil.
	Surface Soil	Surface Soil	Surface Soil	Off-Site Construction Worker	Adult	Ingestion	Quant.	Off-site construction workers in the existing residential area west of OU2 may incidentally ingest surface soil.
						Dermal	Quant.	Off-site construction workers in the existing residential area west of OU2 may have exposed skin come into contact with surface soil.
		Particulates	Outdoor Air	Off-Site Construction Worker	Adult	Inhalation	Quant.	Off-site construction workers in the existing residential area west of OU2 may inhale fugitive dust that migrates from surface soil to outdoor air. Inhalation of volatiles from surface soils is expected to be incomplete for off-site construction workers.

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Soil	Surface Soil	Surface Soil	Off-Site Utility Worker	Adult	Ingestion	Quant.	Off-site utility workers in the existing residential area west of OU2 may incidentally ingest surface soil.
						Dermal	Quant.	Off-site utility workers in the existing residential area west of OU2 may have exposed skin come into contact with surface soil.
		Particulates	Outdoor Air	Off-Site Utility Worker	Adult	Inhalation	Quant.	Off-site utility workers in the existing residential area west of OU2 may inhale fugitive dust that migrates from surface soil to outdoor air. Inhalation of volatiles from surface soils is expected to be incomplete for off-site utility workers.
	Surface Soil	Surface Soil	Surface Soil	Off-Site Recreationalist	Adult	Ingestion	Quant.	Off-site recreationalists in the area across (east) of the Little Vermilion River may incidentally ingest surface soil.
						Dermal	Quant.	Off-site recreationalists in the area across (east) of the Little Vermilion River may have exposed skin come into contact with surface soil.
		Particulates	Outdoor Air	Off-Site Recreationalist	Adult	Inhalation	Quant.	Off-site recreationalists in the area across (east) of the Little Vermilion River may inhale fugitive dust that migrates from surface soil to air. Inhalation of volatiles from surface soils is expected to be incomplete for off-site recreationalists.
	Surface Soil	Surface Soil	Surface Soil	Off-Site Recreationalist	Adolescent (6-16 years)	Ingestion	Quant.	Off-site recreationalists in the area across (east) of the Little Vermilion River may incidentally ingest surface soil.
						Dermal	Quant.	Off-site recreationalists in the area across (east) of the Little Vermilion River may have exposed skin come into contact with surface soil.
		Particulates	Outdoor Air	Off-Site Recreationalist	Adolescent (6-16 years)	Inhalation	Quant.	Off-site recreationalists in the area across (east) of the Little Vermilion River may inhale fugitive dust that migrates from surface soil to air. Inhalation of volatiles from surface soils is expected to be incomplete for off-site recreationalists.
	Surface Soil	Surface Soil	Surface Soil	Off-Site Recreationalist	Child	Ingestion	Quant.	Off-site recreationalists in the area across (east) of the Little Vermilion River may incidentally ingest surface soil.
						Dermal	Quant.	Off-site recreationalists in the area across (east) of the Little Vermilion River may have exposed skin come into contact with surface soil.
		Particulates	Outdoor Air	Off-Site Recreationalist	Child	Inhalation	Quant.	Off-site recreationalists in the area across (east) of the Little Vermilion River may inhale fugitive dust that migrates from surface soil to air. Inhalation of volatiles from surface soils is expected to be incomplete for off-site recreationalists.
Future	Surface Soil	Homegrown Produce	Homegrown Produce	On-Site Resident	Adult	Ingestion	Quant.	Future residents may ingest homegrown produce that have taken up contaminants from surface soil.
					Child	Ingestion	Quant.	Future residents may ingest homegrown produce that have taken up contaminants from surface soil.
	Subsurface Soil	Homegrown Produce	Homegrown Produce	On-Site Resident	Adult	Ingestion	Quant.	Future residents may ingest homegrown produce that have taken up contaminants from subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of Site development.
					Child	Ingestion	Quant.	Future residents may ingest homegrown produce that have taken up contaminants from subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of Site development.
	Surface Soil	Surface Soil	Surface Soil	On-Site Resident	Adult	Ingestion	Quant.	Future residents may incidentally ingest surface soil.
						Dermal	Quant.	Future residents may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air	On-Site Resident	Adult	Inhalation	Quant.	Future residents may inhale volatiles and fugitive dust that migrate from surface soil to air.

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Subsurface Soil	Subsurface Soil	Subsurface Soil	On-Site Resident	Adult	Ingestion	Quant.	Future residents may incidentally ingest subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of Site development.
						Dermal	Quant.	Future residents may have exposed skin come into contact with subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of Site development.
		Particulates and Vapors	Outdoor Air	On-Site Resident	Adult	Inhalation	Quant.	Future residents may inhale volatiles and fugitive dust that migrate from subsurface soil to air, if subsurface soil is brought to the surface and mixed with surface soil as a result of Site development.
	Surface Soil	Surface Soil	Surface Soil	On-Site Resident	Child	Ingestion	Quant.	Future residents may incidentally ingest surface soil.
						Dermal	Quant.	Future residents may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air	On-Site Resident	Child	Inhalation	Quant.	Future residents may inhale volatiles and fugitive dust that migrate from surface soil to air.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	On-Site Resident	Child	Ingestion	Quant.	Future residents may incidentally ingest subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of Site development.
						Dermal	Quant.	Future residents may have exposed skin come into contact with subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of Site development.
		Particulates and Vapors	Outdoor Air	On-Site Resident	Child	Inhalation	Quant.	Future residents may inhale volatiles and fugitive dust that migrate from subsurface soil to air, if subsurface soil is brought to the surface and mixed with surface soil as a result of Site development.
	Groundwater	Vapors	Indoor Air	On-Site Resident	Adult	Inhalation	Quant.	Future residents may be exposed to volatile groundwater contaminants migrating into indoor air via vapor intrusion.
					Child	Inhalation	Quant.	Future residents may be exposed to volatile groundwater contaminants migrating into indoor air via vapor intrusion.
	Groundwater	Groundwater	Groundwater	On-Site Resident	Adult	Ingestion	Quant.	Future residents may ingest groundwater from the Site.
						Dermal Contact	Quant.	Future residents may have exposed skin come into contact with groundwater from the Site; however, per the RSL User's Guide (EPA 2008), the tap water calculations do not include the dermal exposure route.
		Vapors	Indoor Air	On-Site Resident	Adult	Inhalation	Quant.	Future residents may be exposed to volatile groundwater contaminants released from groundwater to indoor air from household groundwater use (e.g., showering).
		Vapors	Outdoor Air	On-Site Resident	Adult	Inhalation	Quant.	Future residents may inhale groundwater vapors from the Site. However, this exposure is expected to be insignificant.
	Groundwater	Groundwater	Groundwater	On-Site Resident	Child	Ingestion	Quant.	Future residents may ingest groundwater from the Site.
						Dermal Contact	Quant.	Future residents may have exposed skin come into contact with groundwater from the Site; however, per the RSL User's Guide (EPA 2008), the tap water calculations do not include the dermal exposure route.
		Vapors	Indoor Air	On-Site Resident	Child	Inhalation	Quant.	Future residents may be exposed to volatile groundwater contaminants released from groundwater to indoor air from household groundwater use (e.g., showering).
		Vapors	Outdoor Air	On-Site Resident	Child	Inhalation	Quant.	Future residents may inhale groundwater vapors from the Site. However, this exposure is expected to be insignificant.
	Surface Soil	Surface Soil	Surface Soil	On-Site Recreationalist	Adult	Ingestion	Quant.	Future recreationalists may incidentally ingest surface soil.
						Dermal	Quant.	Future recreationalists may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air	On-Site Recreationalist	Adult	Inhalation	Quant.	Future recreationalists may inhale volatiles and fugitive dust that migrate from surface soil to air.
	Surface Soil	Surface Soil	Surface Soil	On-Site Recreationalist	Adolescent (6-16 years)	Ingestion	Quant.	Future recreationalists may incidentally ingest surface soil.
						Dermal	Quant.	Future recreationalists may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air	On-Site Recreationalist	Adolescent (6-16 years)	Inhalation	Quant.	Future recreationalists may inhale volatiles and fugitive dust that migrate from surface soil to air.

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Surface Soil	Surface Soil	Surface Soil	On-Site Recreationalist	Child	Ingestion	Quant.	Future recreationalists may incidentally ingest surface soil.
						Dermal	Quant.	Future recreationalists may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air	On-Site Recreationalist	Child	Inhalation	Quant.	Future recreationalists may inhale volatiles and fugitive dust that migrate from surface soil to air.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	On-Site Recreationalist	Adult	Ingestion	Quant.	Future recreationalists may incidentally ingest subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as a result of Site development.
						Dermal	Quant.	Future recreationalists may have exposed skin come into contact with subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as a result of Site development.
		Particulates and Vapors	Outdoor Air	On-Site Recreationalist	Adult	Inhalation	Quant.	Future recreationalists may inhale volatiles and fugitive dust that migrate from subsurface soil to air if subsurface soil is brought to the surface and mixed with surface soil as a result of Site development.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	On-Site Recreationalist	Adolescent (6-16 years)	Ingestion	Quant.	Future recreationalists may incidentally ingest subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as a result of Site development.
						Dermal	Quant.	Future recreationalists may have exposed skin come into contact with subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as a result of Site development.
		Particulates and Vapors	Outdoor Air	On-Site Recreationalist	Adolescent (6-16 years)	Inhalation	Quant.	Future recreationalists may inhale volatiles and fugitive dust that migrate from subsurface soil to air if subsurface soil is brought to the surface and mixed with surface soil as a result of Site development.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	On-Site Recreationalist	Child	Ingestion	Quant.	Future recreationalists may incidentally ingest subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as a result of Site development.
						Dermal	Quant.	Future recreationalists may have exposed skin come into contact with subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as a result of Site development.
		Particulates and Vapors	Outdoor Air	On-Site Recreationalist	Child	Inhalation	Quant.	Future recreationalists may inhale volatiles and fugitive dust that migrate from subsurface soil to air if subsurface soil is brought to the surface and mixed with surface soil as a result of Site development.
	Sediment	Sediment	Sediment	On-Site Recreationalist	Adult	Ingestion	Quant.	Future recreationalists may incidentally ingest on-site sediment.
						Dermal	Quant.	Future recreationalists may have exposed skin come into contact with on-site sediment.
					Adolescent (6-16 years)	Ingestion	Quant.	Future recreationalists may incidentally ingest on-site sediment.
						Dermal	Quant.	Future recreationalists may have exposed skin come into contact with on-site sediment.
					Child	Ingestion	Quant.	Future recreationalists may incidentally ingest on-site sediment.
						Dermal	Quant.	Future recreationalists may have exposed skin come into contact with on-site sediment.
	Surface Water	Surface Water	Surface Water	On-Site Recreationalist	Adult	Ingestion	Quant.	Future recreationalists may incidentally ingest on-site surface water.
						Dermal	Quant.	Future recreationalists may have exposed skin come into contact with on-site surface water.
					Adolescent (6-16 years)	Ingestion	Quant.	Future recreationalists may incidentally ingest on-site surface water.
						Dermal	Quant.	Future recreationalists may have exposed skin come into contact with on-site surface water.
					Child	Ingestion	Quant.	Future recreationalists may incidentally ingest on-site surface water.
						Dermal	Quant.	Future recreationalists may have exposed skin come into contact with on-site surface water.

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Surface Soil	Surface Soil	Surface Soil	On-Site Commercial/Industrial Worker	Adult	Ingestion	Quant.	Future commercial/industrial workers may incidentally ingest surface soil.
						Dermal	Quant.	Future commercial/industrial workers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air	On-Site Commercial/Industrial Worker	Adult	Inhalation	Quant.	Future commercial/industrial workers may inhale volatiles and fugitive dust that migrate from surface soil to air.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	On-Site Commercial/Industrial Worker	Adult	Ingestion	Quant.	Future commercial/industrial workers may incidentally ingest subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of Site development.
						Dermal	Quant.	Future commercial/industrial workers may have exposed skin come into contact with subsurface soil if subsurface soil is brought to the surface and mixed with surface soil as the result of Site development.
		Particulates and Vapors	Outdoor Air	On-Site Commercial/Industrial Worker	Adult	Inhalation	Quant.	Future commercial/industrial workers may inhale volatiles and fugitive dust that migrate from subsurface soil to air if subsurface soil is brought to the surface and mixed with surface soil as the result of Site development.
	Groundwater	Vapors	Indoor Air	On-Site Commercial/Industrial Worker	Adult	Inhalation	Quant.	Future commercial/industrial workers may be exposed to volatile groundwater contaminants migrating into indoor air via vapor intrusion.
	Groundwater	Groundwater	Groundwater	On-Site Commercial/Industrial Worker	Adult	Ingestion	Quant.	Future commercial/industrial workers may ingest groundwater from the Site.
		Vapors	Outdoor Air	On-Site Commercial/Industrial Worker	Adult	Inhalation	Quant.	Future commercial/industrial workers may inhale groundwater vapors from the Site. However, this exposure is expected to be insignificant.
	Surface Soil	Surface Soil	Surface Soil	On-Site Construction Worker	Adult	Ingestion	Quant.	Future construction workers may incidentally ingest surface soil.
						Dermal	Quant.	Future construction workers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air	On-Site Construction Worker	Adult	Inhalation	Quant.	Future construction workers may inhale volatiles and fugitive dust that migrate from surface soil to outdoor air.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	On-Site Construction Worker	Adult	Ingestion	Quant.	Future construction workers may incidentally ingest subsurface soil.
						Dermal	Quant.	Future construction workers may have exposed skin come into contact with subsurface soil.
		Particulates and Vapors	Outdoor Air	On-Site Construction Worker	Adult	Inhalation	Quant.	Future construction workers may inhale volatiles and fugitive dust that migrate from subsurface soil to outdoor air.
	Groundwater	Groundwater	Groundwater	On-Site Construction Worker	Adult	Ingestion	Quant.	Future construction workers may ingest groundwater from the Site.
						Dermal Contact	Quant.	Future construction workers may have exposed skin come into contact with groundwater from the Site.
		Vapors	Outdoor Air (trenches)	On-Site Construction Worker	Adult	Inhalation	Quant.	Future construction workers may inhale groundwater vapors from trench air.
	Surface Soil	Surface Soil	Surface Soil	On-Site Utility Worker	Adult	Ingestion	Quant.	Future utility workers may incidentally ingest surface soil.
						Dermal	Quant.	Future utility workers may have exposed skin come into contact with surface soil.
		Particulates and Vapors	Outdoor Air	On-Site Utility Worker	Adult	Inhalation	Quant.	Future utility workers may inhale volatiles and fugitive dust that migrate from surface soil to trench air.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	On-Site Utility Worker	Adult	Ingestion	Quant.	Future utility workers may incidentally ingest subsurface soil.
						Dermal	Quant.	Future utility workers may have exposed skin come into contact with subsurface soil.
		Particulates and Vapors	Outdoor Air	On-Site Utility Worker	Adult	Inhalation	Quant.	Future utility workers may inhale volatiles and fugitive dust that migrate from subsurface soil to trench air.
	Groundwater	Groundwater	Groundwater	On-Site Utility Worker	Adult	Ingestion	Quant.	Future utility workers may ingest groundwater from the Site.
						Dermal Contact	Quant.	Future utility workers may have exposed skin come into contact with groundwater from the Site.
		Vapors	Outdoor Air (trenches)	On-Site Utility Worker	Adult	Inhalation	Quant.	Future utility workers may inhale groundwater vapors from trench air.

Notes:

Quant. Quantitative; this scenario was quantitatively assessed in the human health risk assessment

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TABLE 4.1a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE ON-SITE COMMERCIAL/INDUSTRIAL WORKER - SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, Particulates/Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Commercial/ Industrial Worker	Adult	Surface and Subsurface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	CDI (mg/kg-day) = EPCs x RBA x IRS x FI x EF x ED x CFs / BW x AT
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	
				IRS	Soil Ingestion Rate	100	mg/day	EPA, 2002 (1)	
				FI	Fractional Intake	1.0	unitless	BPJ (2)	
				EF	Exposure Frequency	250	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	25	years	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Future On-Site Commercial/ Industrial Worker	Adult	Surface and Subsurface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	CDI (mg/kg-day) = EPCs x DAF x SA x AF x EF x ED x CFs / BW x AT
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	
				SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	
				AF	Soil-to-Skin Adherence Factor	0.2	mg/cm^2	EPA, 2002 (8)	
				EF	Exposure Frequency	250	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	25	years	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Future On-Site Commercial/ Industrial Worker	Adult	Outdoor Air Particulates and Vapors from Surface and Subsurface Soil	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	CDE_C ($\mu g/m^3$) = EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt / ATc
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	
				EF	Exposure Frequency	250	days/year	EPA, 1991 (3)	
				ED	Exposure Duration	25	years	EPA, 1991 (4)	
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	CDE_{NC} (mg/m^3) = EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt / ATnc
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Default soil ingestion rate for outdoor workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Default exposure frequency for outdoor workers.
(4) ED: Default exposure duration for workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: Default soil-to-skin adherence factor for outdoor workers.
(9) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(10) ET: Assumes 40-hour work week (5 days per week).

Sources:
BPJ= Best Professional Judgment.
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TABLE 4.1a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE ON-SITE COMMERCIAL/INDUSTRIAL WORKER - SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Surface Soil, Subsurface Soil
Exposure Medium: Surface Soil, Subsurface Soil, Particulates/Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Commercial/ Industrial Worker	Adult	Surface and Subsurface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	50	mg/day	EPA, 2002 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	219	days/year	EPA, 1997 (3)	
				ED	Exposure Duration	9	years	EPA, 1997 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Future On-Site Commercial/ Industrial Worker	Adult	Surface and Subsurface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.02	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	219	days/year	EPA, 1997 (3)	
				ED	Exposure Duration	9	years	EPA, 1997 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Future On-Site Commercial/ Industrial Worker	Adult	Outdoor Air Particulates and Vapors from Surface and Subsurface Soil	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	219	days/year	EPA, 1997 (3)	ATc
				ED	Exposure Duration	9	years	EPA, 1997 (4)	
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Default soil ingestion rate for indoor workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Default exposure frequency for indoor workers.
(4) ED: Recommended central tendency exposure duration for industrial scenarios.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: Default central tendency soil-to-skin adherence factor for industrial workers.
(9) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(10) ET: Assumes 40-hour work week (5 days per week).

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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TABLE 4.1b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE ON-SITE COMMERCIAL/INDUSTRIAL WORKER - GROUNDWATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Commercial/ Industrial Worker	Adult	Groundwater	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
				IRgw	Groundwater Ingestion Rate	1	L/day	EPA, 1991 (1)	CDI (mg/kg-day) =
				FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCgw x IRgw x FI x EF x ED x CFgw
				EF	Exposure Frequency	250	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	25	years	EPA, 1989 (4)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Future On-Site Commercial/ Industrial Worker	Adult	Outdoor Air Vapors	EPCgw	Exposure Point Concentration - Groundwater	See Table 3s	mg/L	See Table 3s	
				EF	Exposure Frequency	250	days/year	BPJ (3)	CDE_C ($\mu g/m^3$) =
				ED	Exposure Duration	25	years	EPA, 1989 (4)	EPCgw x (1/VFwamb) x EF x ED x ET x CFa x CFt
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	ATc
				VF_{wamb}	Volatilization factor, Water to Ambient Air	See Table XX	m^{-3}/L	See Table XX	
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCgw x (1/VFwamb) x EF x ED x ET x CFt
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	ATnc
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Future On-Site Commercial/ Industrial Worker	Adult	Indoor Air Vapors	EPCia	Chemical Concentration in Indoor Air	Calculated	$\mu g/m^3$	See Table XX	CDE_C ($\mu g/m^3$) =
				EF	Exposure Frequency	250	days/year	BPJ (3)	EPCia x EF x ED x ET x CFt
				ED	Exposure Duration	25	years	EPA, 1989 (4)	ATc
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCia x EF x ED x ET x CFa x CFt
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	ATnc
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRgw: Assumes that a commercial/industrial worker ingests one-half of daily water intake (2 liters) at work.
(2) FI: Assumes 100% of incidental groundwater ingestion occurs on-site.
(3) EF: Default exposure frequency for indoor workers.
(4) ED: Default exposure duration for workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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TABLE 4.1b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE ON-SITE COMMERCIAL/INDUSTRIAL WORKER - GROUNDWATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Commercial/ Industrial Worker	Adult	Groundwater	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
				IRgw	Groundwater Ingestion Rate	1	L/day	EPA, 1991 (1)	CDI (mg/kg-day) =
				FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCgw x IRgw x FI x EF x ED x CFgw
				EF	Exposure Frequency	219	days/year	IPCB, 2007 (3)	BW x AT
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Future On-Site Commercial/ Industrial Worker	Adult	Outdoor Air Vapors	EPCgw	Exposure Point Concentration - Groundwater	See Table 3s	mg/L	See Table 3s	
				EF	Exposure Frequency	219	days/year	BPJ (3)	CDE_C ($\mu g/m^3$) =
				ED	Exposure Duration	9	years	EPA, 1989 (4)	EPCgw x (1/VFwamb) x EF x ED x ET x CFa x CFt
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	ATc
				VF_{wamb}	Volatilization factor, Water to Ambient Air	See Table XX	m^{-3}/L	See Table XX	
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCgw x (1/VFwamb) x EF x ED x ET x CFt
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	ATnc
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Future On-Site Commercial/ Industrial Worker	Adult	Indoor Air Vapors	EPCia	Chemical Concentration in Indoor Air	Calculated	$\mu g/m^3$	See Table XX	CDE_C ($\mu g/m^3$) =
				EF	Exposure Frequency	219	days/year	BPJ (3)	EPCia x EF x ED x ET x CFt
				ED	Exposure Duration	9	years	EPA, 1989 (4)	ATc
				ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCia x EF x ED x ET x CFa x CFt
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	ATnc
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRgw: Assumes that a commercial/industrial worker would incidentally ingest 0.03 L/day (about one ounce) on one-fourth of the total days or, on average, 0.0075 L/day.
(2) FI: Assumes 100% of incidental groundwater ingestion occurs on-site.
(3) EF: Default exposure frequency for indoor workers.
(4) ED: Recommended central tendency exposure duration for industrial scenarios.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 1 year ED.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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TABLE 4.2a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE OFF-SITE AND FUTURE ON-SITE UTILITY WORKER - SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates/Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
Ingestion	Current and Future	Adult	Surface Soil	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	Off-Site Utility		(Off-Site)	IRS	Soil Ingestion Rate	330	mg/day	EPA, 2002 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
	Worker			FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	20	days/year	BPJ (3)	
	Future On-Site		Surface and	ED	Exposure Duration	25	years	EPA, 2002 (4)	
	Utility Worker		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	BW	Body Weight	70	kg	EPA, 2002 (4)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
Dermal	Current and Future	Adult	Surface Soil	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	Off-Site Utility		(Off-Site)	SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
	Worker			AF	Soil-to-Skin Adherence Factor	0.3	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	20	days/year	BPJ (3)	
	Future On-Site		Surface and	ED	Exposure Duration	25	years	EPA, 2002 (4)	
	Utility Worker		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
			Outdoor Air	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
	Current and Future	Adult	Particulates and	VF	Volatilization Factor	chemical-specific	m^3/kg	Table 5 and 6 Series	
Inhalation	Off-Site Utility		Vapors from Surface	PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	CDE_C ($\mu g/m^3$) =
	Worker		Soil (Off-Site)	EF	Exposure Frequency	20	days/year	BPJ (3)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				ED	Exposure Duration	25	years	EPA, 2002 (4)	ATc
	Future On-Site		Outdoor Air	ET	Exposure Time	4	hrs/day	VDEQ, 2008 (10)	
	Utility Worker		Particulates and	CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
			Vapors from Surface	CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
			and Subsurface Soil	ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	ATnc
			(On-Site)	ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Recommended soil ingestion rate for construction workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Assumes 20 days per year.
(4) ED: Default exposure duration for workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: 95th percentile weighted soil adherence factor for construction workers.
(9) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(10) ET: Based on Virginia Department of Environmental Quality (VDEQ) model for trench work.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
Virginia Department of Environmental Quality (VDEQ). 2008. "Voluntary Remediation Program Risk Assessment Guidance." On-Line Address: http://www.deq.virginia.gov/vrprisk/raguide.html

TABLE 4.2a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE OFF-SITE AND FUTURE ON-SITE UTILITY WORKER - SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates/Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
Ingestion	Current and Future	Adult	Surface Soil	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	Off-Site Utility		(Off-Site)	IRS	Soil Ingestion Rate	100	mg/day	EPA, 2002 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
	Worker			FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	10	days/year	BPJ (3)	
	Future On-Site		Surface and	ED	Exposure Duration	9	years	EPA, 2002 (4)	
	Utility Worker		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	BW	Body Weight	70	kg	EPA, 2002 (4)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
Dermal	Current and Future	Adult	Surface Soil	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	Off-Site Utility		(Off-Site)	SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
	Worker			AF	Soil-to-Skin Adherence Factor	0.1	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	10	days/year	BPJ (3)	
	Future On-Site		Surface and	ED	Exposure Duration	9	years	EPA, 2002 (4)	
	Utility Worker		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
			Outdoor Air	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
	Current and Future	Adult	Particulates and	VF	Volatilization Factor	chemical-specific	m^3/kg	Table 5 and 6 Series	
Inhalation	Off-Site Utility		Vapors from Surface	PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	CDE_C ($\mu g/m^3$) =
	Worker		Soil (Off-Site)	EF	Exposure Frequency	10	days/year	BPJ (3)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				ED	Exposure Duration	9	years	EPA, 2002 (4)	ATc
	Future On-Site		Outdoor Air	ET	Exposure Time	4	hrs/day	VDEQ, 2008 (10)	
	Utility Worker		Particulates and	CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
			Vapors from Surface	CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
			and Subsurface Soil	ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	ATnc
			(On-Site)	ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Recommended soil ingestion rate for outdoor workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Assumes 10 days per year.
(4) ED: Recommended central tendency exposure duration for industrial scenarios.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: Mean weighted soil adherence factor for construction workers.
(9) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(10) ET: Based on Virginia Department of Environmental Quality (VDEQ) model for trench work.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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TABLE 4.2b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE ON-SITE UTILITY WORKER - GROUNDWATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Utility Worker	Adult	Groundwater	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
				IRgw	Groundwater Ingestion Rate (Incidental)	0.0125	L/day	BPJ (1)	CDI (mg/kg-day) =
				FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCgw x IRgw x FI x EF x ED x CFgw
				EF	Exposure Frequency	20	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	25	years	EPA, 1989 (4)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Future On-Site Utility Worker	Adult	Groundwater	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	2,129	cm^2	EPA, 2004 (7)	EPCgw x Kp x SA x EF x ED x ET x CFgw x CFv
				EF	Exposure Frequency	20	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	25	years	EPA, 1989 (4)	
				ET	Exposure Time	4	hrs/day	VDEQ, 2008 (8)	For Organics:
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x SA x ED
				BW	Body Weight	70	kg	EPA, 1989 (5)	BW x AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
				B	Ratio of Permeability Coefficient of a Compound Through	chemical-specific	unitless	See Table 5 & 6 Series	
					Corneum Relative to its Permeability Coefficient Across th	--	--	--	
					Viable Epidermis	--	--	--	If tevent > t*, then:
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	DAevent = FA x Kp x EPCgw x CFv x CFgw x sqrt [ET/(1+B) + 2 x τevent
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	x ({1+3B+3B^2}/{1+B})^2)]
				EV	Event Frequency	1	event/day	EPA, 2004	
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Future On-Site Utility Worker	Adult	Outdoor Air (Trenches) Vapors	CAtrench	Chemical Concentration in Trench	Calculated	$\mu g/m^3$	See Table B.2	
				CFa	Conversion Factor - Air	1.0E-03	mg/µg	--	CDEc (µg/m3) =
				ET	Exposure Time	4	hrs/day	VDEQ, 2008 (8)	CAtrench x EF x ET x ED x CFt
				EF	Exposure Frequency	20	days/year	BPJ (3)	ATc
				ED	Exposure Duration	25	years	EPA, 1989 (4)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	CDEnc (mg/m3) =
				ATnc	Averaging Time - Noncarcinogens	9,125	days	EPA, 1989 (6)	CAtrench x EF x ET x ED x CFt x CFa
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	ATnc

Notes:
(1) IRgw: Assumes that a utility worker would incidentally ingestion 0.05 L/day on one-fourth of the total days or, on average, 0.0125 L/day.
(2) FI: Assumes 100% of incidental groundwater ingestion occurs on-site.
(3) EF: Assumes 20 days per year.
(4) ED: Default exposure duration for workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.
(7) SA: Average surface area of hands and feet for adult males and females.
(8) ET: Based on Virginia Department of Environmental Quality (VDEQ) model for trench work.

Definitions:
GW = Groundwater

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
Virginia Department of Environmental Quality (VDEQ). 2008. "Voluntary Remediation Program Risk Assessment Guidance." On-Line Address: http://www.deq.virginia.gov/vrprisk/raguide.html

TABLE 4.2b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE ON-SITE UTILITY WORKER - GROUNDWATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
Ingestion	Future	Adult	Groundwater	IRgw	Groundwater Ingestion Rate (Incidental)	0.0075	L/day	BPJ (1)	CDI (mg/kg-day) =
	On-Site Utility			FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCgw x IRgw x FI x EF x ED x CFgw
	Worker			EF	Exposure Frequency	10	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	For Inorganics:
Dermal	Future	Adult	Groundwater	Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
	On-Site Utility			SA	Skin Surface Area	2,129	cm^2	EPA, 2004 (7)	EPCgw x Kp x SA x EF x ED x ET x CFgw x CFv
	Worker			EF	Exposure Frequency	10	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				ET	Exposure Time	4	hrs/day	VDEQ, 2008 (8)	For Organics:
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x SA x ED
				BW	Body Weight	70	kg	EPA, 1989 (5)	BW x AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
				B	Ratio of Permeability Coefficient of a Compound Through	chemical-specific	unitless	See Table 5 & 6 Series	
					Corneum Relative to its Permeability Coefficient Across th	--	--	--	
					Viable Epidermis	--	--	--	If tevent > t*, then:
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	DAevent = FA x Kp x EPCgw x CFv x CFgw x sqrt [ET/(1+B) + 2 x τevent
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	x ({1+3B+3B^2}/{1+B})^2)]
				EV	Event Frequency	1	event/day	EPA, 2004	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				CAtrench	Chemical Concentration in Trench	Calculated	$\mu g/m^3$	See Table B.2	
Inhalation	Future	Adult	Outdoor Air	CFa	Conversion Factor - Air (2)	1.0E-03	mg/µg	--	CDEc (µg/m3) =
	On-Site Utility		(Trenches)	ET	Exposure Time	4	hours/day	BPJ (8)	CAtrench x EF x ET x ED x CFt
	Worker		Vapors	EF	Exposure Frequency	10	days/year	BPJ (3)	ATc
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	CDEnc (mg/m3) =
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	CAtrench x EF x ET x ED x CFt x CFa
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	ATnc

Notes:
(1) IRgw: Assumes that a utility worker would incidentally ingestion 0.03 L/day (about one ouunce) on one-fourth of the total days or, on average, 0.0075 L/day.
(2) FI: Assumes 100% of incidental groundwater ingestion occurs on-site.
(3) EF: Assumes 10 days per year.
(4) ED: Recommended central tendency exposure duration for industrial scenarios.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 1 year ED.
(7) SA: Average surface area of hands and feet for adult males and females.
(8) ET: Based on Virginia Department of Environmental Quality (VDEQ) model for trench work.

Definitions:
GW = Groundwater

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
Virginia Department of Environmental Quality (VDEQ). 2008. "Voluntary Remediation Program Risk Assessment Guidance." On-Line Address: http://www.deq.virginia.gov/vrprisk/raguide.html

TABLE 4.3a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE OFF-SITE AND FUTURE ON-SITE CONSTRUCTION WORKER - SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
Ingestion	Current and Future	Adult	Surface Soil	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	Off-Site Construction		(Off-Site)	IRS	Soil Ingestion Rate	330	mg/day	EPA, 2002 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
	Worker			FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	65	days/year	BPJ (3)	
				ED	Exposure Duration	1	years	EPA, 2002 (4)	
	Future		Surface and	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
	On-Site Construction		Subsurface Soil	BW	Body Weight	70	kg	EPA, 1989 (5)	
	Worker		(On-Site)	ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
Dermal	Current and Future	Adult	Surface Soil	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	Off-Site Construction		(Off-Site)	SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
	Worker			AF	Soil-to-Skin Adherence Factor	0.3	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	65	days/year	BPJ (3)	
				ED	Exposure Duration	1	years	EPA, 2002 (4)	
	Future		Surface and	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
	On-Site Construction		Subsurface Soil	BW	Body Weight	70	kg	EPA, 1989 (5)	
	Worker		(On-Site)	ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
			Outdoor Air	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
Inhalation	Current and Future	Adult	Particulates and	VF	Volatilization Factor	chemical-specific	m^3/kg	Table 5 & 6 Series	
	Off-Site Construction		Vapors from Surface	PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	CDE_C ($\mu g/m^3$) =
	Worker		Soil (Off-Site)	EF	Exposure Frequency	65	days/year	BPJ (3)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				ED	Exposure Duration	1	years	EPA, 2002 (4)	ATc
	Future		Outdoor Air	ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	
	On-Site Construction		Particulates and	CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
	Worker		Vapors from Surface	CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
			and Subsurface Soil	ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	ATnc
			(On-Site)	ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Recommended soil ingestion rate for construction workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Assumes 5 days per week for a 13-week construction project.
(4) ED: Recommended exposure duration for construction workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 1 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: 95th percentile weighted soil adherence factor for construction workers.
(9) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(10) ET: Assumes 40-hour work week (5 days per week).

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.3a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE OFF-SITE AND FUTURE ON-SITE CONSTRUCTION WORKER - SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
Ingestion	Current and Future	Adult	Surface Soil	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	Off-Site Construction		(Off-Site)	IRS	Soil Ingestion Rate	100	mg/day	EPA, 2002 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
	Worker			FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	30	days/year	IPCB, 2007 (3)	
				ED	Exposure Duration	1	years	EPA, 2002 (4)	
	Future		Surface and	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
	On-Site Construction		Subsurface Soil	BW	Body Weight	70	kg	EPA, 1989 (5)	
	Worker		(On-Site)	ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
Dermal	Current and Future	Adult	Surface Soil	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	Off-Site Construction		(Off-Site)	SA	Skin Surface Area	3,300	cm^2	EPA, 2002 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
	Worker			AF	Soil-to-Skin Adherence Factor	0.1	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	30	days/year	IPCB, 2007 (3)	
				ED	Exposure Duration	1	years	EPA, 2002 (4)	
	Future		Surface and	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
	On-Site Construction		Subsurface Soil	BW	Body Weight	70	kg	EPA, 1989 (5)	
	Worker		(On-Site)	ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
			Outdoor Air	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
Inhalation	Current and Future	Adult	Particulates and	VF	Volatilization Factor	chemical-specific	m^3/kg	Table 5 & 6 Series	
	Off-Site Construction		Vapors from Surface	PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	CDE_C ($\mu g/m^3$) =
	Worker		Soil (Off-Site)	EF	Exposure Frequency	30	days/year	BPJ (3)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				ED	Exposure Duration	1	years	EPA, 2002 (4)	ATc
	Future		Outdoor Air	ET	Exposure Time	8	hrs/day	EPA, 2008 (10)	
	On-Site Construction		Particulates and	CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
	Worker		Vapors from Surface	CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
			and Subsurface Soil	ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	ATnc
			(On-Site)	ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Recommended soil ingestion rate for outdoor workers.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Illinois Pollution Control Board recommended exposure duration for construction projects.
(4) ED: Recommended exposure duration for construction workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 1 year ED.
(7) SA: Default skin surface area for workers.
(8) AF: Mean weighted soil adherence factor for construction workers.
(9) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(10) ET: Assumes 40-hour work week (5 days per week).

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." Office of Solid Waste and Emergency Response (OSWER). OSWER 9355.4-24. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
Illinois Pollution Control Board (IPCB). 2007. 35 Illinois Administrative Code (IAC), Part 742. "Tiered Approach to Corrective Action Objectives." February 23.

TABLE 4.3b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE ON-SITE CONSTRUCTION WORKER - GROUNDWATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
Ingestion	Future	Adult	Groundwater	IRgw	Groundwater Ingestion Rate (Incidental)	0.0125	L/day	BPJ (1)	CDI (mg/kg-day) =
	On-Site Construction			FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCgw x IRgw x FI x EF x ED x CFgw
	Worker			EF	Exposure Frequency	65	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	1	years	EPA, 1989 (4)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	For Inorganics:
Dermal	Future	Adult	Groundwater	Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
	On-Site Construction			SA	Skin Surface Area	2,129	cm^2	EPA, 2004 (7)	EPCgw x Kp x SA x EF x ED x ET x CFgw x CFv
	Worker			EF	Exposure Frequency	65	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	1	years	EPA, 1989 (4)	
				ET	Exposure Time	4	hrs/day	VDEQ, 2008 (8)	For Organics:
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x SA x ED
				BW	Body Weight	70	kg	EPA, 1989 (5)	BW x AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	If tevent < or = t*, then:
				B	Ratio of Permeability Coefficient of a Compound Through th	chemical-specific	unitless	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	
					Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	If tevent > t*, then:
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	DAevent = FA x Kp x EPCgw x CFv x CFgw x sqrt [ET/(1+B) + 2 x τevent
				EV	Event Frequency	1	event/day	EPA, 2004	x ({1+3B+$3B^2$}/{1+B})^2)]
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				CAtrench	Chemical Concentration in Trench	Calculated	$\mu g/m^3$	See Table B.2	
Inhalation	Future	Adult	Outdoor Air	ET	Exposure Time	4	hrs/day	VDEQ, 2008 (8)	CDEc (µg/m3) =
	On-Site Construction		(Trenches)	EF	Exposure Frequency	65	days/year	BPJ (3)	CAtrench x EF x ET x ED x CFt
	Worker		Vapors	ED	Exposure Duration	1	years	EPA, 1989 (4)	ATc
				CFa	Conversion Factor - Air	1.0E-03	mg/ug	--	CDEnc (mg/m3) =
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	CAtrench x EF x ET x ED x CFt x CFa
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	ATnc
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRgw: Assumes that a construction worker would incidentally ingestion 0.05 L/day on one-fourth of the total days or, on average, 0.0125 L/day.
(2) FI: Assumes 100% of incidental groundwater ingestion occurs on-site.
(3) EF: Assumes 5 days per week for a 13-week construction project.
(4) ED: Recommended exposure duration for construction workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 1 year ED.
(7) SA: Average surface area of hands and feet for adult males and females.
(8) ET: Based on the Virginia Department of Environmental Protection trench exposure model.

Definitions:
GW = Groundwater

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
Virginia Department of Environmental Quality (VDEQ). 2008. "Voluntary Remediation Program Risk Assesment Guidance." On-line Address: http://www.deq.virginia.gov/vprisk/raguide.html
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

TABLE 4.3b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE ON-SITE CONSTRUCTION WORKER - GROUNDWATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
Ingestion	Future	Adult	Groundwater	IRgw	Groundwater Ingestion Rate (Incidental)	0.0075	L/day	BPJ (1)	CDI (mg/kg-day) =
	On-Site Construction			FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCgw x IRgw x FI x EF x ED x CFgw
	Worker			EF	Exposure Frequency	30	days/year	IPCB, 2007 (3)	BW x AT
				ED	Exposure Duration	1	years	EPA, 1989 (4)	
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	For Inorganics:
Dermal	Future	Adult	Groundwater	Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
	On-Site Construction			SA	Skin Surface Area	2,129	cm^2	EPA, 2004 (7)	EPCgw x Kp x SA x EF x ED x ET x CFgw x CFv
	Worker			EF	Exposure Frequency	30	days/year	IPCB, 2007 (3)	BW x AT
				ED	Exposure Duration	1	years	EPA, 1989 (4)	
				ET	Exposure Time	4	hrs/day	VDEQ, 2008 (8)	For Organics:
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x SA x ED
				BW	Body Weight	70	kg	EPA, 1989 (5)	BW x AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	If tevent < or = t*, then:
				B	Ratio of Permeability Coefficient of a Compound Through the	chemical-specific	unitless	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	
					Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	If tevent > t*, then:
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	DAevent = FA x Kp x EPCgw x CFv x CFgw x sqrt [ET/(1+B) + 2 x τevent
				EV	Event Frequency	1	event/day	EPA, 2004	x ({1+3B+3B^2}/{1+B}^{2})]
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				CAtrench	Chemical Concentration in Trench	Calculated	$\mu g/m^3$	See Table B.2	
Inhalation	Future	Adult	Outdoor Air	ET	Exposure Time	4	hours/day	BPJ (8)	CDEc (µg/m3) =
	On-Site Construction		(Trenches)	EF	Exposure Frequency	30	days/year	IPCB, 2007 (3)	CAtrench x EF x ET x ED x CFt
	Worker		Vapors	ED	Exposure Duration	1	years	EPA, 1989 (4)	ATc
				CFa	Conversion Factor - Air	1.0E-03	mg/ug	--	CDEnc (mg/m3) =
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	CAtrench x EF x ET x ED x CFt x CFa
				ATnc	Averaging Time - Noncarcinogens	365	days	EPA, 1989 (6)	ATnc
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRgw: Assumes that a construction worker would incidentally ingestion 0.03 L/day (about one ouunce) on one-fourth of the total days or, on average, 0.0075 L/day.
(2) FI: Assumes 100% of incidental groundwater ingestion occurs on-site.
(3) EF: Illinois Pollution Control Board recommended exposure duration for construction projects.
(4) ED: Recommended exposure duration for construction workers.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 1 year ED.
(7) SA: Average surface area of hands and feet for adult males and females.
(8) ET: Based on the Virginia Department of Environmental Protection trench exposure model.

Definitions:
GW = Groundwater

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
Illinois Pollution Control Board (IPCB). 2007. 35 Illinois Administrative Code (IAC), Part 742. "Tiered Approach to Corrective Action Objectives." February 23.
Virginia Department of Environmental Quality (VDEQ). 2008. "Voluntary Remediation Program Risk Assesment Guidance." On-line Address: http://www.deq.virginia.gov/vprisk/raguide.html

TABLE 4.4a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADOLESCENT ON-SITE TRESPASSER - SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates/Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Trespasser	Adolescent Age 6-16	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	14.3	mg-year/kg-day	EPA, 2008 (1)	EPCs x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	42.9	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future On-Site Trespasser	Adolescent Age 6-16	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	57	mg-year/kg-day	EPA, 2008 (6)	EPCs x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	171	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPJ (8)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Current and Future On-Site Trespasser	Adolescent Age 6-16	Outdoor Air Particulates and Vapors from Surface Soil	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m3/kg	See Table 5 & 6 Series	CDE_{C} ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m3/kg	EPA, 2008 (8)	EPCs x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				EF	Exposure Frequency	43	days/year	BPJ (4)	ATc
				ED	Exposure Duration	10	years	--	
				EDadj	Mutagenic ED	30	years	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				ET	Exposure Time	2	hrs/day	BPJ (11)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	ATnc
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:
(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for trespassers ages 6 to 16 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)
(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for trespassers ages 6 to 16 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)
(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]
(5) ATc:365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.
(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for trespassers ages 6 to 16 calculated as:
DFSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5700 cm^2) x AF_{adult} (0.07 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)
(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for trespassers ages 6 to 16 calculated as:
DFSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5700 cm^2) x AF_{adult} (0.07 mg/cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)
(8) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(9) ED: Assumes 10 years (ages 6 to 16).
(10) EDadj: For ages 6 to 16, an age-dependent adjustment factor of 3 is applied to ED to account for mutagenic effects via inhalation [(3*10)=30].
(11) ET: Assumes a 2 hour Site visit.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.4a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADOLESCENT ON-SITE TRESPASSER - SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates/Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Trespasser	Adolescent Age 6-16	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	7.1	mg-year/kg-day	EPA, 2008 (1)	EPCs x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	21.4	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future On-Site Trespasser	Adolescent Age 6-16	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	8.1	mg-year/kg-day	EPA, 2008 (6)	EPCs x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	24	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	21	days/year	BPJ (8)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Current and Future On-Site Trespasser	Adolescent Age 6-16	Outdoor Air Particulates and Vapors from Surface Soil	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	EPCs x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				EF	Exposure Frequency	21	days/year	BPJ (4)	ATc
				ED	Exposure Duration	10	years	--	
				EDadj	Mutagenic ED	30	years	EPA, 2008 (10)	CDE_{NC} (mg/m^3) =
				ET	Exposure Time	2	hrs/day	BPJ (11)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	ATnc
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for trespassers ages 6 to 16 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (50 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for trespassers ages 6 to 16 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (50 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21]

(5) ATc:365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for trespassers ages 6 to 16 calculated as:
DFSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5700 cm^2) x AFadult-cte (0.01 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Adult Resident CTE (EPA, 2004) Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for trespassers ages 6 to 16 calculated as:
DFSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5700 cm^2) x AFadult-cte (0.01 mg/cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Adult Resident CTE (EPA, 2004) Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.

(9) ED: Assumes 10 years (ages 6 to 16).

(10) EDadj: For ages 6 to 16, an age-dependent adjustment factor of 3 is applied to ED to account for mutagenic effects via inhalation [(3*10)=30].

(11) ET: Assumes a 2 hour Site visit.

Sources:

BPJ= Best Professional Judgment.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.4b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADOLESCENT ON-SITE TRESPASSER - SEDIMENT
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
Ingestion	Current and Future	Adolescent	Sediment	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	On-Site Trespasser	Age 6-16		IRSEDadj	Age-Adjusted Sediment Ingestion Rate	14.3	mg-year/kg-day	EPA, 2008 (1)	EPCsed x RBA x IRS(M)adj x FI x EF x CFs
				IRSEDMadj	Mutagenic IRSadj	42.9	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
				EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
Dermal	Current and Future	Adolescent	Sediment	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	On-Site Trespasser	Age 6-16		DFSEDadj	Age-Adjusted Dermal Contact Factor - Sediment	70	mg-year/kg-day	EPA, 2008 (6)	EPCsed x DAF x DFS(M)adj x EF x CFs
				DFSEDMadj	Mutagenic DFSEDadj	211	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPJ (8)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSEDadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted sediment ingestion rates for trespassers ages 6 to 16 were calculated as:
IRSEDadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSEDMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted sediment ingestion rates for mutagens for trespassers ages 6 to 16 were calculated as:
IRSEDMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSEDadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for trespassers ages 6 to 16 were calculated as:
DFSEDadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (1,640 cm^2) x $AF_{reed\ gatherer}$ (0.3 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of feet and hands (cm^2); AF = Soil-to-skin Adherence Factor (EPA, 2004) (mg/cm^2); BW = Body Weight (kg)

(7) DFSEDMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for trespassers ages 6 to 16 calculated as:
DFSEDMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (1,640 cm^2) x $AF_{reed\ gatherer}$ (0.3 mg/cm^2) * $ADAF_{6-16}$ (3)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of feet and hands (cm^2); AF = Soil-to-skin Adherence Factor (EPA, 2004) (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

Sources:

BPJ= Best Professional Judgment.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.4b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADOLESCENT ON-SITE TRESPASSER - SEDIMENT
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
Ingestion	Current and Future	Adolescent	Sediment	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	On-Site Trespasser	Age 6-16		IRSEDadj	Age-Adjusted Sediment Ingestion Rate	7.1	mg-year/kg-day	EPA, 2008 (1)	EPCsed x RBA x IRS(M)adj x FI x EF x CFs
				IRSEDMadj	Mutagenic IRSadj	21.4	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
				EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
Dermal	Current and Future	Adolescent	Sediment	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	On-Site Trespasser	Age 6-16		DFSEDadj	Age-Adjusted Dermal Contact Factor - Sediment	70	mg-year/kg-day	EPA, 2008 (6)	EPCsed x DAF x DFS(M)adj x EF x CFs
				DFSEDMadj	Mutagenic DFSEDadj	211	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	21	days/year	BPJ (8)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSEDadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted central tendency exposure (CTE) sediment ingestion rates for trespassers ages 6 to 16 were calculated as:
IRSEDadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (50 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSEDMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted CTE sediment ingestion rates for mutagens for trespassers ages 6 to 16 were calculated as:
IRSEDMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 1 days per week during the summer (13 weeks) and 2 day per month during April, May, September, and October [13 + (2*4)=21]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSEDadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for trespassers ages 6 to 16 were calculated as:
DFSEDadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (1,640 cm^2) x $AF_{reed\ gatherer}$ (0.3 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of feet and hands (cm^2); AF = Soil-to-skin Adherence Factor assumes feet and hands (EPA, 2004) (mg/cm^2); BW = Body Weight (kg)

(7) DFSEDMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for trespassers ages 6 to 16 calculated as:
DFSEDMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (1,640 cm^2) x $AF_{reed\ gatherer}$ (0.3 mg/cm^2) * $ADAF_{6-16}$ (3)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of feet and hands (cm^2); AF = Soil-to-skin Adherence Factor assumes feet and hands (EPA, 2004) (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

Sources:

BPJ= Best Professional Judgment.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.4c.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADOLESCENT ON-SITE TRESPASSER - SURFACE WATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Trespasser	Adolescent Age 6-16	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
				IRSWadj	Age-Adjusted Surface Water Ingestion Rate (Incidental)	0.0018	L-year/kg-day	EPA, 2008; BPJ (1)	CDI (mg/kg-day) =
				IRSWMadj	Mutagenic IRSWadj (Incidental)	0.0054	L-year/kg-day	EPA, 2008; BPJ (2)	EPCsw x IRSW(M)adj x FI x EF x CFsw
				FI	Fractional Intake	1.0	unitless	BPJ (3)	AT
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future On-Site Trespasser	Adolescent Age 6-16	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSWadj	Age-Adjusted Dermal Contact Factor - Surface Water	304 (643)	cm^2-year/kg	EPA, 2008 (6)	EPCsw x Kp x DFS(M)adj x EF x ET x CFsw x CFv
				DFSWMadj	Mutagenic DFSWadj	921 (1,928)	cm^2-year/kg	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPL (4)	
				ET	Exposure Time	2	hrs/day	BPJ (8)	For Organics:
				CFsw	Conversion Factor - Surface Water	1.0E-03	ug/mg	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x DFS[M]adj
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	AT
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	If tevent < or = t*, then:
				B	Ratio of Permeability Coefficient of a Compound Through the Corneu	chemical-specific	unitless	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCsw x CFv x CFsw x [sqrt (6 x τevent x ET/pi)]
					Relative to its Permeability Coefficient Across the Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	If tevent > t*, then:
				EV	Event Frequency	1	event/day	EPA, 2004	DAevent = FA x Kp x EPCsw x CFv x CFsw x sqrt [ET/(1+B) + 2 x τevent
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	x {(1+3B+3B^2)/(1+B)}^{2})]
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:
(1) IRSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental surface water ingestion rate for trespassers ages 6 to 16 calculated as:
IRSWadj (L-year/kg-day) = (ED_{6-16} (10 yr) x IRSW (0.0125 L/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRSW = Ingestion Rate of Surface Water (L/day); BW = Body Weight (kg)
RME IRSW assumes an incidental ingestion rate of 0.05 L/day on one-fourth of total days (0.05 x 0.25).
(2) IRSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental surface water ingestion rates for mutagens for trespassers ages 6 to 16 calculated as:
IRSMadj (L-year/kg-day) = (ED_{6-16} (10 yr) x IRSW (0.0125 L/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRSW = Ingestion Rate of Surface Water (L/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)
RME IRSW assumes an incidental ingestion rate of 0.05 L/day on one-fourth of total days (0.05 x 0.25).
(3) FI: Conservatively assuems 100% of incidntal surface water ingestion occurs at the Site.
(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]
(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.
(6) DFSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for trespassers ages 6 to 16 calculated as:
DFSWadj (cm^2-year/kg) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (2,129 [4,499] cm^2) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet and hands (add lower legs for stream from abandoned sewer) (EPA, 2004); BW = Body Weight (kg)
(7) DFSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for mutagens for trespassers ages 6 to 16 calculated as:
DFSWMadj (cm^2-year/kg) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (2,129 [4,499] cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet and hands (add lower legs for stream from abandoned sewer) (EPA, 2004); BW = Body Weight (kg)
(8) ET: Assumes a 2 hour Site visit.

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.4c.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADOLESCENT ON-SITE TRESPASSER - SURFACE WATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Trespasser	Adolescent Age 7-16	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
				IRSWadj	Age-Adjusted Surface Water Ingestion Rate (Incidental)	0.0011	L-year/kg-day	EPA, 2008; BPJ (1)	CDI (mg/kg-day) =
				IRSWMadj	Mutagenic IRSWadj (Incidental)	0.0032	L-year/kg-day	EPA, 2008; BPJ (2)	EPCsw x IRSW(M)adj x FI x EF x CFsw
				FI	Fractional Intake	1.0	unitless	BPJ (3)	AT
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future On-Site Trespasser	Adolescent Age 7-16	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSWadj	Age-Adjusted Dermal Contact Factor - Surface Water	304 (643)	cm^2-year/kg	EPA, 2008 (6)	EPCsw x Kp x DFS(M)adj x EF x ET x CFsw x CFv
				DFSWMadj	Mutagenic DFSWadj	921 (1,928)	cm^2-year/kg	EPA, 2008 (7)	AT
				EF	Exposure Frequency	21	days/year	BPL (4)	
				ET	Exposure Time	2	hrs/day	BPJ (8)	For Organics:
				CFsw	Conversion Factor - Surface Water	1.0E-03	ug/mg	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x DFS[M]adj
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	AT
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	If tevent < or = t*, then:
				B	Ratio of Permeability Coefficient of a Compound Through the Corneu	chemical-specific	unitless	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCsw x CFv x CFsw x [sqrt (6 x τevent x ET/pi)]
					Relative to its Permeability Coefficient Across the Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	If tevent > t*, then:
				EV	Event Frequency	1	event/day	EPA, 2004	DAevent = FA x Kp x EPCsw x CFv x CFsw x sqrt [ET/(1+B) + 2 x τevent
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	x {(1+3B+3B^2)/(1+B)}^{2})]
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:
(1) IRSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental surface water ingestion rate for trespassers ages 6 to 16 calculated as:
IRSWadj (L-year/kg-day) = (ED_{6-16} (10 yr) x IRSW (0.0075 L/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Surface Water (L/day); BW = Body Weight (kg)
CTE IRS assumes an incidental ingestion rate of 0.03 L/day (about 1 ounce) on one-fourth of total days (0.03 x 0.25).
(2) IRSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental surface water ingestion rates for mutagens for trespassers ages 6 to 16 calculated as:
IRSMadj (L-year/kg-day) = (ED_{6-16} (10 yr) x IRSW (0.0075 L/day) x $ADAF_{6-16}$ (3)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Surface Water (L/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)
CTE IRS assumes an incidental ingestion rate of 0.03 L/day (about 1 ounce) on one-fourth of total days (0.03 x 0.25).
(3) FI: Conservatively assuems 100% of incidntal surface water ingestion occurs at the Site.
(4) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21]
(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.
(6) DFSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for trespassers ages 6 to 16 calculated as:
DFSWadj (cm^2-year/kg) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (2,129 [4,499] cm^2) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); Skin Surface Area (cm2) of feet and hands (add lower legs for stream from abandoned sewer) (EPA, 2004); BW = Body Weight (kg)
(7) DFSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for mutagens for trespassers ages 6 to 16 calculated as:
DFSWMadj (cm^2-year/kg) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (2,129 [4,499] cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); Skin Surface Area (cm2) of feet and hands (add lower legs for stream from abandoned sewer) (EPA, 2004); ADAF = Age-Dependent Adjustement Factor (unitless); BW = Body Weight (kg)
(8) ET: Assumes a 2 hour Site visit.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.5a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADULT ON-SITE TRESPASSER - SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates/Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Trespasser	Adult	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	100	mg/day	EPA, 1997 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future On-Site Trespasser	Adult	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	5,700	cm^2	EPA, 2004 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.07	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Trespasser	Adult	Outdoor Air Particulates and Vapors from Surface Soil	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_C ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	43	days/year	BPJ (3)	ATc
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				ET	Exposure Time	2	hrs/day	BPJ (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Recommended soil ingestion rate for adult residents.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]
(4) ED: Default exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 30 year ED.
(7) SA: Default skin surface area for adult residents.
(8) AF: Default soil-to-skin adherence factor for adult residents.
(9) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(10) ET: Assumes a 2 hour Site visit.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.5a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADULT ON-SITE TRESPASSER - SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates/Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Trespasser	Adult	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	50	mg/day	EPA, 1997 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future On-Site Trespasser	Adult	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	5,700	cm^2	EPA, 2004 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.01	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future On-Site Trespasser	Adult	Outdoor Air Particulates and Vapors from Surface Soil	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
				VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_{C} ($\mu g/m^3$) =
				PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				EF	Exposure Frequency	21	days/year	BPJ (3)	ATc
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				ET	Exposure Time	2	hrs/day	BPJ (10)	CDE_{NC} (mg/m^3) =
				CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Mean soil ingestion rate for adults.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21]
(4) ED: Default central tendency exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 9 year ED.
(7) SA: Default skin surface area for adult residents.
(8) AF: Default central tendency soil-to-skin adherence factor for adult residents.
(9) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(10) ET: Assumes a 2 hour Site visit.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
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EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.5b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADULT ON-SITE TRESPASSER - SEDIMENT
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
Ingestion	Current and Future	Adult	Sediment	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	On-Site Trespasser			IRSED	Sediment Ingestion Rate	100	mg/day	EPA, 1997 (1)	EPCsed x RBA x IRSED x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
Dermal	Current and Future	Adult	Sediment	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	On-Site Trespasser			SA	Skin Surface Area	2,129	cm^2	EPA, 2004 (7)	EPCsed x DAF x SA x AFsed x EF x ED x CFs
				AFsed	Sediment-to-Skin Adherence Factor	0.3	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRSED: Recommended soil ingestion rate for adult residents.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]
(4) ED: Default exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 30 year ED.
(7) SA: Average skin surface areas of hands and feet for adult males and females.
(8) AFsed: Sediment-to-skin adherence factor for reed gatherers.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

TABLE 4.5b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADULT ON-SITE TRESPASSER - SEDIMENT
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future On-Site Trespasser	Adult	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSED	Sediment Ingestion Rate	50	mg/day	EPA, 1997 (1)	EPCsed x RBA x IRSED x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future On-Site Trespasser	Adult	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	2,129	cm^2	EPA, 2004 (7)	EPCsed x DAF x SA x AFsed x EF x ED x CFs
				AFsed	Sediment-to-Skin Adherence Factor	0.3	mg/cm^2	EPA, 2002 (8)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRSED: CT assumed to be 1/2 recommended soil ingestion rate for adult residents.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 1 day per week during the summer (13 weeks) and 2 day per month during April, May, September, and October [(1*13)+8=21]
(4) ED: Default CT exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 9 year ED.
(7) SA: Average skin surface areas of hands and feet for adult males and females.
(8) AFsed: Soil-to-skin adherence factor for reed gatherers.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

TABLE 4.5c.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADULT ON-SITE TRESPASSER - SURFACE WATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
Ingestion	Current and Future	Adult	Surface Water	IRSW	Surface Water Ingestion Rate (Incidental)	0.0125	L/day	EPA, 1997 (1)	CDI (mg/kg-day) =
	On-Site Trespasser			FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCsw x IRSW x FI x EF x ED x CFsw
				EF	Exposure Frequency	43	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	For Inorganics:
Dermal	Current and Future	Adult	Surface Water	Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
	On-Site Trespasser			SA	Skin Surface Area	2,129 (4,499)	cm^2	EPA, 2004 (7)	EPCsw x Kp x SA x EF x ED x ET x CFsw x CFv
				EF	Exposure Frequency	43	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				ET	Exposure Time	2	hrs/day	BPJ (8)	For Organics:
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x SA x ED
				BW	Body Weight	70	kg	EPA, 1989 (5)	BW x AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	If tevent < or = t*, then:
				B	Ratio of Permeability Coefficient of a Compound Through the	chemical-specific	unitless	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCsw x CFv x CFsw x [sqrt (6 x τevent x ET/pi)]
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	
					Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	If tevent > t*, then:
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	DAevent = FA x Kp x EPCsw x CFv x CFsw x sqrt [ET/(1+B) + 2 x τevent
				EV	Event Frequency	1	event/day	EPA, 2004	x ({1+3B+$3B^2$}/{1+B})^2)]
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRSW: Based on best professional judgment; assumes an incidental ingestion rate of 0.05 L/day on one-fourth of total days.
(2) FI: Conservatively assumes 100% of incidental surface water ingestion occurs at the Site.
(3) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]
(4) ED: Default exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 30 year ED.
(7) SA: Average skin surface area of feet and hands for adult males and females (add lower legs for stream from abandoned sewer) (EPA, 2004).
(8) ET: Assumes a 2 hour Site visit.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

TABLE 4.5c.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADULT ON-SITE TRESPASSER - SURFACE WATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
Ingestion	Current and Future	Adult	Surface Water	IRSW	Surface Water Ingestion Rate (Incidental)	0.0075	L/day	EPA, 1997 (1)	CDI (mg/kg-day) =
	On-Site Trespasser			FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCsw x IRSW x FI x EF x ED x CFsw
				EF	Exposure Frequency	21	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
				EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	For Inorganics:
Dermal	Current and Future	Adult	Surface Water	Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
	On-Site Trespasser			SA	Skin Surface Area	2,129 (4,499)	cm^2	EPA, 2004 (7)	EPCsw x Kp x SA x EF x ED x ET x CFsw x CFv
				EF	Exposure Frequency	21	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				ET	Exposure Time	2	hrs/day	BPJ (8)	For Organics:
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x SA x ED
				BW	Body Weight	70	kg	EPA, 1989 (5)	BW x AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	If tevent < or = t*, then:
				B	Ratio of Permeability Coefficient of a Compound Through the	chemical-specific	unitless	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCsw x CFv x CFsw x [sqrt (6 x τevent x ET/pi)]
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	
					Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	If tevent > t*, then:
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	DAevent = FA x Kp x EPCsw x CFv x CFsw x sqrt [ET/(1+B) + 2 x τevent
				EV	Event Frequency	1	event/day	EPA, 2004	x ({1+3B+$3B^2$}/{1+B})^2)]
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRSW: Based on best professional judgment; assumes an incidental ingestion rate of 0.03 L/day (about one ounce) on one-fourth of total days.
(2) FI: Conservatively assuems 100% of incidntal surface water ingestion occurs at the Site.
(3) EF: Assumes 1 days per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+8=21]
(4) ED: Default CT exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 9 year ED.
(7) SA: Average skin surface area of feet and hands for adult males and females (add lower legs for stream from abandoned sewer) (EPA, 2004).
(8) ET: Assumes a 2 hour Site visit.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

TABLE 4.6a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE CHILD OFF-SITE RECREATIONALIST AND FUTURE CHILD ON-SITE RECREATIONALIST- SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future	Child	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
	Off-Site Recreationalist	Age 0-6	(Off-Site)	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	80	mg-year/kg-day	EPA, 2008 (1)	EPCs x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	427	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
	Future		Surface and	EF	Exposure Frequency	43	days/year	BPJ (4)	
	On-Site Recreationalist		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future	Child	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
	Off-Site Recreationalist	Age 0-6	(Off-Site)	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	224	mg-year/kg-day	EPA, 2008 (6)	EPCs x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	1,195	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPJ (8)	
	Future		Surface and	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
	On-Site Recreationalist		Subsurface Soil	ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
			(On-Site)	ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Current and Future	Child	Outdoor Air P & V	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
	Off-Site Recreationalist	Age 0-6	from Surface Soil	VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	
			(Off-Site)	PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	CDE_{C} ($\mu g/m^3$) =
				EF	Exposure Frequency	43	days/year	BPJ (4)	EPCs x (1/PEF+ 1/VF) x EF x ED(adj) x ET x CFa x CFt
				ED	Exposure Duration	6	years	--	ATc
				EDadj	Mutagenic ED	32	years	EPA, 2008 (10)	
	Future		Outdoor Air P & V	ET	Exposure Time	2	hrs/day	BPJ (11)	CDE_{NC} (mg/m^3) =
	On-Site Recreationalist		from Surface	CFa	Conversion Factor - Air	1.00E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
			and Subsurface Soil	CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
			(On-Site)	ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for recreationalists ages 0 to 6 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (200 mg/day) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x IRS_{child} (200 mg/day) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for recreationalists ages 0 to 6 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (200 mg/day) x $ADAF_{0-2}$ (10) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x IRS_{child} (200 mg/day) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 6 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for recreationalists ages 0 to 6 calculated as:
DFSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2)/ BW_{child} (15kg)) + (ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2)/ BW_{child} (15kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for recreationalists ages 0 to 6 calculated as:
DFSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2) x $ADAF_{0-2}$ (10) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.

(9) ED: Assumes 6 years (ages 0 to 6).

(10) EDadj: To account for potential mutagenic effects via inhalation an age-dependent adjustment factor (ADAF) of 10 is applied to the ED for ages 0 to 2 and an ADAF of 3 is applied to the ED for ages 2 to 6 [(2x10)+(4x3)=32].

(11) ET: Assumes a 2 hour Site visit.

Definition:
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.6a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE CHILD OFF-SITE RECREATIONALIST AND FUTURE CHILD ON-SITE RECREATIONALIST- SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future	Child	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
	Off-Site Recreationalist	Age 0-6	(Off-Site)	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	40	mg-year/kg-day	EPA, 2008 (1)	EPCs x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	213	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
	Future		Surface and	EF	Exposure Frequency	21	days/year	BPJ (4)	
	On-Site Recreationalist		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future	Child	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
	Off-Site Recreationalist	Age 0-6	(Off-Site)	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	44.8	mg-year/kg-day	EPA, 2008 (6)	EPCs x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	239	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	21	days/year	BPJ (8)	
	Future		Surface and	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
	On-Site Recreationalist		Subsurface Soil	ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
			(On-Site)	ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Current and Future	Child	Outdoor Air P & V	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
	Off-Site Recreationalist	Age 0-6	from Surface Soil	VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	
			(Off-Site)	PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	CDE_{C} ($\mu g/m^3$) =
				EF	Exposure Frequency	21	days/year	BPJ (4)	EPCs x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				ED	Exposure Duration	6	years	--	ATc
				EDadj	Mutagenic ED	32	years	EPA, 2008 (10)	
	Future		Outdoor Air P & V	ET	Exposure Time	2	hrs/day	BPJ (11)	CDE_{NC} (mg/m^3) =
	On-Site Recreationalist		from Surface	CFa	Conversion Factor - Air	1.00E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
			and Subsurface Soil	CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
			(On-Site)	ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for recreationalists ages 0 to 6 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (100 mg/day) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x IRS_{child} (100 mg/day) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for recreationalists ages 0 to 6 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (100 mg/day) x $ADAF_{0-2}$ (10) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x IRS_{child} (100 mg/day) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21].

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 6 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for recreationalists ages 0 to 6 calculated as:
DFSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.04 mg/cm^2)/ BW_{child} (15kg)) + (ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.04 mg/cm^2)/ BW_{child} (15kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Child Resident CTE (EPA, 2004) Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for recreationalists ages 0 to 6 calculated as:
DFSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.04 mg/cm^2) x $ADAF_{0-2}$ (10) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.04 mg/cm^2) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Child resident CTE (EPA, 2004) Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.

(9) ED: Assumes 6 years (ages 0 to 6).

(10) EDadj: To account for potential mutagenic effects via inhalation an age-dependent adjustment factor (ADAF) of 10 is applied to the ED for ages 0 to 2 and an ADAF of 3 is applied to the ED for ages 2 to 6 [(2x10)+(4x3)=32].

(11) ET: Assumes a 2 hour Site visit.

Definition:
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.6b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE CHILD ON-SITE RECREATIONALIST - SEDIMENT
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Child Age 0-6	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSEDadj	Age-Adjusted Sediment Ingestion Rate	80	mg-year/kg-day	EPA, 2008 (1)	EPCsed x RBA x IRS(M)adj x FI x EF x CFs
				IRSEDMadj	Mutagenic IRSadj	427	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future On-Site Recreationalist	Child Age 0-6	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSEDadj	Age-Adjusted Dermal Contact Factor - Sediment	97	mg-year/kg-day	EPA, 2008 (6)	EPCsed x DAF x DFS(M)adj x EF x CFs
				DFSEDMadj	Mutagenic DFSEDadj	518	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for recreationalists ages 0 to 6 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (200 mg/day) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x IRS_{child} (200 mg/day) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for recreationalists ages 0 to 6 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (200 mg/day) x $ADAF_{0-2}$ (10) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x IRS_{child} (200 mg/day) x $ADAF_{0-2}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 6 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for recreationalists ages 0 to 6 calculated as:
DFSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.3 mg/cm^2)/ BW_{child} (15kg)) + (ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.3 mg/cm^2)/ BW_{child} (15kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-Skin Adherence Factor (reed gatherers) (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for recreationalists ages 0 to 6 calculated as:
DFSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.3 mg/cm^2) x $ADAF_{0-2}$ (10) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.3 mg/cm^2) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-Skin Adherence Factor (reed gatherers) (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

Sources:

BPJ= Best Professional Judgment.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.6b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE CHILD ON-SITE RECREATIONALIST - SEDIMENT
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Child Age 0-6	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSEDadj	Age-Adjusted Sediment Ingestion Rate	40	mg-year/kg-day	EPA, 2008 (1)	EPCsed x RBA x IRS(M)adj x FI x EF x CFs
				IRSEDMadj	Mutagenic IRSadj	213	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future On-Site Recreationalist	Child Age 0-6	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSEDadj	Age-Adjusted Dermal Contact Factor - Sediment	97	mg-year/kg-day	EPA, 2008 (6)	EPCsed x DAF x DFS(M)adj x EF x CFs
				DFSEDMadj	Mutagenic DFSEDadj	518	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for recreationalists ages 0 to 6 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (100 mg/day) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x IRS_{child} (100 mg/day) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for recreationalists ages 0 to 6 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (100 mg/day) x $ADAF_{0-2}$ (10) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x IRS_{child} (100 mg/day) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21].

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 6 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for recreationalists ages 0 to 6 calculated as:
DFSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.3 mg/cm^2)/ BW_{child} (15kg)) + (ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.3 mg/cm^2)/ BW_{child} (15kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-Skin Adherence Factor (reed gatherers) (mg/cm^2) CTE (EPA, 2004); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for recreationalists ages 0 to 6 calculated as:
DFSadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.3 mg/cm^2) x $ADAF_{0-2}$ (10) / BW_{child} (15kg)) + (ED_{2-6} (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.3 mg/cm^2) x $ADAF_{2-6}$ (3) / BW_{child} (15kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-Skin Adherence Factor (reed gatherers) (mg/cm^2) CTE (EPA, 2004); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

Sources:

BPJ= Best Professional Judgment.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.6c.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE CHILD ON-SITE RECREATIONALIST - SURFACE WATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Child Age 0-6	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
				IRSWadj	Age-Adjusted Surface Water Ingestion Rate (Incidental)	0.003	L-year/kg-day	BPJ (1)	CDI (mg/kg-day) =
				IRSWMadj	Mutagenic IRSWadj (Incidental)	0.016	L-year/kg-day	BPJ (2)	EPCsw x IRSW(M)adj x FI x EF x CFsw
				FI	Fractional Intake	1.00	unitless	BPJ (3)	AT
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future On-Site Recreationalist	Child Age 0-6	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				EF	Exposure Frequency	43	days/year	BPJ (4)	EPCsw x Kp x DFS(M)adj x EF x ET x CFsw x CFv
				DFSWadj	Age-Adjusted Dermal Contact Factor - Surface Water	324 (584)	cm^2-year/kg	EPA ,2008 (6)	AT
				DFSWMadj	Mutagenic DFSWadj	1,726 (3,113)	cm^2-year/kg	EPA, 2008 (7)	
				ET	Exposure Time	2	hrs/day	VDEQ, 2008 (8)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	For Organics:
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	CDI (mg/kg-day) =
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	DAevent x EV x EF x DFS[M]adj
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	AT
				B	Ratio of Permeability Coefficient of a Compound Through th	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	DAevent = 2 x FA x Kp x EPCsw x CFv x CFsw x [sqrt (6 x τevent x ET/pi)]
					Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	If tevent > t*, then:
				EV	Event Frequency	1	event/day	EPA, 2004	DAevent = FA x Kp x EPCsw x CFv x CFsw x sqrt [ET/(1+B) + 2 x τevent
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	x ({1+3B+3B^2}/{1+B}^{2})]
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental ingestion rate for child recreationalists age 0 to 6 is calculated as:
IRSWadj (L-year/kg-day) = ((ED_{0-2} (2 yrs) x IRSW (0.0075 L/day) / BW_{child} (15 kg)) + ((ED_{2-6} (4 yrs) x IRSW (0.0075 L/day) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); IRSW = Ingestion Rate of Surface Water (L/day); BW = Body Weight (kg)
RME IRSW assumes an incidental ingestion of 0.03 L/day (approximately one ounce) on one-fourth of total days (0.03 x 0.25).

(2): IRSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide , age-adjusted incidental surface water ingestion rate for mutagens for child recreationalists age 0 to 6 is calculated as:
IRSWMadj (L-yr/kg-day) = ((ED_{0-2} (2 years) x IRSW (0.0075 L/day) x $ADAF_{0-2}$ (10) / BW_{child} (15 kg)) + ((ED_{2-6} (4 years) x IRSW (0.0075 L/day) x $ADAF_{2-6}$ (3) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); IRSW = Ingestion Rate of Surface Water (L/day); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)
RME IRSW assumes an incidental ingestion rate of 0.03 L/day (approximately one ounce) on one-fourth of total days (0.03 x 0.25).

(3) FI: Conservatively assumes 100% of incidental surface water ingestion occurs on-site.

(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) ([2 x 13] + 17 = 43).

(5) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.

(6): DFSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for recreationalists age 0 to 6 are calculated as:
DFSWadj (cm^2-year/kg) = ((ED_{0-2} (2 years) x $SA_{site-specific}$ (809 [1,459] cm^2) / BW_{child} (15 kg)) + ((ED_{2-6} (4 years) x $SA_{site-specific}$ (809 [1,459] cm^2) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet and hands (add lower legs for stream from abandoned sewer) (EPA 2004); BW = Body Weight (kg)

(7): DFSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rate for mutagens for recreationalists age 0 to 6 is calculated as:
DFSWMadj (cm^2-year/kg) = ((ED_{0-2} (2 years) x $SA_{site-specific}$ (809 [1,459] cm^2) x $ADAF_{0-2}$ (10) / BWchild (15 kg)) + (ED_{2-6} (4 years) x $SAs_{ite-specific}$ (809 [1,459] cm^2) x $ADAF_{2-6}$ (3) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet and hands (add lower legs for stream from abandoned sewer) (EPA 2004); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)

(8) ET: Based on Virginia Department of Environmental Quality (VDEQ) model for trench work.

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
Virginia Department of Environmental Quality. (VDEQ). 2008. "Voluntary Remediation Program Risk Assessment Guidance." On-Line Address: http://www.deq.virginia.gov/vrprisk/raguide.html

TABLE 4.6c.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE CHILD ON-SITE RECREATIONALIST - SURFACE WATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future	Child	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
	On-Site Recreationalist	Age 0-6		IRSWadj	Age-Adjusted Surface Water Ingestion Rate (Incidental)	0.0015	L-year/kg-day	BPJ (1)	CDI (mg/kg-day) =
				IRSWMadj	Mutagenic IRSWadj (Incidental)	0.008	L-year/kg-day	BPJ (2)	EPCsw x IRSW(M)adj x FI x EF x CFsw
				FI	Fractional Intake	1.0	unitless	BPJ (3)	AT
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future	Child	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	For Inorganics:
	On-Site Recreationalist	Age 0-6		Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				EF	Exposure Frequency	21	days/year	BPJ (4)	EPCsw x Kp x DFS(M)adj x EF x ET x CFsw x CFv
				DFSWadj	Age-Adjusted Dermal Contact Factor - Surface Water	324 (584)	cm^2-year/kg	EPA ,2008 (6)	AT
				DFSWMadj	Mutagenic DFSWadj	1,726 (3,113)	cm^2-year/kg	EPA, 2008 (7)	
				ET	Exposure Time	2	hrs/day	VDEQ, 2008 (8)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	For Organics:
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	CDI (mg/kg-day) =
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	DAevent x EV x EF x DFS[M]adj
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	AT
				B	Ratio of Permeability Coefficient of a Compound Through th	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	DAevent = 2 x FA x Kp x EPCsw x CFv x CFsw x [sqrt (6 x τevent x ET/pi)]
					Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	If tevent > t*, then:
				EV	Event Frequency	1	event/day	EPA, 2004	DAevent = FA x Kp x EPCsw x CFv x CFsw x sqrt [ET/(1+B) + 2 x τevent
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	x ({1+3B+3B^2}/{1+B}^{2})]
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental ingestion rate for child recreationalists age 0 to 6 is calculated as:
IRSWadj (L-year/kg-day) = ((ED_{0-2} (2 yrs) x IRSW (0.00375 L/day) / BW_{child} (15 kg)) + ((ED_{2-6} (4 yrs) x IRSW (0.00375 L/day) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); IRSW = Ingestion Rate of Surface Water (L/day); BW = Body Weight (kg)
CTE IRSW assumes an incidental ingestion of 0.015 L/day (approximately 0.5 ounce) on one-fourth of total days (0.015 x 0.25).

(2): IRSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide , age-adjusted incidental surface water ingestion rate for mutagens for child recreationalists age 0 to 6 is calculated as:
IRSWMadj (L-yr/kg-day) = ((ED_{0-2} (2 years) x IRSW (0.00375 L/day) x $ADAF_{0-2}$ (10) / BW_{child} (15 kg)) + ((ED_{2-6} (4 years) x IRSW (0.00375 L/day) x $ADAF_{2-6}$ (3) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); IRSW = Ingestion Rate of Surface Water (L/day); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)
CTE IRSW assumes an incidental ingestion of 0.015 L/day (approximately 0.5 ounce) on one-fourth of total days (0.015 x 0.25).

(3) FI: Conservatively assumes 100% of incidental surface water ingestion occurs on-site.

(4) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October ([1 x 13] + [2 x 4] = 21).

(5) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 25 year ED.

(6): DFSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for recreationalists age 0 to 6 are calculated as:
DFSWadj (cm^2-year/kg) = ((ED_{0-2} (2 years) x $SA_{site-specific}$ ((809 [1,459] cm^2) / BW_{child} (15 kg)) + ((ED_{2-6} (4 years) x $SA_{site-specific}$ ((809 [1,459] cm2) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet and hands (add lower legs for stream from abandoned sewer) (EPA 2004); BW = Body Weight (kg)

(7): DFSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rate for mutagens for recreationalists age 0 to 6 is calculated as:
DFSWMadj (cm^2-year/kg) = ((ED_{0-2} (2 years) x $SA_{site-specific}$ (809 [1,459] cm^2) x $ADAF_{0-2}$ (10) / BWchild (15 kg)) + (ED_{2-6} (4 years) x $SAs_{ite-specific}$ ((809 [1,459] cm2) x $ADAF_{2-6}$ (3) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet and hands (add lower legs for stream from abandoned sewer) (EPA 2004); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)

(8) ET: Based on Virginia Department of Environmental Quality (VDEQ) model for trench work.

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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VDEQ. (Virginia Department of Environmental Quality). 2008. "Voluntary Remediation Program Risk Assessment Guidance." On-Line Address: http://www.deq.virginia.gov/vrprisk/raguide.html

TABLE 4.7a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADOLESCENT OFF-SITE RECREATIONALIST AND FUTURE ADOLESCENT ON-SITE RECREATIONALIST- SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
Ingestion	Current and Future	Adolescent	Surface Soil	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	Off-Site Recreationalist	Age 6-16	(Off-Site)	IRSadj	Age-Adjusted Soil Ingestion Rate	14.3	mg-year/kg-day	EPA, 2008 (1)	EPCs x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	42.9	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
	Future		Surface and	EF	Exposure Frequency	43	days/year	BPJ (4)	
	On-Site Recreationalist		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
Dermal	Current and Future	Adolescent	Surface Soil	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
	Off-Site Recreationalist	Age 6-16	(Off-Site)	DFSadj	Age-Adjusted Dermal Contact Factor - Soil	57	mg-year/kg-day	EPA, 2008 (6)	EPCs x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	171	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPJ (8)	
	Future		Surface and	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
	On-Site Recreationalist		Subsurface Soil	ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
			(On-Site)	ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
				EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
	Current and Future	Adolescent	Outdoor Air P & V	VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	
Inhalation	Off-Site Recreationalist	Age 6-16	from Surface Soil	PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	CDE_{C} ($\mu g/m^3$) =
			(Off-Site)	EF	Exposure Frequency	43	days/year	BPJ (4)	EPCs x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				ED	Exposure Duration	10	years	--	Atc
	Future			EDadj	Mutagenic ED	30	years	EPA, 2008 (10)	
	On-Site Recreationalist		Outdoor Air P & V	ET	Exposure Time	2	hrs/day	BPJ (11)	CDE_{NC} (mg/m^3) =
			from Surface	CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
			and Subsurface Soil	CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
			(On-Site)	ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for recreationalists ages 6 to 16 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for recreationalists ages 6 to 16 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for recreationalists ages 6 to 16 calculated as:
DFSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5,700 cm^2) x AF_{adult} (0.07 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for recreationalists ages 6 to 16 calculated as:
DFSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5,700 cm^2) x AF_{adult} (0.07 mg/cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.

(9) ED: Assumes 10 years (ages 6 to 16).

(10) EDadj: To account for potential mutagenic effects via inhalation an age-dependent adjustment factor of 3 is applied to the ED for ages 6 to 16 [3x10=30].

(11) ET: Assumes a 2 hour Site visit.

Definition:
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.7a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADOLESCENT OFF-SITE RECREATIONALIST AND FUTURE ADOLESCENT ON-SITE RECREATIONALIST- SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future	Adolescent	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
	Off-Site Recreationalist	Age 6-16	(Off-Site)	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSadj	Age-Adjusted Soil Ingestion Rate	7.1	mg-year/kg-day	EPA, 2008 (1)	EPCs x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	21.4	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
	Future		Surface and	EF	Exposure Frequency	21	days/year	BPJ (4)	
	On-Site Recreationalist		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Current and Future	Adolescent	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
	Off-Site Recreationalist	Age 6-16	(Off-Site)	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	8.1	mg-year/kg-day	EPA, 2008 (6)	EPCs x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	24	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	21	days/year	BPJ (8)	
	Future		Surface and	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
	On-Site Recreationalist		Subsurface Soil	ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
			(On-Site)	ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Current and Future	Adolescent	Outdoor Air P & V	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
	Off-Site Recreationalist	Age 6-16	from Surface Soil	VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	
			(Off-Site)	PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (8)	CDE_{C}: ($\mu g/m^3$) =
				EF	Exposure Frequency	21	days/year	BPJ (4)	EPCs x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				ED	Exposure Duration	10	years	--	Atc
	Future			EDadj	Mutagenic ED	30	years	EPA, 2008 (10)	
	On-Site Recreationalist		Outdoor Air P & V	ET	Exposure Time	2	hrs/day	BPJ (11)	CDE_{NC}: (mg/m^3) =
			from Surface	CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
			and Subsurface Soil	CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	ATnc
			(On-Site)	ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for recreationalists ages 6 to 16 were calculated as:
IRSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (50 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted soil ingestion rate for mutagens for recreationalists ages 6 to 16 were calculated as:
IRSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (50 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21].

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for recreationalists ages 6 to 16 calculated as:
DFSadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5,700 cm^2) x AF_{adult} (0.01 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Adult Resident CTE (EPA, 2004) Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for recreationalists ages 6 to 16 calculated as:
DFSMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x SA_{adult} (5,700 cm^2) x AF_{adult} (0.01 mg/cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Adult Resident CTE (EPA, 2004) Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.

(9) ED: Assumes 10 years (ages 6 to 16).

(10) EDadj: To account for potential mutagenic effects via inhalation an age-dependent adjustment factor of 3 is applied to the ED for ages 6 to 16 [3x10=30].

(11) ET: Assumes a 2 hour Site visit.

Definition:
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.7b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE ADOLESCENT ON-SITE RECREATIONALIST - SEDIMENT
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Adolescent Age 6-16	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSEDadj	Age-Adjusted Sediment Ingestion Rate	14.3	mg-year/kg-day	EPA, 2008 (1)	EPCsed x RBA x IRS(M)adj x FI x EF x CFs
				IRSEDMadj	Mutagenic IRSadj	42.9	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future On-Site Recreationalist	Adolescent Age 6-16	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSEDadj	Age-Adjusted Dermal Contact Factor - Sediment	70	mg-year/kg-day	EPA, 2008 (6)	EPCsed x DAF x DFS(M)adj x EF x CFs
				DFSEDMadj	Mutagenic DFSEDadj	211	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSEDadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted sediment ingestion rates for recreationalists ages 6 to 16 were calculated as:
IRSEDadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSEDMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted sediment ingestion rates for mutagens for recreationalists ages 6 to 16 were calculated as:
IRSEDMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSEDadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for recreationalists ages 6 to 16 were calculated as:
DFSEDadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (1,640 cm^2) x $AF_{reed\ gatherer}$ (0.3 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of feet and hands (cm^2); AF = Soil-to-skin Adherence Factor (EPA, 2004) (mg/cm^2); BW = Body Weight (kg)

(7) DFSEDMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for recreationalists ages 6 to 16 calculated as:
DFSEDMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (1,640 cm^2) x $AF_{reed\ gatherer}$ (0.3 mg/cm^2) * $ADAF_{6-16}$ (3)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of feet and hands (cm^2); AF = Soil-to-skin Adherence Factor (EPA, 2004) (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

Sources:

BPJ= Best Professional Judgment.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.7b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE ADOLESCENT ON-SITE RECREATIONALIST - SEDIMENT
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Adolescent Age 6-16	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSEDadj	Age-Adjusted Sediment Ingestion Rate	7.1	mg-year/kg-day	EPA, 2008 (1)	EPCsed x RBA x IRS(M)adj x FI x EF x CFs
				IRSEDMadj	Mutagenic IRSadj	21.4	mg-year/kg-day	EPA, 2008 (2)	AT
				FI	Fractional Intake	0.125	unitless	BPJ (3)	
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future On-Site Recreationalist	Adolescent Age 6-16	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSEDadj	Age-Adjusted Dermal Contact Factor - Sediment	70	mg-year/kg-day	EPA, 2008 (6)	EPCsed x DAF x DFS(M)adj x EF x CFs
				DFSEDMadj	Mutagenic DFSEDadj	211	mg-year/kg-day	EPA, 2008 (7)	AT
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRSEDadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted central tendency exposure (CTE) sediment ingestion rates for recreationalists ages 6 to 16 were calculated as:
IRSEDadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (50 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSEDMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted soil ingestion rates for residents; age-adjusted CTE sediment ingestion rates for mutagens for recreationalists ages 6 to 16 were calculated as:
IRSEDMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

(3) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).

(4) EF: Assumes 1 days per week during the summer (13 weeks) and 2 day per month during April, May, September, and October (13 + (2*4)=21]

(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.

(6) DFSEDadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for recreationalists ages 6 to 16 were calculated as:
DFSEDadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (1,640 cm^2) x $AF_{reed\ gatherer}$ (0.3 mg/cm^2)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of feet and hands (cm^2); AF = Soil-to-skin Adherence Factor assumes feet and hands (EPA, 2004) (mg/cm^2); BW = Body Weight (kg)

(7) DFSEDMadj: Consistent with the EPA (2008) RSL User's Guide for calculating age-adjusted dermal contact rates for residents; age-adjusted dermal contact rates for mutagens for recreationalists ages 6 to 16 calculated as:
DFSEDMadj (mg-year/kg-day) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (1,640 cm^2) x $AF_{reed\ gatherer}$ (0.3 mg/cm^2) * $ADAF_{6-16}$ (3)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of feet and hands (cm^2); AF = Soil-to-skin Adherence Factor assumes feet and hands (EPA, 2004) (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless) BW = Body Weight (kg)

Sources:

BPJ= Best Professional Judgment.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.7c.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE ADOLESCENT ON-SITE RECREATIONALIST - SURFACE WATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Adolescent Age 6-16	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
				IRSWadj	Age-Adjusted Surface Water Ingestion Rate (Incidental)	0.0018	L-year/kg-day	EPA, 2008; BPJ (1)	CDI (mg/kg-day) =
				IRSWMadj	Mutagenic IRSWadj (Incidental)	0.0054	L-year/kg-day	EPA, 2008; BPJ (2)	EPCsw x IRSW(M)adj x FI x EF x CFsw
				FI	Fractional Intake	1.0	unitless	BPJ (3)	AT
				EF	Exposure Frequency	43	days/year	BPJ (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future On-Site Recreationalist	Adolescent Age 6-16	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSWadj	Age-Adjusted Dermal Contact Factor - Surface Water	304 (643)	cm^2-year/kg	EPA, 2008 (6)	EPCsw x Kp x DFSW(M)adj x EF x ET x CFsw x CFv
				DFSWMadj	Mutagenic DFSWadj	912 (1,928)	cm^2-year/kg	EPA, 2008 (7)	AT
				EF	Exposure Frequency	43	days/year	BPL (4)	
				ET	Exposure Time	2	hrs/day	BPJ (8)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	ug/mg	--	For Organics:
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	CDI (mg/kg-day) =
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	DAevent x EV x EF x DFS[M]adj
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	AT
				B	Ratio of Permeability Coefficient of a Compound Through the	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	DAevent = 2 x FA x Kp x EPCsw x CFv x CFsw x [sqrt (6 x τevent x ET/pi)]
					Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	If tevent > t*, then:
				EV	Event Frequency	1	event/day	EPA, 2004	DAevent = FA x Kp x EPCsw x CFv x CFsw x sqrt [ET/(1+B) + 2 x τevent
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	x ({1+3B+3B^2}/{1+B}^{2})]
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:
(1) IRSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental surface water ingestion rate for recreationalists ages 6 to 16 calculated as:
IRSWadj (L-year/kg-day) = (ED_{6-16} (10 yr) x IRSW (0.0125 L/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Surface Water (L/day); BW = Body Weight (kg)
RME IRS assumes an incidental ingestion rate of 0.05 L/day on one-fourth of total days (0.05 x 0.25).
(2) IRSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental surface water ingestion rates for mutagens for recreationalists ages 6 to 16 calculated as:
IRSMadj (L-year/kg-day) = (ED_{6-16} (10 yr) x IRSW (0.01253 L/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Surface Water (L/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)
RME IRS assumes an incidental ingestion rate of 0.05 L/day on one-fourth of total days (0.05 x 0.25).
(3) FI: Conservatively assuems 100% of incidntal surface water ingestion occurs at the Site.
(4) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]
(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.
(6) DFSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for recreationalists ages 6 to 16 calculated as:
DFSWadj (cm^2-year/kg) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (2,129 [4,499] cm^2) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet and hands (add lower legs for stream from abandoned sewer) (EPA, 2004); BW = Body Weight (kg)
(7) DFSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for mutagens for recreationalists ages 6 to 16 calculated as:
DFSWMadj (cm^2-year/kg) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (2,129 [4,499] cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet and hands (add lower legs for stream from abandoned sewer) (EPA, 2004); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)
(8) ET: Assumes a 2 hour Site visit.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.7c.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE ADOLESCENT ON-SITE RECREATIONALIST - SURFACE WATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Adolescent Age 6-16	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
				IRSWadj	Age-Adjusted Surface Water Ingestion Rate (Incidental)	0.0011	L-year/kg-day	EPA, 2008; BPJ (1)	CDI (mg/kg-day) =
				IRSWMadj	Mutagenic IRSWadj (Incidental)	0.0032	L-year/kg-day	EPA, 2008; BPJ (2)	EPCsw x IRSW(M)adj x FI x EF x CFsw / AT
				FI	Fractional Intake	1.0	unitless	BPJ (3)	
				EF	Exposure Frequency	21	days/year	BPJ (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future On-Site Recreationalist	Adolescent Age 6-16	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFSWadj	Age-Adjusted Dermal Contact Factor - Surface Water	304 (643)	cm^2-year/kg	EPA, 2008 (6)	EPCsw x Kp x DFSW(M)adj x EF x ET x CFsw x CFv / AT
				DFSWMadj	Mutagenic DFSWadj	912 (1,928)	cm^2-year/kg	EPA, 2008 (7)	
				EF	Exposure Frequency	21	days/year	BPL (4)	
				ET	Exposure Time	2	hrs/day	BPJ (8)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	ug/mg	--	For Organics:
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	CDI (mg/kg-day) =
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	DAevent x EV x EF x DFS[M]adj / AT
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	
				B	Ratio of Permeability Coefficient of a Compound Through the	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	DAevent = 2 x FA x Kp x EPCsw x CFv x CFsw x [sqrt (6 x τevent x ET/pi)]
					Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	If tevent > t*, then:
				EV	Event Frequency	1	event/day	EPA, 2004	DAevent = FA x Kp x EPCsw x CFv x CFsw x sqrt [ET/(1+B) + 2 x τevent x {(1+3B+3B^2)/(1+B)}^{2})]
				ATnc	Averaging Time - Noncarcinogens	3,650	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:
(1) IRSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental surface water ingestion rate for recreationalists ages 6 to 16 calculated as:
IRSWadj (L-year/kg-day) = (ED_{6-16} (10 yr) x IRSW (0.0075 L/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Surface Water (L/day); BW = Body Weight (kg)
CTE IRS assumes an incidental ingestion rate of 0.03 L/day (about 1 ounce) on one-fourth of total days (0.03 x 0.25).
(2) IRSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted incidental surface water ingestion rates for mutagens for recreationalists ages 6 to 16 calculated as:
IRSMadj (L-year/kg-day) = (ED_{6-16} (10 yr) x IRSW (0.0075 L/day) x $ADAF_{6-16}$ (3)/ BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Surface Water (L/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)
CTE IRS assumes an incidental ingestion rate of 0.03 L/day (about 1 ounce) on one-fourth of total days (0.03 x 0.25).
(3) FI: Conservatively assuems 100% of incidntal surface water ingestion occurs at the Site.
(4) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21]
(5) ATc: 365 days per year x 70-year lifetime; ATnc: 365 days per year x 10 year ED.
(6) DFSWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for recreationalists ages 6 to 16 calculated as:
DFSWadj (cm^2-year/kg) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (2,129 [4,499] cm^2) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm2) of feet and hands (add lower legs for stream from abandoned sewer) (EPA, 2004); BW = Body Weight (kg)
(7) DFSWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for mutagens for recreationalists ages 6 to 16 calculated as:
DFSWMadj (cm^2-year/kg) = (ED_{6-16} (10 yr) x $SA_{site-specific}$ (2,129 [4,499] cm^2) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2) of feet and hands (add lower legs for stream from abandoned sewer) (EPA, 2004); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)
(8) ET: Assumes a 2 hour Site visit.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.8a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE ADULT OFF-SITE RECREATIONALIST AND FUTURE ADULT ON-SITE RECREATIONALIST- SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future	Adult	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
	Off-Site Recreationalist		(Off-Site)	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	100	mg/day	EPA, 2004 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
	Future		Surface and	ED	Exposure Duration	30	years	EPA, 1989 (4)	
	On-Site Recreationalist		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future	Adult	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
	Off-Site Recreationalist		(Off-Site)	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	5,700	cm^2	EPA, 2004 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.07	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
	Future		Surface and	ED	Exposure Duration	30	years	EPA, 1989 (4)	
	On-Site Recreationalist		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future		Outdoor Air P & V	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
	Off-Site Recreationalist	Adult	from Surface Soil	VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	
			(Off-Site)	PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	CDE_C ($\mu g/m^3$) =
				EF	Exposure Frequency	43	days/year	BPJ (3)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				ED	Exposure Duration	30	years	EPA, 1989 (4)	ATc
	Future		Outdoor Air P & V	ET	Exposure Time	2	hrs/day	BPJ (10)	
	On-Site Recreationalist		from Surface	CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
			and Subsurface Soil	CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
			(On-Site)	ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	ATnc
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Recommended soil ingestion rate for adult residents.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+(1*17)=43]
(4) ED: Default exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 30 year ED.
(7) SA: Default skin surface area for adult residents.
(8) AF: Default soil-to-skin adherence factor for adult residents.
(9) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(10) ET: Assumes a 2 hour Site visit.

Definition:
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.8a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE ADULT OFF-SITE RECREATIONALIST AND FUTURE ADULT ON-SITE RECREATIONALIST- SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future	Adult	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
	Off-Site Recreationalist		(Off-Site)	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRS	Soil Ingestion Rate	50	mg/day	EPA, 2004 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
	Future		Surface and	ED	Exposure Duration	9	years	EPA, 1989 (4)	
	On-Site Recreationalist		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Current and Future	Adult	Surface Soil	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
	Off-Site Recreationalist		(Off-Site)	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	5,700	cm^2	EPA, 2004 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.01	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
	Future		Surface and	ED	Exposure Duration	9	years	EPA, 1989 (4)	
	On-Site Recreationalist		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Inhalation	Current and Future		Outdoor Air P & V	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
	Off-Site Recreationalist	Adult	from Surface Soil	VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	
			(Off-Site)	PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	CDE_C ($\mu g/m^3$) =
				EF	Exposure Frequency	21	days/year	BPJ (3)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFa x CFt
				ED	Exposure Duration	9	years	EPA, 1989 (4)	ATc
	Future		Outdoor Air P & V	ET	Exposure Time	2	hrs/day	BPJ (10)	
	On-Site Recreationalist		from Surface	CFa	Conversion Factor - Air	1.0E+03	ug/mg	--	CDE_{NC} (mg/m^3) =
			and Subsurface Soil	CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
			(On-Site)	ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	ATnc
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRS: Mean soil ingestion rate for adults.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 1 day per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+(2*4)=21]
(4) ED: Default central tendency exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 9 year ED.
(7) SA: Default skin surface area for adult residents.
(8) AF: Default central tendency soil-to-skin adherence factor for adult residents.
(9) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(10) ET: Assumes a 2 hour Site visit.

Definition:
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.8b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE ADULT ON-SITE RECREATIONALIST - SEDIMENT
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future	Adult	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
	On-Site Recreationalist			RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSED	Sediment Ingestion Rate	100	mg/day	EPA, 2004 (1)	EPCsed x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Future	Adult	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
	On-Site Recreationalist			DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	2,129	cm^2	EPA, 2004 (7)	EPCsed x DAF x SA x AF x EF x ED x CFs
				AF	Sediment-to-Skin Adherence Factor	0.3	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	43	days/year	BPJ (3)	
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRSED: Recommended RME soil ingestion rate for adult residents.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]
(4) ED: Default exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 30 year ED.
(7) SA: Average skin surface areas of hands and feet for adult males and females.
(8) AFsed: Sediment-to-skin adherence factor for reed gatherers.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

TABLE 4.8b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE ADULT ON-SITE RECREATIONALIST - SEDIMENT
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Adult	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	See Table 3 Series	
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				IRSED	Sediment Ingestion Rate	50	mg/day	EPA, 2004 (1)	EPCsed x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	0.125	unitless	BPJ (2)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Future On-Site Recreationalist	Adult	Sediment	EPCsed	Exposure Point Concentration - Sediment	medium-specific	mg/kg	Table 3 Series	
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	2,129	cm^2	EPA, 2004 (7)	EPCsed x DAF x SA x AF x EF x ED x CFs
				AF	Sediment-to-Skin Adherence Factor	0.3	mg/cm^2	EPA, 2004 (8)	BW x AT
				EF	Exposure Frequency	21	days/year	BPJ (3)	
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFs	Conversion Factor - Sediment	1.0E-06	kg/mg	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRSED: Recommended CTE soil ingestion rate for adult residents.
(2) FI: Assumes 16 hours of total activity time, with a 2 hour Site visit (=2/16).
(3) EF: Assumes 1 day per week during the summer (13 weeks) and 2 day per month during April, May, September, and October [(1*13)+8=21]
(4) ED: Default CT exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 9 year ED.
(7) SA: Average skin surface areas of hands and feet for adult males and females.
(8) AFsed: Soil-to-skin adherence factor for reed gatherers.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

TABLE 4.8c.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE ADULT ON-SITE RECREATIONALIST - SURFACE WATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Adult	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
				IRSW	Surface Water Ingestion Rate (Incidental)	0.0125	L/day	BPJ (1)	CDI (mg/kg-day) =
				FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCsw x IRSW x FI x EF x ED x CFsw
				EF	Exposure Frequency	43	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Future On-Site Recreationalist	Adult	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	2,129 (4,499)	cm^2	EPA, 2004 (7)	EPCsw x Kp x SA x EF x ED x ET x CFsw x CFv
				EF	Exposure Frequency	43	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	30	years	EPA, 1989 (4)	
				ET	Exposure Time	2	hrs/day	BPJ (8)	For Organics:
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x SA x ED
				BW	Body Weight	70	kg	EPA, 1989 (5)	BW x AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCsw x CFv x CFsw x [sqrt (6 x τevent x ET/pi)]
				B	Ratio of Permeability Coefficient of a Compound Through the	chemical-specific	unitless	See Table 5 & 6 Series	
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	
					Viable Epidermis	--	--	--	If tevent > t*, then:
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	DAevent = FA x Kp x EPCsw x CFv x CFsw x sqrt [ET/(1+B) + 2 x τevent
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	x ({1+3B+3B^2}/{1+B}^{2})]
				EV	Event Frequency	1	event/day	EPA, 2004	
				ATnc	Averaging Time - Noncarcinogens	10,950	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRSW: Based on best professional judgment; assumes an incidental ingestion rate of 0.05 L/day on one-fourth of total days.
(2) FI: Conservatively assuems 100% of incidntal surface water ingestion occurs at the Site.
(3) EF: Assumes 2 days per week during the summer (13 weeks) and 1 day per week during April, May, September, and October (17 weeks) [(2*13)+17=43]
(4) ED: Default exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 30 year ED.
(7) SA: Average skin surface area of feet and hands for adult males and females (add lower legs for stream from abandoned sewer) (EPA 2004).
(8) ET: Assumes a 2 hour Site visit.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

TABLE 4.8c.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE ADULT ON-SITE RECREATIONALIST - SURFACE WATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Recreationalist	Adult	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	See Table 3 Series	
				IRSW	Surface Water Ingestion Rate (Incidental)	0.0075	L/day	BPJ (1)	CDI (mg/kg-day) =
				FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCsw x IRSW x FI x EF x ED x CFsw
				EF	Exposure Frequency	21	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	
				BW	Body Weight	70	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	
Dermal	Future On-Site Recreationalist	Adult	Surface Water	EPCsw	Exposure Point Concentration - Surface Water	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				SA	Skin Surface Area	2,129 (4,499)	cm^2	EPA, 2004 (7)	EPCsw x Kp x SA x EF x ED x ET x CFsw x CFv
				EF	Exposure Frequency	21	days/year	BPJ (3)	BW x AT
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				ET	Exposure Time	2	hrs/day	BPJ (8)	For Organics:
				CFsw	Conversion Factor - Surface Water	1.0E-03	mg/ug	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x SA x ED
				BW	Body Weight	70	kg	EPA, 1989 (5)	BW x AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCsw x CFv x CFsw x [sqrt (6 x τevent x ET/pi)]
				B	Ratio of Permeability Coefficient of a Compound Through the	chemical-specific	unitless	See Table 5 & 6 Series	
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	
					Viable Epidermis	--	--	--	If tevent > t*, then:
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	DAevent = FA x Kp x EPCsw x CFv x CFsw x sqrt [ET/(1+B) + 2 x τevent
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	x {(1+3B+3B^2)/(1+B)^2}]
				EV	Event Frequency	1	event/day	EPA, 2004	
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (6)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (6)	

Notes:
(1) IRSW: Based on best professional judgment; assumes an incidental ingestion rate of 0.03 L/day (about one ounce) on one-fourth of total days.
(2) FI: Conservatively assuems 100% of incidntal surface water ingestion occurs at the Site.
(3) EF: Assumes 1 days per week during the summer (13 weeks) and 2 days per month during April, May, September, and October [(1*13)+8=21]
(4) ED: Default CT exposure duration for residents.
(5) BW: Default adult body weight.
(6) ATc: 365 days/year x 70 year lifetime; ATnc: 365 days/year x 9 year ED.
(7) SA: Average skin surface area of feet and hands for adult males and females (add lower legs for stream from abandoned sewer) (EPA 2004).
(8) ET: Assumes a 2 hour Site visit.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

TABLE 4.9a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE CHILD OFF-SITE RESIDENT AND FUTURE CHILD ON-SITE RESIDENT - SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates/Vapors, Homegrown Produce

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
Ingestion	Current and Future	Child	Surface Soil	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI_{NC} (mg/kg-day) =
	Off-Site Resident	Age 0-6	(Off-Site)	IRS	Soil Ingestion Rate	200	mg/day	EPA, 1991 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x ATnc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	
	Future		Surface and	ED	Exposure Duration	6	years	EPA, 1991 (4)	
	On-Site Resident		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	BW	Body Weight	15	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
Dermal	Current and Future	Child	Surface Soil	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI_{NC} (mg/kg-day) =
	Off-Site Resident	Age 0-6	(Off-Site)	SA	Skin Surface Area	2,800	cm^2	EPA, 2004 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.2	mg/cm^2	EPA, 2004 (8)	BW x ATnc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	
	Future		Surface and	ED	Exposure Duration	6	years	EPA, 1991 (4)	
	On-Site Resident		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	BW	Body Weight	15	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
	Current and Future	Child	Outdoor Air P & V	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
Inhalation	Off-Site Resident	Age 0-6	from Surface Soil	VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_{NC} (mg/m^3) =
			(Off-Site)	PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	ATnc
	Future		Outdoor Air P & V	ED	Exposure Duration	6	years	EPA, 1991 (4)	
	On-Site Resident		from Surface	ET	Exposure Time	24	hrs/day	EPA, 2008 (10)	
			and Subsurface Soil	CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
			(On-Site)	ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
				Prag	Aboveground Exposed and Protected Produce Concentration Due to Root Upt	site-specific	mg/kg DW	EPA, 2005 (11)	
Ingestion	Current and Future	Child	Home Grown	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	See Table 3 Series	CDI_{NC} (mg/kg-day) =
	Off-Site Resident	Age 0-6	Produce from	Brag	Plant-Soil Bioconcentration Factor for Aboveground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (12)	IHP x EF x ED
			Surface Soil	PRbg	Belowground Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (11)	ATnc
			(Off-Site)	BRootveg	Plant-Soil Bioconcentration Factor for Belowground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (12)	where:
				VGrootveg	Empirical Correction Factor for Belowground Produce	0.01 or 1.0	unitless	EPA, 2005 (13)	IHP (mg/kg-day) =
	Future		Home Grown	IHP	Daily Intake From Homegrown Produce	site-specific	mg/kg-day	EPA, 2008 (14)	((Prag x Crag) + (Prbg x CRbg)) x Fp
	On-Site Resident		Produce from	Crag	Aboveground Produce Ingestion Rate	2.27E-03	kg DW/kg-day	EPA, 2005 (15)	and
			Surface and	CRbg	Belowground Produce Ingestion Rate	2.30E-04	kg DW/kg-day	EPA, 2005 (16)	Prag = EPCs x Brag
			Subsurface Soil	Fp	Fraction of Homegrown Produce Ingested From Contaminated Source	1	unitless	BPJ (17)	Prbg = EPCs x Brootveg x VGrootveg
			(On-Site)	EF	Exposure Frequency	350	days/year	EPA, 2005 (3)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 2005 (6)	

Notes:
(1) IRS: Default soil ingestion rate for children.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Default exposure frequency for residents.
(4) ED: Default exposure duration for child residents.
(5) BW: Default child body weight.
(6) ATnc: 365 days/year x 6 year ED; note, carcinogenic effects for residents were evaluated using the more-sensitive aggregate resident receptor only.
(7) SA: Default skin surface area for children.
(8) AF: Default soil-to-skin adherence factor for children.
(9) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(10) ET: Default exposure time for residents.
(11) Prag: Consistent with EPA (2005), calculated using equation presented.
(12) Brag and Brrootveg: Chemical-specific values will be obtained from the HHRAP Comparison Database (ACCESS) or calculated using the procedures presented in Appendix A-2 of EPA (2005).
(13) VGrootveg: Default empirical correction factors for belowground produce. A VGrootveg value of 0.01 will be used for chemicals with a logKow > 4, and a VGrootveg value of 1.0 will be used for chemicals with a logKow ≤ 4.
(14) IHP: Consistent with EPA (2005), this parameter was calculated using the equation presented.
(15): Crag: The RME aboveground produce ingestion rate for resident children ages 0 to 6 was calculated as the sum of default exposed and protected aboveground produce ingestion rates.
(16) Crbg: Default belowground ingestion rate for resident children ages 0 to 6.
(17) Fp: Default fraction of homegrown produce ingested from contaminated source.

Definition:
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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EPA. 2005. "Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities". OSWER. EPA-530-R-05-006. September.
EPA. 2008. "Regional Screening Level User's Guide." November. Available on-line at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 4.9a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE CHILD OFF-SITE RESIDENT AND FUTURE CHILD ON-SITE RESIDENT - SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates/Vapors, Homegrown Produce

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
Ingestion	Current and Future	Child	Surface Soil	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI_{NC} (mg/kg-day) =
	Off-Site Resident	Age 0-6	(Off-Site)	IRS	Soil Ingestion Rate	100	mg/day	EPA, 1997 (1)	EPCs x RBA x IRS x FI x EF x ED x CFs
				FI	Fractional Intake	1.0	unitless	BPJ (2)	BW x ATnc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	
	Future		Surface and	ED	Exposure Duration	6	years	EPA, 1991 (4)	
	On-Site Resident		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	BW	Body Weight	15	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
Dermal	Current and Future	Child	Surface Soil	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDI_{NC} (mg/kg-day) =
	Off-Site Resident	Age 0-6	(Off-Site)	SA	Skin Surface Area	2,800	cm^2	EPA, 2004 (7)	EPCs x DAF x SA x AF x EF x ED x CFs
				AF	Soil-to-Skin Adherence Factor	0.04	mg/cm^2	EPA, 2004 (8)	BW x ATnc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	
	Future		Surface and	ED	Exposure Duration	6	years	EPA, 1991 (4)	
	On-Site Resident		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	BW	Body Weight	15	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
	Current and Future	Child	Outdoor Air P & V	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
Inhalation	Off-Site Resident	Age 0-6	from Surface Soil	VF	Volatilization Factor	chemical-specific	m^3/kg	See Table 5 & 6 Series	CDE_{NC} (mg/m^3) =
			(Off-Site)	PEF	Particulate Emission Factor	site-specific	m^3/kg	EPA, 2008 (9)	EPCs x (1/PEF + 1/VF) x EF x ED x ET x CFt
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	ATnc
	Future		Outdoor Air P & V	ED	Exposure Duration	6	years	EPA, 1991 (4)	
	On-Site Resident		from Surface	ET	Exposure Time	3	hrs/day	EPA, 2005 (10)	
			and Subsurface Soil	CFt	Conversion Factor - Time (1/24)	0.042	day/hrs	--	
			(On-Site)	ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
				Prag	Aboveground Exposed and Protected Produce Concentration Due to Root Upta	site-specific	mg/kg DW	EPA, 2005 (11)	
Ingestion	Current and Future	Child	Home Grown	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	See Table 3 Series	CDI_{NC} (mg/kg-day) =
	Off-Site Resident	Age 0-6	Produce from	Brag	Plant-Soil Bioconcentration Factor for Aboveground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (12)	IHP x EF x ED
			Surface Soil	PRbg	Belowground Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (11)	ATnc
			(Off-Site)	BRrootveg	Plant-Soil Bioconcentration Factor for Belowground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (12)	where:
	Future			VGrootveg	Empirical Correction Factor for Belowground Produce	0.01 or 1.0	unitless	EPA, 2005 (13)	IHP (mg/kg-day) =
	On-Site Resident		Home Grown	IHP	Daily Intake From Homegrown Produce	site-specific	mg/kg-day	EPA, 2008 (14)	((Prag x Crag) + (Prbg x CRbg)) x Fp
			Produce from	Crag	Aboveground Produce Ingestion Rate	2.27E-03	kg DW/kg-day	EPA, 2005 (15)	and
			Surface and	CRbg	Belowground Produce Ingestion Rate	2.30E-04	kg DW/kg-day	EPA, 2005 (16)	Prag = EPCs x Brag
			Subsurface Soil	Fp	Fraction of Homegrown Produce Ingested From Contaminated Source	0.5	unitless	EPA, 2005 (17)	Prbg = EPCs x Brrootveg x VGrootveg
			(On-Site)	EF	Exposure Frequency	350	days/year	EPA, 2005 (3)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 2005 (6)	

Notes:
(1) IRS: Mean daily soil ingestion rate for children.
(2) FI: Assumes 100% of soil ingestion occurs at the Site.
(3) EF: Default exposure frequency for residents.
(4) ED: Default exposure duration for child residents.
(5) BW: Default child body weight.
(6) ATnc: 365 days/year x 6 year ED; note, carcinogenic effects for residents were evaluated using the more-sensitive aggregate resident receptor only.
(7) SA: Default skin surface area for children.
(8) AF: Default central tendency soil-to-skin adherence factor for children.
(9) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.
(10) ET: CTE exposure time outdoors at residence for residential child age 0 to 6 based on BPJ and EPA recommendation for residents of all ages.
(11) Prag: Consistent with EPA (2005), calculated using equation presented.
(12) Brag and Brrootveg: Chemical-specific values will be obtained from the HHRAP Comparison Database (ACCESS) or calculated using the procedures presented in Appendix A-2 of EPA (2005).
(13) VGrootveg: Default empirical correction factors for belowground produce. A VGrootveg value of 0.01 will be used for chemicals with a logKow > 4, and a VGrootveg value of 1.0 will be used for chemicals with a logKow ≤ 4.
(14) IHP: Consistent with EPA (2005), this parameter was calculated using the equation presented.
(15): Crag: The CTE aboveground produce ingestion rate for resident children ages 0 to 6 was calculated as the sum of default exposed and protected aboveground produce ingestion rates.
(16) Crbg: Default belowground ingestion rate for resident children ages 0 to 6.
(17) Fp: The CTE values is equal to 50 percent of the RME value based on best professional judgment.

Definition:
P & V = Particulates and Vapors

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.
EPA. 2005. "Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities". OSWER. EPA-530-R-05-006. September.
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TABLE 4.9b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE CHILD ON-SITE RESIDENT - GROUNDWATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future	Child	Groundwater	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
	On-Site Resident	Age 0-6		IRgw	Tapwater Ingestion Rate	1	L/day	EPA, 1991 (1)	CDI_{NC} (mg/kg-day) =
				FI	Fractional Intake	1.0	unitless	BPJ (2)	EPCgw x IRgw x FI x EF x ED x CFw
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	BW x ATnc
				ED	Exposure Duration	6	years	EPA, 1991 (4)	
				CFdw	Conversion Factor - Water	1.0E+03	mg/ug	--	
				BW	Body Weight	15	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Dermal	Future	Child	Groundwater	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	For Inorganics:
	On-Site Resident	Age 0-6		Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	EPCgw x Kp x DFGW[M]adj x EF x ET x CFgw x CFv
				DFGWadj	Age-Adjusted Dermal Contact Factor - Groundwater	2,640	cm^2-year/kg	EPA ,2008 (7)	AT
				DFGWMadj	Mutagenic DFGWadj	14,080	cm^2-year/kg	EPA, 2008 (8)	For Organics:
				ET	Exposure Time	1	hr/day	EPA, 2004 (9)	CDI (mg/kg-day) =
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	DAevent x EV x EF x DFGW[M]adj
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
				B	Ratio of Permeability Coefficient of a Compound Through the	chemical-specific	unitless	See Table 5 & 6 Series	
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	
					Viable Epidermis	--	--	--	If tevent > t*, then:
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	DAevent = FA x Kp x EPCgw x CFv x CFgw x sqrt [ET/(1+B) + 2 x τevent
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	x ({1+3B+$3B^2$}/{1+B})^2)]
				EV	Event Frequency	1	event/day	EPA, 2004	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Inhalation	Future	Child	Outdoor Air	EPCair	Exposure Point Concentration - Air	Calculated	mg/m^3	Calculated	
	On-Site Resident	Age 0-6	Vapors	EPCgw	Exposure Point Concentration - Groundwater	See Table 3s	mg/L	See Table 3s	CDE (mg/m^3) =
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	EPCair x EF x ED x ETod x CFt
				ED	Exposure Duration	6	years	EPA, 1991 (4)	AT
				ETod	Exposure Time - Outdoors	24	hours/day	EPA, 2008 (9)	
				CFt	Conversion Factor, Time (1/24)	0.042	day/hrs	--	where EPCair =
				VF_{wamb}	Volatilization Factor, Water to Ambient Air	See Table XX	m^3/L	See Table XX	EPCgw
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	VFwamb
Inhalation	Future	Child	Indoor Air	EPCia	Chemical Concentration in Indoor Air	See Table XX	mg/m^3	See Table XX	
	On-Site Resident	Age 0-6	Vapors	EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	CDE (mg/m^3) =
			(Vapor Intrusion)	ED	Exposure Duration	6	years	EPA, 1991 (4)	EPCia x EF x ED
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	AT
Inhalation	Future	Child	Indoor Air	EPCgw	Exposure Point Concentration - Groundwater	See Table XX	µg/L	See Table XX	
	On-Site Resident	Age 0-6	Vapors	EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	CDE (mg/m^3) =
			(Household Use)	ED	Exposure Duration	6	years	EPA, 1991 (4)	EPCgw x VFw x EF x ED x ETb x CFt x CFgw
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	AT
				ETb	Exposure Time - Bathing	1	hr/day	EPA, 2004 (10)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				VF_w	Volatilization Factor, Domestic Use	0.5	L/m^3	EPA 1991	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	

Notes:
(1) IRgw: Default water ingestion rate for children.
(2) FI: Assumes 100% of groundwater ingestion occurs at the Site.
(3) EF: Default exposure frequency for residents.
(4) ED: Default exposure duration for child residents.
(5) BW: Default child body weight.
(6) ATnc: 365 days/year x 6 year ED; note, carcinogenic effects for residents were evaluated using the more-sensitive aggregate resident receptor only.
(7) DFGWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rate for residential children age 0 to 6 is calculated as:
DFGWadj (cm^2-year/kg) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) / BW_{child} (15 kg)) + ((ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of Residential Child (cm^2); BW = Body Weight (kg)
(8) DFGWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rate for residential children age 0 to 6 is calculated as:
DFGWMadj (cm^2-year/kg) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x $ADAF_{0-2}$ (10) / BW_{child} (15 kg)) + ((ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x ADAF2-6 (3) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of Residential Child (cm^2); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)
(9): ET/ETod: Default exposure time for residents.
(10): Etb: Default RME time spent bathing by a residential child.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
EPA. 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors." Interim Final. Office of Emergency and Remedial Response, Toxics Integration Branch. OSWER Directive 9385.6-03. March 25.
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TABLE 4.9b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE CHILD ON-SITE RESIDENT - GROUNDWATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Resident	Child Age 0-6	Groundwater	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
				IRgw	Tapwater Ingestion Rate	1	L/day	EPA, 1991 (1)	
				FI	Fractional Intake	1.0	unitless	BPJ (2)	CDI_{NC} (mg/kg-day) =
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	EPCgw x IRgw x FI x EF x ED x CFw
				ED	Exposure Duration	6	years	EPA, 1991 (4)	BW x ATnc
				CFdw	Conversion Factor - Water	1.0E+03	mg/ug	--	
				BW	Body Weight	15	kg	EPA, 1989 (5)	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Dermal	Future On-Site Resident	Child Age 0-6	Groundwater	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	EPCgw x Kp x DFGW[M]adj x EF x ET x CFgw x CFv
				DFGWadj	Age-Adjusted Dermal Contact Factor - Groundwater	2,640	cm^2-year/kg	EPA ,2008 (7)	AT
				DFGWMadj	Mutagenic DFGWadj	14,080	cm^2-year/kg	EPA, 2008 (8)	For Organics:
				ET	Exposure Time	0.33	hrs/day	EPA, 2004 (9)	CDI (mg/kg-day) =
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	DAevent x EV x EF x DFGW[M]adj
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	If tevent < or = t*, then:
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
				B	Ratio of Permeability Coefficient of a Compound Through the Corneum Relative to its Permeability Coefficient Across the Viable Epidermis	chemical-specific	unitless	See Table 5 & 6 Series	
						--	--	--	
						--	--	--	If tevent > t*, then:
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	DAevent = FA x Kp x EPCgw x CFv x CFgw x sqrt [ET/(1+B) + 2 x τevent
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	x {(1+3B+$3B^2$)/(1+B)^2}]
				EV	Event Frequency	1	event/day	EPA, 2004	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	
Inhalation	Future On-Site Resident	Child Age 0-6	Outdoor Air Vapors	EPCair	Exposure Point Concentration - Air	Calculated	mg/m^3	Calculated	
				EPCgw	Exposure Point Concentration - Groundwater	See Table 3s	mg/L	See Table 3s	CDE (mg/m^3) =
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	EPCair x EF x ED x ETod x CFt
				ED	Exposure Duration	6	years	EPA, 1991 (4)	AT
				ETod	Exposure Time - Outdoors	3	hrs/day	EPA, 1997 (9)	
				CFt	Conversion Factor, Time (1/24)	0.042	day/hrs	--	where EPCair =
				VF_{wamb}	Volatilization factor, Water to Ambient Air	See Table XX	m^3/L	See Table XX	EPCgw
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	VFwamb
Inhalation	Future On-Site Resident	Child Age 0-6	Indoor Air Vapors (Vapor Intrusion)	EPCia	Chemical Concentration in Indoor Air	See Table XX	mg/m^3	See Table XX	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	CDE (mg/m^3) =
				ED	Exposure Duration	6	years	EPA, 1991 (4)	EPCia x EF x ED
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	AT
Inhalation	Future On-Site Resident	Child Age 0-6	Indoor Air Vapors (Household Use)	EPCgw	Exposure Point Concentration - Groundwater	See Table XX	mg/L	See Table XX	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (3)	CDE (mg/m^3) =
				ED	Exposure Duration	6	years	EPA, 1991 (4)	EPCgw x VFw x EF x ED x ETb x CFt x CFgw
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	AT
				ETb	Exposure Time - Bathing	0.33	hr/day	EPA, 2004 (10)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				VF_W	Volatilization Factor, Domestic Use	0.5	L/m^3	EPA 1991	
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (6)	

Notes:
(1) IRgw: Default water ingestion rate for children.
(2) FI: Assumes 100% of groundwater ingestion occurs at the Site.
(3) EF: Default exposure frequency for residents.
(4) ED: Default exposure duration for child residents.
(5) BW: Default child body weight.
(6) ATnc: 365 days/year x 6 year ED; note, carcinogenic effects for residents were evaluated using the more-sensitive aggregate resident receptor only.
(7) DFGWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rate for residential children age 0 to 6 is calculated as:
DFGWadj (cm^2-year/kg) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) / BW_{child} (15 kg)) + ((ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of Residential Child (cm^2); BW = Body Weight (kg)
(8) DFGWMadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, age-adjusted dermal contact rate for residential children age 0 to 6 is calculated as:
DFGWMadj (cm^2-year/kg) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x $ADAF_{0-2}$ (10) / BW_{child} (15 kg)) + ((ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x ADAF2-6 (3) / BW_{child} (15 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area of Residential Child (cm^2); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)
(9): ET/ETod: Default exposure time for residents.
(10): Etb: Default RME time spent bathing by a residential child.

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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EPA. 1997. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA/600/P-95/002Fa, -002Fb, and -002Fc. August.
EPA. 2004. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

TABLE 4.10a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
CURRENT AND FUTURE AGGREGATE OFF-SITE RESIDENT AND FUTURE AGGREGATE ON-SITE RESIDENT- SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates/Vapors, Homegrown Produce

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Current and Future Off-Site Resident	Aggregate Resident Age 0 to 30	Surface Soil (Off-Site)	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	CDIC (mg/kg-day) =
				RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	EPCs x RBA x IRS(M)adj x FI x EF x CFs
				IRSadj	Age-Adjusted Soil Ingestion Rate	114	mg-year/kg-day	EPA, 2008 (1)	ATc
				IRSMadj	Mutagenic IRSadj	490	mg-year/kg-day	EPA, 2008 (2)	
				FI	Fractional Intake	1	unitless	BPJ (3)	
	Future On-Site Resident		Surface and Subsurface Soil (On-Site)	EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
				ATc	Averaging Time - Carcinogens	25550	days	EPA, 1989 (5)	
Dermal	Current and Future Off-Site Resident	Aggregate Resident Age 0 to 30	Surface Soil (Off-Site)	EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	CDIC (mg/kg-day) =
				DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	EPCs x DAF x DFS(M)adj x EF x CFs
				DFSadj	Age-Adjusted Dermal Contact Factor - Soil	361	mg-year/kg-day	EPA, 2008 (6)	ATc
				DFSMadj	Mutagenic DFSadj	1,445	mg-year/kg-day	EPA, 2008 (7)	
	Future On-Site Resident		Surface and Subsurface Soil (On-Site)	EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				CFs	Conversion Factor - Soil	1E-06	kg/mg	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Current and Future Off-Site Resident	Aggregate Resident Age 0 to 30	Outdoor Air P & V from Surface Soil (Off-Site)	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	CDEC (µg/m3) =
				VF	Volatilization Factor	chemical-specific	m3/kg	See Table 5 & 6 Series	EPCs x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
				PEF	Particulate Emission Factor	site-specific	m3/kg	EPA, 2008 (8)	ATc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				ED	Exposure Duration	30	years	EPA, 1991 (9)	
	Future On-Site Resident		Outdoor Air P & V from Surface and Subsurface Soil (On-Site)	EDadj	Mutagenic ED	76	years	EPA, 2008 (10)	
				ET	Exposure Time	24	hrs/day	EPA, 1991 (11)	
				CFa	Conversion Factor - Air	1E+03	ug/mg	--	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Ingestion	Current and Future Off-Site Resident	Aggregate Resident Age 0 to 30	Home Grown Produce from Surface Soil (Off-Site)	Prag	Aboveground Exposed and Protected Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (12)	
				EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	See Table 3 Series	CDI_C (mg/kg-day) =
				Brag	Plant-Soil Bioconcentration Factor for Aboveground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (13)	IHP[M]adj x EF x ED
				Pbg	Belowground Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (12)	ATc
				BRrootveg	Plant-Soil Bioconcentration Factor for Belowground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (13)	
				VGrootveg	Empirical Correction Factor for Belowground Produce	0.01 or 1.0	unitless	EPA, 2005 (14)	where:
	Future On-Site Resident		Home Grown Produce from Surface and Subsurface Soil (On-Site)	IHPadj	Age-Adjusted Daily Intake From Homegrown Produce	site-specific	yr-kg DW/kg-day	EPA, 2008 (15)	IHP[M]adj (yr-kg DW/kg-day) =
				IHP[M]adj	Age-Adjusted Daily Intake From Homegrown Produce for Mutagens	site-specific	yr-kg DW/kg-day	EPA, 2008 (15)	((Prag x Crag[M]adj) + (Prbg x Crbg [M]adj)) x Fp
				Cragadj	Age-Adjusted Aboveground Produce Ingestion Rate	3.59E-02	yr-kg DW/kg-day	EPA, 2008 (16)	
				Crag[M]adj	Age-Adjusted Aboveground Produce Ingestion Rate for Mutagens	1.14E-01	yr-kg DW/kg-day	EPA, 2008 (17)	and
				Crbgadj	Age-Adjusted Belowground Produce Ingestion Rate	4.74E-03	yr-kg DW/kg-day	EPA, 2008 (18)	Prag = EPCs x Brag
				Crbg[M]adj	Age-Adjusted Belowground Produce Ingestion Rate for Mutagens	1.35E-02	yr-kg DW/kg-day	EPA, 2008 (19)	Prbg = EPCs x Brrootveg x VGrootveg
				Fp	Fraction of Homegrown Produce Ingested From Contaminated Source	1	unitless	EPA, 2005 (20)	
				EF	Exposure Frequency	350	days/year	EPA, 2005 (3)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 2005 (6)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted soil ingestion rates for aggregate residents were calculated as:
IRSadj (mg-year/kg-day) = $(ED_{0\text{-}2}$ (2 yr) x IRS_{child} (200 mg/day) / BW_{child} (15kg))+$(ED_{2\text{-}6}$ (4 yr) x IRS_{child} (200 mg/day) / BW_{child} (15kg)) + $(ED_{6\text{-}16}$ (10 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg)) + $(ED_{16\text{-}30}$ (14 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted soil ingestion rates for mutagens for aggregate residents were calculated as:
IRSMadj (mg-year/kg-day) = $(ED_{0\text{-}2}$ (2 yr) x IRS_{child} (200 mg/day) x $ADAF_{0\text{-}2}$ (10)/ BW_{child} (15kg))+$(ED_{2\text{-}6}$ (4 yr) x IRS_{child} (200 mg/day) x $ADAF_{2\text{-}6}$ (3) / BW_{child} (15kg)) + $(ED_{6\text{-}16}$ (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6\text{-}16}$ (3) / BW_{adult} (70kg)) + $(ED_{16\text{-}30}$ (14 yr) x IRS_{adult} (100 mg/day) x $ADAF_{16\text{-}30}$ (1) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(3) FI: Assumes 100% of soil ingestion occurs at the Site.

(4) EF: Default exposure frequency for residents.

(5) ATc: Assumes 365 days per year over a 70-year lifetime. Note that non-carcinogenic effects for residents were evaluated using the more-sensitive child receptor.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for aggregate residents were calculated as:
$(ED_{0\text{-}2}$ (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2)/ BW_{child} (15kg))+$(ED_{2\text{-}6}$ (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2) / BW_{child} (15kg)) + $(ED_{6\text{-}16}$ (10 yr) x SA_{adult} (5700 cm^2) x AF_{adult} (0.07 mg/cm^2) / BW_{adult}(70kg)) + $(ED_{16\text{-}30}$ (14 yr) x SA_{adult} (5700 cm^2) x AF_{adult} (0.07 mg/cm^2) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for mutagens for aggregate residents were calculated as:
$(ED_{0\text{-}2}$ (2 yr) x SA_{child} (2,800 cm^2) x AF_{child} (0.2 mg/cm^2) x $ADAF_{0\text{-}2}$ (10)/ BW_{child} (15kg))+$(ED_{2\text{-}6}$ (4 yr) x SA_{child} (2,800 cm^2) x AF_{child} (0.2 mg/cm^2) x $ADAF_{2\text{-}6}$ (3) / BW_{child} (15kg)) +
(ED6-16 (10 yr) x SAadult (5,700 cm2) x AFadult (0.07 mg/cm2) x ADAF6-16 (3) / BWadult (70kg)) + (ED16-30 (14 yr) x SAadult (5,700 cm2) x AFadult (0.07 mg/cm2) x ADAF16-30 (1) / BWadult (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.

(9) ED: Default exposure duration for residents.

(10) EDadj: To account for potential mutagenic effects via inhalation an age-dependent adjustment factor (ADAF) of 10 is applied to the ED for ages 0 to 2, an ADAF of 3 is applied to the ED for ages 2 to 6, an ADAF of 3 is applied to the ED for ages 6 to 16, and an ADAF of 1 is applied to the ED for ages 16 to 30 [(2x10)+(4x3)+(10*3)+(14*1)=76].

(11) Default exposure time for residents.

(12) Prag: Consistent with EPA (2005), calculated using equation presented.

(13) Brag and Brrootveg: Chemical-specific values will be obtained from the HHRAP Comparison Database (ACCESS) or calculated using the procedures presented in Appendix A-2 of EPA (2005).

(14) VGrootveg: Default empirical correction factors for belowground produce. A VGrootveg value of 0.01 will be used for chemicals with a logKow > 4, and a VGrootveg value of 1.0 will be used for chemicals with a logKow ≤ 4.

(15) IHPadj and IHP[M]adj: Consistent with EPA (2005), these parameters were calculated using the equation presented.

(16): Cragadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted RME aboveground produce ingestion rates for residents age 0 to 30 were calculated as:
Cragadj (yr-kg DW/kg-day) = $(ED_{0\text{-}2}$ (2 yrs) x $IHP_{ag\text{-}child}$ (2.27E-03 kg DW/kg-day)) + $(ED_{2\text{-}6}$ (4 yrs) x $IHP_{ag\text{-}child}$ (2.27E-03 kg DW/kg-day)) + $(ED_{6\text{-}16}$ (10 yrs) x $IHP_{ag\text{-}adult}$ (9.3E-04 kg DW/kg-day)) + $(ED_{16\text{-}30}$ (14 yrs) x $IHP_{ag\text{-}adult}$ (9.3E-04 kg DW/kg-day))
Where: ED = Exposure Duration (yrs); IHPag-child and IHPag-adult = Ingestion Rate of Aboveground Produce - Sum of Exposed and Protected Aboveground Produce (EPA 2005).

(17): Crag[M]adj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted RME aboveground produce ingestion rates for mutagens for residents age 0 to 30 were calculated as:
Crag[M]adj (yr-kg DW/kg-day) = $(ED_{0\text{-}2}$ (2 yrs) x $IHP_{ag\text{-}child}$ (2.27E-03 kg DW/kg-day) x $ADAF_{0\text{-}2}$ (10)) + $(ED_{2\text{-}6}$ (4 yrs) x $IHP_{ag\text{-}child}$ (2.27E-03 kg DW/kg-day) x $ADAF_{2\text{-}6}$ (3)) + $(ED_{6\text{-}16}$ (10 yrs) x $IHP_{ag\text{-}adult}$ (9.3E-04 kg DW/kg-day) x $ADAF_{6\text{-}16}$ (3)) + $(ED_{16\text{-}30}$ (14 yrs) x $IHP_{ag\text{-}adult}$ (9.3E-04 kg DW/kg-day) x $ADAF_{16\text{-}30}$ (1))
Where: ED = Exposure Duration (yrs); IHPag-child and IHPag-adult = Ingestion Rate of Aboveground Produce - Sum of Exposed and Protected Aboveground Produce (EPA 2005); ADAF = Age-Dependent Adjustment Factor (unitless)

(18) Crbgadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted RME belowground produce ingestion rates for residents age 0 to 30 were calculated as:
Crbgadj (yr-kg DW/kg-day) = $(ED_{0\text{-}2}$ (2 yrs) x $IHPb_{g\text{-}child}$ (2.3E-04 kg DW/kg-day)) + $(ED_{2\text{-}6}$ (4 yrs) x $IHPb_{g\text{-}child}$ (2.3E-04 kg DW/kg-day)) + $(ED_{6\text{-}16}$ (10 yrs) x $IHPb_{g\text{-}adult}$ (1.4E-04 kg DW/kg-day)) + $(ED_{16\text{-}30}$ (14 yrs) x $IHPb_{g\text{-}adult}$ (1.4E-04 kg DW/kg-day))
Where: ED = Exposure Duration (yrs); IHPbg-child and IHPbg-adult = Ingestion Rate of Belowground Produce (EPA 2005).

(19): Crbg[M]adj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted RME belowground produce ingestion rates for mutagens for residents age 0 to 30 were calculated as:
Crbg[M]adj (yr-kg DW/kg-day) = $(ED_{0\text{-}2}$ (2 yrs) x $IHPb_{g\text{-}child}$ (2.3E-04 kg DW/kg-day) x $ADAF_{0\text{-}2}$ (10)) + $(ED_{2\text{-}6}$ (4 yrs) x $IHPb_{g\text{-}child}$ (2.3E-04 kg DW/kg-day) x $ADAF_{2\text{-}6}$ (3)) + $(ED_{6\text{-}16}$ (10 yrs) x $IHPb_{g\text{-}adult}$ (1.4E-04 kg DW/kg-day) x $ADAF_{6\text{-}16}$ (3)) + $(ED_{16\text{-}30}$ (14 yrs) x $IHPb_{g\text{-}adult}$ (1.4E-04 kg DW/kg-day) x $ADAF_{16\text{-}30}$ (1))
Where: ED = Exposure Duration (yrs); IHPbg-child and IHPbg-adult = Ingestion Rate of Belowground Produce (EPA 2005); ADAF = Age-Dependent Adjustment Factor (unitless)

(20) Fp: Default fraction of homegrown produce ingested from contaminated source.

Definition:
P & V = Particulates and Vapors

Sources:
BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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TABLE 4.10a.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
CURRENT AND FUTURE AGGREGATE OFF-SITE RESIDENT AND FUTURE AGGREGATE ON-SITE RESIDENT- SOIL
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil, Particulates/Vapors, Homegrown Produce

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	See Table 3 Series	
Ingestion	Current and Future	Aggregate Resident	Surface Soil	RBA	Relative Bioavailability Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDIC (mg/kg-day) =
	Off-Site Resident	Age 0 to 30	(Off-Site)	IRSadj	Age-Adjusted Soil Ingestion Rate	42.1	mg-year/kg-day	EPA, 2008 (1)	EPCs x RBA x IRS(M)adj x FI x EF x CFs
				IRSMadj	Mutagenic IRSadj	220	mg-year/kg-day	EPA, 2008 (2)	ATc
				FI	Fractional Intake	1	unitless	BPJ (3)	
	Future On-Site		Surface and	EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
	Resident		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
				EPCs	Exposure Point Concentration - Soil	medium-specific	mg/kg	Table 3 Series	
Dermal	Current and Future	Aggregate Resident	Surface Soil	DAF	Dermal Absorption Factor	chemical-specific	unitless	See Table 5 & 6 Series	CDIC (mg/kg-day) =
	Off-Site Resident	Age 0 to 30	(Off-Site)	DFSadj	Age-Adjusted Dermal Contact Factor - Soil	241	mg-year/kg-day	EPA, 2008 (6)	EPCs x DAF x DFS(M)adj x EF x CFs
				DFSMadj	Mutagenic DFSadj	1,246	mg-year/kg-day	EPA, 2008 (7)	ATc
	Future On-Site		Surface and	EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
	Resident		Subsurface Soil	CFs	Conversion Factor - Soil	1.0E-06	kg/mg	--	
			(On-Site)	ATc	Averaging Time - Carcinogens	25550	days	EPA, 1989 (5)	
				EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	Table 3 Series	
Inhalation	Current and Future	Aggregate Resident	Outdoor Air P & V	VF	Volatilization Factor	chemical-specific	m3/kg	See Table 5 & 6 Series	CDEC (µg/m3) =
	Off-Site Resident	Age 0 to 30	from Surface Soil	PEF	Particulate Emission Factor	site-specific	m3/kg	EPA, 2008 (8)	EPCs x (1/PEF + 1/VF) x EF x ED(adj) x ET x CFa x CFt
			(Off-Site)	EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	ATc
				ED	Exposure Duration	9	years	EPA, 1991 (9)	
			Outdoor Air P & V	EDadj	Mutagenic ED	41	years	EPA, 2008 (10)	
	Future On-Site		from Surface	ET	Exposure Time	24	hrs/day	EPA, 1991 (11)	
	Resident		and Subsurface Soil	CFa	Conversion Factor - Air	1E+03	ug/mg	--	
			(On-Site)	CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
				Prag	Aboveground Exposed and Protected Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (12)	
Ingestion	Current and Future	Aggregate Resident	Home Grown	EPCs	Exposure Point Concentration - Soil	chemical-specific	mg/kg	See Table 3 Series	CDI_C (mg/kg-day) =
	Off-Site Resident	Age 0 to 30	Produce from	Brag	Plant-Soil Bioconcentration Factor for Aboveground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (13)	IHP[M]adj x EF x ED
			Surface Soil	Pbg	Belowground Produce Concentration Due to Root Uptake	site-specific	mg/kg DW	EPA, 2005 (12)	ATc
			(Off-Site)	BRrootveg	Plant-Soil Bioconcentration Factor for Belowground Produce	chemical-specific	([mg/kg DW]/[mg/kg])	EPA, 2005 (13)	
				VGrootveg	Empirical Correction Factor for Belowground Produce	0.01 or 1.0	unitless	EPA, 2005 (14)	where:
	Future On-Site		Home Grown	IHPadj	Age-Adjusted Daily Intake From Homegrown Produce	site-specific	yr-kg DW/kg-day	EPA, 2008 (15)	IHP[M]adj (yr-kg DW/kg-day) =
	Resident		Produce from	IHP[M]adj	Age-Adjusted Daily Intake From Homegrown Produce for Mutagens	site-specific	yr-kg DW/kg-day	EPA, 2008 (15)	((Prag x Crag[M]adj) + (Prbg x Crbg [M]adj)) x Fp
			Surface and	Cragadj	Age-Adjusted Aboveground Produce Ingestion Rate	3.59E-02	yr-kg DW/kg-day	EPA, 2008 (16)	
			Subsurface Soil	Crag[M]adj	Age-Adjusted Aboveground Produce Ingestion Rate for Mutagens	1.14E-01	yr-kg DW/kg-day	EPA, 2008 (17)	and
			(On-Site)	Crbgadj	Age-Adjusted Belowground Produce Ingestion Rate	4.74E-03	yr-kg DW/kg-day	EPA, 2008 (18)	Prag = EPCs x Brag
				Crbg[M]adj	Age-Adjusted Belowground Produce Ingestion Rate for Mutagens	1.35E-02	yr-kg DW/kg-day	EPA, 2008 (19)	Prbg = EPCs x Brrootveg x VGrootveg
				Fp	Fraction of Homegrown Produce Ingested From Contaminated Source	0.5	unitless	EPA, 2005 (20)	
				EF	Exposure Frequency	350	days/year	EPA, 2005 (3)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 2005 (6)	

Notes:

(1) IRSadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted soil ingestion rates for aggregate residents were calculated as:
IRSadj (mg-year/kg-day) = $(ED_{0\text{-}2}$ (2 yr) x IRS_{child} (200 mg/day) / BW_{child} (15kg))+$(ED_{2\text{-}6}$ (4 yr) x IRS_{child} (200 mg/day) / BW_{child} (15kg)) + $(ED_{6\text{-}16}$ (10 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg)) + $(ED_{16\text{-}30}$ (14 yr) x IRS_{adult} (100 mg/day) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); BW = Body Weight (kg)

(2) IRSadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted soil ingestion rates for mutagens for aggregate residents were calculated as:
IRSMadj (mg-year/kg-day) = $(ED_{0\text{-}2}$ (2 yr) x IRS_{child} (200 mg/day) x $ADAF_{0\text{-}2}$ (10)/ BW_{child} (15kg))+$(ED_{2\text{-}6}$ (4 yr) x IRS_{child} (200 mg/day) x $ADAF_{2\text{-}6}$ (3) / BW_{child} (15kg)) + $(ED_{6\text{-}16}$ (10 yr) x IRS_{adult} (100 mg/day) x $ADAF_{6\text{-}16}$ (3) / BW_{adult} (70kg)) + $(ED_{16\text{-}30}$ (14 yr) x IRS_{adult} (100 mg/day) x $ADAF_{16\text{-}30}$ (1) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Soil (mg/day); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(3) FI: Assumes 100% of soil ingestion occurs at the Site.

(4) EF: Default exposure frequency for residents.

(5) ATc: Assumes 365 days per year over a 70-year lifetime. Note that non-carcinogenic effects for residents were evaluated using the more-sensitive child receptor.

(6) DFSadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for aggregate residents were calculated as:
$(ED_{0\text{-}2}$ (2 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2)/ BW_{child} (15kg))+$(ED_{2\text{-}6}$ (4 yr) x SA_{child} (2800 cm^2) x AF_{child} (0.2 mg/cm^2) / BW_{child} (15kg)) + $(ED_{6\text{-}16}$ (10 yr) x SA_{adult} (5700 cm^2) x AF_{adult} (0.07 mg/cm^2) / BW_{adult} (70kg)) + $(ED_{16\text{-}30}$ (14 yr) x SA_{adult} (5700 cm^2) x AF_{adult} (0.07 mg/cm^2) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); BW = Body Weight (kg)

(7) DFSMadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted dermal contact rates for mutagens for aggregate residents were calculated as:
$(ED_{0\text{-}2}$ (2 yr) x SA_{child} (2,800 cm^2) x AF_{child} (0.2 mg/cm^2) x $ADAF_{0\text{-}2}$ (10)/ BW_{child} (15kg))+$(ED_{2\text{-}6}$ (4 yr) x SA_{child} (2,800 cm^2) x AF_{child} (0.2 mg/cm^2) x $ADAF_{2\text{-}6}$ (3) / BW_{child} (15kg)) +
(ED6-16 (10 yr) x SAadult (5,700 cm^2) x AFadult (0.07 mg/cm^2) x ADAF6-16 (3) / BWadult (70kg)) + (ED16-30 (14 yr) x SAadult (5,700 cm^2) x AFadult (0.07 mg/cm^2) x ADAF16-30 (1) / BWadult (70kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); AF = Soil-to-skin Adherence Factor (mg/cm^2); ADAF = Age-Dependent Adjustment Factor (unitless); BW = Body Weight (kg)

(8) PEF: Exposure-area specific PEFs will be calculated using EPA (2008) guidance based on exposure-area sized site in Chicago, Illinois.

(9) ED: Default exposure duration for residents.

(10) EDadj: To account for potential mutagenic effects via inhalation an age-dependent adjustment factor (ADAF) of 10 is applied to the ED for ages 0 to 2, an ADAF of 3 is applied to the ED for ages 2 to 6, an ADAF of 3 is applied to the ED for ages 6 to 16, and an ADAF of 1 is applied to the ED for ages 16 to 30 [(2x10)+(4x3)+(10*3)+(14*1)=76].

(11) Default exposure time for residents.

(12) Prag: Consistent with EPA (2005), calculated using equation presented.

(13) Brag and Brrootveg: Chemical-specific values will be obtained from the HHRAP Comparison Database (ACCESS) or calculated using the procedures presented in Appendix A-2 of EPA (2005).

(14) VGrootveg: Default empirical correction factors for belowground produce. A VGrootveg value of 0.01 will be used for chemicals with a logKow > 4, and a VGrootveg value of 1.0 will be used for chemicals with a logKow ≤ 4.

(15) IHPadj and IHP[M]adj: Consistent with EPA (2005), these parameters were calculated using the equation presented.

(16): Cragadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted CTE aboveground produce ingestion rates for residents age 0 to 30 were calculated as:
Cragadj (yr-kg DW/kg-day) = $(ED_{0\text{-}2}$ (2 yrs) x $IHP_{ag\text{-}child}$ (2.27E-03 kg DW/kg-day)) + $(ED_{2\text{-}6}$ (4 yrs) x $IHP_{ag\text{-}child}$ (2.27E-03 kg DW/kg-day)) + $(ED_{6\text{-}16}$ (10 yrs) x $IHP_{ag\text{-}adult}$ (9.3E-04 kg DW/kg-day)) + $(ED_{16\text{-}30}$ (14 yrs) x $IHP_{ag\text{-}adult}$ (9.3E-04 kg DW/kg-day))
Where: ED = Exposure Duration (yrs); IHPag-child and IHPag-adult = Ingestion Rate of Aboveground Produce - Sum of Exposed and Protected Aboveground Produce (EPA 2005).

(17): Crag[M]adj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted CTE aboveground produce ingestion rates for mutagens for residents age 0 to 30 were calculated as:
Crag[M]adj (yr-kg DW/kg-day) = $(ED_{0\text{-}2}$ (2 yrs) x $IHP_{ag\text{-}child}$ (2.27E-03 kg DW/kg-day) x $ADAF_{0\text{-}2}$ (10)) + $(ED_{2\text{-}6}$ (4 yrs) x $IHP_{ag\text{-}child}$ (2.27E-03 kg DW/kg-day) x $ADAF_{2\text{-}6}$ (3)) + $(ED_{6\text{-}16}$ (10 yrs) x $IHP_{ag\text{-}adult}$ (9.3E-04 kg DW/kg-day) x $ADAF_{6\text{-}16}$ (3)) + $(ED_{16\text{-}30}$ (14 yrs) x $IHP_{ag\text{-}adult}$ (9.3E-04 kg DW/kg-day) x $ADAF_{16\text{-}30}$ (1))
Where: ED = Exposure Duration (yrs); IHPag-child and IHPag-adult = Ingestion Rate of Aboveground Produce - Sum of Exposed and Protected Aboveground Produce (EPA 2005); ADAF = Age-Dependent Adjustment Factor (unitless)

(18) Crbgadj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted CTE belowground produce ingestion rates for residents age 0 to 30 were calculated as:
Crbgadj (yr-kg DW/kg-day) = $(ED_{0\text{-}2}$ (2 yrs) x $IHPb_{g\text{-}child}$ (2.3E-04 kg DW/kg-day)) + $(ED_{2\text{-}6}$ (4 yrs) x $IHPb_{g\text{-}child}$ (2.3E-04 kg DW/kg-day)) + $(ED_{6\text{-}16}$ (10 yrs) x $IHPb_{g\text{-}adult}$ (1.4E-04 kg DW/kg-day)) + $(ED_{16\text{-}30}$ (14 yrs) x $IHPb_{g\text{-}adult}$ (1.4E-04 kg DW/kg-day))
Where: ED = Exposure Duration (yrs); IHPbg-child and IHPbg-adult = Ingestion Rate of Belowground Produce (EPA 2005).

(19): Crbg[M]adj: Consistent with the EPA (2008) RSL User's Guide, age-adjusted CTE belowground produce ingestion rates for mutagens for residents age 0 to 30 were calculated as:
Crbg[M]adj (yr-kg DW/kg-day) = $(ED_{0\text{-}2}$ (2 yrs) x $IHPb_{g\text{-}child}$ (2.3E-04 kg DW/kg-day) x $ADAF_{0\text{-}2}$ (10)) + $(ED_{2\text{-}6}$ (4 yrs) x $IHPb_{g\text{-}child}$ (2.3E-04 kg DW/kg-day) x $ADAF_{2\text{-}6}$ (3)) + $(ED_{6\text{-}16}$ (10 yrs) x $IHPb_{g\text{-}adult}$ (1.4E-04 kg DW/kg-day) x $ADAF_{6\text{-}16}$ (3)) + $(ED_{16\text{-}30}$ (14 yrs) x $IHPb_{g\text{-}adult}$ (1.4E-04 kg DW/kg-day) x $ADAF_{16\text{-}30}$ (1))
Where: ED = Exposure Duration (yrs); IHPbg-child and IHPbg-adult = Ingestion Rate of Belowground Produce (EPA 2005); ADAF = Age-Dependent Adjustment Factor (unitless)

(20) Fp: The CTE value is assumed to be 50 percent of the RME value based on best professional judgment.

Definition:
P & V = Particulates and Vapors

Sources:

BPJ= Best Professional Judgment.
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TABLE 4.10b.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
FUTURE AGGREGATE ON-SITE RESIDENT - GROUNDWATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future	Aggregate Resident	Tapwater	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
	On-Site Resident	Age 0 to 30		IRGWadj	Age-Adjusted Tapwater Ingestion Rate	1.1	mg-year/kg-day	EPA, 2008 (1)	CDIC (mg/kg-day) =
				IRGW[M]adj	Mutagenic IRGWadj	3.4	mg-year/kg-day	EPA, 2008 (2)	EPCgw x IRGWadj x FI x EF x CFw
				FI	Fractional Intake	1	unitless	BPJ (3)	ATc
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				CFw	Conversion Factor - Water	1.0E-06	kg/mg	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future	Aggregate Resident	Groundwater	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFGWadj	Age-Adjusted Dermal Contact Factor - Groundwater	6,219	cm^2-hr-yr/kg-day	EPA, 2008 (6)	
				DFGW[M]adj	Mutagenic DFGWadj	20,642	cm^2-hr-yr/kg-day	EPA, 2008 (7)	
	On-Site Resident	Age 0 to 30		DFGWadjo	Age-Adjusted Dermal Contact Factor for Organics - Groundwater	7,330	cm^2-hr-yr/kg-day	EPA, 2008 (8)	EPCgw x Kp x DFGW[M]adj x EF x ET x CFgw x CFv
				DFGW[M]adjo	Mutagenic DFGWadjo	22,679	cm^2-hr-yr/kg-day	EPA, 2008 (9)	AT
				EF	Exposure Frequency	350	days/year	BPJ (4)	For Organics:
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x DFGW[M]adjo
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	AT
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	If tevent < or = t*, then:
				B	Ratio of Permeability Coefficient of a Compound Through the Corneum	chemical-specific	unitless	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
					Relative to its Permeability Coefficient Across the Viable Epidermis	--	--	--	
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	If tevent > t*, then:
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	DAevent = FA x Kp x EPCgw x CFv x CFgw x [1/{1+B}] + (FA x Kp x
				ATnc	Averaging Time - Noncarcinogens	2,190	days	EPA, 1989 (5)	EPCgw x CFv x CFgw x [2 x tevent x $\{(1+3B+3B^2)/(1+B)^2\}$]
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Future	Aggregate Resident	Outdoor Air	EPCair	Exposure Point Concentration - Air	Calculated	$\mu g/m^3$	Calculated	
	On-Site Resident	Age 0 to 30	Vapors	EPCgw	Exposure Point Concentration - Groundwater	See Table 3s	µg/L	See Table 3s	CDE ($\mu g/m^3$) =
				EF	Exposure Frequency	350	days/year	BPJ (4)	EPCair x EF x EDadj x ET x CFt
				ED	Exposure Duration	30	years	EPA, 1989 (4)	ATc
				ET	Exposure Time - Outdoors	24	hrs/day	EPA, 2008 (11)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	where EPCair =
				VFwamb	Volatilization factor, Water to Ambient Air	See Table XX	m^3/L	See Table XX	EPCgw
				EDadj	Mutagenic ED	76	yrs	EPA, 1989 (10)	VFwamb
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Future	Aggregate Resident	Indoor Air	EPCia	Chemical Concentration in Indoor Air	See Table XX	$\mu g/m^3$	See Table XX	
	On-Site Resident	Age 0 to 30	Vapors	EDadj	Mutagenic ED	76	yrs	EPA, 1989 (10)	CDE ($\mu g/m^3$) =
			(Vapor Intrusion)	EF	Exposure Frequency	350	days/year	BPJ (4)	EPCia x EF x EDadj x ET x CFt
				ED	Exposure Duration	30	years	EPA, 1989 (4)	ATc
				ET	Exposure Time - Outdoors	24	hrs/day	EPA, 2008 (11)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Future	Aggregate Resident	Indoor Air	EPCgw	Exposure Point Concentration - Groundwater	See Table XX	µg/L	See Table XX	
	On-Site Resident	Age 0 to 30	Vapors	EDadj	Mutagenic ED	76	yrs	EPA, 1989 (10)	CDE ($\mu g/m^3$) =
			(Household Use)	EF	Exposure Frequency	350	days/year	BPJ (4)	EPCgw x VFw x EF x ETb[M]adj x CFt
				ED	Exposure Duration	30	years	EPA, 1989 (4)	BW x Atc
				ETbadj	Age-Adjusted Exposure Time	19.9	yr-hr/day	EPA, 2008 (12)	
				ETb[M]adj	Mutagenic ETbadj	57.5	yr-hr/day	EPA, 2008 (13)	
				VF_W	Volatilization factor, Domestic Use	0.5	L/m^3	EPA 1991	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRGWadj: Consistent with the EPA (2008) RSL User's Guide, an age-adjusted tapwater ingestion rate for aggregate residents calculated as:
IRGWadj (L-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (1 L/day) / BW_{child} (15 kg))+(ED_{2-6} (4 yr) x IRS_{child} (1 L/day) / BW_{child} (15 kg)) + (ED_{6-16} (10 yr) x IRS_{adult} (2 L/day) / BW_{adult} (70 kg)) + (ED_{16-30} (14 yr) x IRS_{adult} (2 L/day) / BW_{adult} (70 kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Tap water (L/day); BW = Body Weight (kg) EPA (2008) recommended value for calculating age-adjusted rates.

(2) IRGW[M]adj: Consistent with the EPA (2008) RSL User's Guide, an age-adjusted tapwater ingestion rate for mutagens for aggregate residents calculated as:
IRSMadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (1 L/day) x $ADAF_{0-2}$ (10)/ BW_{child} (15 kg))+(ED_{2-6} (4 yr) x IRS_{child} (1 L/day) x $ADAF_{2-6}$ (3) / BW_{child} (15 kg)) + (ED_{6-16} (10 yr) x IRS_{adult} (2 L/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70 kg)) + (ED_{16-30} (14 yr) x IRS_{adult} (2 L/day) x $ADAF_{16-30}$ (1) / BW_{adult} (70 kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Tap water (L/day); BW = Body Weight (kg) EPA (2008) recommended value for calculating age-adjusted rates; ADAF = Age-Dependent Adjustment Factor (unitless)

(3) FI: Assumes 100% of groundwater ingestion occurs at the Site.

(4) EF and ED: Default exposure frequency and exposure duration for residents.

(5) ATc: Assumes 365 days per year over a 70-year lifetime. Note that non-carcinogenic effects for residents were evaluated using the more-sensitive child receptor.

(6) DFGWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the RME age-adjusted dermal contact rate for residents age 0 to 30 is calculated as:
DFGWadj (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x ET child (1 hr) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x ETchild (1 hr) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x SAadult (18,000 cm^2) x sqrt ETadult (0.58 hr) / BWadult (70 kg)) + (ED_{16-30} (14 yrs) x SAadult (18,000 cm^2) x ETadult (0.58 hr) / BWadult (70 kg)
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg)

(7) DFGW[M]adj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the RME age-adjusted dermal contact rate for mutagens for residents age 0 to 30 is calculated as:
DFGW[M]adj (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x ETchild (1 hr) x $ADAF_{0-2}$ (10) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x ETchild (1 hr) x $ADAF_{2-6}$ (3) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x
SAadult (18,000 cm^2) x ETadult (0.58 hr) x ADAF6-16 (3) / BWadult (70 kg)) + (ED16-30 (14 yrs) x SAadult (18,000 cm^2) x ETadult (0.58 hr) x ADAF16-30 (1) / BWadult (70 kg)
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)

(8) DFGWadjo: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the RME age-adjusted dermal contact rate for organics for residents age 0 to 30 is calculated as:
DFGWadjo (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (1) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (1) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x SAadult (18,000 cm^2) x sqrt [ETadult] (0.76) / BWadult (70 kg)) + (ED_{16-30} (14 yrs) x SAadult (18,000 cm^2) x sqrt [ETadult] (0.76) / BWadu
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg)

(9) DFGW[M]adjo: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the RME age-adjusted dermal contact rate for organic mutagens for residents age 0 to 30 is calculated as:
DFGW[M]adjo (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (1) x $ADAF_{0-2}$ (10) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (1) x $ADAF_{2-6}$ (3) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x
SAadult (18,000 cm^2) x sqrt [ETadult] (0.76) x ADAF6-16 (3) / BWadult (70 kg)) + (ED16-30 (14 yrs) x SAadult (18,000 cm2) x sqrt [ETadult] (0.76) x ADAF16-30 (1) / BWadult (70 kg)
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor

(10) EDadj: To account for potential mutagenic effects via inhalation, age-dependent factors of 10, 3, 3, and 1 were applied to the EDs for ages 0-2, 2-6, 6-16, and 16-30 years, respectively.

(11) ET: Default exposure time for residents.

(12) ETbadj: Consistent with the EPA (2008) RSL User's Guide, the RME age-adjusted exposure time for bathing for residents 0 to 30 years was calculated as:
ETbadj (yr-hr/day) = ((ED_{0-2} (2 yrs) x ETbchild (1 hr/day) + (ED_{2-6} (4 yrs) x ETbchild (1 hr/day)) + (ED_{6-16} (10 yrs) x ETbadult (0.58 hr)) + (ED_{16-30} (14 yrs) x ETbadult (0.58 hr/day))
Where: ED = Exposure Duration (years); ETb = Exposure Time - Bathing (hr/day)

(13) Etb[M]adj: Consistent with the EPA (2008) RSL User's Guide, the RME age-adjusted exposure time for bathing for mutagens for residents 0 to 30 years was calculated as:
Etb[M]adj (yr-hr/day) = ((ED_{0-2} (2 yrs) x ETbchild (1 hr/day) x $ADAF_{0-2}$ (10) + (ED_{2-6} (4 yrs) x ETbchild (1 hr/day)) $ADAF_{2-6}$ (3) + (ED_{6-16} (10 yrs) x ETbadult (0.58 hr)) x $ADAF_{6-16}$ (3) + (ED_{16-30} (14 yrs) x ETbadult (0.58 hr/day) x $ADAF_{16-30}$ (1))
Where: ED = Exposure Duration (years); ETb = Exposure Time - Bathing (hr/day); Age-Dependent adjustment factor (unitless)

Sources:

BPJ= Best Professional Judgment.

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TABLE 4.10b.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
FUTURE AGGREGATE ON-SITE RESIDENT - GROUNDWATER
MATTHIESSEN AND HEGELER ZINC COMPANY SITE, OU2, LASALLE, ILLINOIS

Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater, Vapors

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Chronic Daily Intake (CDI)/Chronic Daily Exposure (CDE)
Ingestion	Future On-Site Resident	Aggregate Resident Age 0 to 30	Tapwater	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	See Table 3 Series	
				IRGWadj	Age-Adjusted Tapwater Ingestion Rate	0.49	mg-year/kg-day	EPA, 2008 (1)	CDIC (mg/kg-day) =
				IRGW[M]adj	Mutagenic IRGWadj	2.39	mg-year/kg-day	EPA, 2008 (2)	EPCgw x IRGWadj x FI x EF x CFw / ATc
				FI	Fractional Intake	1	unitless	BPJ (3)	
				EF	Exposure Frequency	350	days/year	EPA, 1991 (4)	
				CFw	Conversion Factor - Water	1.0E-06	kg/mg	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Dermal	Future On-Site Resident	Aggregate Resident Age 0 to 30	Groundwater	EPCgw	Exposure Point Concentration - Groundwater	medium-specific	ug/L	Table 3 Series	For Inorganics:
				Kp	Dermal Permeability Constant	chemical-specific	cm/hr	See Table 5 & 6 Series	CDI (mg/kg-day) =
				DFGWadj	Age-Adjusted Dermal Contact Factor - Groundwater	2,414	cm^2-hr-yr/kg-day	EPA, 2008 (6)	
				DFGW[M]adj	Mutagenic DFGWadj	7,475	cm^2-hr-yr/kg-day	EPA, 2008 (7)	
				DFGWadjo	Age-Adjusted Dermal Contact Factor for Organics - Groundwater	4,591	cm^2-hr-yr/kg-day	EPA, 2008 (8)	EPCgw x Kp x DFGW[M]adj x EF x ET x CFgw x CFv / AT
				DFGW[M]adjo	Mutagenic DFGWadjo	9,183	cm^2-hr-yr/kg-day	EPA, 2008 (9)	
				EF	Exposure Frequency	350	days/year	BPJ (3)	For Organics:
				CFgw	Conversion Factor - Groundwater	1.0E-03	mg/ug	--	CDI (mg/kg-day) =
				CFv	Conversion Factor - Volume	1.0E-03	L/cm^3	--	DAevent x EV x EF x DFGW[M]adjo / AT
				FA	Fraction Absorbed - Water	chemical-specific	unitless	See Table 5 & 6 Series	
				τevent	Lag Time per Event	chemical-specific	hr/event	See Table 5 & 6 Series	If tevent < or = t*, then:
				B	Ratio of Permeability Coefficient of a Compound Through the	chemical-specific	unitless	See Table 5 & 6 Series	DAevent = 2 x FA x Kp x EPCgw x CFv x CFgw x [sqrt (6 x τevent x ET/pi)]
					Corneum Relative to its Permeability Coefficient Across the	--	--	--	
					Viable Epidermis	--	--	--	If tevent > t*, then:
				DAevent	Absorbed Dose per Event	site-specific	mg/cm^2-event	EPA, 2004	DAevent = FA x Kp x EPCgw x CFv x CFgw x [1/(1+B)] + (FA x Kp x
				t*	Time to Reach Steady-State	chemical-specific	hr	See Table 5 & 6 Series	EPCgw x CFv x CFgw x [2 x tevent x {(1+3B+$3B^2$)/(1+B)^2}]
				ATnc	Averaging Time - Noncarcinogens	3,285	days	EPA, 1989 (5)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Future On-Site Resident	Aggregate Resident Age 0 to 30	Outdoor Air Vapors	EPCair	Exposure Point Concentration - Air	Calculated	$\mu g/m^3$	Calculated	
				EPCgw	Exposure Point Concentration - Groundwater	See Table 3s	µg/L	See Table 3s	CDE ($\mu g/m^3$) =
				EF	Exposure Frequency	350	days/year	BPJ (3)	EPCair x EF x EDadj x ET x CFt / ATc
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				ET	Exposure Time - Outdoors	3	hrs/day	EPA, 1997 (11)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	where EPCair =
				VFwamb	Volatilization factor, Water to Ambient Air	See Table XX	m^3/L	See Table XX	EPCgw / VFwamb
				EDadj	Mutagenic ED	76	yrs	EPA, 1989 (10)	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Future On-Site Resident	Aggregate Resident Age 0 to 30	Indoor Air Vapors (Vapor Intrusion)	EPCia	Chemical Concentration in Indoor Air	See Table XX	mg/m^3	See Table XX	
				EDadj	Mutagenic ED	76	yrs	EPA, 1989 (10)	CDE ($\mu g/m^3$) =
				EF	Exposure Frequency	350	days/year	BPJ (3)	EPCia x EF x EDadj x ET x CFt / ATc
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				ET	Exposure Time - Outdoors	3	hrs/day	EPA, 1997 (11)	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	
Inhalation	Future On-Site Resident	Aggregate Resident Age 0 to 30	Indoor Air Vapors (Household Use)	EPCgw	Exposure Point Concentration - Groundwater	See Table XX	µg/L	See Table XX	
				EDadj	Mutagenic ED	76	yrs	EPA, 1989 (10)	CDE ($\mu g/m^3$) =
				EF	Exposure Frequency	350	days/year	BPJ (3)	EPCgw x VFw x EF x ETb[M]adj x CFt / BW x Atc
				ED	Exposure Duration	9	years	EPA, 1989 (4)	
				ETbadj	Age-Adjusted Exposure Time	7.98	yr-hr/day	EPA, 2008 (12)	
				ETb[M]adj	Mutagenic ETbadj	21.56	yr-hr/day	EPA, 2008 (13)	
				VF_w	Mutagenic ETbadj	0.5	L/m^3	EPA 1991	
				CFt	Conversion Factor - Time (1/24)	0.042	day/hr	--	
				ATc	Averaging Time - Carcinogens	25,550	days	EPA, 1989 (5)	

Notes:

(1) IRGWadj: Consistent with the EPA (2008) RSL User's Guide, an age-adjusted tapwater ingestion rate for aggregate residents calculated as:
IRGWadj (L-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (1 L/day) / BW_{child} (15 kg))+(ED_{2-6} (4 yr) x IRS_{child} (1 L/day) / BW_{child} (15 kg)) + (ED_{6-16} (10 yr) x IRS_{adult} (2 L/day) / BW_{adult} (70 kg)) + (ED_{16-30} (14 yr) x IRS_{adult} (2 L/day) / BW_{adult} (70 kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Tap water (L/day); BW = Body Weight (kg) EPA (2008) recommended value for calculating age-adjusted rates.

(2) IRGWadj: Consistent with the EPA (2008) RSL User's Guide, an age-adjusted tapwater ingestion rate for mutagens for aggregate residents calculated as:
IRSMadj (mg-year/kg-day) = (ED_{0-2} (2 yr) x IRS_{child} (1 L/day) x $ADAF_{0-2}$ (10)/ BW_{child} (15kg))+(ED_{2-6} (4 yr) x IRS_{child} (1 L/day) x $ADAF_{2-6}$ (3) / BW_{child} (15kg)) + (ED_{6-16} (10 yr) x IRS_{adult} (2 L/day) x $ADAF_{6-16}$ (3) / BW_{adult} (70kg)) + (ED_{16-30} (14 yr) x IRS_{adult} (2 L/day) x $ADAF_{16-30}$ (1) / BW_{adult} (70kg))
Where: ED = Exposure Duration (years); IRS = Ingestion Rate of Tap water (L/day); BW = Body Weight (kg) EPA (2008) recommended value for calculating age-adjusted rates; ADAF = Age-Dependent Adjustment Factor (unitless)

(3) FI: Assumes 100% of groundwater ingestion occurs at the Site.

(4) EF: Default exposure frequency for residents.

(5) ATc: Assumes 365 days per year over a 70-year lifetime. Note that non-carcinogenic effects for residents were evaluated using the more-sensitive child receptor.

(6) DFGWadj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the CTE age-adjusted dermal contact rate for residents age 0 to 30 is calculated as:
DFGWadj (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x ET child (0.33 hr) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x ETchild (0.33 hr) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x SAadult (18,000 cm^2) x sqrt ETadult (0.25 hr) / BWadult (70 kg)) + (ED_{16-30} (14 yrs) x SAadult (18,000 cm^2) x ETadult (0.25 hr) / BWadult (70 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg)

(7) DFGW[M]adj: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the CTE age-adjusted dermal contact rate for mutagens for residents age 0 to 30 is calculated as:
DFGW[M]adj (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x ETchild (0.33 hr) x $ADAF_{0-2}$ (10) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x ETchild (0.33 hr) x $ADAF_{2-6}$ (3) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x SAadult (18,000 cm^2) x ETadult (0.25 hr) x ADAF6-16 (3) / BWadult (70 kg)) + (ED16-30 (14 yrs) x SAadult (18,000 cm2) x ETadult (0.25 hr) x ADAF16-30 (1) / BWadult (70 kg)
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor (unitless)

(8) DFGWadjo: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the CTE age-adjusted dermal contact rate for organics for residents age 0 to 30 is calculated as:
DFGWadjo (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (0.57) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (0.57) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x SAadult (18,000 cm^2) x sqrt [ETadult] (0.50) / BWadult (70 kg)) + (ED_{16-30} (14 yrs) x SAadult (18,000 cm^2) x sqrt [ETadult] (0.50) / BWadult (70 kg))
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg)

(9) DFGW[M]adjo: Consistent with the methodology presented in the EPA (2008) RSL User's Guide, the CTE age-adjusted dermal contact rate for organic mutagens for residents age 0 to 30 is calculated as:
DFGW[M]adjo (cm^2-hr-yr/kg-day) = ((ED_{0-2} (2 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (0.57) x $ADAF_{0-2}$ (10) / BWchild (15 kg)) + (ED_{2-6} (4 yrs) x SAchild (6,600 cm^2) x sqrt [ETchild] (0.57) x $ADAF_{2-6}$ (3) / BWchild (15 kg)) + (ED_{6-16} (10 yrs) x SAadult (18,000 cm^2) x sqrt [ETadult] (0.50) x ADAF6-16 (3) / BWadult (70 kg)) + (ED16-30 (14 yrs) x SAadult (18,000 cm2) x sqrt [ETadult] (0.50) x ADAF16-30 (1) / BWadult (70 kg)
Where: ED = Exposure Duration (years); SA = Skin Surface Area (cm^2); ET = Exposure Time (hr); BW = Body Weight (kg); ADAF = Age-Dependent Adjustment Factor

(10) EDadj: To account for potential mutagenic effects via inhalation, age-dependent factors of 10, 3, 3, and 1 were applied to the EDs for ages 0-2, 2-6, 6-16, and 16-30 years, respectively.

(11) ET: Default exposure time for residents.

(12) ETbadj: Consistent with the EPA (2008) RSL User's Guide, the CTE age-adjusted exposure time for bathing for residents 0 to 30 years was calculated as:
ETbadj (yr-hr/day) = ((ED_{0-2} (2 yrs) x ETbchild (0.33 hr/day) + (ED_{2-6} (4 yrs) x ETbchild (0.33 hr/day)) + (ED_{6-16} (10 yrs) x ETbadult (0.25 hr)) + (ED_{16-30} (14 yrs) x ETbadult (0.25 hr/day))
Where: ED = Exposure Duration (years); ETb = Exposure Time - Bathing (hr/day)

(13) Etb[M]adj: Consistent with the EPA (2008) RSL User's Guide, the CTE age-adjusted exposure time for bathing for mutagens for residents 0 to 30 years was calculated as:
Etb[M]adj (yr-hr/day) = ((ED_{0-2} (2 yrs) x ETbchild (0.33 hr/day) x $ADAF_{0-2}$ (10) + (ED_{2-6} (4 yrs) x ETbchild (0.33 hr/day)) $ADAF_{2-6}$ (3) + (ED_{6-16} (10 yrs) x ETbadult (0.25 hr)) x $ADAF_{6-16}$ (3) + (ED_{16-30} (14 yrs) x ETbadult (0.25 hr/day) x $ADAF_{16-30}$ (1))
Where: ED = Exposure Duration (years); ETb = Exposure Time - Bathing (hr/day); ADAF = Age-Dependent adjustment factor (unitless)

Sources:

BPJ= Best Professional Judgment.
U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part A)." Office of Solid Waste and Emergency Response (OSWER). EPA/540/1-89/002a. December.
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