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200-PO-1 Groundwater Operable Unit Tap Water Risk Assessment

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

P.O. Box 1600
Richland, Washington 99352

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I. M. Ross
Freestone Environmental Services, Inc.

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Preparer:

IM Ross / Risk Assessor
NAME/POSITION

SIGNATURE DATE 9/13/11

Checker:

SL Lindberg / Environmental Chemist
NAME/POSITION

SIGNATURE DATE 9/12/2011

Senior Reviewer:

SL Lindberg / Environmental Chemist
NAME/POSITION

SIGNATURE DATE 9/12/2011

Responsible Manager:

AH Aly / Risk and Modeling Integration Manager
NAME/POSITION

SIGNATURE DATE 9/13/11

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Terms

ATSDR	Agency for Toxic Substances and Disease Registry
CalEPA	California Environmental Protection Agency
CDI	Chronic Daily Intake
COPC	contaminant of potential concern
DA_{event}	dermally absorbed dose per event
ECF	environmental calculation file
ELCR	excess lifetime cancer risk
EPA	Environmental Protection Agency
EPC	exposure point concentration
ET	event time
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
MRL	minimal risk level
NJDEP	New Jersey Department of Environmental Protection
NCEA	National Center for Environmental Assessment
OEHHA	Office of Environmental Health Hazard Assessment
OU	operable unit
PPRTVs	Provisional Peer Reviewed Toxicity Values
RAIS	Risk Assessment Information System
RfD	reference dose
RME	Reasonalbe maximum exposure
VF	volatilization factor

1 Purpose

The purpose of this environmental calculation is to document the assumptions, equations, and methods used to calculate the potential human health risks and hazards associated with exposure to radionuclides and nonradionuclides in tap water under a residential exposure scenario where the tap water source is the groundwater from the 200-PO-1 Groundwater Operable Unit (OU). Potential health risks and hazards are calculated for ingestion, dermal, and inhalation exposure routes associated with the tap water exposure pathway. The results of all exposure routes are summed to provide total excess lifetime cancer risk (ELCR) or hazard index (HI) from direct contact with tap water by a residential receptor. This methodology is used to calculate intake, ELCR and HI from exposure to tap water for the radionuclide and nonradionuclide contaminants of potential concern (COPCs) identified for the 200-PO-1 OU. The risks and hazards are calculated and presented separately for each of the three 200-PO-1 Groundwater OU exposure areas consisting of: 1) near-field, 2) far-field, and 3) river.

2 Background

The following provides a brief description of cancer risk and health hazards, exposure routes included with the tap water exposure pathway, and the applicable references used in this environmental calculation.

2.1 Carcinogenic Effects

The potential for carcinogenic effects is evaluated by estimating the incremental increase in the probability of developing cancer over a lifetime (ELCR) in addition to the background probability of developing cancer (that is, if no exposure to site contaminants occurs). Cancer slope factors developed by the Environmental Protection Agency (EPA) are considered to be a plausible upper bound estimate of the cancer potency of a contaminant. By using these upper bound estimates for the cancer slope factors, there is reasonable confidence that the actual cancer risk will not exceed the estimated risks calculated with these slope factors and may actually be lower (EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final*).

Although synergistic or antagonistic interactions might occur between cancer-causing contaminants and other contaminants, information is generally lacking in the toxicological literature to predict quantitatively the effects of these potential interactions. Therefore, cancer risks are treated as additive within an exposure route in this assessment. This is consistent with the EPA guidelines on chemical mixtures presented in EPA/630/P-03/001F, *Guidelines for Carcinogen Risk Assessment* .

2.2 Noncarcinogenic Effects

For noncarcinogenic effects, the likelihood that a receptor will develop an adverse effect is estimated by comparing the predicted level of exposure for a particular contaminant with the highest level of exposure that is considered protective (that is, its reference dose [RfD]). This ratio is referred to as the hazard quotient (HQ).

When the HQ for a contaminant exceeds 1 (that is, exposure exceeds RfD), there is a concern for potential noncarcinogenic health effects. To assess the potential for noncarcinogenic effects posed by exposure to multiple contaminants, a hazard index (HI) approach is used according to EPA guidance (EPA/540/1-89/002). This approach assumes that the noncancer hazard associated

with exposure to more than one contaminant is additive; therefore, synergistic or antagonistic interactions between contaminants are not accounted for.

2.3 Exposure Routes

Potentially complete exposure routes associated with the tap water exposure pathway for the residential exposure scenario are as follows:

- Ingestion of tap water;
- Inhalation of volatiles when showering or bathing using tap water;
- Dermal exposure from showering or bathing using tap water.

It should be noted that EPA considers external radiation to be a significant exposure route only for radionuclides in soil (EPA/540/1-89/002). External radiation from radionuclides in water is considered insignificant due to its shielding effects. EPA does not publish radionuclide cancer slope factors to quantify cancer risk from external or dermal exposure to radioactive COPCs in groundwater. Radionuclide cancer risk is therefore calculated in this evaluation only for ingestion and inhalation exposures.

2.4 References

For the tap water exposure pathway, contaminant intake is quantified using standard equations and procedures as specified in the following references:

- EPA/540/1-89/002, *Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual, Part A, Interim Final*;
- EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim*;
- EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final*; and
- EPA-540-R-070-002, *Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*;
- ORNL, 2010, The Risk Assessment Information System (RAIS) (http://rais.ornl.gov/)
    - RAIS Risk Exposure Models for Chemicals User's Guide (http://rais.ornl.gov/tools/rais_chemical_risk_guide.html)
    - RAIS Risk Exposure Models for Radionuclides User's Guide (http://rais.ornl.gov/tools/rais_rad_risk_guide.html)

3 Methodology

The following provide the equations and the applicable bases used to calculate the cancer risks and noncancer hazards associated with exposure to the 200-PO-1 Groundwater OU COPCs via the tap water exposure routes. Definitions of variables and input values for the equations are provided in Table 3-1.

3.1 Intake and Risk Equations for Tap Water Ingestion

The bases for the equations used to calculate intake, risk, and hazard associated with the tap water ingestion route are summarized in Table 3-2. Equations are provided in the following subsections.

Table 3-2. Exposure Assumptions Used for the Tap Water Ingestion Route

Effect	Symbol for Calculated Value	Reference
Carcinogenic	CDI IRW_{adj}	RAIS Risk Exposure Models for Chemicals User's Guide (ORNL, 2010)
	Risk	EPA/540/R-92/003
Noncarcinogenic	CDI	RAIS Risk Exposure Models for Chemicals User's Guide (ORNL, 2010)
	HQ	EPA/540/R-92/003
Radionuclide	CDI IRW_RAD_{adj}	RAIS Risk Exposure Models for Radionuclides User's Guide (ORNL, 2010)
	Risk	EPA/540/R-92/003

Notes:

CDI= chronic daily intake

HQ= hazard quotient

IRW_{adj} = age-adjusted water ingestion rate.

IRW_RAD_{adj} = age-adjusted water ingestion rate for radionuclides.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

ORNL, 2010, The Risk Assessment Information System (RAIS).

Table 3-1. Summary of Exposure Assumptions Used for the Tap Water Exposure Pathway for the 200-PO-1 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
Averaging Time – Cancer risk	AT	70	years	EPA/540/R-92/003
Averaging Time – Noncancer hazard Index	AT	30	years	EPA/540/R-92/003
Partitioning constant derived by Bunge Model	B	COPC-specific	unitless	See Table 4-2
Adult Body Weight	BW_a	70	kg	EPA/540/R-92/003
Body Weight - child	BW_c	15	kg	EPA/540/R-92/003
Conversion Factor	CF1	365	days/year	1 year = 365 days/year
Conversion Factor	CF2	1/24	days/ hour	1 day = 24 hours
Conversion Factor	CF3	0.001	L/cm^3	1 L = 1,000 cm^3
Cancer Slope Factor - oral	CSF_o	COPC-specific	$(mg/kg\text{-}day)^{-1}$	See Table 4-2
Chronic Daily Intake – carcinogen ingestion	CDI	Calculated value	mg/kg-day	Equation 1
Chronic Daily Intake – noncarcinogen ingestion	CDI	Calculated value	mg/kg-day	Equation 4
Chronic Daily Intake – radiological ingestion	CDI	Calculated value	pCi	Equation 6
Chronic Daily Intake – carcinogen inhalation	CDI	Calculated value	$\mu g/m^3$	Equation 9
Chronic Daily Intake – noncarcinogen inhalation	CDI	Calculated value	mg/m^3	Equation 11
Chronic Daily Intake – radiological inhalation	CDI	Calculated value	pCi	Equation 13
Chronic Daily Intake – carcinogen dermal	CDI	Calculated value	mg/kg-day	Equation 17
Chronic Daily Intake – noncarcinogen dermal	CDI	Calculated value	mg/kg-day	Equation 20
Contaminant concentration in groundwater	C_w	COPC-specific	mg/L or pCi/L	ECF-200PO1-09-2018
Absorbed dose per event	DA_{event}	Calculated value	mg/cm^2-event	Equation 23, 24,and 25
Exposure Duration	ED_a	30	years	EPA/540/R-92/003
Exposure Duration - child	ED_c	6	year	EPA/540/R-92/003
Exposure Frequency	EF	350	days/year	EPA/540/R-92/003
Exposure Time - adult	ET_a	0.58	hours/day	EPA/540/R/99/005
Exposure Time - child	ET_c	1	hours/day	EPA/540/R/99/005
Age-Adjusted Exposure Time	ET_{adj}	0.664	hours/day	Equation 15
			hours/event	Equation 22

Table 3-1. Summary of Exposure Assumptions Used for the Tap Water Exposure Pathway for the 200-PO-1 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
Event frequency	EV	1	event/day	EPA/540/R/99/005
Fraction of absorbed water	FA	COPC-specific	unitless	See Table 4-2
Gastrointestinal absorption factor	GIABS	COPC-specific	unitless	See Table 4-2
Age-Adjusted Inhalation Rate - radiological	INH_RAD_{adj}	540	m^3-year/day	Equation 14
Inhalation Rate - adult	INH_a	20	m^3/day	OSWER Directive 9285.6-03
Inhalation Rate - child	INH_c	10	m^3/day	EPA/600/P-95/002Fa
Water Ingestion Rate - adult	IRW_a	2	L/day	EPA/540/R-92/003
Water Ingestion Rate - child	IRW_c	1	L/day	EPA/600/P-95/002Fa
Age-adjusted Water Ingestion Rate – nonradiological	IRW_{adj}	1.086	L-year/kg-day	Equation 2
Age-adjusted Water Ingestion Rate – radiological	IRW_RAD_{adj}	54	L-year/day	Equation 7
Inhalation Unit Risk	IUR	COPC-specific	$(\mu g/m^3)^{-1}$	See Table 4-2
Dermal permeability coefficient	K_p	COPC-specific	cm/hour	See Table 4-2
The constant pi	Π	3.14159	unitless	--
Reference Concentration	RfC	COPC-specific	mg/m^3	See Table 4-2
Oral Chronic Reference Dose	RfD_o	COPC-specific	mg/kg-day	See Table 4-2
Age-adjusted Skin Surface Area	SA_{adj}	8,811	cm^2-year-event/kg-day	Equation 18
Skin Surface Area - adult	SA_a	18,000	cm^2	EPA/540/R/99/005
Skin Surface Area - child	SA_c	6,600	cm^2	EPA/540/R/99/005
Slope Factor - inhalation	SF_i	COPC-specific	risk/pCi	See Table 4-2
Slope Factor - oral	SF_o	COPC-specific	risk/pCi	See Table 4-2
Time to reach steady state conditions	t*	COPC-specific	hour	See Table 4-2
Lag time	τ	COPC-specific	hours/event	See Table 4-2
Volatilization Factor	VF	0.5	L/m^3	EPA/540/R-92/003

Table 3-1. Summary of Exposure Assumptions Used for the Tap Water Exposure Pathway for the 200-PO-1 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source

Notes:

ECF-200PO1-09-2018, *Calculation of Exposure Point Concentrations for the 200-PO-1 Groundwater Operable Unit.*

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

OSWER Directive 9285.6-03, *Risk Assessment Guidance For Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance, "Standard Default Exposure Factors," Interim Final.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*

3.1.1 Tap Water Ingestion—Carcinogenic Effects

For ingestion of carcinogens, the chronic daily intake (CDI) is calculated with the following equations:

$$CDI = \frac{C_w \times IRW_{adj} \times EF}{AT \times CF1} \tag{1}$$

where:

$$IRW_{adj} = \frac{ED_c \times IRW_c}{BW_c} + \frac{(ED_a - ED_c) \times IRW_a}{BW_a} \tag{2}$$

Cancer risk is calculated using the following equation:

$$RISK = CDI \times CSFo \tag{3}$$

3.1.2 Tap Water Ingestion—Noncarcinogenic Effects

For ingestion of noncarcinogens, the CDI is calculated with the following equation:

$$CDI = \frac{C_w \times IRW_a \times EF \times ED_a}{BW_a \times AT \times CF1} \tag{4}$$

Noncancer hazard is calculated using the following equation:

$$HQ = \frac{CDI}{RfDo} \tag{5}$$

3.1.3 Tap Water Ingestion—Radionuclides

For ingestion of radionuclides, the CDI is calculated with the following equations:

$$CDI = C_w \times IRW_RAD_{adj} \times EF \tag{6}$$

where:

$$IRW_RAD_{adj} = (ED_c \times IRW_c) + ([ED_a - ED_c] \times IRW_a) \tag{7}$$

Radiological cancer risk is calculated with the following equation:

$$RISK = CDI \times SFo \tag{8}$$

3.2 Intake and Risk Equations for Tap Water Inhalation of Volatiles

The bases for the equations used to calculate intake, risk, and hazard associated with the inhalation of volatiles in tap water are summarized in Table 3-3. Equations are provided in the following subsections.

Table 3-3. Exposure Assumptions Used for the Tap Water Inhalation of Volatiles Route

Effect	Symbol for Calculated Value	Reference
Carcinogenic	CDI	RAIS Risk Exposure Models for Chemicals User's Guide (ORNL, 2010)
	Risk	EPA-540-R-070-002

Table 3-3. Exposure Assumptions Used for the Tap Water Inhalation of Volatiles Route

Effect	Symbol for Calculated Value	Reference
Noncarcinogenic	CDI	RAIS Risk Exposure Models for Chemicals User's Guide (ORNL, 2010)
	HQ	EPA-540-R-070-002
Radionuclide	CDI INH_RAD_{adj}	RAIS Risk Exposure Models for Radionuclides User's Guide (ORNL, 2010)
	ET_{adj}	EPA-540-R-070-002 and EPA/540/R/99/005
	Risk	EPA/540/R-92/003

Notes:
CDI= chronic daily intake.
ET_{adj} = age-adjusted exposure time.HQ = hazard quotient.
INH_RAD_{adj} = adjusted radionuclide inhalation rate.

EPA-540-R-070-002, *Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment).*

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

ORNL, 2010, The Risk Assessment Information System (RAIS).

3.2.1 Tap Water Inhalation of Volatiles—Carcinogenic Effects

For inhalation of carcinogens, the CDI is calculated with the following equation:

$$CDI = \frac{C_W \times ED_a \times EF \times ET_a \times CF2 \times VF \times \left(1000 \frac{\mu g}{mg}\right)}{AT \times CF1} \tag{9}$$

Cancer risk is calculated with the following equation:

$$RISK = CDI \times IUR \tag{10}$$

3.2.2 Tap Water Inhalation of Volatiles— Noncarcinogenic Effects

For inhalation of noncarcinogens, the CDI is calculated with the following equation:

$$CDI = \frac{C_W \times ED_a \times EF \times ET_a \times CF2 \times VF}{AT \times CF1} \tag{11}$$

Noncancer hazard is calculated with the following equation:

$$HQ = \frac{CDI}{RfC} \tag{12}$$

3.2.3 Tap Water Inhalation of Volatiles— Radionuclides

For inhalation of radionuclides, the CDI is calculated with the following equations:

$$CDI = C_w \times INH_RAD_{adj} \times VF \times EF \times ET_{adj} \times CF2 \quad (13)$$

where:

$$INH_RAD_{adj} = (ED_c \times INH_c) + ([ED_a - ED_c] \times INH_a) \quad (14)$$

and:

$$ET_{adj} = \frac{(ET_c \times ED_c) + ((ED_a - ED_c) \times ET_a)}{ED_a} \quad (15)$$

Radiological cancer risk is calculated with the following equation:

$$RISK = CDI \times SFi \quad (16)$$

3.3 Intake and Risk Equations for Tap Water Dermal Absorption

The bases for the equations used to calculate intake, risk, and hazard associated with the tap water dermal absorption exposure route is provided in Table 3-4. The equations are presented in the following subsections.

Table 3-4. Exposure Assumptions Used for the Tap Water Dermal Exposure Route

Effect	Calculated Value	Reference
Carcinogenic	CDI	EPA/540/R/99/005
	SA_{adj}	EPA/540/R/99/005
	ET_{adj}	EPA/540/R/99/005
	DA_{event}	EPA/540/R/99/005
	Risk	EPA/540/R/99/005
Noncarcinogenic	CDI	EPA/540/R/99/005
	DA_{event}	EPA/540/R/99/005
	HQ	EPA/540/R/99/005
Radionuclide	Not applicable	

Notes:
CDI= chronic daily intake.
DA_{event} = absorbed dose per event.
ET_{adj} = age-adjusted exposure time.
HQ = hazard quotient.
SA_{adj} = age-adjusted skin surface area.
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

3.3.1 Tap Water Dermal Absorption—Carcinogenic Effects

For dermal exposure to carcinogens, the CDI is calculated with the following equations:

$$CDI = \frac{DA_{event} \times SA_{adj} \times EF}{AT \times CF1} \tag{17}$$

where:

$$SA_{adj} = \frac{ED_c \times SA_c \times EV_c}{BW_c} + \frac{(ED_a - ED_c) \times SA_a \times EV_a}{BW_a} \tag{18}$$

Cancer risk is calculated with the following equation:

$$RISK = CDI \times \frac{CSFo}{GIABS} \tag{19}$$

3.3.2 Tap Water Dermal Absorption—Noncarcinogenic Effects

For dermal exposure to noncarcinogens, the CDI is calculated with the following equation:

$$CDI = \frac{DA_{event} \times SA_a \times EF \times ED_a \times EV_a}{BW_a \times AT \times CF1} \tag{20}$$

Noncancer hazard is calculated with the following equation:

$$HQ = \frac{CDI}{RfDo \times GIABS} \tag{21}$$

3.3.3 Tap Water Dermal Absorption—Event Time (Carcinogenic Effects and Noncarcinogenic Effects)

The exposure time of each event, ET, is dependent upon the calculated effect. For noncarcinogens, the event time is not age-adjusted. For carcinogens, the age-adjusted exposure event times are calculated with the following equation:

$$ET_{adj} = \frac{(ET_c \times ED_c) + ((ED_a - ED_c) \times ET_a)}{ED_a} \tag{22}$$

3.3.4 Tap Water Dermal Absorption—Dermally Absorbed Dose (Carcinogenic Effects and Noncarcinogenic Effects)

For organics, the following equations are used to calculate the dermally absorbed dose per event (DA_{event}), using the age-adjusted exposure time as calculated above for carcinogen effects and the adult exposure time for noncarcinogenic effects:

If ET[1] $\leq$ t*, then the following nonsteady-state equation is used:

$$DA_{event} = 2 \times FA \times Kp \times Cw \times CF3 \times \sqrt{\frac{6 \times \tau \times ET}{\pi}} \tag{23}$$

If ET[1] > t*, then the following pseudosteady-state equation is used:

[1] ETadj is used in place of ET for the calculation of CDI for carcinogenic COPCs.

$$DA_{event} = FA \times Kp \times Cw \times CF3 \times \left[\frac{ET}{1+B} + 2 \times \tau \times \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right] \tag{24}$$

For inorganics, the following steady-state equation is used to estimate DA_{event}, using the age-adjusted exposure time as calculated above for carcinogenic effects and the adult exposure time for noncarcinogenic effects:

$$DA_{event} = Kp \times Cw \times ET \times CF3 \tag{25}$$

3.3.5 Tap Water Dermal Absorption—Radionuclides

Dermal exposure to radionuclides in tap water is not evaluated. As noted, EPA does not publish radionuclide cancer slope factors to quantify cancer risk from external or dermal exposure to radioactive contaminants in water due to the shielding effects of water.

3.4 Cumulative Risk—Cancer

For estimating the cancer risks from exposure to multiple carcinogens from a single exposure route, the following equation is used. The basis for the equation is provided in EPA/540/1-89/002.

$$Risk_T = \sum_1^N Risk_i \tag{26}$$

where:

$Risk_T$	=	Total cancer risk from route of exposure
$Risk_i$	=	Cancer risk for the ith chemical
N	=	Number of chemicals

3.5 Hazard Index—Noncancer

The HI is calculated with the following equation. The basis for the equation is provided in EPA/540/1-89/002.

$$HI = \sum_1^N CDI_i \Big/ RfD_i \tag{27}$$

where:

HI	=	hazard index
CDI_i	=	chronic daily intake of the ith chemical (mg/kg-day)
RfD_i	=	reference dose of the ith chemical (mg/kg-day)
N	=	number of chemicals

4 Assumptions and Inputs

Assumptions and inputs associated with the residential exposure scenario and human health toxicity values used in the human health risk calculations and the groundwater COPCs and associated exposure point concentrations (EPCs) are described below.

4.1 Exposure Inputs and Assumptions

- Exposure routes evaluated for the tap water exposure pathway under a residential exposure scenario are ingestion, inhalation, and dermal absorption (dermal exposure is evaluated for nonradionuclides only).
- Exposure assumptions for the tap water exposure pathway are consistent with EPA guidance and provide a reasonable maximum exposure (RME) estimate for the residential scenario.
- Exposure inputs used to quantify contaminant intake (CDI) from tap water exposure for the RME residential scenario are provided in Table 3-1.
- For domestic use of groundwater as a drinking water supply, EPA considers the inhalation pathway potentially complete only for volatile contaminants because there is no mechanism for release of nonvolatile chemicals into the air in significant concentrations (EPA/540/R-92/003). For the tap water exposure pathway, inhalation intake is quantified only for volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
- Exposure times for dermal exposure to tap water (35 minutes for an adult, 1 hour for a child) are the EPA recommended values for showering/bathing for the RME residential scenario (EPA/540/R/99/005). Exposure times for inhalation of volatiles in tap water are assumed to be the same as for the dermal exposure route.

4.2 Groundwater Contaminants of Potential Concern and Exposure Point Concentrations

The COPCs used for this environmental calculation were selected by applying an initial screening step to the 200-PO-1 Groundwater OU analytical data set as described in *Contaminant of Potential Concern Selection for the 200-PO-1 Groundwater Operable Unit* (ECF-200PO1-09-2018). For purposes of this evaluation, comparisons to action levels were not made; any analyte in the (processed) combined 200-PO-1 Groundwater Area data set with at least one reported detection in either the 5-year or 10-year data set was identified as a COPC and assessed in the risk calculations. The EPCs associated with each COPC are the 95UCL groundwater concentration values calculated from the 200-PO-1 Groundwater OU analytical data set as described in *Calculation of Exposure Point Concentrations for the 200-PO-1 Groundwater Operable Unit* (ECF-200PO1-09-2027). The COPCs and associated EPCs for both the 5-year and 10-year data sets are presented in Table 4-3. EPCs for the 10-year data set are presented for comparison purposes only.

Table 4-3. 200-PO-1 Groundwater Operable Unit Contaminants of Potential Concern and Exposure Point Concentrations

Detected Analyte/COPC[a]	5-Year Data Set			10-Year Data Set		
	Near-Field EPC[b] (µg/L) or (pCi/L)	Far-Field EPC[b] (µg/L) or pCi/L)	River EPC[b] (µg/L) or pCi/L)	Near-Field EPC[b] (µg/L) or (pCi/L)	Far-Field EPC[b] (µg/L) or (pCi/L)	River EPC[b] (µg/L) or pCi/L)
(m+p)-Xylene	--	--	--	--	0.50	--
1,1,1-Trichloroethane	--	0.69	--	--	1.2	--
1,1-Dichloroethane	--	0.26	--	--	0.39	--
1,1-Dichloroethene	--	0.17	--	--	0.16	--
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	3.73E-06	--	--	3.73E-06	--	--
1,2,3,4,6,7,8-Heptachlorodibenzofuran	5.66E-06	--	--	5.60E-06	--	--
1,2,3,4,7,8-Hexachlorodibenzofuran	2.90E-06	--	--	2.90E-06	--	--
1,2,3,6,7,8-Hexachlorodibenzofuran	2.10E-06	--	--	2.10E-06	--	--
1,2-Dichlorobenzene	--	3.0	--	--	3.0	--
1,2-Dichloroethane	0.64	--	--	0.64	0.31	--
1,4-Dichlorobenzene	--	0.13	--	--	0.13	--
1,4-Dioxane	--	8.1	--	--	8.1	--
2,3,4,6-Tetrachlorophenol	7.7	--	--	7.7	--	--
2-Butanone	--	0.55	--	--	2.9	--
2-Methylphenol (cresol, o-)	--	--	--	7.5	--	--
2-Pentanone, 4-Methyl	--	0.64	--	--	0.64	--
4-Nitrophenol	--	--	--	7.2	--	--
Acetone	--	1.5	1.1	--	1.3	1.1
Aluminum	47	--	--	112	42	--
Arsenic	5.8	3.1	5.8	5.8	3.1	5.8
Barium	53	73	49	53	68	49
Benzene	--	--	--	--	1.9	--
Benzyl alcohol	--	--	--	--	2.7	--
Beryllium	0.34	--	--	0.34	0.36	--
Bis(2-ethylhexyl) phthalate	11	1.0	--	11	1.3	--
Cadmium	2.7	4.5	--	18	4.5	--
Carbon disulfide	--	0.21	--	--	0.39	--

Table 4-3. 200-PO-1 Groundwater Operable Unit Contaminants of Potential Concern and Exposure Point Concentrations

Detected Analyte/COPC[a]	5-Year Data Set			10-Year Data Set		
	Near-Field EPC[b] (µg/L) or (pCi/L)	Far-Field EPC[b] (µg/L) or pCi/L)	River EPC[b] (µg/L) or pCi/L)	Near-Field EPC[b] (µg/L) or (pCi/L)	Far-Field EPC[b] (µg/L) or (pCi/L)	River EPC[b] (µg/L) or pCi/L)
Carbon tetrachloride	0.28	0.17	0.27	1.8	0.16	0.28
Carbon-14	--	--	--	--	15	--
Chloride	12,623	9,970	11,373	11,440	9,821	12,545
Chlorobenzene	--	--	--	--	0.41	--
Chloroform	0.38	0.21	0.81	0.38	0.22	2.3
Chromium	15	9.5	10.0	16	7.5	14
cis-1,2-Dichloroethylene	--	--	--	--	0.20	--
Cobalt	4.5	--	--	4.4	--	--
Copper	4.4	4.9	6.0	4.5	3.0	6.0
Dinoseb(2-secButyl-4,6-dinitrophenol)	--	--	--	5.5	--	--
Fluoride	294	301	287	317	329	306
Gross alpha	5.3	6.4	2.4	4.9	6.0	2.8
Gross beta	--	32	31	--	27	22
Hexavalent Chromium	191	--	--	191	--	--
Iodine-129	2.7	2.0	--	3.2	1.8	--
Iron	90	121	611	144	473	611
Lead	1.5	0.58	0.68	1.4	0.71	0.66
Lithium	--	--	--	--	8.3	--
Manganese	6.2	16	42	9.6	11	41
Methanol	--	--	--	--	1,100	--
Methylene chloride	--	2.1	--	--	0.85	--
Molybdenum	--	--	--	--	1.5	--
Nickel	12	6.0	5.6	11	3.6	5.6
Nickel-63	--	4.1	--	--	7.7	--
Nitrate	34,098	23,864	28,582	31,205	23,757	28,952
Nitrite	57	82	460	34	79	460
Nitrogen in Nitrite and Nitrate	14,700	--	--	14,700	--	--

Table 4-3. 200-PO-1 Groundwater Operable Unit Contaminants of Potential Concern and Exposure Point Concentrations

Detected Analyte/COPC[a]	5-Year Data Set			10-Year Data Set		
	Near-Field EPC[b] (µg/L) or (pCi/L)	Far-Field EPC[b] (µg/L) or pCi/L)	River EPC[b] (µg/L) or pCi/L)	Near-Field EPC[b] (µg/L) or (pCi/L)	Far-Field EPC[b] (µg/L) or (pCi/L)	River EPC[b] (µg/L) or pCi/L)
Octachlorodibenzofuran	9.96E-06	--	--	9.96E-06	--	--
Octachlorodibenzo-p-dioxin	5.81E-06	--	--	5.69E-06	--	--
o-Xylene	--	--	--	--	0.21	--
Plutonium-239/240	0.029	--	--	0.029	--	--
Protactinium-231	0.28	0.31	--	0.28	0.31	--
Silver	5.7	5.8	--	5.7	5.3	--
Strontium	269	384	390	265	364	390
Strontium-90	4.3	0.61	2.6	4.6	0.61	2.6
Sulfate	64,094	45,031	42,560	56,164	45,070	41,899
Technetium-99	1,667	94	121	1,568	76	115
Tetrachloroethene	--	0.87	--	--	0.99	--
Thallium	--	--	0.37	--	--	0.37
Toluene	0.036	--	--	0.065	0.27	--
Total petroleum hydrocarbons - gasoline range	50	--	--	50	--	--
Tributyl phosphate	--	12	--	--	41	--
Trichloroethene	0.56	0.43	--	0.57	0.49	--
Trichloromonofluoromethane	--	0.58	--	--	0.58	--
Tritium	156,901	264,107	70,724	192,558	497,900	59,534
Uranium	20	17	5.6	15	17	5.5
Vanadium	22	13	17	22	13	17
Vinyl chloride	--	--	--	--	1.8	--
Zinc	96	69	6.7	92	109	6.7

Notes:

a. Source = ECF-200PO1-09-2018

b. Source = ECF-200PO1-09-2027

COPC = contaminant of potential concern.

EPC = exposure point concentration.

ECF-200PO1-09-2018, *Identification of Contaminants of Potential Concern for Groundwater Risk Assessment*

Table 4-3. 200-PO-1 Groundwater Operable Unit Contaminants of Potential Concern and Exposure Point Concentrations

Detected Analyte/COPC[a]	5-Year Data Set			10-Year Data Set		
	Near-Field EPC[b] (µg/L) or (pCi/L)	Far-Field EPC[b] (µg/L) or pCi/L)	River EPC[b] (µg/L) or pCi/L)	Near-Field EPC[b] (µg/L) or (pCi/L)	Far-Field EPC[b] (µg/L) or (pCi/L)	River EPC[b] (µg/L) or pCi/L)

at the 200-PO-1 Operable Unit.

ECF-200PO1-09-2027, *Calculation of Exposure Point Concentrations for the 200-PO-1 Groundwater Operable Unit.*

4.3 Toxicity Values

The toxicity criteria used for the human health risk calculations are provided in Table 4-2. The sources for these criteria are discussed below.

4.3.1 Toxicity Values for Nonradionuclides

For nonradionuclides, the COPC-specific toxicity values shown in Table 4-2 are determined using the recommended reference hierarchy as described in Cook, 2003, *Human Health Toxicity Values in Superfund Risk Assessments* . The hierarchy is summarized below.

- Tier 1 – The EPA Integrated Risk Information System (IRIS)
- Tier 2 – The EPA Provisional Peer Reviewed Toxicity Values (PPRTVs)
- Tier 3 – Other Toxicity Values

Tier 1 – IRIS

The preferred source of toxicity data is the EPA IRIS database (http://www.epa.gov/iris/index.html). Expert toxicologists at EPA have derived the values in this database and most values have undergone a thorough review and validation both within and outside EPA. If a toxicity value is available in IRIS, that value is used in preference to any other value.

Tier 2 – PPRTVs

If a toxicity value is not available in IRIS, the next source is the EPA PPRTVs. This source includes toxicity values that have been developed by the Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center. This database is not available to the general public, but is accessible to EPA risk assessors via the EPA intranet. These values are also published at the EPA Regional Screening Levels website (EPA, 2009).

Tier 3 – Other Toxicity Values

Tier 3 includes additional EPA and non-EPA sources of toxicity information, including:

- The California EPA (CalEPA) Toxicity Criteria Database contains toxicity values that are peer reviewed and address both carcinogenic and noncarcinogenic effects.

- The Agency for Toxic Substances and Disease Registry (ATSDR)'s Minimal Risk Levels (MRLs) for Hazard Substances are peer-reviewed estimates of the daily human exposure to hazardous substances that is likely to be without appreciable risk of adverse noncarcinogenic health effects over a specified duration of exposure.
- Toxicity values in EPA 540/R-97/036, *Health Effects Assessment Summary Tables (HEAST*

A derived RfD for nitrate was calculated from the RfD reported in IRIS (1.6 mg/kg-day) for nitrate as nitrogen (NO_3^--N) using the mass fraction of nitrogen in nitrate. The mass fraction of nitrogen in nitrate = mol wt N/mol wt NO_3^- = (14 g/mol)/(62 g/mol) = 0.226. The derived RfD for nitrate = (1.6 mg NO_3^--N/kg-day) x (1 mg NO_3^-/0.226 mg NO_3^--N) = 7.1 mg NO_3^-/kg-day.

A derived RfD for nitrite was calculated from the RfD reported in IRIS (0.1 mg/kg-day) for nitrite as nitrogen (NO_2^--N) using the mass fraction of nitrogen in nitrite. The mass fraction of nitrogen in nitrite = mol wt N/mol wt NO_2^- = (14 g/mol)/(46 g/mol) = 0.304. The derived RfD for nitrite = (0.1 mg NO_2^--N /kg-day) x (1 mg NO_2^-/0.304 mg NO_2^--N) = 0.3 mg NO_2^-/kg-day.

When Tier 1, Tier 2, or Tier 3 toxicity values are not available for a COPC, the toxicity values from the National Center for Environmental Assessment (NCEA) are used. NCEA values can be found in RAIS (ORNL, 2010).
For several nonradionuclide COPCs, the toxicity value used was obtained from a different source than recommended by the EPA Superfund hierarchy (Cook 2003). The differences in toxicity values are summarized below.

- For trichloroethene, the oral cancer slope factor of 0.089 $(mg/kg\text{-}day)^{-1}$ and inhalation unit risk of 2.5E-05 $(\mu g/m^3)^{-1}$ published in HEAST are used for this assessment. HEAST has not been updated since 1997 and does not reflect the most current source of information. The oral cancer slope factor and inhalation unit risk currently implemented by EPA in the Regional Screening Levels(EPA, 2009) are established by the CalEPA OEHHA. The oral slope factor of 0.0059 $(mg/kg\text{-}day)^{-1}$ and the Inhalation Unit Risk of 2.0E-06 $(\mu g/m^3)^{-1}$ derived by OEHHA are presented in OEHHA, 2009, *Public Health Goal for Chemicals In Drinking Water Trichloroethylene*. Use of the HEAST values in this assessment has the potential to over-estimate cancer risk.
- For fluoride, the oral reference dose of 0.06 mg/kg-day published on IRIS is used for this assessment. The value reported on IRIS has not been updated since 1989 and does not reflect the most current source of information. The oral reference dose currently implemented by EPA in the Regional Screening Levels (EPA, 2009) is established by the CalEPA OEHHA. The oral reference dose derived by OEHHA is 0.04 mg/kg-day as documented in OEHHA, 2003,*Chronic Toxicity Summary: Fluorides including Hydrogen Fluoride* . Use of the IRIS value in this assessment has the potential to under-estimate noncancer hazards.
- For hexavalent chromium, the current assessment considers carcinogenic effects only for inhalation exposures. An oral cancer slope factor has recently been published by the New Jersey Department of Environmental Protection (NJDEP). The oral cancer slope factor derived by NJDEP is 0.5 $(mg/kg\text{-}day)^{-1}$, as presented in NJDEP, 2009, *Derivation of an Ingestion-Based Soil Remediation Criterion for Cr+6 Based on the NTP Chronic Bioassay Data for Sodium Dichromate Dihydrate*. Assessing only inhalation carcinogenic effects from hexavalent chromium has the potential to under-estimate cancer risk.
- For consistency with previous Hanford analyses of carbon tetrachloride, the toxicity assessment uses an oral cancer slope factor of 0.13 $(mg/kg\text{-}day)^{-1}$, an oral reference dose of 0.0007 (mg/kg-day), and an inhalation unit risk factor of 1.5E-05 $(\mu g/m^3)^{-1}$ previously published in IRIS, as well as the inhalation reference concentration of 0.19 (mg/m^3) published by ATSDR. These values do

not reflect the most current toxicity values published for carbon tetrachloride. The oral cancer slope factor of 0.07 $(mg/kg\text{-}day)^{-1}$, oral reference dose of 0.004 (mg/kg-day), inhalation unit risk of 6E-06 $(\mu g/m^3)^{-1}$, and inhalation reference concentration of 0.1 (mg/m^3) for carbon tetrachloride is currently implemented by EPA in the Regional Screening Levels (EPA, 2009) and are established by IRIS. Use of the previous IRIS values in this assessment has the potential to over-estimate both cancer risks and noncancer hazards.

- For 1,1-dichloroethane, the oral reference dose of 0.2 mg/kg-day published by the PPRTV and inhalation reference concentration of 0.7 mg/m^3 published by HEAST (EPA 540-R-97-036) are used for this assessment. Both an oral carcinogenic potency factor and inhalation unit risk have recently been published by the CalEPA OEHHA. The oral carcinogenic potency factor derived by OEHHA is 0.0057 $(mg/kg\text{-}day)^{-1}$, and the inhalation unit risk derived by OEHHA is 1.6E-06 $(\mu g/m^3)^{-1}$, as presented in OEHHA, 2003, *Public Health Goals for Chemicals in Drinking Water: 1,1-Dichloroethane in Drinking Water*. Use of the PPRTV and HEAST values in this assessment has the potential to under-estimate cancer risk.

4.3.2 Toxicity Values for Radionuclides

The cancer slope factors for radionuclides in Table 4-2 were obtained online from EPA, 2001, "*Health Effects Assessment Summary Tables* database", "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

Table 4-2. Toxicity Criteria for 200-PO-1 Groundwater Operable Unit Contaminants of Potential Concern

COPC[a]	Oral Reference Dose (RfD_o)[b] (mg/kg-day)	Key	Oral Cancer Slope Factor (CSF_o)[b] $(mg/kg\text{-}day)^{-1}$ or Oral Slope Factor (SF_o)[c] (Risk/pCi)	Key	Inhalation Reference Concentration (RfC)[b] (mg/m^3)	Key	Inhalation Unit Risk (IUR)[b] $(\mu g/m^3)^{-1}$	Key	Inhalation Slope Factor (SF_i)[c] (Risk/pCi)	Key	Volatile Nonradionuclides[b] Radionuclides[c]	GIABS Nonradionuclides[b] Radionuclides[c] (unitless)	K_p[d] (cm/hr)	B[d] (unitless)	τ[d] (hours/event)	t^*[d] (hours)	FA[d] (unitless)
(m+p)-Xylene	2.00E-01	I	--	--	0.7	C	--	--	--	--	V	1	0.053	0.2	0.42	1.01	1
1,1,1-Trichloroethane	2.00E+00	I	--	--	5	I	--	--	--	--	V	1	0.013	0.1	0.6	1.43	1
1,1-Dichloroethane	2.00E-01	P	--	--	0.7	H	--	--	--	--	V	1	0.0067	0	0.38	0.92	1
1,1-Dichloroethene	5.00E-02	I	--	--	0.2	I	--	--	--	--	V	1	0.012	0	0.37	0.89	1
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	--	--	1300	WHO	--	--	0.38	WHO	--	--	--	1	--	--	--	--	--
1,2,3,4,6,7,8-Heptachlorodibenzofuran[e]	--	--	1300	WHO	--	--	0.38	WHO	--	--	--	1	1.45	--	--	--	--
1,2,3,4,7,8-Hexachlorodibenzofuran[e]	--	--	13000	WHO	--	--	3.8	WHO	--	--	--	1	2.25	--	--	--	--
1,2,3,6,7,8-Hexachlorodibenzofuran[e]	--	--	13000	WHO	--	--	3.8	WHO	--	--	--	1	2.25	--	--	--	--
1,2-Dichlorobenzene	9.00E-02	I	--	--	0.2	H	--	--	--	--	V	1	0.041	0.2	0.71	1.71	1
1,2-Dichloroethane	2.00E-02	P	0.091	I	2.4	A	0.000026	I	--	--	V	1	0.0042	0	0.38	0.92	1
1,4-Dichlorobenzene	7.00E-02	A	0.0054	C	0.8	I	0.000011	C	--	--	V	1	0.042	0.2	0.71	1.71	1
1,4-Dioxane	1.00E-01	A	0.011	I	3.6	A	7.7E-06	C	--	--	--	1	0.00033	0	0.33	0.8	1
2,3,4,6-Tetrachlorophenol[e]	3.00E-02	I	--	--	--	--	--	--	--	--	--	1	0.071	--	--	--	--
2-Butanone	6.00E-01	I	--	--	5	I	--	--	--	--	V	1	0.00096	0	0.27	0.65	1
2-Methylphenol (cresol, o-)	5.00E-02	I	--	--	0.6	C	--	--	--	--	--	1	0.0077	0	0.43	1.03	1
2-Pentanone, 4-Methyl	8.00E-02	H	--	--	3	I	--	--	--	--	V	1	0.0027	0	0.39	0.93	1
4-Nitrophenol	8.00E-03	N	--	--	--	--	--	--	--	--	--	1	0.0048	0	0.64	1.54	1
Acetone[e]	9.00E-01	I	--	--	31	A	--	--	--	--	V	1	0.000512	--	--	--	--
Aluminum	1.00E+00	P	--	--	5.00E-03	P	--	--	--	--	--	1	0.001	--	--	--	--
Arsenic	3.00E-04	I	1.50E+00	I	1.50E-05	C	4.30E-03	I	--	--	--	1	0.001	--	--	--	--
Barium	2.00E-01	I	--	--	0.0005	H	--	--	--	--	--	0.07	0.001	--	--	--	--
Benzene	4.00E-03	I	0.055	I	0.03	I	7.8E-06	I	--	--	V	1	0.015	0.1	0.29	0.7	1
Benzyl alcohol[e]	1.00E-01	P	--	--	--	--	--	--	--	--	--	1	0.00209	--	--	--	--
Beryllium	2.00E-03	I	--	--	2.00E-05	I	2.40E-03	I	--	--	--	0.007	0.001	--	--	--	--
Bis(2-ethylhexyl) phthalate	2.00E-02	I	0.014	I	--	--	2.4E-06	C	--	--	--	1	0.025	0.2	16.64	39.93	0.8
Cadmium	5.00E-04	I	--	--	1.00E-05	A	1.80E-03	I	--	--	--	0.05	0.001	--	--	--	--
Carbon disulfide	1.00E-01	I	--	--	0.7	I	--	--	--	--	V	1	0.017	0.1	0.3	0.72	1
Carbon tetrachloride	7.00E-04	I	1.30E-01	I	1.90E-01	A	1.50E-05	I	--	--	V	1	0.016	0.1	0.78	1.86	1
Carbon-14	--	--	1.55E-12	H	--	--	--	--	7.07E-12	H	--	--	--	--	--	--	--
Chloride	--	--	--	--	--	--	--	--	--	--	--	1	0.001	--	--	--	--
Chlorobenzene	2.00E-02	I	--	--	0.05	P	--	--	--	--	V	1	0.028	0.1	0.46	1.09	1
Chloroform	1.00E-02	I	3.10E-02	C	9.80E-02	A	2.30E-05	H	--	--	V	1	0.0068	0	0.5	1.19	1
Chromium	1.5	I	--	--	--	--	--	--	--	--	--	0.013	0.001	--	--	--	--
cis-1,2-Dichloroethylene	1.00E-02	P	--	--	--	--	--	--	--	--	V	1	0.0077	0	0.37	0.89	1
Cobalt	3.00E-04	P	--	--	6.00E-06	P	9.00E-03	P	--	--	--	1	0.0004	--	--	--	--
Copper	4.00E-02	H	--	--	--	--	--	--	--	--	--	1	0.001	--	--	--	--
Dinoseb(2-secButyl-4,6-dinitrophenol)[e]	1.00E-03	I	--	--	--	--	--	--	--	--	--	1	0.0163	--	--	--	--

Table 4-2. Toxicity Criteria for 200-PO-1 Groundwater Operable Unit Contaminants of Potential Concern

COPC[a]	Oral Reference Dose (RfD_o)[b] (mg/kg-day)	Key	Oral Cancer Slope Factor (CSF_o)[b] $(mg/kg\text{-}day)^{-1}$ or Oral Slope Factor (SF_o)[c] (Risk/pCi)	Key	Inhalation Reference Concentration (RfC)[b] (mg/m^3)	Key	Inhalation Unit Risk (IUR)[b] $(\mu g/m^3)^{-1}$	Key	Inhalation Slope Factor (SF_i)[c] (Risk/pCi)	Key	Volatile Nonradionuclides[b] Radionuclides[c]	GIABS Nonradionuclides[b] Radionuclides[c] (unitless)	K_p[d] (cm/hr)	B[d] (unitless)	τ[d] (hours/event)	t*[d] (hours)	FA[d] (unitless)
Fluoride	6.00E-02	I	--	--	1.30E-02	C	--	--	--	--	--	1	0.001	--	--	--	--
Gross alpha	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gross beta	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexavalent Chromium	3.00E-03	I	--	--	1.00E-04	I	8.40E-02	I	--	--	--	0.025	0.002	--	--	--	--
Iodine-129	--	--	1.48E-10	H	--	--	--	--	6.07E-11	H	--	1	--	--	--	--	--
Iron	7.00E-01	P	--	--	--	--	--	--	--	--	--	1	0.001	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	1	0.0001	--	--	--	--
Lithium	2.00E-03	P	--	--	--	--	--	--	--	--	--	1	0.001	--	--	--	--
Manganese	2.40E-02	I	--	--	5.00E-05	I	--	--	--	--	--	0.04	0.001	--	--	--	--
Methanol	5.00E-01	I	--	--	4	C	--	--	--	--	--	1	0.00032	0	0.16	0.39	1
Methylene chloride	6.00E-02	I	7.50E-03	I	1.00E+00	A	4.70E-07	I	--	--	V	1	0.0035	0	0.32	0.76	1
Molybdenum	5.00E-03	I	--	--	--	--	--	--	--	--	--	1	0.001	--	--	--	--
Nickel	2.00E-02	I	--	--	9.00E-05	A	2.60E-04	C	--	--	--	0.04	0.0002	--	--	--	--
Nickel-63	--	--	6.7E-13	H	--	--	--	--	1.64E-12	H	--	--	--	--	--	--	--
Nitrate	7.10E+00	I	--	--	--	--	--	--	--	--	--	1	0.001	--	--	--	--
Nitrite	3.00E-01	I	--	--	--	--	--	--	--	--	--	1	0.001	--	--	--	--
Nitrogen in Nitrite and Nitrate	1.60E+00	I	--	--	--	--	--	--	--	--	--	1	0.001	--	--	--	--
Octachlorodibenzofuran[e]	--	--	39	WHO	--	--	0.0114	WHO	--	--	--	1	2.63	--	--	--	--
Octachlorodibenzo-p-dioxin[e]	--	--	39	WHO	--	--	0.0114	WHO	--	--	--	1	1.16	--	--	--	--
o-Xylene	2.00E-01	I	--	--	0.7	C	--	--	--	--	V	1	0.054	0.2	0.42	1.01	1
Plutonium-239/240	--	--	1.35E-10	H	--	--	--	--	3.33E-08	H	--	--	--	--	--	--	--
Protactinium-231	--	--	1.73E-10	H	--	--	--	--	4.55E-08	H	--	--	--	--	--	--	--
Silver	5.00E-03	I	--	--	--	--	--	--	--	--	--	0.04	0.0006	--	--	--	--
Strontium	6.00E-01	I	--	--	--	--	--	--	--	--	--	1	0.001	--	--	--	--
Strontium-90	--	--	5.59E-11	H	--	--	--	--	1.05E-10	H	--	0.3	--	--	--	--	--
Sulfate	--	--	--	--	--	--	--	--	--	--	--	--	0.001	--	--	--	--
Technetium-99	--	--	2.75E-12	H	--	--	--	--	1.41E-11	H	--	0.5	--	--	--	--	--
Tetrachloroethene	1.00E-02	I	5.40E-01	C	2.70E-01	A	5.90E-06	C	--	C	V	1	0.033	0.2	0.91	2.18	1
Thallium	--	--	--	--	--	--	--	--	--	--	--	1	0.001	--	--	--	--
Toluene	8.00E-02	I	--	--	5	I	--	--	--	--	V	1	0.031	0.1	0.35	0.84	1
Total petroleum hydrocarbons - gasoline range	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Uranium Isotopes	3.00E-03	I	--	--	3.00E-04	A	--	--	--	--	--	1	0.001	--	--	--	--
Tributyl phosphate[e]	2.00E-01	P	9.20E-03	P	--	--	--	--	--	--	--	1	0.0228	--	--	--	--
Trichloroethene	--	--	8.90E-02	H	3.50E-02	H	2.50E-05	H	--	--	V	1	0.012	0.1	0.58	1.39	1
Trichloromonofluoromethane	3.00E-01	I	--	--	0.7	H	--	--	--	--	V	1	0.013	0.1	0.63	1.51	1
Tritium	--	--	5.07E-14	H	--	--	--	--	5.62E-14	H	V	1	--	--	--	--	--
Uranium	3.00E-03	I	--	--	3.00E-04	A	--	--	--	--	--	1	0.001	--	--	--	--
Vanadium	5.00E-03	S	--	--	--	--	--	--	--	--	--	1	0.001	--	--	--	--

Table 4-2. Toxicity Criteria for 200-PO-1 Groundwater Operable Unit Contaminants of Potential Concern

COPC[a]	Oral Reference Dose (RfD_o)[b] (mg/kg-day)	Key	Oral Cancer Slope Factor (CSF_o)[b] $(mg/kg\text{-}day)^{-1}$ or Oral Slope Factor (SF_o)[c] (Risk/pCi)	Key	Inhalation Reference Concentration (RfC)[b] (mg/m^3)	Key	Inhalation Unit Risk (IUR)[b] $(\mu g/m^3)^{-1}$	Key	Inhalation Slope Factor (SF_i)[c] (Risk/pCi)	Key	Volatile Nonradionuclides[b] Radionuclides[c]	GIABS Nonradionuclides[b] Radionuclides[c] (unitless)	K_p[d] (cm/hr)	B[d] (unitless)	τ[d] (hours/event)	t*[d] (hours)	FA[d] (unitless)
Vinyl chloride	3.00E-03	I	0.72	I	0.1	I	4.4E-06	I	--	--	V	1	0.0056	0	0.24	0.57	1
Zinc	3.00E-01	I	--	--	--	--	--	--	--	--	--	1	0.0006	--	--	--	--

Notes:

a. Source = ECF-200PO1-09-2018

b. Source = EPA, 2009.

c. Source = EPA, 2001.

d. Source = EPA/540/R/99/005, Exhibits 3-1 (inorganic COPCs) and B-3 (organic COPCs).

e. Source = ORNL, 2009.

-- = indicates toxicity value not available for this contaminant and exposure route.

A = ATSDR

B = partitioning constant.

C = Cal EPA

COPC = contaminant of potential concern.

FA = fraction absorbed.

GIABS = gastrointestinal absorption factor.

H = HEAST

I = IRIS

K_p = dermal permeability constant.

P = PPRTV

S= Vanadium uses the toxicity values for "Vanadium and Compounds"

t* = time to reach steady-state.

τ = lag time

V = volatile

WHO = World Health Organization as presented in EPA, 2009

ECF-100PO1-09-2018, *Identification of Contaminants of Potential Concern for Groundwater Risk Assessment at the 200-PO-1 Operable Unit.*

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

ORNL, 2009, The Risk Assessment Information System (RAIS).

5 Software Applications

All supporting calculations for this environmental calculation are performed on electronic spreadsheets using Microsoft Excel[2]. These spreadsheets are provided as electronic attachments to this environmental calculation.

6 Calculation

Potential human health risk is calculated using the methodology and the COPCs, EPCs, and toxicity factors documented in Sections 3 and 4 of this environmental calculation. The calculation spreadsheets (formatted for on-screen viewing) are provided as electronic attachments and are validated by comparison with hand calculations.

6.1 Tap Water Exposure Pathway Worksheets

The tap water exposure pathway calculations are contained in the Excel workbook "200-PO-1 Tap Water Equations - Attach A (5-Year Data Set 95 UCL).xlsx" for the 5-Year data set and "200-PO-1 Tap Water Equations - Attach B (10-Year Data Set 95 UCL).xlsx" for the 10-Year data set. The 10-year data set workbooks are provided for comparison purposes only. The worksheets in this workbook are listed in Table 6-1.

Table 6-1. Worksheets for the Tap Water Exposure Pathway Calculations

Far-Field Exposure Area	Near-Field Exposure Area	River Exposure Area
5-Year Data Set		
A-1: Results summary	A-7: Results summary	A-13: Results summary
A-2: Ingestion of nonradioactive COPCs in tap water	A-8: Ingestion of nonradioactive COPCs in tap water	A-14: Ingestion of nonradioactive COPCs in tap water
A-3: Inhalation of volatile nonradioactive COPCs in tap water	A-9: Inhalation of volatile nonradioactive COPCs in tap water	A-15: Inhalation of volatile nonradioactive COPCs in tap water
A-4: Dermal absorption of nonradioactive COPCs in tap water	A-10: Dermal absorption of nonradioactive COPCs in tap water	A-16: Dermal absorption of nonradioactive COPCs in tap water
10-Year Data Set		
B-1: Results summary	B-7: Results summary	B-13: Results summary
B-2: Ingestion of nonradioactive COPCs in tap water	B-8: Ingestion of nonradioactive COPCs in tap water	B-14: Ingestion of nonradioactive COPCs in tap water
B-3: Inhalation of volatile	B-9: Inhalation of volatile	B-15: Inhalation of volatile

[2] Excel is a trademark of Microsoft Corporation, Redmond, Washington.

Table 6-1. Worksheets for the Tap Water Exposure Pathway Calculations

Far-Field Exposure Area	Near-Field Exposure Area	River Exposure Area
nonradioactive COPCs in tap water	nonradioactive COPCs in tap water	nonradioactive COPCs in tap water
B-4: Dermal absorption of nonradioactive COPCs in tap water	B-10: Dermal absorption of nonradioactive COPCs in tap water	B-16: Dermal absorption of nonradioactive COPCs in tap water

6.2 Hand Calculations

The electronic spreadsheet calculations are validated by comparison with hand calculations. The hand calculations are presented in Appendix A. The hand calculations are intended to provide validation for the equations used.

7 Results/Conclusions

This section summarizes the results of the human health risk calculations for use of groundwater in the 200-PO-1 OU as a tap water source. Exposure to groundwater as a tap water source is evaluated using the following potential exposure routes: ingestion, inhalation of volatiles, and dermal contact (nonradionuclides only) under a residential exposure scenario. Table 7-1 provides a summary of the risk estimates by exposure route for the 5-Year data set. Table 7-2 provides a summary of the risk estimates by exposure route for the 10-Year data set. The results of 10-Year data set are provided for comparison purposes only. Additional detail including COPC-specific risk contributions is provided in the electronic spreadsheet attachments (identified in Table 6-1).

Table 7-1. Summary of Risk Estimates from Groundwater from the 200-PO-1 Groundwater Operable Unit via the Tap Water Exposure Pathway (5-Year Groundwater Data Set)

	Far-Field Exposure Area		Near-Field Exposure Area		River Exposure Area	
Exposure Route	**ELCR**	**HI**	**ELCR**	**HI**	**ELCR**	**HI**
Nonradionuclide COPCs						
Ingestion	8.2E-05	1.1	1.3E-04	3.8	1.3E-04	1.1
Inhalation	1.3E-07	< 0.01	2.2E-07	< 0.01	1.1E-07	< 0.01
Dermal	4.9E-06	0.04	4.4E-06	0.8	8.6E-07	0.02
Total	8.7E-05	1.2	1.4E-04	4.6	1.3E-04	1.1
Radionuclide COPCs						
Ingestion	2.7E-04	--	2.5E-04	--	7.7E-05	--
Inhalation	3.9E-05	--	2.3E-05	--	1.0E-05	--
Total	3.0E-04	--	2.7E-04	--	8.7E-05	--
Total ELCR[a]	3.9E-04	--	4.1E-04	--	2.2E-04	--

Notes:
a. Total ELCR represents the sum of the total nonradionuclide ELCR and the total radionuclide ELCR.
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
HI = hazard index.
-- = Indicates HI not applicable..

Table 7-2. Summary of Risk Estimates from Groundwater for the 200-PO-1 Groundwater Operable Unit via the Tap Water Exposure Pathway (10-Year Groundwater Data Set)

	Far-Field Exposure Area		Near-Field Exposure Area		River Exposure Area	
Exposure Route	**ELCR**	**HI**	**ELCR**	**HI**	**ELCR**	**HI**
Nonradionuclide COPCs						
Ingestion	1.1E-04	1.3	1.4E-04	4.8	1.3E-04	1.1
Inhalation	2.9E-07	< 0.01	3.3E-07	< 0.01	2.8E-07	< 0.01
Dermal	6.8E-06	0.05	5.2E-06	0.89	9.3E-07	0.02
Total	1.1E-04	1.4	1.4E-04	5.7	1.3E-04	1.1
Radionuclide COPCs						
Ingestion	4.9E-04	--	2.8E-04	--	6.6E-05	--
Inhalation	7.3E-05	--	2.8E-05	--	8.8E-06	--
Total	5.6E-04	--	3.1E-04	--	7.5E-05	--
Total ELCR[a]	6.7E-04	--	4.5E-04	--	2.1E-04	--

Notes:
a. Total ELCR represents the sum of the total nonradionuclide ELCR and the total radionuclide ELCR.
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
HI = hazard index.
-- = Indicates HI not applicable..

7.1.1.1 Far-Field Exposure Area

The cumulative ELCRs for the far-field exposure area 5-year data set are 8.7×10^{-5} for nonradiological COPCs and 3.0×10^{-4} for radiological COPCs. Both ELCRs are greater than the WAC 173-340-708 cumulative risk threshold of 1×10^{-5} for multiple hazardous substances and the radiological ELCR is greater than the EPA upper target risk threshold of 1×10^{-4}. The individual ELCR value for tritium is greater than the EPA upper target risk threshold of 1×10^{-4}.The individual ELCR values for iodine-129, technetium-99, and tetrachloroethene are within the EPA range of 1×10^{-4} to 1×10^{-6}. The risk for tetrachloroethene is greater than the WAC 173-340 cumulative risk threshold of 1×10^{-5}. The HI for the far-field exposure area 5-year data set is 1.2, which is greater than the EPA and WAC 173-340 target HI of 1.0. No individual COPCs in the 200-PO-1 far-field exposure area 5-year data set had a HQ greater than the EPA and WAC 173-340 target HI of 1.0.

Although the individual ELCR value associated with arsenic is within the EPA range of 1×10^{-4} to 1×10^{-6}, the EPC of 3.1 μg/L is considered to be within the range of naturally occurring concentrations. Therefore, arsenic is not considered to be a contributor to risk.

Although the individual ELCR value for 1,4-dioxane is within the EPA range of 1×10^{-4} to 1×10^{-6}, 1,4-dioxane is not considered to be a contributor to the ELCR. 1,4-Dioxane was detected in one of 307 water samples at well 699-24-33 at a concentration of 8.1 μg/L with a "B" data qualifier, indicating that the detection was a result of laboratory contamination and is not considered to be associated with a trend or local exposure point.

Although the individual ELCR value for protactinium-231 is within the EPA range of 1×10^{-4} to 1×10^{-6}, protactinium-231 is not considered to be a contributor to the ELCR. Protactinium-231 was detected in two of 11 water samples at wells 699-33-56 and 699-46-21B at concentrations of 0.19 μg/L and 0.31 μg/L respectively, and is not considered to be associated with a trend or local exposure point.

The individual ELCR value associated with tributyl phosphate is within the EPA range of 1×10^{-4} to 1×10^{-6}. Tributyl phosphate does not originate from a 200-PO-1 OU source instead it originates from the 618-10 burial ground therefore it is not considered to be a contributor to risk or HI.

7.1.1.2 Near-Field Exposure Area

The cumulative ELCRs for the near-field exposure area 5-year data set are 1.4×10^{-4} for nonradiological COPCs and 2.7×10^{-4} for radiological COPCs. Both ELCRs are greater than the WAC 173-340-708 cumulative risk threshold of 1×10^{-5} for multiple hazardous substances and greater than the EPA upper target risk threshold of 1×10^{-4}. The individual ELCR value for tritium is greater than the EPA upper target risk threshold of 1×10^{-4}. The individual ELCR values for iodine-129, strontium-90, and technetium-99 are within the EPA range of 1×10^{-4} to 1×10^{-6}. The HI for the near-field exposure area 5-year data set is 4.6, which is greater than the EPA and WAC 173-340 target HI of 1.0. No individual COPCs in the near-field exposure area had a HQ greater than the EPA and WAC 173-340 target HI of 1.0.

Although the individual ELCR value associated with arsenic is greater than EPA's regulatory target risk threshold of 1×10^{-4}, the EPC of 5.8 μg/L is considered to be within the range of naturally occurring concentrations of arsenic. Therefore, arsenic is not considered a contributor to risk or hazard.

Although the individual ELCR value for bis(2-ethylhexyl) phthalate is within the EPA range of 1×10^{-4} to 1×10^{-6}, bis(2-ethylhexyl) phthalate is not considered to be a contributor to the ELCR. Bis(2-ethylhexyl) phthalate was detected in one of 31 water samples at well 299-E25-39 at a concentration of 11 μg/L with a "B" data qualifier, indicating that the detection was a result of laboratory contamination.

Although hexavalent chromium is reported with an HQ greater than 1.0 it is not considered a contributor to the HI. Hexavalent chromium was only analyzed in three groundwater samples and was not identified as a preliminary COPC in DOE/RL-2007-31, 2008, *Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit.*

7.1.1.3 River Exposure Area

The cumulative ELCRs for the river exposure area 5-year data set are 1.3×10^{-4} for nonradiological COPCs and 8.7×10^{-5} for radiological COPCs. Both ELCRs are greater than the WAC 173-340-708 cumulative risk threshold of 1×10^{-5} for multiple hazardous substances and the nonradiological ELCR is great than the EPA upper target risk threshold of 1×10^{-4}. The individual ELCR values for strontium-90, technetium-99, and tritium are within the EPA range of 1×10^{-4} to 1×10^{-6}. The HI for the river exposure area 5-year data set is 1.1, which is greater than the EPA and WAC 173-340 target HI of 1.0. No individual COPCs in the 200-PO-1 river exposure area 5-year data set had a HQ greater than the EPA and WAC 173-340 target HI of 1.0.

Although the individual ELCR value associated with arsenic is greater than the EPA's regulatory target risk threshold of 1×10^{-4}, the EPC of 5.8 μg/L is considered to be within the range of naturally occurring concentrations. Therefore, arsenic is not considered to be a contributor to risk.

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APPENDIX A
HAND CALCULATIONS
(8 Sheets)

ECF-200PO1-11-0087 | 200-PO-1 Tap Water | [illegible] 9/7/2011 1 of 8

Tap Water Ingestion - Carcinogenic Effects

$$CDI = \frac{C_w * IRW_{adj} * EF}{AT * CF}$$

1,2-Dichloroethane - [illegible] - Nearfield

$$CDI = 0.00064\ mg/L * 1.086\ \frac{L\text{-year}}{kg\text{-day}} * 350\ \frac{days}{year}$$

$$70\ years * 365\ \frac{days}{year}$$

$$= 9.52\ E\text{-}06\ mg/kg\text{-day} \checkmark$$

where $IRW_{adj} = \frac{ED_c * IRW_a}{BW_a} + \frac{(ED_a - ED_c) * IRW_a}{BW_a}$

$$= \frac{6\ years * 1\ L/day}{15\ kg} + \frac{(30\ years - 6\ years)}{(70\ kg)} * 2\ L/day$$

$$= 1.086\ \frac{L\text{-year}}{kg\text{-day}} \checkmark$$

$$Risk = CDI * CSF_o$$

$$= 9.52\ E\text{-}06\ \frac{mg}{kg\text{-day}} * 9.1\ E\text{-}02\ \frac{kg\text{-day}}{mg}$$

$$= 8.66\ E\text{-}07 \checkmark$$

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Tap Water Ingestion Noncarcinogenic Effects

$CDI = \frac{C_w * IRW_a * EF * ED_a}{BW_a * AT_{nc} * 365}$

Silver - 5 year dataset Partial exposure Area

$= \frac{0.00518\ mg/L * 2\ L/day * 350\ days/year * 30\ years}{10\ kg * 3\ years * 365\ days/year}$

$= 1.58\ E\ 04\ \frac{mg}{kg \cdot day}$ ✓

$HQ = \frac{CDI}{RfD_o}$

$= 1.58\ E\ 04\ mg/kg\ day$

$5.0E-03\ mg/kg \cdot day$

$= 3.17\ E-02$ ✓

Tap Water Ingestion - Radionuclides

$CDI = C_w * IRW_RAD_{ad_1} * EF$

Technetium-99 - River Exposure Area

$= 121\ \frac{pCi}{L} * 541\ \frac{L\text{-}year}{day} * 350\ \frac{days}{year}$

$= 2.291\ 10^6\ pCi$ ✓

where

$IRW_RAD_{ad_1} = (ED_c * IRW_c) + ([ED_a - ED_c] * IRW_a)$

$= (6\ years * 1\ L/day) + ([30-6]\ years * 2\ L/day)$

$= 541\ \frac{L\text{-}year}{day}$ ✓

ECF-200PO1-11-0087 [illegible] Tap Water [illegible] Sam [illegible] 9/13/2011 [illegible]
Tap Water [illegible] Risk includes [illegible].

Risk = [illegible] * [illegible]

= 2.29 E-06 pCi * 2.15 E-12 Risk/pCi

= 6.29 E-06 ✓

Tap Water Inhalation of Volatile - Carcinogenic Effects

$$CDI = \frac{C_w * ER_w * F_w * T_w * CF_w * VF * (1000\,\mu g/mg)}{AT * C_w}$$

Chloroform - 10 year Data Set - Near Field

$$CDI = \frac{0.000381\ \frac{\mu g}{L} * 30\ years * 350\ \frac{days}{year} * 0.58\ \frac{hrs}{day} * \frac{1\ day}{24\ hr} * 0.54\ \frac{L}{m^3} * 1000\ \frac{\mu g}{mg}}{70\ years * 365\ days/year}$$

= 1.89 E-03 µg/m³ ✓

Risk = CDI * IUR

= 1.89 E-03 µg/m³ * 2.3 E-05 m³/µg

= 4.35 E-08 ✓

ECF-200PO1-11-0087 | 200-PO-1 Tap Water | [illegible] Cauthen 7/5/2011 4:08

Tap Water Inhalation of Volatiles - noncarcinogenic effects

$$CDI = \frac{C_w * ED * EF * ET * CF2 * VF}{AT * CF1}$$

Benzene - 10 ppm [illegible] - Fairfield

$$CDI = \frac{1.1E-01\ mg/L * 30\ years * 350\ days/year * 0.58\ hrs/day * 1\ day/24\ hrs * 0.5\ L/m^3}{30\ years * 365\ days/year}$$

$= 2.20E-05\ mg/m^3$ ✓

$$HQ = \frac{2.2E-05\ mg/m^3}{0.03\ mg/m^3}$$

$= 7.34E-04$ ✓

Tap Water Inhalation of Volatiles - radionuclides

$$CDI = C_w * INH_RAD_{adj} * VF * EF * ET_{adj} * CF2$$

where $INH_RAD_{adj} = (ED_c * INH_c) + ([ED_a - ED_c] * INH_a)$

$= 6\ years * 10\ m^3/day + [30 - 6]\ years * 20\ m^3/day$

$= 540\ m^3/day$

and $ET_{adj} = \frac{(ET_c * ED_c) + ([ED_a - ED_c] * ET_a)}{ED_a}$

$= \frac{(1\ hr/day * 6\ years) + ([30 - 6]\ years * 0.58\ hr/day)}{30\ years}$

$= 0.664\ hr/day$

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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[illegible]

[illegible]

CDI = [illegible] mg/kg-day * [illegible] kg/day * 350 days/year

10 years * 365 days/year

= 7.46E-06 mg/kg-day ✓

Risk = CDI * CSF

= 7.46E-06 mg/kg-day * 5.9 (mg/kg-day)$^{-1}$

= 4.4[illegible]E-05 ✓

Tap Water [illegible]

Tetrachloroethylene [illegible]

CDI = DI [illegible] * [illegible]

[illegible]

= [illegible] mg/cm^2-event * 15000 cm^2 * 365 d/yr * [illegible] / 70 kg * 30 years * 365 days/yr

= 1.42E-05 mg/kg-day ✓

ECF-200PO1-11-0087 [illegible] 9/3/2011 Tab 8

Tap [illegible] Dermal Absorption [illegible]

Tetrachloroethene - [illegible]

where DAevent = 1 * 1 * 0.0035 [illegible] * 8.11 [illegible] * 0.001 L/cm³

$$\times \sqrt{6 \times 0.011\,hr \times 0.55\,hrs}$$

= 5.76 E-08 mg/cm²-event ✓ (only for decomposed solid)

$$HQ = \frac{0.5\,E}{RfD \times 70\,AT}$$

$$= \frac{1.92\,E\text{-}05\ mg/kg\text{-}day}{1.0\,E\text{-}02\ mg/kg\text{-}day}$$

= 1.92 E-03 ✓

For DAevent,

When ET > 1 *

$$DA_{event} = FA * k_p * C_w * CF3 * \left[\frac{E1}{1+B} + 2 * \tau * \left[\frac{1+3B+3B^2}{(1+B)^2}\right]\right]$$

Exposure: 10 years [illegible]

$$DA_{event} = 1 * 0.0035 * 1.1\,\frac{mg}{L} * 0.001\,\frac{L}{cm^3} \left[\frac{0.58}{1+0} + 2 * 0.16 * \left[\frac{1+3\cdot 0+3\cdot 0^2}{(1+0)^2}\right]\right]$$

= 3.17 E-05 mg/cm²-event ✓

ECF-200PO1-0087 | 200-PO-1 Tap Water | Sam Luellen 9/13/2011 8of8

Tap Water Dermal Absorption

For DAevent Benzene –

$$DAevent = K_p * C_w * ET * C$$

Cadmium 10 year dermal non-child exposure a non-noncancer

$$DAevent = 0.001 \frac{cm}{hr} * 0.018 \frac{mg}{L} * 0.58 \frac{hr}{event} * 0.001 \frac{L}{cm^3}$$

$$= 1.04 \times 10^{-5} \frac{mg}{cm^2\text{-}event}$$ ✓

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Tap Water Risk Assessment (5 Year 95UCL)--Summary of Tap Water Exposure Pathway Noncancer Hazard Results for Nonradioactive COPCs in Groundwater.

Nonradioactive COPCs	Contaminant Concentration in Groundwater C_w (mg/L)	Volatile[a]	HQ (Inhalation) (unitless)	HQ (Ingestion) (unitless)	HQ (Dermal) (unitless)	Total HQ (unitless)	% Contribution
1,1,1-Trichloroethane	0.000691076	Yes	1.60E-06	9.47E-06	1.81E-06	1.29E-05	0.0011
1,1-Dichloroethane	0.000255649	Yes	4.23E-06	3.50E-05	2.74E-06	4.20E-05	0.0036
1,1-Dichloroethene	0.00016874	Yes	9.78E-06	9.25E-05	1.28E-05	1.15E-04	0.0100
1,2-Dichlorobenzene	0.003	Yes	1.74E-04	9.13E-04	5.98E-04	1.68E-03	0.15
1,4-Dichlorobenzene	0.000130957	Yes	1.90E-06	5.13E-05	3.44E-05	8.75E-05	0.0076
1,4-Dioxane	0.0081	--	--(b)	2.22E-03	7.97E-06	2.23E-03	0.19
2-Butanone	0.00055	Yes	1.27E-06	2.51E-05	2.37E-07	2.66E-05	0.0023
2-Pentanone, 4-Methyl	0.00064	Yes	2.47E-06	2.19E-04	7.00E-06	2.29E-04	0.020
Acetone	0.001511507	Yes	5.65E-07	4.60E-05	--	4.66E-05	0.0040
Arsenic	0.003140238	--	--(b)	2.87E-01	1.50E-03	2.88E-01	25
Barium	0.072881156	--	--(b)	9.98E-03	7.45E-04	1.07E-02	0.93
Bis(2-ethylhexyl) phthalate	0.001	--	--(b)	1.37E-03	2.12E-03	3.49E-03	0.30
Cadmium	0.0045	--	--(b)	2.47E-01	2.57E-02	2.72E-01	24
Carbon disulfide	0.00021	Yes	3.48E-06	5.75E-05	1.01E-05	7.12E-05	0.0062
Carbon tetrachloride	0.000170123	Yes	1.04E-05	6.66E-03	1.78E-03	8.45E-03	0.73
Chloride	9.9702351	--	--(b)	--	--	--	
Chloroform	0.000214204	Yes	2.53E-05	5.87E-04	5.35E-05	6.66E-04	0.058
Chromium	0.009493374	--	--(b)	1.73E-04	6.96E-05	2.43E-04	0.021
Copper	0.004884201	--	--(b)	3.35E-03	1.75E-05	3.36E-03	0.29
Fluoride	0.30080145	--	--(b)	1.37E-01	7.17E-04	1.38E-01	12
Iron	0.12126178	--	--(b)	4.75E-03	2.48E-05	4.77E-03	0.41
Lead	0.000581898	--	--(b)	--	--	--	
Manganese	0.015530827	--	--(b)	1.77E-02	2.31E-03	2.00E-02	1.7
Methylene chloride	0.002069589	Yes	2.40E-05	9.45E-04	3.54E-05	1.00E-03	0.087
Nickel	0.006014142	--	--(b)	8.24E-03	2.15E-04	8.45E-03	0.73
Nitrate	23.863649	--	--(b)	9.21E-02	4.81E-04	9.26E-02	8.0
Nitrite	0.081906164	--	--(b)	7.48E-03	3.90E-05	7.52E-03	0.65
Silver	0.005776818	--	--(b)	3.17E-02	2.48E-03	3.41E-02	3.0
Strontium	0.38364144	--	--(b)	1.75E-02	9.14E-05	1.76E-02	1.5
Sulfate	45.030868	--	--(b)	--	--	--	
Tetrachloroethene	0.000872033	Yes	3.74E-05	2.39E-03	1.42E-03	3.85E-03	0.33
Tributyl phosphate	0.012498806	--	--(b)	1.71E-03	--	1.71E-03	0.15
Trichloroethene	0.000433871	Yes	1.44E-04	--	--	1.44E-04	0.012
Trichloromonofluoromethane	0.00058	Yes	9.60E-06	5.30E-05	1.04E-05	7.29E-05	0.0063
Uranium	0.016629145	--	--(b)	1.52E-01	7.93E-04	1.53E-01	13
Vanadium	0.012904693	--	--(b)	7.07E-02	3.69E-04	7.11E-02	6.2
Zinc	0.068859746	--	--(b)	6.29E-03	1.97E-05	6.31E-03	0.55
Total HI			4.49E-04	1.1	0.042	1.2	100

[a]Volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
[b]Nonvolatile constituents are not considered in the inhalation exposure route
-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.
COPC = contaminant of potential concern.
HI = hazard index.
HQ = hazard quotient.

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Tap Water Risk Assessment (5 Year 95UCL)--Summary of Tap Water Exposure Pathway Cancer Risk Results for Nonradioactive COPCs in Groundwater.

Nonradioactive COPCs	Contaminant Concentration in Groundwater C_w (mg/L)	Volatile[a]	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Risk (Dermal) (unitless)	Total Risk (unitless)	% Contribution
1,1,1-Trichloroethane	0.000691076	Yes	--	--	--	--	
1,1-Dichloroethane	0.000255649	Yes	--	--	--	--	
1,1-Dichloroethene	0.00016874	Yes	--	--	--	--	
1,2-Dichlorobenzene	0.003	Yes	--	--	--	--	
1,4-Dichlorobenzene	0.000130957	Yes	7.15E-09	1.05E-08	6.80E-09	2.45E-08	0.028
1,4-Dioxane	0.0081	--	--(b)	1.33E-06	4.59E-09	1.33E-06	1.5
2-Butanone	0.00055	Yes	--	--	--	--	
2-Pentanone, 4-Methyl	0.00064	Yes	--	--	--	--	
Acetone	0.001511507	Yes	--	--	--	--	
Arsenic	0.003140238	--	--(b)	7.01E-05	3.78E-07	7.04E-05	81
Barium	0.072881156	--	--(b)	--	--	--	
Bis(2-ethylhexyl) phthalate	0.001	--	--(b)	2.08E-07	3.11E-07	5.19E-07	0.60
Cadmium	0.0045	--	--(b)	--	--	--	
Carbon disulfide	0.00021	Yes	--	--	--	--	
Carbon tetrachloride	0.000170123	Yes	1.27E-08	3.29E-07	8.50E-08	4.27E-07	0.49
Chloride	9.9702351	--	--(b)	--	--	--	
Chloroform	0.000214204	Yes	2.45E-08	9.88E-08	8.68E-09	1.32E-07	0.15
Chromium	0.009493374	--	--(b)	--	--	--	
Copper	0.004884201	--	--(b)	--	--	--	
Fluoride	0.30080145	--	--(b)	--	--	--	
Iron	0.12126178	--	--(b)	--	--	--	
Lead	0.000581898	--	--(b)	--	--	--	
Manganese	0.015530827	--	--(b)	--	--	--	
Methylene chloride	0.002069589	Yes	4.83E-09	2.31E-07	8.35E-09	2.44E-07	0.28
Nickel	0.006014142	--	--(b)	--	--	--	
Nitrate	23.863649	--	--(b)	--	--	--	
Nitrite	0.081906164	--	--(b)	--	--	--	
Silver	0.005776818	--	--(b)	--	--	--	
Strontium	0.38364144	--	--(b)	--	--	--	
Sulfate	45.030868	--	--(b)	--	--	--	
Tetrachloroethene	0.000872033	Yes	2.55E-08	7.00E-06	4.03E-06	1.11E-05	13
Tributyl phosphate	0.012498806	--	--(b)	1.71E-06	--	1.71E-06	2
Trichloroethene	0.000433871	Yes	5.39E-08	5.74E-07	9.59E-08	7.24E-07	0.84
Trichloromonofluoromethane	0.00058	Yes	--	--	--	--	
Uranium	0.016629145	--	--(b)	--	--	--	
Vanadium	0.012904693	--	--(b)	--	--	--	
Zinc	0.068859746	--	--(b)	--	--	--	
Total ELCR			1.29E-07	8.15E-05	4.93E-06	8.66E-05	100

[a]Volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
[b]Nonvolatile constituents are not considered in the inhalation exposure route
-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Tap Water Risk Assessment (5 Year 95UCL)--Summary of Tap Water Exposure Pathway Cancer Risk Results for Radioactive COPCs in Groundwater.

Radioactive COPCs	Contaminant Concentration in Groundwater C_w (pCi/L)	Volatile[a]	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Total Risk (unitless)	% Contribution
Gross alpha	6.4100896	--	--(b)	--	--	
Gross beta	32.397036	--	--(b)	--	--	
Iodine-129	1.9883847	--	--(b)	5.56E-06	5.56E-06	1.8
Nickel-63	4.07	--	--(b)	5.15E-08	5.15E-08	0.017
Protactinium-231	0.308	--	--(b)	1.01E-06	1.01E-06	0.33
Strontium-90	0.611	--	--(b)	6.46E-07	6.46E-07	0.21
Technetium-99	93.996334	--	--(b)	4.89E-06	4.89E-06	1.6
Tritium	264106.86	Yes	3.88E-05	2.53E-04	2.92E-04	96
Total ELCR			3.88E-05	2.65E-04	3.04E-04	100

[a]Volatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Fa
[b]Nonvolatile constituents are not considered in the inhalation exposure route
-- = Indicates radionuclide toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)

Far-field Exposure Area

Ingestion of Nonradioactive COPCs in Tap Water

Intake Parameter Values		Value			
Parameter	Symbol	Adult	Child	Unit	Source
Ingestion Chronic Daily Intake	CDI	Calculated		mg/kg-day	Calculated
Contaminant Concentration	C_w	COPC-specific		mg/L	ECF-200PO1-09-2027
Average Body Weight	BW	70	15	kg	EPA/540/R-92/003
Drinking Water Ingestion Rate	IRW	2	1	L/day	EPA/540/R-92/003 EPA/600/P-95/002Fa
Age-Adjusted Drinking Water Ingestion Rate	IRW_{adj}	1.086		L-year/kg-day	Calculated
Exposure Frequency	EF	350		days/year	EPA/540/R-92/003
Exposure Duration	ED	30	6	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70		years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30		years	EPA/540/R-92/003
Oral Reference Dose	RfD_o	COPC-specific		mg/kg-day	EPA, 2009
Oral Cancer Slope Factor	CSF_o	COPC-specific		$(mg/kg\text{-}day)^{-1}$	EPA, 2009
Conversion Factor	CF1	365		days/year	365 days = 1 year

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors*.

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD_o[a] (mg/kg-day)	HQ (unitless)	% Contribution
1,1,1-Trichloroethane	71-55-6	0.000691076	1.89E-05	2.00E+00	9.47E-06	8.53E-04
1,1-Dichloroethane	75-34-3	0.000255649	7.00E-06	2.00E-01	3.50E-05	0.0032
1,1-Dichloroethene	75-35-4	0.00016874	4.62E-06	5.00E-02	9.25E-05	0.0083
1,2-Dichlorobenzene	95-50-1	0.003	8.22E-05	9.00E-02	9.13E-04	0.082
1,4-Dichlorobenzene	106-46-7	0.000130957	3.59E-06	7.00E-02	5.13E-05	0.0046
1,4-Dioxane	123-91-1	0.0081	2.22E-04	1.00E-01	2.22E-03	0.20
2-Butanone	78-93-3	0.00055	1.51E-05	6.00E-01	2.51E-05	0.0023
2-Pentanone, 4-Methyl	108-10-1	0.00064	1.75E-05	8.00E-02	2.19E-04	0.020
Acetone	67-64-1	0.001511507	4.14E-05	9.00E-01	4.60E-05	0.0041
Arsenic	7440-38-2	0.003140238	8.60E-05	3.00E-04	2.87E-01	26
Barium	7440-39-3	0.072881156	2.00E-03	2.00E-01	9.98E-03	0.90
Bis(2-ethylhexyl) phthalate	117-81-7	0.001	2.74E-05	2.00E-02	1.37E-03	0.12
Cadmium	7440-43-9	0.0045	1.23E-04	5.00E-04	2.47E-01	22
Carbon disulfide	75-15-0	0.00021	5.75E-06	1.00E-01	5.75E-05	0.0052
Carbon tetrachloride	56-23-5	0.000170123	4.66E-06	7.00E-04	6.66E-03	0.60
Chloride	16887-00-6	9.9702351	2.73E-01	--	--	
Chloroform	67-66-3	0.000214204	5.87E-06	1.00E-02	5.87E-04	0.053
Chromium	7440-47-3	0.009493374	2.60E-04	1.50E+00	1.73E-04	0.016
Copper	7440-50-8	0.004884201	1.34E-04	4.00E-02	3.35E-03	0.30
Fluoride	16984-48-8	0.30080145	8.24E-03	6.00E-02	1.37E-01	12
Iron	7439-89-6	0.12126178	3.32E-03	7.00E-01	4.75E-03	0.43
Lead	7439-92-1	0.000581898	1.59E-05	--	--	
Manganese	7439-96-5	0.015530827	4.26E-04	2.40E-02	1.77E-02	1.6
Methylene chloride	75-09-2	0.002069589	5.67E-05	6.00E-02	9.45E-04	0.085
Nickel	7440-02-0	0.006014142	1.65E-04	2.00E-02	8.24E-03	0.74
Nitrate	14797-55-8	23.863649	6.54E-01	7.10E+00	9.21E-02	8.3
Nitrite	14797-65-0	0.081906164	2.24E-03	3.00E-01	7.48E-03	0.67
Silver	7440-22-4	0.005776818	1.58E-04	5.00E-03	3.17E-02	2.9
Strontium	7440-24-6	0.38364144	1.05E-02	6.00E-01	1.75E-02	1.6
Sulfate	14808-79-8	45.030868	1.23E+00	--	--	
Tetrachloroethene	127-18-4	0.000872033	2.39E-05	1.00E-02	2.39E-03	0.22
Tributyl phosphate	126-73-8	0.012498806	3.42E-04	2.00E-01	1.71E-03	0.15
Trichloroethene	79-01-6	0.000433871	1.19E-05	--	--	
Trichloromonofluoromethane	75-69-4	0.00058	1.59E-05	3.00E-01	5.30E-05	0.0048
Uranium	7440-61-1	0.016629145	4.56E-04	3.00E-03	1.52E-01	14
Vanadium	7440-62-2	0.012904693	3.54E-04	5.00E-03	7.07E-02	6.4
Zinc	7440-66-6	0.068859746	1.89E-03	3.00E-01	6.29E-03	0.57
Total HI					1.11	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HQ = hazard quotient.

HI = hazard index.

EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

Cancer risk calculation

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF_o[a] $(mg/kg\text{-}day)^{-1}$	Risk (unitless)	% Contribution
1,1,1-Trichloroethane	71-55-6	0.000691076	1.03E-05	--	--	
1,1-Dichloroethane	75-34-3	0.000255649	3.80E-06	--	--	
1,1-Dichloroethene	75-35-4	0.00016874	2.51E-06	--	--	
1,2-Dichlorobenzene	95-50-1	0.003	4.46E-05	--	--	
1,4-Dichlorobenzene	106-46-7	0.000130957	1.95E-06	5.40E-03	1.05E-08	0.013
1,4-Dioxane	123-91-1	0.0081	1.20E-04	1.10E-02	1.33E-06	1.6
2-Butanone	78-93-3	0.00055	8.18E-06	--	--	
2-Pentanone, 4-Methyl	108-10-1	0.00064	9.52E-06	--	--	
Acetone	67-64-1	0.001511507	2.25E-05	--	--	
Arsenic	7440-38-2	0.003140238	4.67E-05	1.50E+00	7.01E-05	86
Barium	7440-39-3	0.072881156	1.08E-03	--	--	
Bis(2-ethylhexyl) phthalate	117-81-7	0.001	1.49E-05	1.40E-02	2.08E-07	0.26
Cadmium	7440-43-9	0.0045	6.69E-05	--	--	
Carbon disulfide	75-15-0	0.00021	3.12E-06	--	--	
Carbon tetrachloride	56-23-5	0.000170123	2.53E-06	1.30E-01	3.29E-07	0.40
Chloride	16887-00-6	9.9702351	1.48E-01	--	--	
Chloroform	67-66-3	0.000214204	3.19E-06	3.10E-02	9.88E-08	0.12
Chromium	7440-47-3	0.009493374	1.41E-04	--	--	
Copper	7440-50-8	0.004884201	7.26E-05	--	--	
Fluoride	16984-48-8	0.30080145	4.47E-03	--	--	
Iron	7439-89-6	0.12126178	1.80E-03	--	--	
Lead	7439-92-1	0.000581898	8.65E-06	--	--	
Manganese	7439-96-5	0.015530827	2.31E-04	--	--	
Methylene chloride	75-09-2	0.002069589	3.08E-05	7.50E-03	2.31E-07	0.28
Nickel	7440-02-0	0.006014142	8.94E-05	--	--	
Nitrate	14797-55-8	23.863649	3.55E-01	--	--	
Nitrite	14797-65-0	0.081906164	1.22E-03	--	--	
Silver	7440-22-4	0.005776818	8.59E-05	--	--	
Strontium	7440-24-6	0.38364144	5.71E-03	--	--	
Sulfate	14808-79-8	45.030868	6.70E-01	--	--	
Tetrachloroethene	127-18-4	0.000872033	1.30E-05	5.40E-01	7.00E-06	8.6
Tributyl phosphate	126-73-8	0.012498806	1.86E-04	9.20E-03	1.71E-06	2.1
Trichloroethene	79-01-6	0.000433871	6.45E-06	8.90E-02	5.74E-07	0.70
Trichloromonofluoromethane	75-69-4	0.00058	8.63E-06	--	--	
Uranium	7440-61-1	0.016629145	2.47E-04	--	--	
Vanadium	7440-62-2	0.012904693	1.92E-04	--	--	
Zinc	7440-66-6	0.068859746	1.02E-03	--	--	
Total ELCR					8.15E-05	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
Far-field Exposure Area

Inhalation of Volatile Nonradioactive COPCs in Tap Water

Intake Parameter Values				
Parameter	Symbol	Value	Unit	Source
Inhalation Chronic Daily Intake	CDI	Calculated	mg/m^3 for noncarcinogens, $\mu g/m^3$ for carcinogens	Calculated
Contaminant Concentration	C_w	COPC-specific	mg/L	ECF-200PO1-09-2027
Exposure Time	ET	0.58	hours/day	EPA/540/R/99/005
Exposure Frequency	EF	350	days/year	EPA/540/R-92/003
Exposure Duration	ED	30	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70	years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30	years	EPA/540/R-92/003
Andelman Volatilization Factor	VF	0.5	L/m^3	EPA/540/R-92/003
Inhalation Reference Concentration	RfC	COPC-specific	mg/m^3	EPA, 2009
Inhalation Unit Risk	IUR	COPC-specific	$(\mu g/m^3)^{-1}$	EPA, 2009
Conversion Factor	CF1	365	days/year	365 days = 1 year
Conversion Factor	CF2	1/24	days/hour	1 day = 24 hours

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors* .

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Nonradioactive COPC	CAS #	Volatile[a]	C_w (mg/L)	CDI (noncarcinogen) (mg/m^3)	RfC[a] (mg/m^3)	HQ (unitless)	% Contribution
1,1,1-Trichloroethane	71-55-6	Yes	0.000691076	8.01E-06	5.00E+00	1.60E-06	0.36
1,1-Dichloroethane	75-34-3	Yes	0.000255649	2.96E-06	7.00E-01	4.23E-06	0.94
1,1-Dichloroethene	75-35-4	Yes	0.00016874	1.96E-06	2.00E-01	9.78E-06	2.2
1,2-Dichlorobenzene	95-50-1	Yes	0.003	3.48E-05	2.00E-01	1.74E-04	39
1,4-Dichlorobenzene	106-46-7	Yes	0.000130957	1.52E-06	8.00E-01	1.90E-06	0.42
1,4-Dioxane	123-91-1	--	0.0081	--(b)	3.60E+00	--(b)	
2-Butanone	78-93-3	Yes	0.00055	6.37E-06	5.00E+00	1.27E-06	0.28
2-Pentanone, 4-Methyl	108-10-1	Yes	0.00064	7.42E-06	3.00E+00	2.47E-06	0.55
Acetone	67-64-1	Yes	0.001511507	1.75E-05	3.10E+01	5.65E-07	0.13
Arsenic	7440-38-2	--	0.003140238	--(b)	1.50E-05	--(b)	
Barium	7440-39-3	--	0.072881156	--(b)	5.00E-04	--(b)	
Bis(2-ethylhexyl) phthalate	117-81-7	--	0.001	--(b)	--	--(b)	
Cadmium	7440-43-9	--	0.0045	--(b)	1.00E-05	--(b)	
Carbon disulfide	75-15-0	Yes	0.00021	2.43E-06	7.00E-01	3.48E-06	0.77
Carbon tetrachloride	56-23-5	Yes	0.000170123	1.97E-06	1.90E-01	1.04E-05	2.3
Chloride	16887-00-6	--	9.9702351	--(b)	--	--(b)	
Chloroform	67-66-3	Yes	0.000214204	2.48E-06	9.80E-02	2.53E-05	5.6
Chromium	7440-47-3	--	0.009493374	--(b)	--	--(b)	
Copper	7440-50-8	--	0.004884201	--(b)	--	--(b)	
Fluoride	16984-48-8	--	0.30080145	--(b)	1.30E-02	--(b)	
Iron	7439-89-6	--	0.12126178	--(b)	--	--(b)	
Lead	7439-92-1	--	0.000581898	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.015530827	--(b)	5.00E-05	--(b)	
Methylene chloride	75-09-2	Yes	0.002069589	2.40E-05	1.00E+00	2.40E-05	5.3
Nickel	7440-02-0	--	0.006014142	--(b)	9.00E-05	--(b)	
Nitrate	14797-55-8	--	23.863649	--(b)	--	--(b)	
Nitrite	14797-65-0	--	0.081906164	--(b)	--	--(b)	
Silver	7440-22-4	--	0.005776818	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.38364144	--(b)	--	--(b)	
Sulfate	14808-79-8	--	45.030868	--(b)	--	--(b)	
Tetrachloroethene	127-18-4	Yes	0.000872033	1.01E-05	2.70E-01	3.74E-05	8.3
Tributyl phosphate	126-73-8	--	0.012498806	--(b)	--	--(b)	
Trichloroethene	79-01-6	Yes	0.000433871	5.03E-06	3.50E-02	1.44E-04	32
Trichloromonofluoromethane	75-69-4	Yes	0.00058	6.72E-06	7.00E-01	9.60E-06	2.1
Uranium	7440-61-1	--	0.016629145	--(b)	3.00E-04	--(b)	
Vanadium	7440-62-2	--	0.012904693	--(b)	--	--(b)	
Zinc	7440-66-6	--	0.068859746	--(b)	--	--(b)	
Total HI						4.49E-04	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HQ = hazard quotient.

HI = hazard index.

EPA-540-R-070-002, *Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment).*

Cancer risk calculation

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Nonradioactive COPC	CAS #	Volatile[a]	C_w (mg/L)	CDI (carcinogen) ($\mu g/m^3$)	IUR[a] $(\mu g/m^3)^{-1}$	Risk (unitless)	% Contribution
1,1,1-Trichloroethane	71-55-6	Yes	0.000691076	3.43E-03	--	--	
1,1-Dichloroethane	75-34-3	Yes	0.000255649	1.27E-03	--	--	
1,1-Dichloroethene	75-35-4	Yes	0.00016874	8.38E-04	--	--	
1,2-Dichlorobenzene	95-50-1	Yes	0.003	1.49E-02	--	--	
1,4-Dichlorobenzene	106-46-7	Yes	0.000130957	6.50E-04	1.10E-05	7.15E-09	5.6
1,4-Dioxane	123-91-1	--	0.0081	--(b)	7.70E-06	--(b)	
2-Butanone	78-93-3	Yes	0.00055	2.73E-03	--	--	
2-Pentanone, 4-Methyl	108-10-1	Yes	0.00064	3.18E-03	--	--	
Acetone	67-64-1	Yes	0.001511507	7.51E-03	--	--	
Arsenic	7440-38-2	--	0.003140238	--(b)	4.30E-03	--(b)	
Barium	7440-39-3	--	0.072881156	--(b)	--	--(b)	
Bis(2-ethylhexyl) phthalate	117-81-7	--	0.001	--(b)	2.40E-06	--(b)	
Cadmium	7440-43-9	--	0.0045	--(b)	1.80E-03	--(b)	
Carbon disulfide	75-15-0	Yes	0.00021	1.04E-03	--	--	
Carbon tetrachloride	56-23-5	Yes	0.000170123	8.45E-04	1.50E-05	1.27E-08	9.9
Chloride	16887-00-6	--	9.9702351	--(b)	--	--(b)	
Chloroform	67-66-3	Yes	0.000214204	1.06E-03	2.30E-05	2.45E-08	19
Chromium	7440-47-3	--	0.009493374	--(b)	--	--(b)	
Copper	7440-50-8	--	0.004884201	--(b)	--	--(b)	
Fluoride	16984-48-8	--	0.30080145	--(b)	--	--(b)	
Iron	7439-89-6	--	0.12126178	--(b)	--	--(b)	
Lead	7439-92-1	--	0.000581898	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.015530827	--(b)	--	--(b)	
Methylene chloride	75-09-2	Yes	0.002069589	1.03E-02	4.70E-07	4.83E-09	3.8
Nickel	7440-02-0	--	0.006014142	--(b)	2.60E-04	--(b)	
Nitrate	14797-55-8	--	23.863649	--(b)	--	--(b)	
Nitrite	14797-65-0	--	0.081906164	--(b)	--	--(b)	
Silver	7440-22-4	--	0.005776818	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.38364144	--(b)	--	--(b)	
Sulfate	14808-79-8	--	45.030868	--(b)	--	--(b)	
Tetrachloroethene	127-18-4	Yes	0.000872033	4.33E-03	5.90E-06	2.55E-08	20
Tributyl phosphate	126-73-8	--	0.012498806	--(b)	--	--(b)	
Trichloroethene	79-01-6	Yes	0.000433871	2.15E-03	2.50E-05	5.39E-08	42
Trichloromonofluoromethane	75-69-4	Yes	0.00058	2.88E-03	--	--	
Uranium	7440-61-1	--	0.016629145	--(b)	--	--(b)	
Vanadium	7440-62-2	--	0.012904693	--(b)	--	--(b)	
Zinc	7440-66-6	--	0.068859746	--(b)	--	--(b)	
Total ELCR						1.29E-07	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

EPA-540-R-070-002, *Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment).*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
Near-field Exposure Area

Dermal Absorption of Nonradioactive COPCs in Tap Water

Intake Parameter Values		Value			
Parameter	Symbol	Adult	Child	Unit	Source
Chronic Daily Intake	CDI	calculated		mg/kg-day	Calculated
Contaminant Concentration	C_w	COPC-specific		mg/L	ECF-200PO1-09-2027
Average Body Weight	BW	70	15	kg	EPA/540/R-92/003
Exposure Time	ET	0.58	1	hours/event	EPA/540/R/99/005
Exposure Time (Age-Adjusted)	ET_{adj}	0.664		hours/event	Calculated
Surface Area	SA	18,000	6,600	cm^2	EPA/540/R/99/005
Age-Adjusted Surface Area	SA_{adj}	8,811		(cm^2-year-event)/(kg/day)	Calculated
Event Frequency	EV	1		event/day	EPA/540/R/99/005
Exposure Frequency	EF	350		days/year	EPA/540/R-92/003
Exposure Duration	ED	30	6	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70		years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30		years	EPA/540/R-92/003
Oral Reference Dose	RfD_o	COPC-specific		mg/kg-day	EPA, 2009
Oral Cancer Slope Factor	CSF_o	COPC-specific		$(mg/kg\text{-}day)^{-1}$	EPA, 2009
Conversion Factor	CF1	365		days/year	365 days = 1 year
Conversion Factor	CF3	0.001		L/cm^3	1 L = 1000 cm^3
The constant pi	π	3.14159		unitless	--
Time to reach steady state	t^*	COPC-specific		hours	EPA/540/R/99/005
Dermal Partitioning Constant	B	COPC-specific		unitless	EPA/540/R/99/005
Absorbed Dose per Event	DA	calculated		mg/cm^2-event	Calculated
Dermal Permeability Constant	K_p	COPC-specific		cm/hour	EPA/540/R/99/005
Fraction Absorbed	FA	COPC-specific		unitless	EPA/540/R/99/005
Lag Time	τ	COPC-specific		hours/event	EPA/540/R/99/005
Fraction of Contaminant Absorbed in Gastrointestinal Tract	GIABS	COPC-specific		unitless	EPA, 2009

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.
EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*
EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Absorbed Dermal Dose Calculation

Contaminant of Potential Concern	CAS #	C_w (mg/L)	Inorganic/organic[a]	FA[b] (unitless)	K_p[c] (cm/hour)	B[b] (unitless)	t^*[b] (hours/event)	t^{*b} (hours)	DA (noncancer) (mg/cm^2-event)	DA (cancer) (mg/cm^2-event)
1,1,1-Trichloroethane	71-55-6	0.000691076	--	1.00E+00	0.013	0.1	0.6	1.43	1.46E-08	1.57E-08
1,1-Dichloroethane	75-34-3	0.000255649	--	1.00E+00	0.0067	0	0.38	0.92	2.22E-09	2.38E-09
1,1-Dichloroethene	75-35-4	0.00016874	--	1.00E+00	0.012	0	0.37	0.89	2.59E-09	2.77E-09
1,2-Dichlorobenzene	95-50-1	0.003	--	1.00E+00	0.041	0.2	0.71	1.71	2.18E-07	2.33E-07
1,4-Dichlorobenzene	106-46-7	0.000130957	--	1.00E+00	0.042	0.2	0.71	1.71	9.76E-09	1.04E-08
1,4-Dioxane	123-91-1	0.0081	--	1.00E+00	0.00033	0	0.33	0.8	3.23E-09	3.46E-09
2-Butanone	78-93-3	0.00055	--	1.00E+00	0.00096	0	0.27	0.65	5.78E-10	6.36E-10
2-Pentanone, 4-Methyl	108-10-1	0.00064	--	1.00E+00	0.0027	0	0.39	0.93	2.27E-09	2.43E-09
Acetone[c]	67-64-1	0.001511507	--	--	0.000512	--	--	--	--	--
Arsenic	7440-38-2	0.003140238	INORGANIC	--	0.001	--	--	--	1.82E-09	2.09E-09
Barium	7440-39-3	0.072881156	INORGANIC	--	0.001	--	--	--	4.23E-08	4.84E-08
Bis(2-ethylhexyl) phthalate	117-81-7	0.001	--	8.00E-01	0.025	0.2	16.64	39.93	1.72E-07	1.84E-07
Cadmium	7440-43-9	0.0045	INORGANIC	--	0.001	--	--	--	2.61E-09	2.99E-09
Carbon disulfide	75-15-0	0.00021	--	1.00E+00	0.017	0.1	0.3	0.72	4.12E-09	4.40E-09
Carbon tetrachloride	56-23-5	0.000170123	--	1.00E+00	0.016	0.1	0.78	1.86	5.06E-09	5.41E-09
Chloride	16887-00-6	9.9702351	INORGANIC	--	0.001	--	--	--	5.78E-06	6.62E-06
Chloroform	67-66-3	0.000214204	--	1.00E+00	0.0068	0	0.5	1.19	2.17E-09	2.32E-09
Chromium	7440-47-3	0.009493374	INORGANIC	--	0.001	--	--	--	5.51E-09	6.30E-09
Copper	7440-50-8	0.004884201	INORGANIC	--	0.001	--	--	--	2.83E-09	3.24E-09
Fluoride	16984-48-8	0.30080145	INORGANIC	--	0.001	--	--	--	1.74E-07	2.00E-07
Iron	7439-89-6	0.12126178	INORGANIC	--	0.001	--	--	--	7.03E-08	8.05E-08
Lead	7439-92-1	0.000581898	INORGANIC	--	0.0001	--	--	--	3.38E-11	3.86E-11
Manganese	7439-96-5	0.015530827	INORGANIC	--	0.001	--	--	--	9.01E-09	1.03E-08
Methylene chloride	75-09-2	0.002069589	--	1.00E+00	0.0035	0	0.32	0.76	8.63E-09	9.23E-09
Nickel	7440-02-0	0.006014142	INORGANIC	--	0.0002	--	--	--	6.98E-10	7.99E-10
Nitrate	14797-55-8	23.863649	INORGANIC	--	0.001	--	--	--	1.38E-05	1.58E-05
Nitrite	14797-65-0	0.081906164	INORGANIC	--	0.001	--	--	--	4.75E-08	5.44E-08
Silver	7440-22-4	0.005776818	INORGANIC	--	0.0006	--	--	--	2.01E-09	2.30E-09
Strontium	7440-24-6	0.38364144	INORGANIC	--	0.001	--	--	--	2.23E-07	2.55E-07
Sulfate	14808-79-8	45.030868	INORGANIC	--	0.001	--	--	--	2.61E-05	2.99E-05
Tetrachloroethene	127-18-4	0.000872033	--	1.00E+00	0.033	0.2	0.91	2.18	5.78E-08	6.18E-08
Tributyl phosphate[c]	126-73-8	0.012498806	--	--	0.0228	--	--	--	--	--
Trichloroethene	79-01-6	0.000433871	--	1.00E+00	0.012	0.1	0.58	1.39	8.35E-09	8.93E-09
Trichloromonofluoromethane	75-69-4	0.00058	--	1.00E+00	0.013	0.1	0.63	1.51	1.26E-08	1.35E-08
Uranium	7440-61-1	0.016629145	INORGANIC	--	0.001	--	--	--	9.64E-09	1.10E-08
Vanadium	7440-62-2	0.012904693	INORGANIC	--	0.001	--	--	--	7.48E-09	8.57E-09
Zinc	7440-66-6	0.068859746	INORGANIC	--	0.0006	--	--	--	2.40E-08	2.74E-08

[a]EPA/540/R/99/005, Exhibit 3-1 (inorganics) and Exhibit B-3 (organics)
[b]EPA/540/R/99/005, Exhibit B-3
[c]the K_p value was taken from ORNL, 2010, The Risk Assessment Information System (RAIS).

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD_o[a] (mg/kg-day)	GIABS[a] (unitless)	HQ (unitless)	% Contribution
1,1,1-Trichloroethane	71-55-6	0.000691076	3.61E-06	2.00E+00	1	1.81E-06	0.0043
1,1-Dichloroethane	75-34-3	0.000255649	5.48E-07	2.00E-01	1	2.74E-06	0.0066
1,1-Dichloroethene	75-35-4	0.00016874	6.39E-07	5.00E-02	1	1.28E-05	0.031
1,2-Dichlorobenzene	95-50-1	0.003	5.38E-05	9.00E-02	1	5.98E-04	1.4
1,4-Dichlorobenzene	106-46-7	0.000130957	2.41E-06	7.00E-02	1	3.44E-05	0.082
1,4-Dioxane	123-91-1	0.0081	7.97E-07	1.00E-01	1	7.97E-06	0.019
2-Butanone	78-93-3	0.00055	1.42E-07	6.00E-01	1	2.37E-07	5.69E-04
2-Pentanone, 4-Methyl	108-10-1	0.00064	5.60E-07	8.00E-02	1	7.00E-06	0.017
Acetone	67-64-1	0.001511507	--	9.00E-01	1	--	--
Arsenic	7440-38-2	0.003140238	4.49E-07	3.00E-04	1	1.50E-03	3.6
Barium	7440-39-3	0.072881156	1.04E-05	2.00E-01	0.07	7.45E-04	1.8
Bis(2-ethylhexyl) phthalate	117-81-7	0.001	4.23E-05	2.00E-02	1	2.12E-03	5.1
Cadmium	7440-43-9	0.0045	6.44E-07	5.00E-04	0.05	2.57E-02	62
Carbon disulfide	75-15-0	0.00021	1.01E-06	1.00E-01	1	1.01E-05	0.024
Carbon tetrachloride	56-23-5	0.000170123	1.25E-06	7.00E-04	1	1.78E-03	4.3
Chloride	16887-00-6	9.9702351	1.43E-03	--	1	--	
Chloroform	67-66-3	0.000214204	5.35E-07	1.00E-02	1	5.35E-05	0.13
Chromium	7440-47-3	0.009493374	1.36E-06	1.50E+00	0.013	6.96E-05	0.17
Copper	7440-50-8	0.004884201	6.99E-07	4.00E-02	1	1.75E-05	0.042
Fluoride	16984-48-8	0.30080145	4.30E-05	6.00E-02	1	7.17E-04	1.7
Iron	7439-89-6	0.12126178	1.73E-05	7.00E-01	1	2.48E-05	0.059
Lead	7439-92-1	0.000581898	8.32E-09	--	1	--	--
Manganese	7439-96-5	0.015530827	2.22E-06	2.40E-02	0.04	2.31E-03	5.5
Methylene chloride	75-09-2	0.002069589	2.13E-06	6.00E-02	1	3.54E-05	0.085
Nickel	7440-02-0	0.006014142	1.72E-07	2.00E-02	0.04	2.15E-04	0.52
Nitrate	14797-55-8	23.863649	3.41E-03	7.10E+00	1	4.81E-04	1.2
Nitrite	14797-65-0	0.081906164	1.17E-05	3.00E-01	1	3.90E-05	0.094
Silver	7440-22-4	0.005776818	4.96E-07	5.00E-03	0.04	2.48E-03	5.9
Strontium	7440-24-6	0.38364144	5.49E-05	6.00E-01	1	9.14E-05	0.22
Sulfate	14808-79-8	45.030868	6.44E-03	--	--	--	
Tetrachloroethene	127-18-4	0.000872033	1.42E-05	1.00E-02	1	1.42E-03	3.4
Tributyl phosphate	126-73-8	0.012498806	--	2.00E-01	1	--	
Trichloroethene	79-01-6	0.000433871	2.06E-06	--	1	--	
Trichloromonofluoromethane	75-69-4	0.00058	3.11E-06	3.00E-01	1	1.04E-05	0.025
Uranium	7440-61-1	0.016629145	2.38E-06	3.00E-03	1	7.93E-04	1.9
Vanadium	7440-62-2	0.012904693	1.85E-06	5.00E-03	1	3.69E-04	0.88
Zinc	7440-66-6	0.068859746	5.91E-06	3.00E-01	1	1.97E-05	0.047
Total HI						0.04	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.
COPC = contaminant of potential concern.
HI = hazard index
HQ = hazard quotient.
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

Cancer risk calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF_o[a] $(mg/kg\text{-}day)^{-1}$	GIABS[a] (unitless)	Risk (unitless)	% Contribution
1,1,1-Trichloroethane	71-55-6	0.000691076	1.89E-06	--	1	--	
1,1-Dichloroethane	75-34-3	0.000255649	2.87E-07	--	1	--	
1,1-Dichloroethene	75-35-4	0.00016874	3.35E-07	--	1	--	
1,2-Dichlorobenzene	95-50-1	0.003	2.82E-05	--	1	--	
1,4-Dichlorobenzene	106-46-7	0.000130957	1.26E-06	5.40E-03	1	6.80E-09	0.14
1,4-Dioxane	123-91-1	0.0081	4.17E-07	1.10E-02	1	4.59E-09	0.093
2-Butanone	78-93-3	0.00055	7.67E-08	--	1	--	
2-Pentanone, 4-Methyl	108-10-1	0.00064	2.93E-07	--	1	--	
Acetone	67-64-1	0.001511507	--	--	1	--	
Arsenic	7440-38-2	0.003140238	2.52E-07	1.50E+00	1	3.78E-07	7.7
Barium	7440-39-3	0.072881156	5.84E-06	--	0.07	--	
Bis(2-ethylhexyl) phthalate	117-81-7	0.001	2.22E-05	1.40E-02	1	3.11E-07	6.3
Cadmium	7440-43-9	0.0045	3.61E-07	--	0.05	--	
Carbon disulfide	75-15-0	0.00021	5.32E-07	--	1	--	
Carbon tetrachloride	56-23-5	0.000170123	6.54E-07	1.30E-01	1	8.50E-08	1.7
Chloride	16887-00-6	9.9702351	7.59E-04	--	1	--	
Chloroform	67-66-3	0.000214204	2.80E-07	3.10E-02	1	8.68E-09	0.18
Chromium	7440-47-3	0.009493374	7.61E-07	--	0.013	--	
Copper	7440-50-8	0.004884201	3.91E-07	--	1	--	
Fluoride	16984-48-8	0.30080145	2.41E-05	--	1	--	
Iron	7439-89-6	0.12126178	9.72E-06	--	1	--	
Lead	7439-92-1	0.000581898	4.66E-09	--	1	--	
Manganese	7439-96-5	0.015530827	1.24E-06	--	0.04	--	
Methylene chloride	75-09-2	0.002069589	1.11E-06	7.50E-03	1	8.35E-09	0.17
Nickel	7440-02-0	0.006014142	9.64E-08	--	0.04	--	
Nitrate	14797-55-8	23.863649	1.91E-03	--	1	--	
Nitrite	14797-65-0	0.081906164	6.56E-06	--	1	--	
Silver	7440-22-4	0.005776818	2.78E-07	--	0.04	--	
Strontium	7440-24-6	0.38364144	3.07E-05	--	1	--	
Sulfate	14808-79-8	45.030868	3.61E-03	--	--	--	
Tetrachloroethene	127-18-4	0.000872033	7.46E-06	5.40E-01	1	4.03E-06	82
Tributyl phosphate	126-73-8	0.012498806	--	9.20E-03	1	--	
Trichloroethene	79-01-6	0.000433871	1.08E-06	8.90E-02	1	9.59E-08	1.9
Trichloromonofluoromethane	75-69-4	0.00058	1.63E-06	--	1	--	
Uranium	7440-61-1	0.016629145	1.33E-06	--	1	--	
Vanadium	7440-62-2	0.012904693	1.03E-06	--	1	--	
Zinc	7440-66-6	0.068859746	3.31E-06	--	1	--	
Total ELCR						4.93E-06	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
Far-field Exposure Area

Inhalation of Volatile Radioactive COPCs in Tap Water

Intake Parameter Values		Value			
Factor	Symbol	Adult	Child	Unit	Reference
Chronic Daily Intake	CDI	Calculated		pCi	Calculated
Contaminant Concentration	C_w	COPC-specific		pCi/L	ECF-200PO1-09-2027
Exposure frequency	EF	350		days/year	EPA/540/R-92/003
Exposure duration	ED	30	6	years	EPA/540/R-92/003
Inhalation Rate	INH	20	10	m^3/day	OSWER Directive 9285.6-03 EPA/600/P-95/002Fa
Exposure time	ET	0.58	1	hours/day	EPA/540/R/99/005
Age Adjusted Exposure Time	ET_{adj}	0.664		hours/day	Calculated
Radiation Age-adjusted Inhalation Rate	INH_RAD_{adj}	540		m^3-year/day	Calculated
Andelman Volatilization Factor	VF	0.5		L/m^3	EPA/540/R-92/003
Slope Factor - Inhalation	SF_i	COPC-specific		risk/pCi	EPA, 2001
Conversion Factor	CF2	1/24		days/hour	1 day = 24 hours

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010
EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*
EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*
EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."
OSWER Directive 9285.6-03, *Risk Assessment Guidance For Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance "Standard Default Exposure Factors Interim Final"*

Inhalation of Volatile Radioactive Constituents in Groundwater

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Radioactive COPC	CAS #	Volatile[a]	C_w (pCi/L)	CDI (radiological inhalation) (pCi)	SF_i (risk/pCi)	Risk (unitless)	% Contribution
Gross alpha	12587-46-1	--	6.4100896	--(b)	--	--(b)	
Gross beta	12587-47-2	--	32.397036	--(b)	--	--(b)	
Iodine-129	15046-84-1	--	1.9883847	--(b)	6.07E-11	--(b)	
Nickel-63	13981-37-8	--	4.07	--(b)	1.64E-12	--(b)	
Protactinium-231	14331-85-2	--	0.308	--(b)	4.55E-08	--(b)	
Strontium-90	10098-97-2	--	0.611	--(b)	1.05E-10	--(b)	
Technetium-99	14133-76-7	--	93.996334	--(b)	1.41E-11	--(b)	
Tritium	10028-17-8	Yes	264106.86	6.91E+08	5.62E-14	3.88E-05	100
Total ELCR						3.88E-05	100

[a]Volatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."
[b]Nonvolatile constituents are not considered in the inhalation exposure route
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
Far-field Exposure Area

Ingestion of Radioactive COPCs in Tap Water

Intake Parameter Values		Value			
Factor	Symbol	Adult	Child	Unit	Reference
Chronic Daily Intake	CDI	Calculated		pCi	Calculated
Contaminant Concentration	C_w	COPC-specific		pCi/L	ECF-200PO1-09-2027
Exposure frequency	EF	350		days/year	EPA/540/R-92/003
Exposure duration	ED	30	6	years	EPA/540/R-92/003
Drinking Water Ingestion Rate	IRW	2	1	L/day	EPA/540/R-92/003 EPA/600/P-95/002Fa
Radiation Age-adjusted Drinking Water Ingestion Rate	IRW_RAD_{adj}	54		L-year/day	Calculated
Slope Factor - Oral	SF_o	COPC-specific		risk/pCi	EPA, 2001

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.
EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*
EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*
EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

Ingestion of Radioactive Constituents in Groundwater

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Radioactive COPC	CAS #	C_w (pCi/L)	CDI (radiological ingestion) (pCi)	SF_o (risk/pCi)	Risk (unitless)	% Contribution
Gross alpha	12587-46-1	6.4100896	1.21E+05	--	--	
Gross beta	12587-47-2	32.397036	6.12E+05	--	--	
Iodine-129	15046-84-1	1.9883847	3.76E+04	1.48E-10	5.56E-06	2.1
Nickel-63	13981-37-8	4.07	7.69E+04	6.70E-13	5.15E-08	0.019
Protactinium-231	14331-85-2	0.308	5.82E+03	1.73E-10	1.01E-06	0.38
Strontium-90	10098-97-2	0.611	1.15E+04	5.59E-11	6.46E-07	0.24
Technetium-99	14133-76-7	93.996334	1.78E+06	2.75E-12	4.89E-06	1.8
Tritium	10028-17-8	264106.86	4.99E+09	5.07E-14	2.53E-04	95
Total ELCR					2.65E-04	100

COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Tap Water Risk Assessment (5 Year 95UCL)--Summary of Tap Water Exposure Pathway Noncancer Hazard Results for Nonradioactive COPCs in Groundwater.

Nonradioactive COPCs	Contaminant Concentration in Groundwater C_w (mg/L)	Volatile[a]	HQ (Inhalation) (unitless)	HQ (Ingestion) (unitless)	HQ (Dermal) (unitless)	Total HQ (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	3.734E-09	--	--(b)	--	--	--	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	5.66E-09	--	--(b)	--	--	--	
1,2,3,4,7,8-Hexachlorodibenzofuran	2.9E-09	--	--(b)	--	--	--	
1,2,3,6,7,8-Hexachlorodibenzofuran	2.1E-09	--	--(b)	--	--	--	
1,2-Dichloroethane	0.00064	Yes	3.09E-06	8.77E-04	4.30E-05	9.23E-04	0.020
2,3,4,6-Tetrachlorophenol	0.0077	--	--(b)	7.03E-03	--	7.03E-03	0.15
Aluminum	0.046776593	--	--(b)	1.28E-03	6.69E-06	1.29E-03	0.028
Arsenic	0.00579213	--	--(b)	5.29E-01	2.76E-03	5.32E-01	12
Barium	0.053448218	--	--(b)	7.32E-03	5.46E-04	7.87E-03	0.17
Beryllium	0.000342265	--	--(b)	4.69E-03	3.50E-03	8.18E-03	0.18
Bis(2-ethylhexyl) phthalate	0.011	--	--(b)	1.51E-02	2.33E-02	3.84E-02	0.84
Cadmium	0.002729138	--	--(b)	1.50E-01	1.56E-02	1.65E-01	3.6
Carbon tetrachloride	0.000282669	Yes	1.72E-05	1.11E-02	2.96E-03	1.40E-02	0.31
Chloride	12.62269	--	--(b)	--	--	--	
Chloroform	0.00038106	Yes	4.51E-05	1.04E-03	9.51E-05	1.18E-03	0.026
Chromium	0.015259293	--	--(b)	2.79E-04	1.12E-04	3.91E-04	0.0085
Cobalt	0.004495239	--	--(b)	4.11E-01	8.57E-04	4.11E-01	9.0
Copper	0.004447607	--	--(b)	3.05E-03	1.59E-05	3.06E-03	0.067
Fluoride	0.2940596	--	--(b)	1.34E-01	7.01E-04	1.35E-01	2.9
Hexavalent Chromium	0.191	--	--(b)	1.74E+00	7.28E-01	2.47E+00	54
Iron	0.090209963	--	--(b)	3.53E-03	1.84E-05	3.55E-03	0.078
Lead	0.001548018	--	--(b)	--	--	0.00E+00	0
Manganese	0.006198141	--	--(b)	7.08E-03	9.23E-04	8.00E-03	0.17
Nickel	0.011729633	--	--(b)	1.61E-02	4.19E-04	1.65E-02	0.36
Nitrate	34.098186	--	--(b)	1.32E-01	6.87E-04	1.32E-01	2.9
Nitrite	0.057119962	--	--(b)	5.22E-03	2.72E-05	5.24E-03	0.11
Nitrogen in Nitrite and Nitrate	14.7	--	--(b)	2.52E-01	1.31E-03	2.53E-01	5.5
Octachlorodibenzofuran	9.9649E-09	--	--(b)	--	--	--	
Octachlorodibenzo-p-dioxin	5.8071E-09	--	--(b)	--	--	--	
Silver	0.005686587	--	--(b)	3.12E-02	2.44E-03	3.36E-02	0.73
Strontium	0.2694514	--	--(b)	1.23E-02	6.42E-05	1.24E-02	0.27
Sulfate	64.094058	--	--(b)	--	--	--	
Toluene	3.56519E-05	Yes	8.26E-08	1.22E-05	4.24E-06	1.65E-05	3.61E-04
Total petroleum hydrocarbons - gasoline range	0.05	--	--(b)	--	--	--	
Trichloroethene	0.000563286	Yes	1.86E-04	--	--	1.86E-04	0.0041
Uranium	0.020191069	--	--(b)	1.84E-01	9.63E-04	1.85E-01	4.0
Vanadium	0.02186531	--	--(b)	1.20E-01	6.25E-04	1.20E-01	2.6
Zinc	0.095789222	--	--(b)	8.75E-03	2.74E-05	8.78E-03	0.19
Total HI			2.52E-04	3.8	0.79	4.6	100

[a]Volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HI = hazard index.

HQ = hazard quotient.

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Tap Water Risk Assessment (5 Year 95UCL)--Summary of Tap Water Exposure Pathway Cancer Risk Results for Nonradioactive COPCs in Groundwater.

Nonradioactive COPCs	Contaminant Concentration in Groundwater C_w (mg/L)	Volatile[a]	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Risk (Dermal) (unitless)	Total Risk (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	3.734E-09	--	--(b)	7.22E-08	--	7.22E-08	0.052
1,2,3,4,6,7,8-Heptachlorodibenzofuran	5.66E-09	--	--(b)	1.09E-07	--	1.09E-07	0.078
1,2,3,4,7,8-Hexachlorodibenzofuran	2.9E-09	--	--(b)	5.61E-07	--	5.61E-07	0.40
1,2,3,6,7,8-Hexachlorodibenzofuran	2.1E-09	--	--(b)	4.06E-07	--	4.06E-07	0.29
1,2-Dichloroethane	0.00064	Yes	8.26E-08	8.66E-07	4.10E-08	9.90E-07	0.71
2,3,4,6-Tetrachlorophenol	0.0077	--	--(b)	--	--	--	
Aluminum	0.046776593	--	--(b)	--	--	--	
Arsenic	0.00579213	--	--(b)	1.29E-04	6.96E-07	1.30E-04	93
Barium	0.053448218	--	--(b)	--	--	--	
Beryllium	0.000342265	--	--(b)	--	--	--	
Bis(2-ethylhexyl) phthalate	0.011	--	--(b)	2.29E-06	3.42E-06	5.71E-06	4.1
Cadmium	0.002729138	--	--(b)	--	--	--	
Carbon tetrachloride	0.000282669	Yes	2.11E-08	5.47E-07	1.41E-07	7.09E-07	0.51
Chloride	12.62269	--	--(b)	--	--	--	
Chloroform	0.00038106	Yes	4.35E-08	1.76E-07	1.54E-08	2.35E-07	0.17
Chromium	0.015259293	--	--(b)	--	--	--	
Cobalt	0.004495239	--	--(b)	--	--	--	
Copper	0.004447607	--	--(b)	--	--	--	
Fluoride	0.2940596	--	--(b)	--	--	--	
Hexavalent Chromium	0.191	--	--(b)	--	--	--	
Iron	0.090209963	--	--(b)	--	--	--	
Lead	0.001548018	--	--(b)	--	--	--	
Manganese	0.006198141	--	--(b)	--	--	--	
Nickel	0.011729633	--	--(b)	--	--	--	
Nitrate	34.098186	--	--(b)	--	--	--	
Nitrite	0.057119962	--	--(b)	--	--	--	
Nitrogen in Nitrite and Nitrate	14.7	--	--(b)	--	--	--	
Octachlorodibenzofuran	9.9649E-09	--	--(b)	5.78E-09	--	5.78E-09	0.0041
Octachlorodibenzo-p-dioxin	5.8071E-09	--	--(b)	3.37E-09	--	3.37E-09	0.0024
Silver	0.005686587	--	--(b)	--	--	--	
Strontium	0.2694514	--	--(b)	--	--	--	
Sulfate	64.094058	--	--(b)	--	--	--	
Toluene	3.56519E-05	Yes	--	--	--	--	
Total petroleum hydrocarbons - gasoline range	0.05	--	--(b)	--	--	--	
Trichloroethene	0.000563286	Yes	6.99E-08	7.46E-07	1.25E-07	9.40E-07	0.67
Uranium	0.020191069	--	--(b)	--	--	--	
Vanadium	0.02186531	--	--(b)	--	--	--	
Zinc	0.095789222	--	--(b)	--	--	--	
Total ELCR			2.17E-07	1.35E-04	4.43E-06	1.40E-04	100

[a]Volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Tap Water Risk Assessment (5 Year 95UCL)--Summary of Tap Water Exposure Pathway Cancer Risk Results for Radioactive COPCs in Groundwater.

Radioactive COPCs	Contaminant Concentration in Groundwater C_w (pCi/L)	Volatile[a]	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Total Risk (unitless)	% Contribution
Gross alpha	5.3264311	--	--(b)	--	--	
Iodine-129	2.708038	--	--(b)	7.57E-06	7.57E-06	2.8
Plutonium-239/240	0.029	--	--(b)	7.40E-08	7.40E-08	0.027
Protactinium-231	0.28	--	--(b)	9.16E-07	9.16E-07	0.34
Strontium-90	4.3004432	--	--(b)	4.54E-06	4.54E-06	1.7
Technetium-99	1667.3497	--	--(b)	8.67E-05	8.67E-05	32
Tritium	156901.45	Yes	2.31E-05	1.50E-04	1.73E-04	63
Total ELCR			2.31E-05	2.50E-04	2.73E-04	100

[a]Volatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates radionuclide toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
Near-field Exposure Area

Ingestion of Nonradioactive COPCs in Tap Water

Intake Parameter Values		Value			
Parameter	Symbol	Adult	Child	Unit	Source
Ingestion Chronic Daily Intake	CDI	Calculated		mg/kg-day	Calculated
Contaminant Concentration	C_w	COPC-specific		mg/L	ECF-200PO1-09-2027
Average Body Weight	BW	70	15	kg	EPA/540/R-92/003
Drinking Water Ingestion Rate	IRW	2	1	L/day	EPA/540/R-92/003 EPA/600/P-95/002Fa
Age-Adjusted Drinking Water Ingestion Rate	IRW_{adj}	1.086		L-year/kg-day	Calculated
Exposure Frequency	EF	350		days/year	EPA/540/R-92/003
Exposure Duration	ED	30	6	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70		years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30		years	EPA/540/R-92/003
Oral Reference Dose	RfD_o	COPC-specific		mg/kg-day	EPA, 2009
Oral Cancer Slope Factor	CSF_o	COPC-specific		$(mg/kg\text{-}day)^{-1}$	EPA, 2009
Conversion Factor	CF1	365		days/year	365 days = 1 year

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors .*

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD_o[a] (mg/kg-day)	HQ (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	3.734E-09	1.02E-10	--	--	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	5.66E-09	1.55E-10	--	--	
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	2.9E-09	7.95E-11	--	--	
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	2.1E-09	5.75E-11	--	--	
1,2-Dichloroethane	107-06-2	0.00064	1.75E-05	2.00E-02	8.77E-04	0.023
2,3,4,6-Tetrachlorophenol	58-90-2	0.0077	2.11E-04	3.00E-02	7.03E-03	0.19
Aluminum	7429-90-5	0.046776593	1.28E-03	1.00E+00	1.28E-03	0.034
Arsenic	7440-38-2	0.00579213	1.59E-04	3.00E-04	5.29E-01	14
Barium	7440-39-3	0.053448218	1.46E-03	2.00E-01	7.32E-03	0.19
Beryllium	7440-41-7	0.000342265	9.38E-06	2.00E-03	4.69E-03	0.12
Bis(2-ethylhexyl) phthalate	117-81-7	0.011	3.01E-04	2.00E-02	1.51E-02	0.40
Cadmium	7440-43-9	0.002729138	7.48E-05	5.00E-04	1.50E-01	3.9
Carbon tetrachloride	56-23-5	0.000282669	7.74E-06	7.00E-04	1.11E-02	0.29
Chloride	16887-00-6	12.62269	3.46E-01	--	--	
Chloroform	67-66-3	0.00038106	1.04E-05	1.00E-02	1.04E-03	0.028
Chromium	7440-47-3	0.015259293	4.18E-04	1.50E+00	2.79E-04	0.0074
Cobalt	7440-48-4	0.004495239	1.23E-04	3.00E-04	4.11E-01	11
Copper	7440-50-8	0.004447607	1.22E-04	4.00E-02	3.05E-03	0.080
Fluoride	16984-48-8	0.2940596	8.06E-03	6.00E-02	1.34E-01	3.5
Hexavalent Chromium	18540-29-9	0.191	5.23E-03	3.00E-03	1.74E+00	46
Iron	7439-89-6	0.090209963	2.47E-03	7.00E-01	3.53E-03	0.093
Lead	7439-92-1	0.001548018	4.24E-05	--	--	
Manganese	7439-96-5	0.006198141	1.70E-04	2.40E-02	7.08E-03	0.19
Nickel	7440-02-0	0.011729633	3.21E-04	2.00E-02	1.61E-02	0.42
Nitrate	14797-55-8	34.098186	9.34E-01	7.10E+00	1.32E-01	3.5
Nitrite	14797-65-0	0.057119962	1.56E-03	3.00E-01	5.22E-03	0.14
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	14.7	4.03E-01	1.60E+00	2.52E-01	6.6
Octachlorodibenzofuran	39001-02-0	9.9649E-09	2.73E-10	--	--	
Octachlorodibenzo-p-dioxin	3268-87-9	5.8071E-09	1.59E-10	--	--	
Silver	7440-22-4	0.005686587	1.56E-04	5.00E-03	3.12E-02	0.82
Strontium	7440-24-6	0.2694514	7.38E-03	6.00E-01	1.23E-02	0.32
Sulfate	14808-79-8	64.094058	1.76E+00	--	--	
Toluene	108-88-3	3.56519E-05	9.77E-07	8.00E-02	1.22E-05	3.22E-04
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	0.05	1.37E-03	--	--	
Trichloroethene	79-01-6	0.000563286	1.54E-05	--	--	
Uranium	7440-61-1	0.020191069	5.53E-04	3.00E-03	1.84E-01	4.9
Vanadium	7440-62-2	0.02186531	5.99E-04	5.00E-03	1.20E-01	3.2
Zinc	7440-66-6	0.095789222	2.62E-03	3.00E-01	8.75E-03	0.23
Total HI					3.79E+00	100

a EPA Region 3 Regional Screening Level tables downloaded January 2009. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HQ = hazard quotient.

U.S. EPA 1989. Risk assessment guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A). EPA/540/1/89/002.

Cancer risk calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF_o[a] $(mg/kg\text{-}day)^{-1}$	Risk (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	3.734E-09	5.55E-11	1.30E+03	7.22E-08	0.053
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	5.66E-09	8.42E-11	1.30E+03	1.09E-07	0.081
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	2.9E-09	4.31E-11	1.30E+04	5.61E-07	0.42
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	2.1E-09	3.12E-11	1.30E+04	4.06E-07	0.30
1,2-Dichloroethane	107-06-2	0.00064	9.52E-06	9.10E-02	8.66E-07	0.64
2,3,4,6-Tetrachlorophenol	58-90-2	0.0077	1.15E-04	--	--	
Aluminum	7429-90-5	0.046776593	6.96E-04	--	--	
Arsenic	7440-38-2	0.00579213	8.61E-05	1.50E+00	1.29E-04	96
Barium	7440-39-3	0.053448218	7.95E-04	--	--	
Beryllium	7440-41-7	0.000342265	5.09E-06	--	--	
Bis(2-ethylhexyl) phthalate	117-81-7	0.011	1.64E-04	1.40E-02	2.29E-06	1.7
Cadmium	7440-43-9	0.002729138	4.06E-05	--	--	
Carbon tetrachloride	56-23-5	0.000282669	4.20E-06	1.30E-01	5.47E-07	0.40
Chloride	16887-00-6	12.62269	1.88E-01	--	--	
Chloroform	67-66-3	0.00038106	5.67E-06	3.10E-02	1.76E-07	0.13
Chromium	7440-47-3	0.015259293	2.27E-04	--	--	
Cobalt	7440-48-4	0.004495239	6.69E-05	--	--	
Copper	7440-50-8	0.004447607	6.61E-05	--	--	
Fluoride	16984-48-8	0.2940596	4.37E-03	--	--	
Hexavalent Chromium	18540-29-9	0.191	2.84E-03	--	--	
Iron	7439-89-6	0.090209963	1.34E-03	--	--	
Lead	7439-92-1	0.001548018	2.30E-05	--	--	
Manganese	7439-96-5	0.006198141	9.22E-05	--	--	
Nickel	7440-02-0	0.011729633	1.74E-04	--	--	
Nitrate	14797-55-8	34.098186	5.07E-01	--	--	
Nitrite	14797-65-0	0.057119962	8.50E-04	--	--	
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	14.7	2.19E-01	--	--	
Octachlorodibenzofuran	39001-02-0	9.9649E-09	1.48E-10	3.90E+01	5.78E-09	0.0043
Octachlorodibenzo-p-dioxin	3268-87-9	5.8071E-09	8.64E-11	3.90E+01	3.37E-09	0.0025
Silver	7440-22-4	0.005686587	8.46E-05	--	--	
Strontium	7440-24-6	0.2694514	4.01E-03	--	--	
Sulfate	14808-79-8	64.094058	9.53E-01	--	--	
Toluene	108-88-3	3.56519E-05	5.30E-07	--	--	
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	0.05	7.44E-04	--	--	
Trichloroethene	79-01-6	0.000563286	8.38E-06	8.90E-02	7.46E-07	0.55
Uranium	7440-61-1	0.020191069	3.00E-04	--	--	
Vanadium	7440-62-2	0.02186531	3.25E-04	--	--	
Zinc	7440-66-6	0.095789222	1.42E-03	--	--	
Total ELCR					1.35E-04	100

a EPA Region 3 Regional Screening Level tables downloaded January 2009. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

U.S. EPA 1989. Risk assessment guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A). EPA/540/1/89/002.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
Near-field Exposure Area

Inhalation of Volatile Nonradioactive COPCs in Tap Water

Intake Parameter Values				
Parameter	Symbol	Value	Unit	Source
Inhalation Chronic Daily Intake	CDI	Calculated	mg/m^3 for noncarcinogens, $\mu g/m^3$ for carcinogens	Calculated
Contaminant Concentration	C_w	COPC-specific	mg/L	ECF-200PO1-09-2027
Exposure Time	ET	0.58	hours/day	EPA/540/R/99/005
Exposure Frequency	EF	350	days/year	EPA/540/R-92/003
Exposure Duration	ED	30	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70	years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30	years	EPA/540/R-92/003
Andelman Volatilization Factor	VF	0.5	L/m^3	EPA/540/R-92/003
Inhalation Reference Concentration	RfC	COPC-specific	mg/m^3	EPA, 2009
Inhalation Unit Risk	IUR	COPC-specific	$(\mu g/m^3)^{-1}$	EPA, 2009
Conversion Factor	CF1	365	days/year	365 days = 1 year
Conversion Factor	CF2	1/24	days/hour	1 day = 24 hours

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors* .

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	Volatile[a]	C_w (mg/L)	CDI (non-cancer) mg/m^3	RfCi[a] (mg/m^3)	HQ (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	--	3.734E-09	--(b)	--	--(b)	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	--	5.66E-09	--(b)	--	--(b)	
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	--	2.9E-09	--(b)	--	--(b)	
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	--	2.1E-09	--(b)	--	--(b)	
1,2-Dichloroethane	107-06-2	Yes	0.00064	7.42E-06	2.40E+00	3.09E-06	1.2
2,3,4,6-Tetrachlorophenol	58-90-2	--	0.0077	--(b)	--	--(b)	
Aluminum	7429-90-5	--	0.046776593	--(b)	5.00E-03	--(b)	
Arsenic	7440-38-2	--	0.00579213	--(b)	1.50E-05	--(b)	
Barium	7440-39-3	--	0.053448218	--(b)	5.00E-04	--(b)	
Beryllium	7440-41-7	--	0.000342265	--(b)	2.00E-05	--(b)	
Bis(2-ethylhexyl) phthalate	117-81-7	--	0.011	--(b)	--	--(b)	
Cadmium	7440-43-9	--	0.002729138	--(b)	1.00E-05	--(b)	
Carbon tetrachloride	56-23-5	Yes	0.000282669	3.28E-06	1.90E-01	1.72E-05	6.8
Chloride	16887-00-6	--	12.62269	--(b)	--	--(b)	
Chloroform	67-66-3	Yes	0.00038106	4.42E-06	9.80E-02	4.51E-05	18
Chromium	7440-47-3	--	0.015259293	--(b)	--	--(b)	
Cobalt	7440-48-4	--	0.004495239	--(b)	6.00E-06	--(b)	
Copper	7440-50-8	--	0.004447607	--(b)	--	--(b)	
Fluoride	16984-48-8	--	0.2940596	--(b)	1.30E-02	--(b)	
Hexavalent Chromium	18540-29-9	--	0.191	--(b)	1.00E-04	--(b)	
Iron	7439-89-6	--	0.090209963	--(b)	--	--(b)	
Lead	7439-92-1	--	0.001548018	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.006198141	--(b)	5.00E-05	--(b)	
Nickel	7440-02-0	--	0.011729633	--(b)	9.00E-05	--(b)	
Nitrate	14797-55-8	--	34.098186	--(b)	--	--(b)	
Nitrite	14797-65-0	--	0.057119962	--(b)	--	--(b)	
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	--	14.7	--(b)	--	--(b)	
Octachlorodibenzofuran	39001-02-0	--	9.9649E-09	--(b)	--	--(b)	
Octachlorodibenzo-p-dioxin	3268-87-9	--	5.8071E-09	--(b)	--	--(b)	
Silver	7440-22-4	--	0.005686587	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.2694514	--(b)	--	--(b)	
Sulfate	14808-79-8	--	64.094058	--(b)	--	--(b)	
Toluene	108-88-3	Yes	3.56519E-05	4.13E-07	5.00E+00	8.26E-08	0.033
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	--	0.05	--(b)	--	--(b)	
Trichloroethene	79-01-6	Yes	0.000563286	6.53E-06	3.50E-02	1.86E-04	74
Uranium	7440-61-1	--	0.020191069	--(b)	3.00E-04	--(b)	
Vanadium	7440-62-2	--	0.02186531	--(b)	--	--(b)	
Zinc	7440-66-6	--	0.095789222	--(b)	--	--(b)	
Total HI						2.52E-04	100

a EPA Region 3 Regional Screening Level tables downloaded January 2009. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

[b] Nonvolatile constituents are not considered in the inhalation of groundwater in the drinking water pathway

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HQ = hazard quotient.

U.S. EPA 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). EPA-540-R-070-002.

Cancer risk calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	Volatile[a]	C_w (mg/L)	CDI (cancer) $\mu g/m^3$	IUR[a] $(\mu g/m^3)^{-1}$	Risk (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	--	3.734E-09	--(b)	3.80E-01	--(b)	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	--	5.66E-09	--(b)	3.80E-01	--(b)	
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	--	2.9E-09	--(b)	3.80E+00	--(b)	
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	--	2.1E-09	--(b)	3.80E+00	--(b)	
1,2-Dichloroethane	107-06-2	Yes	0.00064	3.18E-03	2.60E-05	8.26E-08	38
2,3,4,6-Tetrachlorophenol	58-90-2	--	0.0077	--(b)	--	--(b)	
Aluminum	7429-90-5	--	0.046776593	--(b)	--	--(b)	
Arsenic	7440-38-2	--	0.00579213	--(b)	4.30E-03	--(b)	
Barium	7440-39-3	--	0.053448218	--(b)	--	--(b)	
Beryllium	7440-41-7	--	0.000342265	--(b)	2.40E-03	--(b)	
Bis(2-ethylhexyl) phthalate	117-81-7	--	0.011	--(b)	2.40E-06	--(b)	
Cadmium	7440-43-9	--	0.002729138	--(b)	1.80E-03	--(b)	
Carbon tetrachloride	56-23-5	Yes	0.000282669	1.40E-03	1.50E-05	2.11E-08	9.7
Chloride	16887-00-6	--	12.62269	--(b)	--	--(b)	
Chloroform	67-66-3	Yes	0.00038106	1.89E-03	2.30E-05	4.35E-08	20
Chromium	7440-47-3	--	0.015259293	--(b)	--	--(b)	
Cobalt	7440-48-4	--	0.004495239	--(b)	9.00E-03	--(b)	
Copper	7440-50-8	--	0.004447607	--(b)	--	--(b)	
Fluoride	16984-48-8	--	0.2940596	--(b)	--	--(b)	
Hexavalent Chromium	18540-29-9	--	0.191	--(b)	8.40E-02	--(b)	
Iron	7439-89-6	--	0.090209963	--(b)	--	--(b)	
Lead	7439-92-1	--	0.001548018	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.006198141	--(b)	--	--(b)	
Nickel	7440-02-0	--	0.011729633	--(b)	2.60E-04	--(b)	
Nitrate	14797-55-8	--	34.098186	--(b)	--	--(b)	
Nitrite	14797-65-0	--	0.057119962	--(b)	--	--(b)	
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	--	14.7	--(b)	--	--(b)	
Octachlorodibenzofuran	39001-02-0	--	9.9649E-09	--(b)	1.14E-02	--(b)	
Octachlorodibenzo-p-dioxin	3268-87-9	--	5.8071E-09	--(b)	1.14E-02	--(b)	
Silver	7440-22-4	--	0.005686587	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.2694514	--(b)	--	--(b)	
Sulfate	14808-79-8	--	64.094058	--(b)	--	--(b)	
Toluene	108-88-3	Yes	3.56519E-05	1.77E-04	--	--	
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	--	0.05	--(b)	--	--(b)	
Trichloroethene	79-01-6	Yes	0.000563286	2.80E-03	2.50E-05	6.99E-08	32
Uranium	7440-61-1	--	0.020191069	--(b)	--	--(b)	
Vanadium	7440-62-2	--	0.02186531	--(b)	--	--(b)	
Zinc	7440-66-6	--	0.095789222	--(b)	--	--(b)	
Total ELCR						2.17E-07	100

a EPA Region 3 Regional Screening Level tables downloaded January 2009. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

[b] Nonvolatile constituents are not considered in the inhalation of groundwater in the drinking water pathway

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

U.S. EPA 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). EPA-540-R-070-002.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
Near-field Exposure Area

Dermal Absorption of Nonradioactive COPCs in Tap Water

Intake Parameter Values		Value			
Parameter	Symbol	Adult	Child	Unit	Source
Chronic Daily Intake	CDI	Calculated		mg/kg-day	Calculated
Contaminant Concentration	C_w	COPC-specific		mg/L	ECF-200PO1-09-2027
Average Body Weight	BW	70	15	kg	EPA/540/R-92/003
Exposure Time	ET	0.58	1	hours/event	EPA/540/R/99/005
Exposure Time (Age-Adjusted)	ET_{adj}	0.664		hours/event	Calculated
Surface Area	SA	18,000	6,600	cm^2	EPA/540/R/99/005
Age-Adjusted Surface Area	SA_{adj}	8,811		(cm^2-year-event)/(kg/day)	Calculated
Event Frequency	EV	1		event/day	EPA/540/R/99/005
Exposure Frequency	EF	350		days/year	EPA/540/R-92/003
Exposure Duration	ED	30	6	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70		years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30		years	EPA/540/R-92/003
Oral Reference Dose	RfD_o	COPC-specific		mg/kg-day	EPA, 2009
Oral Cancer Slope Factor	CSF_o	COPC-specific		$(mg/kg\text{-}day)^{-1}$	EPA, 2009
Conversion Factor	CF1	365		days/year	365 days = 1 year
Conversion Factor	CF3	0.001		L/cm^3	1 L = 1000 cm^3
The constant pi	π	3.14159		unitless	--
Time to reach steady state	t^*	COPC-specific		hours	EPA/540/R/99/005
Dermal Partitioning Constant	B	COPC-specific		unitless	EPA/540/R/99/005
Absorbed Dose per Event	DA	calculated		mg/cm^2-event	Calculated
Dermal Permeability Constant	K_p	COPC-specific		cm/hour	EPA/540/R/99/005
Fraction Absorbed	FA	COPC-specific		unitless	EPA/540/R/99/005
Lag Time	τ	COPC-specific		hours/event	EPA/540/R/99/005
Fraction of Contaminant Absorbed in Gastrointestinal Tract	GIABS	COPC-specific		unitless	EPA, 2009

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.
EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*
EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Absorbed Dermal Dose Calculation

Contaminant of Potential Concern	CAS #	C_w (mg/L)	Inorganic/organic[a]	FA[b] (unitless)	K_p[c] (cm/hour)	B[b] (unitless)	t^*[b] (hours/event)	t^*[b] (hours)	DA (noncancer) (mg/cm^2-event)	DA (cancer) (mg/cm^2-event)
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	3.734E-09	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-Heptachlorodibenzofuran[1]	67562-39-4	5.66E-09	--	--	1.45	--	--	--	--	--
1,2,3,4,7,8-Hexachlorodibenzofuran[1]	70648-26-9	2.9E-09	--	--	2.25	--	--	--	--	--
1,2,3,6,7,8-Hexachlorodibenzofuranc	57117-44-9	2.1E-09	--	--	2.25	--	--	--	--	--
1,2-Dichloroethane	107-06-2	0.00064	--	1.0	0.0042	0	0.38	0.92	3.49E-09	3.73E-09
2,3,4,6-Tetrachlorophenol[1]	58-90-2	0.0077	--	--	0.071	--	--	--	--	--
Aluminum	7429-90-5	0.046776593	INORGANIC	--	0.001	--	--	--	2.71E-08	3.11E-08
Arsenic	7440-38-2	0.00579213	INORGANIC	--	0.001	--	--	--	3.36E-09	3.85E-09
Barium	7440-39-3	0.053448218	INORGANIC	--	0.001	--	--	--	3.10E-08	3.55E-08
Beryllium	7440-41-7	0.000342265	INORGANIC	--	0.001	--	--	--	1.99E-10	2.27E-10
Bis(2-ethylhexyl) phthalate	117-81-7	0.011	--	0.8	0.025	0.2	16.64	39.93	1.89E-06	2.02E-06
Cadmium	7440-43-9	0.002729138	INORGANIC	--	0.001	--	--	--	1.58E-09	1.81E-09
Carbon tetrachloride	56-23-5	0.000282669	--	1.0	0.016	0.1	0.78	1.86	8.41E-09	9.00E-09
Chloride	16887-00-6	12.62269	INORGANIC	--	0.001	--	--	--	7.32E-06	8.38E-06
Chloroform	67-66-3	0.00038106	--	1.0	0.0068	0	0.50	1.19	3.86E-09	4.13E-09
Chromium	7440-47-3	0.015259293	INORGANIC	--	0.001	--	--	--	8.85E-09	1.01E-08
Cobalt	7440-48-4	0.004495239	INORGANIC	--	0.0004	--	--	--	1.04E-09	1.19E-09
Copper	7440-50-8	0.004447607	INORGANIC	--	0.001	--	--	--	2.58E-09	2.95E-09
Fluoride	16984-48-8	0.2940596	INORGANIC	--	0.001	--	--	--	1.71E-07	1.95E-07
Hexavalent Chromium	18540-29-9	0.191	INORGANIC	--	0.002	--	--	--	2.22E-07	2.54E-07
Iron	7439-89-6	0.090209963	INORGANIC	--	0.001	--	--	--	5.23E-08	5.99E-08
Lead	7439-92-1	0.001548018	INORGANIC	--	0.0001	--	--	--	8.98E-11	1.03E-10
Manganese	7439-96-5	0.006198141	INORGANIC	--	0.001	--	--	--	3.59E-09	4.12E-09
Nickel	7440-02-0	0.011729633	INORGANIC	--	0.0002	--	--	--	1.36E-09	1.56E-09
Nitrate	14797-55-8	34.098186	INORGANIC	--	0.001	--	--	--	1.98E-05	2.26E-05
Nitrite	14797-65-0	0.057119962	INORGANIC	--	0.001	--	--	--	3.31E-08	3.79E-08
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	14.7	INORGANIC	--	0.001	--	--	--	8.53E-06	9.76E-06
Octachlorodibenzofuran[1]	39001-02-0	9.9649E-09	--	--	2.63	--	--	--	--	--
Octachlorodibenzo-p-dioxin[1]	3268-87-9	5.8071E-09	--	--	1.16	--	--	--	--	--
Silver	7440-22-4	0.005686587	INORGANIC	--	0.0006	--	--	--	1.98E-09	2.27E-09
Strontium	7440-24-6	0.2694514	INORGANIC	--	0.001	--	--	--	1.56E-07	1.79E-07
Sulfate	14808-79-8	64.094058	INORGANIC	--	0.001	--	--	--	3.72E-05	4.26E-05
Toluene	108-88-3	3.56519E-05	--	1.0	0.031	0.1	0.35	0.84	1.38E-09	1.47E-09
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	0.05	--	--	--	--	--	--	--	--
Trichloroethene	79-01-6	0.000563286	--	1.0	0.012	0.1	0.58	1.39	1.08E-08	1.16E-08
Uranium	7440-61-1	0.020191069	INORGANIC	--	0.001	--	--	--	1.17E-08	1.34E-08
Vanadium	7440-62-2	0.02186531	INORGANIC	--	0.001	--	--	--	1.27E-08	1.45E-08
Zinc	7440-66-6	0.095789222	INORGANIC	--	0.0006	--	--	--	3.33E-08	3.82E-08

[a]EPA/540/R/99/005, Exhibit 3-1 (inorganics) and Exhibit B-3 (organics)
[b]EPA/540/R/99/005, Exhibit B-3
[c]the K_p value was taken from. ORNL, 2010, The Risk Assessment Information System (RAIS).

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD_o[a] (mg/kg-day)	GIABS[a] (unitless)	HQ (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	3.734E-09	--	--	1	--	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	5.66E-09	--	--	1	--	
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	2.9E-09	--	--	1	--	
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	2.1E-09	--	--	1	--	
1,2-Dichloroethane	107-06-2	0.00064	8.60E-07	2.00E-02	1	4.30E-05	0.0055
2,3,4,6-Tetrachlorophenol	58-90-2	0.0077	--	3.00E-02	1	--	
Aluminum	7429-90-5	0.046776593	6.69E-06	1.00E+00	1	6.69E-06	8.51E-04
Arsenic	7440-38-2	0.00579213	8.28E-07	3.00E-04	1	2.76E-03	0.35
Barium	7440-39-3	0.053448218	7.64E-06	2.00E-01	0.07	5.46E-04	0.069
Beryllium	7440-41-7	0.000342265	4.89E-08	2.00E-03	0.007	3.50E-03	0.44
Bis(2-ethylhexyl) phthalate	117-81-7	0.011	4.66E-04	2.00E-02	1	2.33E-02	3.0
Cadmium	7440-43-9	0.002729138	3.90E-07	5.00E-04	0.05	1.56E-02	2.0
Carbon tetrachloride	56-23-5	0.000282669	2.07E-06	7.00E-04	1	2.96E-03	0.38
Chloride	16887-00-6	12.62269	1.81E-03	--	1	--	
Chloroform	67-66-3	0.00038106	9.51E-07	1.00E-02	1	9.51E-05	0.012
Chromium	7440-47-3	0.015259293	2.18E-06	1.50E+00	0.013	1.12E-04	0.014
Cobalt	7440-48-4	0.004495239	2.57E-07	3.00E-04	1	8.57E-04	0.11
Copper	7440-50-8	0.004447607	6.36E-07	4.00E-02	1	1.59E-05	0.0020
Fluoride	16984-48-8	0.2940596	4.21E-05	6.00E-02	1	7.01E-04	0.089
Hexavalent Chromium	18540-29-9	0.191	5.46E-05	3.00E-03	0.025	7.28E-01	93
Iron	7439-89-6	0.090209963	1.29E-05	7.00E-01	1	1.84E-05	0.0023
Lead	7439-92-1	0.001548018	2.21E-08	--	1	--	
Manganese	7439-96-5	0.006198141	8.86E-07	2.40E-02	0.04	9.23E-04	0.12
Nickel	7440-02-0	0.011729633	3.35E-07	2.00E-02	0.04	4.19E-04	0.053
Nitrate	14797-55-8	34.098186	4.88E-03	7.10E+00	1	6.87E-04	0.087
Nitrite	14797-65-0	0.057119962	8.17E-06	3.00E-01	1	2.72E-05	0.0035
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	14.7	2.10E-03	1.60E+00	1	1.31E-03	0.17
Octachlorodibenzofuran	39001-02-0	9.9649E-09	--	--	1	--	
Octachlorodibenzo-p-dioxin	3268-87-9	5.8071E-09	--	--	1	--	
Silver	7440-22-4	0.005686587	4.88E-07	5.00E-03	0.04	2.44E-03	0.31
Strontium	7440-24-6	0.2694514	3.85E-05	6.00E-01	1	6.42E-05	0.0082
Sulfate	14808-79-8	64.094058	9.17E-03	--	1	--	
Toluene	108-88-3	3.56519E-05	3.39E-07	8.00E-02	1	4.24E-06	5.39E-04
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	0.05	--	--	--	--	
Trichloroethene	79-01-6	0.000563286	2.67E-06	--	1	--	
Uranium	7440-61-1	0.020191069	2.89E-06	3.00E-03	1	9.63E-04	0.12
Vanadium	7440-62-2	0.02186531	3.13E-06	5.00E-03	1	0.0006	0.080
Zinc	7440-66-6	0.095789222	8.22E-06	3.00E-01	1	2.74E-05	0.0035
Total HI						0.79	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.
COPC = contaminant of potential concern.
HI = hazard index
HQ = hazard quotient.
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

Cancer risk calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF_o[a] $(mg/kg\text{-}day)^{-1}$	GIABS[a] (unitless)	Risk (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	3.734E-09	--	1.30E+03	1	--	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	5.66E-09	--	1.30E+03	1	--	
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	2.9E-09	--	1.30E+04	1	--	
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	2.1E-09	--	1.30E+04	1	--	
1,2-Dichloroethane	107-06-2	0.00064	4.50E-07	9.10E-02	1	4.10E-08	0.92
2,3,4,6-Tetrachlorophenol	58-90-2	0.0077	--	--	1	--	
Aluminum	7429-90-5	0.046776593	3.75E-06	--	1	--	
Arsenic	7440-38-2	0.00579213	4.64E-07	1.50E+00	1	6.96E-07	16
Barium	7440-39-3	0.053448218	4.28E-06	--	0.07	--	
Beryllium	7440-41-7	0.000342265	2.74E-08	--	0.007	--	
Bis(2-ethylhexyl) phthalate	117-81-7	0.011	2.44E-04	1.40E-02	1	3.42E-06	77
Cadmium	7440-43-9	0.002729138	2.19E-07	--	0.05	--	
Carbon tetrachloride	56-23-5	0.000282669	1.09E-06	1.30E-01	1	1.41E-07	3.2
Chloride	16887-00-6	12.62269	1.01E-03	--	1	--	
Chloroform	67-66-3	0.00038106	4.98E-07	3.10E-02	1	1.54E-08	0.35
Chromium	7440-47-3	0.015259293	1.22E-06	--	0.013	--	
Cobalt	7440-48-4	0.004495239	1.44E-07	--	1	--	
Copper	7440-50-8	0.004447607	3.56E-07	--	1	--	
Fluoride	16984-48-8	0.2940596	2.36E-05	--	1	--	
Hexavalent Chromium	18540-29-9	0.191	3.06E-05	--	0.025	--	
Iron	7439-89-6	0.090209963	7.23E-06	--	1	--	
Lead	7439-92-1	0.001548018	1.24E-08	--	1	--	
Manganese	7439-96-5	0.006198141	4.97E-07	--	0.04	--	
Nickel	7440-02-0	0.011729633	1.88E-07	--	0.04	--	
Nitrate	14797-55-8	34.098186	2.73E-03	--	1	--	
Nitrite	14797-65-0	0.057119962	4.58E-06	--	1	--	
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	14.7	1.18E-03	--	1	--	
Octachlorodibenzofuran	39001-02-0	9.9649E-09	--	3.90E+01	1	--	
Octachlorodibenzo-p-dioxin	3268-87-9	5.8071E-09	--	3.90E+01	1	--	
Silver	7440-22-4	0.005686587	2.73E-07	--	0.04	--	
Strontium	7440-24-6	0.2694514	2.16E-05	--	1	--	
Sulfate	14808-79-8	64.094058	5.14E-03	--	--	--	
Toluene	108-88-3	3.56519E-05	1.78E-07	--	1	--	
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	0.05	--	--	--	--	
Trichloroethene	79-01-6	0.000563286	1.40E-06	8.90E-02	1	1.25E-07	2.8
Uranium	7440-61-1	0.020191069	1.62E-06	--	1	--	
Vanadium	7440-62-2	0.02186531	1.75E-06	--	1	--	
Zinc	7440-66-6	0.095789222	4.61E-06	--	1	--	
Total ELCR						4.43E-06	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
Near-field Exposure Area

Inhalation of Volatile Radioactive COPCs in Tap Water

Intake Parameter Values		Value			
Factor	Symbol	Adult	Child	Unit	Reference
Chronic Daily Intake	CDI	Calculated		pCi	Calculated
Contaminant Concentration	C_w	COPC-specific		pCi/L	ECF-200PO1-09-2027
Exposure frequency	EF	350		days/year	EPA/540/R-92/003
Exposure duration	ED	30	6	years	EPA/540/R-92/003
Inhalation Rate	INH	20	10	m^3/day	OSWER Directive 9285.6-03 EPA/600/P-
Exposure time	ET	0.58	1	hours/day	EPA/540/R/99/005
Age Adjusted Exposure Time	ET_{adj}	0.664		hours/day	Calculated
Radiation Age-adjusted Inhalation Rate	INH_RAD_{adj}	540		m^3-year/day	Calculated
Andelman Volatilization Factor	VF	0.5		L/m^3	EPA/540/R-92/003
Slope Factor - Inhalation	SF_i	COPC-specific		risk/pCi	EPA, 2001
Conversion Factor	CF2	1/24		days/hour	1 day = 24 hours

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*
EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."
OSWER Directive 9285.6-03, *Risk Assessment Guidance For Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance "Standard Default Exposure Factors Interim Final"*

Inhalation of Volatile Radioactive Constituents in Groundwater

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Radioactive COPC	CAS #	Volatile[a]	C_w (pCi/L)	CDI (radiological inhalation) (pCi)	SF_i (risk/pCi)	Risk (unitless)	% Contribution
Gross alpha	12587-46-1	--	5.3264311	--(b)	--	--(b)	
Iodine-129	15046-84-1	--	2.708038	--(b)	6.07E-11	--(b)	
Plutonium-239/240	PU-239/240	--	0.029	--(b)	3.33E-08	--(b)	
Protactinium-231	14331-85-2	--	0.28	--(b)	4.55E-08	--(b)	
Strontium-90	10098-97-2	--	4.3004432	--(b)	1.05E-10	--(b)	
Technetium-99	14133-76-7	--	1667.3497	--(b)	1.41E-11	--(b)	
Tritium	10028-17-8	Yes	156901.45	4.10E+08	5.62E-14	2.31E-05	100
Total ELCR						2.31E-05	100

[a]Volatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
Near-field Exposure Area

Ingestion of Radioactive COPCs in Tap Water

Intake Parameter Values		Value			
Factor	Symbol	Adult	Child	Unit	Reference
Chronic Daily Intake	CDI	Calculated		pCi	Calculated
Contaminant Concentration	C_w	COPC-specific		pCi/L	ECF-200PO1-09-2027
Exposure frequency	EF	350		days/year	EPA/540/R-92/003
Exposure duration	ED	30	6	years	EPA/540/R-92/003
Drinking Water Ingestion Rate	IRW	2	1	L/day	EPA/540/R-92/003 EPA/600/P-95/002Fa
Radiation Age-adjusted Drinking Water Ingestion Rate	IRW_RAD_{adj}	54		L-year/day	Calculated
Slope Factor - Oral	SF_o	COPC-specific		risk/pCi	EPA, 2001

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*

EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

Ingestion of Radioactive Constituents in Groundwater

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Radioactive COPC	CAS #	C_w (pCi/L)	CDI (radiological ingestion) (pCi)	SF_o (risk/pCi)	Risk (unitless)	% Contribution
Gross alpha	12587-46-1	5.3264311	1.01E+05	--	--	
Iodine-129	15046-84-1	2.708038	5.12E+04	1.48E-10	7.57E-06	3.0
Plutonium-239/240	PU-239/240	0.029	5.48E+02	1.35E-10	7.40E-08	0.030
Protactinium-231	14331-85-2	0.28	5.29E+03	1.73E-10	9.16E-07	0.37
Strontium-90	10098-97-2	4.3004432	8.13E+04	5.59E-11	4.54E-06	1.8
Technetium-99	14133-76-7	1667.3497	3.15E+07	2.75E-12	8.67E-05	35
Tritium	10028-17-8	156901.45	2.97E+09	5.07E-14	1.50E-04	60
Total ELCR					2.50E-04	100

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit River Exposure Area Tap Water Risk Assessment (5 Year 95UCL)--Summary of Tap Water Exposure Pathway Noncancer Hazard Results for Nonradioactive COPCs in Groundwater.

Nonradioactive COPCs	Contaminant Concentration in Groundwater C_w (mg/L)	Volatile[a]	HQ (Inhalation) (unitless)	HQ (Ingestion) (unitless)	HQ (Dermal) (unitless)	Total HQ (unitless)	% Contribution
Acetone	0.0011	Yes	4.11E-07	3.35E-05	--	3.39E-05	0.0031
Arsenic	0.005767892	--	--(b)	5.27E-01	2.75E-03	5.29E-01	49
Barium	0.049451657	--	--(b)	6.77E-03	5.05E-04	7.28E-03	0.67
Carbon tetrachloride	0.000271961	Yes	1.66E-05	1.06E-02	2.85E-03	1.35E-02	1.2
Chloride	11.3727	--	--(b)	--	--	--	
Chloroform	0.000814875	Yes	9.63E-05	2.23E-03	2.03E-04	2.53E-03	0.23
Chromium	0.009951236	--	--(b)	1.82E-04	7.30E-05	2.55E-04	0.023
Copper	0.00597989	--	--(b)	4.10E-03	2.14E-05	4.12E-03	0.38
Fluoride	0.28680392	--	--(b)	1.31E-01	6.84E-04	1.32E-01	12
Iron	0.61057915	--	--(b)	2.39E-02	1.25E-04	2.40E-02	2.2
Lead	0.0006805	--	--(b)	--	--	--	
Manganese	0.041694118	--	--(b)	4.76E-02	6.21E-03	5.38E-02	4.9
Nickel	0.0056	--	--(b)	7.67E-03	2.00E-04	7.87E-03	0.72
Nitrate	28.582087	--	--(b)	1.10E-01	5.76E-04	1.11E-01	10
Nitrite	0.46	--	--(b)	4.20E-02	2.19E-04	4.22E-02	3.9
Strontium	0.38963943	--	--(b)	1.78E-02	9.29E-05	1.79E-02	1.6
Sulfate	42.560202	--	--(b)	--	--	--	
Thallium	0.00037	--	--(b)	--	--	--	
Uranium	0.005589723	--	--(b)	5.10E-02	2.66E-04	5.13E-02	4.7
Vanadium	0.016788235	--	--(b)	9.20E-02	4.80E-04	9.25E-02	8.5
Zinc	0.006671161	--	--(b)	6.09E-04	1.91E-06	6.11E-04	0.056
Total HI			1.13E-04	1.07	0.02	1.09	100

[a]Volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HI = hazard index.

HQ = hazard quotient.

200-PO-1 Groundwater Operable Unit River Exposure Area Tap Water Risk Assessment (5 Year 95UCL)--Summary of Tap Water Exposure Pathway Cancer Risk Results for Nonradioactive COPCs in Groundwater.

Nonradioactive COPCs	Contaminant Concentration in Groundwater C_w (mg/L)	Volatile[a]	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Risk (Dermal) (unitless)	Total Risk (unitless)	% Contribution
Acetone	0.0011	Yes	--	--	--	--	
Arsenic	0.005767892	--	--(b)	1.29E-04	6.93E-07	1.29E-04	99
Barium	0.049451657	--	--(b)	--	--	--	
Carbon tetrachloride	0.000271961	Yes	2.03E-08	5.26E-07	1.36E-07	6.82E-07	0.52
Chloride	11.3727	--	--(b)	--	--	--	
Chloroform	0.000814875	Yes	9.31E-08	3.76E-07	3.30E-08	5.02E-07	0.38
Chromium	0.009951236	--	--(b)	--	--	--	
Copper	0.00597989	--	--(b)	--	--	--	
Fluoride	0.28680392	--	--(b)	--	--	--	
Iron	0.61057915	--	--(b)	--	--	--	
Lead	0.0006805	--	--(b)	--	--	--	
Manganese	0.041694118	--	--(b)	--	--	--	
Nickel	0.0056	--	--(b)	--	--	--	
Nitrate	28.582087	--	--(b)	--	--	--	
Nitrite	0.46	--	--(b)	--	--	--	
Strontium	0.38963943	--	--(b)	--	--	--	
Sulfate	42.560202	--	--(b)	--	--	--	
Thallium	0.00037	--	--(b)	--	--	--	
Uranium	0.005589723	--	--(b)	--	--	--	
Vanadium	0.016788235	--	--(b)	--	--	--	
Zinc	0.006671161	--	--(b)	--	--	--	
Total ELCR			1.13E-07	1.30E-04	8.62E-07	1.31E-04	100

[a]Volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

200-PO-1 Groundwater Operable Unit River Exposure Area Tap Water Risk Assessment (5 Year 95UCL)--Summary of Tap Water Exposure Pathway Cancer Risk Results for Radioactive COPCs in Groundwater.

Radioactive COPCs	Contaminant Concentration in Groundwater C_w (pCi/L)	Volatile[a]	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Total Risk (unitless)	% Contribution
Gross alpha	2.4	--	--(b)	--	--	
Gross beta	31.1	--	--(b)	--	--	
Strontium-90	2.60	--	--(b)	2.75E-06	2.75E-06	3.2
Technetium-99	121	--	--(b)	6.29E-06	6.29E-06	7.2
Tritium	70,724	Yes	1.04E-05	6.78E-05	7.82E-05	89.6
Total ELCR			1.04E-05	7.68E-05	8.72E-05	100

[a]Volatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates radionuclide toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
River Exposure Area

Ingestion of Nonradioactive COPCs in Tap Water

Intake Parameter Values		Value			
Parameter	Symbol	Adult	Child	Unit	Source
Ingestion Chronic Daily Intake	CDI	Calculated		mg/kg-day	Calculated
Contaminant Concentration	C_w	COPC-specific		mg/L	ECF-200PO1-09-2027
Average Body Weight	BW	70	15	kg	EPA/540/R-92/003
Drinking Water Ingestion Rate	IRW	2	1	L/day	EPA/540/R-92/003 EPA/600/P-95/002Fa
Age-Adjusted Drinking Water Ingestion Rate	IRW_{adj}	1.086		L-year/kg-day	Calculated
Exposure Frequency	EF	350		days/year	EPA/540/R-92/003
Exposure Duration	ED	30	6	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70		years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30		years	EPA/540/R-92/003
Oral Reference Dose	RfD_o	COPC-specific		mg/kg-day	EPA, 2009
Oral Cancer Slope Factor	CSF_o	COPC-specific		$(mg/kg\text{-}day)^{-1}$	EPA, 2009
Conversion Factor	CF1	365		days/year	365 days = 1 year

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors .*

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit River Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD_o[a] (mg/kg-day)	HQ (unitless)	% Contribution
Acetone	67-64-1	0.0011	3.01E-05	9.00E-01	3.35E-05	0.0031
Arsenic	7440-38-2	0.005767892	1.58E-04	3.00E-04	5.27E-01	49
Barium	7440-39-3	0.049451657	1.35E-03	2.00E-01	6.77E-03	0.63
Carbon tetrachloride	56-23-5	0.000271961	7.45E-06	7.00E-04	1.06E-02	0.99
Chloride	16887-00-6	11.3727	3.12E-01	--	--	
Chloroform	67-66-3	0.000814875	2.23E-05	1.00E-02	2.23E-03	0.21
Chromium	7440-47-3	0.009951236	2.73E-04	1.50E+00	1.82E-04	0.017
Copper	7440-50-8	0.00597989	1.64E-04	4.00E-02	4.10E-03	0.38
Fluoride	16984-48-8	0.28680392	7.86E-03	6.00E-02	1.31E-01	12
Iron	7439-89-6	0.61057915	1.67E-02	7.00E-01	2.39E-02	2.2
Lead	7439-92-1	0.0006805	1.86E-05	--	--	
Manganese	7439-96-5	0.041694118	1.14E-03	2.40E-02	4.76E-02	4.4
Nickel	7440-02-0	0.0056	1.53E-04	2.00E-02	7.67E-03	0.71
Nitrate	14797-55-8	28.582087	7.83E-01	7.10E+00	1.10E-01	10
Nitrite	14797-65-0	0.46	1.26E-02	3.00E-01	4.20E-02	3.9
Strontium	7440-24-6	0.38963943	1.07E-02	6.00E-01	1.78E-02	1.7
Sulfate	14808-79-8	42.560202	1.17E+00	--	--	
Thallium	7440-28-0	0.00037	1.01E-05	--	--	
Uranium	7440-61-1	0.005589723	1.53E-04	3.00E-03	5.10E-02	4.8
Vanadium	7440-62-2	0.016788235	4.60E-04	5.00E-03	9.20E-02	8.6
Zinc	7440-66-6	0.006671161	1.83E-04	3.00E-01	6.09E-04	0.057
Total HI					1.1	100

a EPA Region 3 Regional Screening Level tables downloaded January 2009. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HQ = hazard quotient.

U.S. EPA 1989. Risk assessment guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A). EPA/540/1/89/002.

Cancer risk calculation

200-PO-1 Groundwater Operable Unit River Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF_o[a] $(mg/kg\text{-}day)^{-1}$	Risk (unitless)	% Contribution
Acetone	67-64-1	0.0011	1.64E-05	--	--	
Arsenic	7440-38-2	0.005767892	8.58E-05	1.50E+00	1.29E-04	99
Barium	7440-39-3	0.049451657	7.35E-04	--	--	
Carbon tetrachloride	56-23-5	0.000271961	4.04E-06	1.30E-01	5.26E-07	0.41
Chloride	16887-00-6	11.3727	1.69E-01	--	--	
Chloroform	67-66-3	0.000814875	1.21E-05	3.10E-02	3.76E-07	0.29
Chromium	7440-47-3	0.009951236	1.48E-04	--	--	
Copper	7440-50-8	0.00597989	8.89E-05	--	--	
Fluoride	16984-48-8	0.28680392	4.27E-03	--	--	
Iron	7439-89-6	0.61057915	9.08E-03	--	--	
Lead	7439-92-1	0.0006805	1.01E-05	--	--	
Manganese	7439-96-5	0.041694118	6.20E-04	--	--	
Nickel	7440-02-0	0.0056	8.33E-05	--	--	
Nitrate	14797-55-8	28.582087	4.25E-01	--	--	
Nitrite	14797-65-0	0.46	6.84E-03	--	--	
Strontium	7440-24-6	0.38963943	5.80E-03	--	--	
Sulfate	14808-79-8	42.560202	6.33E-01	--	--	
Thallium	7440-28-0	0.00037	5.50E-06	--	--	
Uranium	7440-61-1	0.005589723	8.31E-05	--	--	
Vanadium	7440-62-2	0.016788235	2.50E-04	--	--	
Zinc	7440-66-6	0.006671161	9.92E-05	--	--	
Total ELCR					1.30E-04	100

a EPA Region 3 Regional Screening Level tables downloaded January 2009. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

U.S. EPA 1989. Risk assessment guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A). EPA/540/1/89/002.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
River Exposure Area

Inhalation of Volatile Nonradioactive COPCs in Tap Water

Intake Parameter Values				
Parameter	Symbol	Value	Unit	Source
Inhalation Chronic Daily Intake	CDI	Calculated	mg/m^3 for noncarcinogens, $\mu g/m^3$ for carcinogens	Calculated
Contaminant Concentration	C_w	COPC-specific	mg/L	ECF-200PO1-09-2027
Exposure Time	ET	0.58	hours/day	EPA/540/R/99/005
Exposure Frequency	EF	350	days/year	EPA/540/R-92/003
Exposure Duration	ED	30	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70	years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30	years	EPA/540/R-92/003
Andelman Volatilization Factor	VF	0.5	L/m^3	EPA/540/R-92/003
Inhalation Reference Concentration	RfC	COPC-specific	mg/m^3	EPA, 2009
Inhalation Unit Risk	IUR	COPC-specific	$(\mu g/m^3)^{-1}$	EPA, 2009
Conversion Factor	CF1	365	days/year	365 days = 1 year
Conversion Factor	CF2	1/24	days/hour	1 day = 24 hours

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors*.

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit River Exposure Area Nonradioactive COPC	CAS #	Volatile[a]	C_w (mg/L)	CDI (non-cancer) (mg/m^3)	RfC[a] (mg/m^3)	HQ (unitless)	% Contribution
Acetone	67-64-1	Yes	0.0011	1.27E-05	3.10E+01	4.11E-07	0.36
Arsenic	7440-38-2	--	0.005767892	--(b)	1.50E-05	--(b)	
Barium	7440-39-3	--	0.049451657	--(b)	5.00E-04	--(b)	
Carbon tetrachloride	56-23-5	Yes	0.000271961	3.15E-06	1.90E-01	1.66E-05	15
Chloride	16887-00-6	--	11.3727	--(b)	--	--(b)	
Chloroform	67-66-3	Yes	0.000814875	9.44E-06	9.80E-02	9.63E-05	85
Chromium	7440-47-3	--	0.009951236	--(b)	--	--(b)	
Copper	7440-50-8	--	0.00597989	--(b)	--	--(b)	
Fluoride	16984-48-8	--	0.28680392	--(b)	1.30E-02	--(b)	
Iron	7439-89-6	--	0.61057915	--(b)	--	--(b)	
Lead	7439-92-1	--	0.0006805	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.041694118	--(b)	5.00E-05	--(b)	
Nickel	7440-02-0	--	0.0056	--(b)	9.00E-05	--(b)	
Nitrate	14797-55-8	--	28.582087	--(b)	--	--(b)	
Nitrite	14797-65-0	--	0.46	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.38963943	--(b)	--	--(b)	
Sulfate	14808-79-8	--	42.560202	--(b)	--	--(b)	
Thallium	7440-28-0	--	0.00037	--(b)	--	--(b)	
Uranium	7440-61-1	--	0.005589723	--(b)	3.00E-04	--(b)	
Vanadium	7440-62-2	--	0.016788235	--(b)	--	--(b)	
Zinc	7440-66-6	--	0.006671161	--(b)	--	--(b)	
Total HI						1.13E-04	100

a EPA Region 3 Regional Screening Level tables downloaded January 2009. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

[b] Nonvolatile constituents are not considered in the inhalation of groundwater in the drinking water pathway

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HQ = hazard quotient.

U.S. EPA 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). EPA-540-R-070-002.

Cancer risk calculation

200-PO-1 Groundwater Operable Unit River Exposure Area Nonradioactive COPC	CAS #	Volatile[a]	C_w (mg/L)	CDI (cancer) ($\mu g/m^3$)	IUR[a] $(\mu g/m^3)^{-1}$	Risk (unitless)	% Contribution
Acetone	67-64-1	Yes	0.0011	5.46E-03	--	--	
Arsenic	7440-38-2	--	0.005767892	--(b)	4.30E-03	--(b)	
Barium	7440-39-3	--	0.049451657	--(b)	--	--(b)	
Carbon tetrachloride	56-23-5	Yes	0.000271961	1.35E-03	1.50E-05	2.03E-08	18
Chloride	16887-00-6	--	11.3727	--(b)	--	--(b)	
Chloroform	67-66-3	Yes	0.000814875	4.05E-03	2.30E-05	9.31E-08	82
Chromium	7440-47-3	--	0.009951236	--(b)	--	--(b)	
Copper	7440-50-8	--	0.00597989	--(b)	--	--(b)	
Fluoride	16984-48-8	--	0.28680392	--(b)	--	--(b)	
Iron	7439-89-6	--	0.61057915	--(b)	--	--(b)	
Lead	7439-92-1	--	0.0006805	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.041694118	--(b)	--	--(b)	
Nickel	7440-02-0	--	0.0056	--(b)	2.60E-04	--(b)	
Nitrate	14797-55-8	--	28.582087	--(b)	--	--(b)	
Nitrite	14797-65-0	--	0.46	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.38963943	--(b)	--	--(b)	
Sulfate	14808-79-8	--	42.560202	--(b)	--	--(b)	
Thallium	7440-28-0	--	0.00037	--(b)	--	--(b)	
Uranium	7440-61-1	--	0.005589723	--(b)	--	--(b)	
Vanadium	7440-62-2	--	0.016788235	--(b)	--	--(b)	
Zinc	7440-66-6	--	0.006671161	--(b)	--	--(b)	
Total ELCR						1.13E-07	100

a EPA Region 3 Regional Screening Level tables downloaded January 2009. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

[b] Nonvolatile constituents are not considered in the inhalation of groundwater in the drinking water pathway

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

U.S. EPA 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). EPA-540-R-070-002.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
River Exposure Area

Dermal Absorption of Nonradioactive COPCs in Tap Water

Intake Parameter Values		Value			
Parameter	Symbol	Adult	Child	Unit	Source
Chronic Daily Intake	CDI	Calculated		mg/kg-day	Calculated
Contaminant Concentration	C_w	COPC-specific		mg/L	ECF-200PO1-09-2027
Average Body Weight	BW	70	15	kg	EPA/540/R-92/003
Exposure Time	ET	0.58	1	hours/event	EPA/540/R/99/005
Exposure Time (Age-Adjusted)	ET_{adj}	0.664		hours/event	Calculated
Surface Area	SA	18,000	6,600	cm^2	EPA/540/R/99/005
Age-Adjusted Surface Area	SA_{adj}	8,811		(cm^2-year-event)/(kg/day)	Calculated
Event Frequency	EV	1		event/day	EPA/540/R/99/005
Exposure Frequency	EF	350		days/year	EPA/540/R-92/003
Exposure Duration	ED	30	6	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70		years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30		years	EPA/540/R-92/003
Oral Reference Dose	RfD_o	COPC-specific		mg/kg-day	EPA, 2009
Oral Cancer Slope Factor	CSF_o	COPC-specific		$(mg/kg\text{-}day)^{-1}$	EPA, 2009
Conversion Factor	CF1	365		days/year	365 days = 1 year
Conversion Factor	CF3	0.001		L/cm^3	1 L = 1000 cm^3
The constant pi	π	3.14159		unitless	--
Time to reach steady state	t^*	COPC-specific		hours	EPA/540/R/99/005
Dermal Partitioning Constant	B	COPC-specific		unitless	EPA/540/R/99/005
Absorbed Dose per Event	DA	calculated		mg/cm^2-event	Calculated
Dermal Permeability Constant	K_p	COPC-specific		cm/hour	EPA/540/R/99/005
Fraction Absorbed	FA	COPC-specific		unitless	EPA/540/R/99/005
Lag Time	τ	COPC-specific		hours/event	EPA/540/R/99/005
Fraction of Contaminant Absorbed in Gastrointestinal Tract	GIABS	COPC-specific		unitless	EPA, 2009

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Absorbed Dermal Dose Calculation

Contaminant of Potential Concern	CAS #	C_w (mg/L)	Inorganic/organic[a]	FA[b] (unitless)	K_p[c] (cm/hour)	B[b] (unitless)	t*[b] (hours/event)	τ*[b] (hours)	DA (noncancer) (mg/cm^2-event)	DA (cancer) (mg/cm^2-event)
Acetone[c]	67-64-1	0.0011	--	--	0.000512	--	--	--	--	--
Arsenic	7440-38-2	0.005767892	INORGANIC	--	0.001	--	--	--	3.35E-09	3.83E-09
Barium	7440-39-3	0.049451657	INORGANIC	--	0.001	--	--	--	2.87E-08	3.28E-08
Carbon tetrachloride	56-23-5	0.000271961	--	1	0.016	0.1	0.78	1.86	8.09E-09	8.66E-09
Chloride	16887-00-6	11.3727	INORGANIC	--	0.001	--	--	--	6.60E-06	7.55E-06
Chloroform	67-66-3	0.000814875	--	1	0.0068	0	0.5	1.19	8.25E-09	8.82E-09
Chromium	7440-47-3	0.009951236	INORGANIC	--	0.001	--	--	--	5.77E-09	6.61E-09
Copper	7440-50-8	0.00597989	INORGANIC	--	0.001	--	--	--	3.47E-09	3.97E-09
Fluoride	16984-48-8	0.28680392	INORGANIC	--	0.001	--	--	--	1.66E-07	1.90E-07
Iron	7439-89-6	0.61057915	INORGANIC	--	0.001	--	--	--	3.54E-07	4.05E-07
Lead	7439-92-1	0.0006805	INORGANIC	--	0.0001	--	--	--	3.95E-11	4.52E-11
Manganese	7439-96-5	0.041694118	INORGANIC	--	0.001	--	--	--	2.42E-08	2.77E-08
Nickel	7440-02-0	0.0056	INORGANIC	--	0.0002	--	--	--	6.50E-10	7.44E-10
Nitrate	14797-55-8	28.582087	INORGANIC	--	0.001	--	--	--	1.66E-05	1.90E-05
Nitrite	14797-65-0	0.46	INORGANIC	--	0.001	--	--	--	2.67E-07	3.05E-07
Strontium	7440-24-6	0.38963943	INORGANIC	--	0.001	--	--	--	2.26E-07	2.59E-07
Sulfate	14808-79-8	42.560202	INORGANIC	--	0.001	--	--	--	2.47E-05	2.83E-05
Thallium	7440-28-0	0.00037	INORGANIC	--	0.001	--	--	--	2.15E-10	2.46E-10
Uranium	7440-61-1	0.005589723	INORGANIC	--	0.001	--	--	--	3.24E-09	3.71E-09
Vanadium	7440-62-2	0.016788235	INORGANIC	--	0.001	--	--	--	9.74E-09	1.11E-08
Zinc	7440-66-6	0.006671161	INORGANIC	--	0.0006	--	--	--	2.32E-09	2.66E-09

[a]EPA/540/R/99/005, Exhibit 3-1 (inorganics) and Exhibit B-3 (organics)

[b]EPA/540/R/99/005, Exhibit B-3

[c]the K_p value was taken from ORNL, 2010, The Risk Assessment Information System (RAIS).

	0.005998362

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit River Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD_o[a] (mg/kg-day)	GIABS[a] (unitless)	HQ (unitless)	% Contribution
Acetone	67-64-1	0.0011	--	9.00E-01	1	--	
Arsenic	7440-38-2	0.005767892	8.25E-07	3.00E-04	1	2.75E-03	18
Barium	7440-39-3	0.049451657	7.07E-06	2.00E-01	0.07	5.05E-04	3.3
Carbon tetrachloride	56-23-5	0.000271961	1.99E-06	7.00E-04	1	2.85E-03	19
Chloride	16887-00-6	11.3727	1.63E-03	--	1	--	
Chloroform	67-66-3	0.000814875	2.03E-06	1.00E-02	1	2.03E-04	1.33
Chromium	7440-47-3	0.009951236	1.42E-06	1.50E+00	0.013	7.30E-05	0.48
Copper	7440-50-8	0.00597989	8.55E-07	4.00E-02	1	2.14E-05	0.140
Fluoride	16984-48-8	0.28680392	4.10E-05	6.00E-02	1	6.84E-04	4.5
Iron	7439-89-6	0.61057915	8.73E-05	7.00E-01	1	1.25E-04	0.82
Lead	7439-92-1	0.0006805	9.73E-09	--	1	--	
Manganese	7439-96-5	0.041694118	5.96E-06	2.40E-02	0.04	6.21E-03	41
Nickel	7440-02-0	0.0056	1.60E-07	2.00E-02	0.04	2.00E-04	1.31
Nitrate	14797-55-8	28.582087	4.09E-03	7.10E+00	1	5.76E-04	3.8
Nitrite	14797-65-0	0.46	6.58E-05	3.00E-01	1	2.19E-04	1.44
Strontium	7440-24-6	0.38963943	5.57E-05	6.00E-01	1	9.29E-05	0.61
Sulfate	14808-79-8	42.560202	6.09E-03	--	--	--	
Thallium	7440-28-0	0.00037	5.29E-08	--	1	--	
Uranium	7440-61-1	0.005589723	7.99E-07	3.00E-03	1	2.66E-04	1.7
Vanadium	7440-62-2	0.016788235	2.40E-06	5.00E-03	1	4.80E-04	3.1
Zinc	7440-66-6	0.006671161	5.72E-07	3.00E-01	1	1.91E-06	0.0125
Total HI						0.015	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HI = hazard index

HQ = hazard quotient.

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

Cancer risk calculation

200-PO-1 Groundwater Operable Unit River Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF_o[a] $(mg/kg\text{-}day)^{-1}$	GIABS[a] (unitless)	Risk (unitless)	% Contribution
Acetone	67-64-1	0.0011	--	--	1	--	
Arsenic	7440-38-2	0.005767892	4.62E-07	1.50E+00	1	6.93E-07	80
Barium	7440-39-3	0.049451657	3.96E-06	--	0.07	--	
Carbon tetrachloride	56-23-5	0.000271961	1.04E-06	1.30E-01	1	1.36E-07	16
Chloride	16887-00-6	11.3727	9.11E-04	--	1	--	
Chloroform	67-66-3	0.000814875	1.07E-06	3.10E-02	1	3.30E-08	3.8
Chromium	7440-47-3	0.009951236	7.98E-07	--	0.013	--	
Copper	7440-50-8	0.00597989	4.79E-07	--	1	--	
Fluoride	16984-48-8	0.28680392	2.30E-05	--	1	--	
Iron	7439-89-6	0.61057915	4.89E-05	--	1	--	
Lead	7439-92-1	0.0006805	5.45E-09	--	1	--	
Manganese	7439-96-5	0.041694118	3.34E-06	--	0.04	--	
Nickel	7440-02-0	0.0056	8.98E-08	--	0.04	--	
Nitrate	14797-55-8	28.582087	2.29E-03	--	1	--	
Nitrite	14797-65-0	0.46	3.69E-05	--	1	--	
Strontium	7440-24-6	0.38963943	3.12E-05	--	1	--	
Sulfate	14808-79-8	42.560202	3.41E-03	--	--	--	
Thallium	7440-28-0	0.00037	2.97E-08	--	1	--	
Uranium	7440-61-1	0.005589723	4.48E-07	--	1	--	
Vanadium	7440-62-2	0.016788235	1.35E-06	--	1	--	
Zinc	7440-66-6	0.006671161	3.21E-07	--	1	--	
Total ELCR						8.62E-07	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
River Exposure Area

Inhalation of Volatile Radioactive COPCs in Tap Water

Intake Parameter Values		Value			
Factor	Symbol	Adult	Child	Unit	Reference
Chronic Daily Intake	CDI	Calculated		pCi	Calculated
Contaminant Concentration	C_w	COPC-specific		pCi/L	ECF-200PO1-09-2027
Exposure frequency	EF	350		days/year	EPA/540/R-92/003
Exposure duration	ED	30	6	years	EPA/540/R-92/003
Inhalation Rate	INH	20	10	m^3/day	OSWER Directive 9285.6-03 EPA/600/P-
Exposure time	ET	0.58	1	hours/day	EPA/540/R/99/005
Age Adjusted Exposure Time	ET_{adj}	0.664		hours/day	Calculated
Radiation Age-adjusted Inhalation Rate	INH_RAD_{adj}	540		m^3-year/day	Calculated
Andelman Volatilization Factor	VF	0.5		L/m^3	EPA/540/R-92/003
Slope Factor - Inhalation	SF_i	COPC-specific		risk/pCi	EPA, 2001
Conversion Factor	CF2	1/24		days/hour	1 day = 24 hours

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010
EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*
EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*
EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."
OSWER Directive 9285.6-03, *Risk Assessment Guidance For Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance "Standard Default Exposure Factors Interim Final"*

Inhalation of Volatile Radioactive Constituents in Groundwater

200-PO-1 Groundwater Operable Unit River Exposure Area Radioactive COPC	CAS #	Volatile[a]	C_w (pCi/L)	CDI (radiological inhalation) (pCi)	SF_i (risk/pCi)	Risk (unitless)	% Contribution
Gross alpha	12587-46-1	--	2.4	--(b)	--	--(b)	
Gross beta	12587-47-2	--	31.1	--(b)	--	--(b)	
Strontium-90	10098-97-2	--	2.60	--(b)	1.05E-10	--(b)	
Technetium-99	14133-76-7	--	121	--(b)	1.41E-11	--(b)	
Tritium	10028-17-8	Yes	70,724	1.85E+08	5.62E-14	1.04E-05	100
Total ELCR						1.04E-05	100

[a]Volatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."
[b]Nonvolatile constituents are not considered in the inhalation exposure route
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (5 Year 95UCL)
River Exposure Area

Ingestion of Radioactive COPCs in Tap Water

Intake Parameter Values		Value			
Factor	Symbol	Adult	Child	Unit	Reference
Chronic Daily Intake	CDI	Calculated		pCi	Calculated
Contaminant Concentration	C_w	COPC-specific		pCi/L	ECF-200PO1-09-2027
Exposure frequency	EF	350		days/year	EPA/540/R-92/003
Exposure duration	ED	30	6	years	EPA/540/R-92/003
Drinking Water Ingestion Rate	IRW	2	1	L/day	EPA/540/R-92/003 EPA/600/P-95/002Fa
Radiation Age-adjusted Drinking Water Ingestion Rate	IRW_RAD_{adj}	54		L-year/day	Calculated
Slope Factor - Oral	SF_o	COPC-specific		risk/pCi	EPA, 2001

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*

EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

Ingestion of Radioactive Constituents in Groundwater

200-PO-1 Groundwater Operable Unit River Exposure Area Radioactive COPC	CAS #	C_w (pCi/L)	CDI (radiological ingestion) (pCi)	SF_o (risk/pCi)	Risk (unitless)	% Contribution
Gross alpha	12587-46-1	2.4	4.51E+04	--	--	
Gross beta	12587-47-2	31.1	5.88E+05	--	--	
Strontium-90	10098-97-2	2.60	4.91E+04	5.59E-11	2.75E-06	3.6
Technetium-99	14133-76-7	121	2.29E+06	2.75E-12	6.29E-06	8.2
Tritium	10028-17-8	70,724	1.34E+09	5.07E-14	6.78E-05	88
Total ELCR					7.68E-05	100

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Tap Water Risk Assessment (10 year)--Summary of Tap Water Exposure Pathway Noncancer Hazard Results for Nonradioactive COPCs in Groundwater.

Nonradioactive COPCs	Contaminant Concentration in Groundwater C_w (mg/L)	Volatile[a]	HQ (Inhalation) (unitless)	HQ (Ingestion) (unitless)	HQ (Dermal) (unitless)	Total HQ (unitless)	% Contribution
(m+p)-Xylene	0.0005	Yes	8.28E-06	6.85E-05	4.46E-05	1.21E-04	0.0087
1,1,1-Trichloroethane	0.001204711	Yes	2.79E-06	1.65E-05	3.15E-06	2.24E-05	1.61E-03
1,1-Dichloroethane	0.000389235	Yes	6.44E-06	5.33E-05	4.17E-06	6.39E-05	0.0046
1,1-Dichloroethene	0.000164225	Yes	9.51E-06	9.00E-05	1.24E-05	1.12E-04	0.008
1,2-Dichlorobenzene	0.003	Yes	1.74E-04	9.13E-04	5.98E-04	1.68E-03	0.121
1,2-Dichloroethane	0.000305426	Yes	1.47E-06	4.18E-04	2.05E-05	4.40E-04	0.032
1,4-Dichlorobenzene	0.000130994	Yes	1.90E-06	5.13E-05	3.44E-05	8.75E-05	0.006
1,4-Dioxane	0.0081	--	--(b)	2.22E-03	7.97E-06	2.23E-03	0.160
2-Butanone	0.0029	Yes	6.72E-06	1.32E-04	1.25E-06	1.40E-04	0.0101
2-Pentanone, 4-Methyl	0.00064	Yes	2.47E-06	2.19E-04	7.00E-06	2.29E-04	0.0164
Acetone	0.00128316	Yes	4.80E-07	3.91E-05	--	3.95E-05	0.0028
Aluminum	0.041755539	--	--(b)	1.14E-03	5.97E-06	1.15E-03	0.083
Arsenic	0.003060574	--	--(b)	2.80E-01	1.46E-03	2.81E-01	20.2
Barium	0.068082679	--	--(b)	9.33E-03	6.95E-04	1.00E-02	0.72
Benzene	0.0019	Yes	7.34E-04	1.30E-02	1.99E-03	1.57E-02	1.13
Benzyl alcohol	0.0027	--	--(b)	7.40E-04	--	7.40E-04	0.053
Beryllium	0.000360659	--	--(b)	4.94E-03	3.68E-03	8.62E-03	0.6
Bis(2-ethylhexyl) phthalate	0.001271216	--	--(b)	1.74E-03	2.69E-03	4.43E-03	0.32
Cadmium	0.0045	--	--(b)	2.47E-01	2.57E-02	2.72E-01	19.5
Carbon disulfide	0.00039	Yes	6.46E-06	1.07E-04	1.88E-05	1.32E-04	0.0095
Carbon tetrachloride	0.000164414	Yes	1.00E-05	6.43E-03	1.72E-03	8.17E-03	0.59
Chloride	9.821328	--	--(b)	--	--	--	
Chlorobenzene	0.00041	Yes	9.50E-05	5.62E-04	2.02E-04	8.59E-04	0.062
Chloroform	0.00022061	Yes	2.61E-05	6.04E-04	5.51E-05	6.86E-04	0.049
Chromium	0.007505402	--	--(b)	1.37E-04	5.50E-05	1.92E-04	0.0138
cis-1,2-Dichloroethylene	0.0002	Yes	--	5.48E-04	4.86E-05	5.97E-04	0.043
Copper	0.002993571	--	--(b)	2.05E-03	1.07E-05	2.06E-03	0.148
Fluoride	0.32861624	--	--(b)	1.50E-01	7.83E-04	1.51E-01	10.8
Iron	0.47301923	--	--(b)	1.85E-02	9.66E-05	1.86E-02	1.34
Lead	0.000710361	--	--(b)	--	--	--	
Lithium	0.0083	--	--(b)	1.14E-01	5.94E-04	1.14E-01	8.2
Manganese	0.011254937	--	--(b)	1.28E-02	1.68E-03	1.45E-02	1.04
Methanol	1.1	--	--(b)	6.03E-02	1.56E-04	6.04E-02	4.3
Methylene chloride	0.000852962	Yes	9.88E-06	3.89E-04	1.46E-05	4.14E-04	0.030
Molybdenum	0.0015	--	--(b)	8.22E-03	4.29E-05	8.26E-03	0.59
Nickel	0.003603478	--	--(b)	4.94E-03	1.29E-04	5.07E-03	0.36
Nitrate	23.756902	--	--(b)	9.17E-02	4.79E-04	9.22E-02	6.6
Nitrite	0.079227256	--	--(b)	7.24E-03	3.78E-05	7.27E-03	0.52
o-Xylene	0.000210551	Yes	3.49E-06	2.88E-05	1.91E-05	5.15E-05	0.0037
Silver	0.005341496	--	--(b)	2.93E-02	2.29E-03	3.16E-02	2.27
Strontium	0.36357229	--	--(b)	1.66E-02	8.67E-05	1.67E-02	1.20
Sulfate	45.069738	--	--(b)	--	--	--	
Tetrachloroethene	0.000993146	Yes	4.26E-05	2.72E-03	1.62E-03	4.39E-03	0.31
Toluene	0.000274725	Yes	6.37E-07	9.41E-05	3.27E-05	1.27E-04	0.0091
Tributyl phosphate	0.040836371	--	--(b)	5.59E-03	--	5.59E-03	0.401
Trichloroethene	0.000492361	Yes	1.63E-04	--	--	1.63E-04	0.0117
Trichloromonofluoromethane	0.00058	Yes	9.60E-06	5.30E-05	1.04E-05	7.29E-05	0.005
Uranium	0.016251153	--	--(b)	1.48E-01	7.75E-04	1.49E-01	10.7
Vanadium	0.013487657	--	--(b)	7.39E-02	3.86E-04	7.43E-02	5.3
Vinyl chloride	0.0018	Yes	2.09E-04	1.64E-02	8.78E-04	1.75E-02	1.258
Zinc	0.10896358	--	--(b)	9.95E-03	3.12E-05	9.98E-03	0.7164
Total HI			1.52E-03	1.34	0.05	1.39	100

[a]Volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
[b]Nonvolatile constituents are not considered in the inhalation exposure route
-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.
COPC = contaminant of potential concern.
HI = hazard index.
HQ = hazard quotient.

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Tap Water Risk Assessment (10 year)--Summary of Tap Water Exposure Pathway Cancer Risk Results for Nonradioactive COPCs in Groundwater.

Nonradioactive COPCs	Contaminant Concentration in Groundwater C_w (mg/L)	Volatile[a]	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Risk (Dermal) (unitless)	Total Risk (unitless)	% Contribution
(m+p)-Xylene	0.0005	Yes	--	--	--	--	
1,1,1-Trichloroethane	0.001204711	Yes	--	--	--	--	
1,1-Dichloroethane	0.000389235	Yes	--	--	--	--	
1,1-Dichloroethene	0.000164225	Yes	--	--	--	--	
1,2-Dichlorobenzene	0.003	Yes	--	--	--	--	
1,2-Dichloroethane	0.000305426	Yes	3.94E-08	4.13E-07	1.96E-08	4.72E-07	0.42
1,4-Dichlorobenzene	0.000130994	Yes	7.16E-09	1.05E-08	6.81E-09	2.45E-08	0.02
1,4-Dioxane	0.0081	--	--(b)	1.33E-06	4.59E-09	1.33E-06	1.2
2-Butanone	0.0029	Yes	--	--	--	--	
2-Pentanone, 4-Methyl	0.00064	Yes	--	--	--	--	
Acetone	0.00128316	Yes	--	--	--	--	
Aluminum	0.041755539	--	--(b)	--	--	--	
Arsenic	0.003060574	--	--(b)	6.83E-05	3.68E-07	6.86E-05	61
Barium	0.068082679	--	--(b)	--	--	--	
Benzene	0.0019	Yes	7.36E-08	1.55E-06	2.29E-07	1.86E-06	1.64
Benzyl alcohol	0.0027	--	--(b)	--	--	--	
Beryllium	0.000360659	--	--(b)	--	--	--	
Bis(2-ethylhexyl) phthalate	0.001271216	--	--(b)	2.65E-07	3.95E-07	6.59E-07	0.6
Cadmium	0.0045	--	--(b)	--	--	--	
Carbon disulfide	0.00039	Yes	--	--	--	--	
Carbon tetrachloride	0.000164414	Yes	1.22E-08	3.18E-07	8.21E-08	4.12E-07	0.4
Chloride	9.821328	--	--(b)	--	--	--	
Chlorobenzene	0.00041	Yes	--	--	--	--	
Chloroform	0.00022061	Yes	2.52E-08	1.02E-07	8.94E-09	1.36E-07	0.12
Chromium	0.007505402	--	--(b)	--	--	--	
cis-1,2-Dichloroethylene	0.0002	Yes	--	--	--	--	
Copper	0.002993571	--	--(b)	--	--	--	
Fluoride	0.32861624	--	--(b)	--	--	--	
Iron	0.47301923	--	--(b)	--	--	--	
Lead	0.000710361	--	--(b)	--	--	--	
Lithium	0.0083	--	--(b)	--	--	--	
Manganese	0.011254937	--	--(b)	--	--	--	
Methanol	1.1	--	--(b)	--	--	--	
Methylene chloride	0.000852962	Yes	1.99E-09	9.51E-08	3.44E-09	1.01E-07	0.09
Molybdenum	0.0015	--	--(b)	--	--	--	
Nickel	0.003603478	--	--(b)	--	--	--	
Nitrate	23.756902	--	--(b)	--	--	--	
Nitrite	0.079227256	--	--(b)	--	--	--	
o-Xylene	0.000210551	Yes	--	--	--	--	
Silver	0.005341496	--	--(b)	--	--	--	
Strontium	0.36357229	--	--(b)	--	--	--	
Sulfate	45.069738	--	--(b)	--	--	--	
Tetrachloroethene	0.000993146	Yes	2.91E-08	7.98E-06	4.59E-06	1.26E-05	11
Toluene	0.000274725	Yes	--	--	--	--	
Tributyl phosphate	0.040836371	--	--(b)	5.59E-06	--	5.59E-06	4.9
Trichloroethene	0.000492361	Yes	6.11E-08	6.52E-07	1.09E-07	8.22E-07	0.7
Trichloromonofluoromethane	0.00058	Yes	--	--	--	--	
Uranium	0.016251153	--	--(b)	--	--	--	
Vanadium	0.013487657	--	--(b)	--	--	--	
Vinyl chloride	0.0018	Yes	3.93E-08	1.93E-05	1.00E-06	2.03E-05	17.99
Zinc	0.10896358	--	--(b)	--	--	--	
Total ELCR			2.89E-07	1.06E-04	6.82E-06	1.13E-04	100

[a]Volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
[b]Nonvolatile constituents are not considered in the inhalation exposure route
-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Tap Water Risk Assessment (10 year)--Summary of Tap Water Exposure Pathway Cancer Risk Results for Radioactive COPCs in Groundwater.

Radioactive COPCs	Contaminant Concentration in Groundwater C_w (pCi/L)	Volatile[a]	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Total Risk (unitless)	% Contribution
Carbon-14	15.2	--	--(b)	4.45E-07	4.45E-07	0.08
Gross alpha	5.9880167	--	--(b)	--	--	
Gross beta	26.717649	--	--(b)	--	--	
Iodine-129	1.7529182	--	--(b)	4.90E-06	4.90E-06	0.9
Nickel-63	7.66125	--	--(b)	9.70E-08	9.70E-08	0.017
Protactinium-231	0.308	--	--(b)	1.01E-06	1.01E-06	0.18
Strontium-90	0.611	--	--(b)	6.46E-07	6.46E-07	0.115
Technetium-99	75.671084	--	--(b)	3.93E-06	3.93E-06	0.7
Tritium	497899.63	Yes	7.32E-05	4.77E-04	5.50E-04	98
Total ELCR			7.32E-05	4.88E-04	5.61E-04	100

[a]Volatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope
[b]Nonvolatile constituents are not considered in the inhalation exposure route
-- = Indicates radionuclide toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)
Far-field Exposure Area

Ingestion of Nonradioactive COPCs in Drinking Water

Intake Parameter Values		Value			
Parameter	Symbol	Adult	Child	Unit	Source
Ingestion Chronic Daily Intake	CDI	Calculated		mg/kg-day	Calculated
Contaminant Concentration	C_w	COPC-specific		mg/L	ECF-200PO1-09-2027
Average Body Weight	BW	70	15	kg	EPA/540/R-92/003
Drinking Water Ingestion Rate	IRW	2	1	L/day	EPA/540/R-92/003 EPA/600/P-95/002Fa
Age-Adjusted Drinking Water Ingestion Rate	IRW_{adj}	1.086		L-year/kg-day	Calculated
Exposure Frequency	EF	350		days/year	EPA/540/R-92/003
Exposure Duration	ED	30	6	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70		years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30		years	EPA/540/R-92/003
Oral Reference Dose	RfD_o	COPC-specific		mg/kg-day	EPA, 2009
Oral Cancer Slope Factor	CSF_o	COPC-specific		$(mg/kg\text{-}day)^{-1}$	EPA, 2009
Conversion Factor	CF1	365		days/year	365 days = 1 year

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.
EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*
EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors* .
EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD_o* (mg/kg-day)	HQ (unitless)	% Contribution
(m+p)-Xylene	179601-23-1	0.0005	1.37E-05	2.00E-01	6.85E-05	0.0051
1,1,1-Trichloroethane	71-55-6	0.001204711	3.30E-05	2.00E+00	1.65E-05	1.23E-03
1,1-Dichloroethane	75-34-3	0.000389235	1.07E-05	2.00E-01	5.33E-05	0.0040
1,1-Dichloroethene	75-35-4	0.000164225	4.50E-06	5.00E-02	9.00E-05	0.0067
1,2-Dichlorobenzene	95-50-1	0.003	8.22E-05	9.00E-02	9.13E-04	0.068
1,2-Dichloroethane	107-06-2	0.000305426	8.37E-06	2.00E-02	4.18E-04	0.031
1,4-Dichlorobenzene	106-46-7	0.000130994	3.59E-06	7.00E-02	5.13E-05	0.0038
1,4-Dioxane	123-91-1	0.0081	2.22E-04	1.00E-01	2.22E-03	0.165
2-Butanone	78-93-3	0.0029	7.95E-05	6.00E-01	1.32E-04	0.0099
2-Pentanone, 4-Methyl	108-10-1	0.00064	1.75E-05	8.00E-02	2.19E-04	0.0163
Acetone	67-64-1	0.00128316	3.52E-05	9.00E-01	3.91E-05	0.0029
Aluminum	7429-90-5	0.041755539	1.14E-03	1.00E+00	1.14E-03	0.085
Arsenic	7440-38-2	0.003060574	8.39E-05	3.00E-04	2.80E-01	20.8
Barium	7440-39-3	0.068082679	1.87E-03	2.00E-01	9.33E-03	0.69
Benzene	71-43-2	0.0019	5.21E-05	4.00E-03	1.30E-02	0.97
Benzyl alcohol	100-51-6	0.0027	7.40E-05	1.00E-01	7.40E-04	0.055
Beryllium	7440-41-7	0.000360659	9.88E-06	2.00E-03	4.94E-03	0.37
Bis(2-ethylhexyl) phthalate	117-81-7	0.001271216	3.48E-05	2.00E-02	1.74E-03	0.130
Cadmium	7440-43-9	0.0045	1.23E-04	5.00E-04	2.47E-01	18.4
Carbon disulfide	75-15-0	0.00039	1.07E-05	1.00E-01	1.07E-04	0.0080
Carbon tetrachloride	56-23-5	0.000164414	4.50E-06	7.00E-04	6.43E-03	0.48
Chloride	16887-00-6	9.821328	2.69E-01	--	--	
Chlorobenzene	108-90-7	0.00041	1.12E-05	2.00E-02	5.62E-04	0.042
Chloroform	67-66-3	0.00022061	6.04E-06	1.00E-02	6.04E-04	0.045
Chromium	7440-47-3	0.007505402	2.06E-04	1.50E+00	1.37E-04	0.0102
cis-1,2-Dichloroethylene	156-59-2	0.0002	5.48E-06	1.00E-02	5.48E-04	0.041
Copper	7440-50-8	0.002993571	8.20E-05	4.00E-02	2.05E-03	0.153
Fluoride	16984-48-8	0.32861624	9.00E-03	6.00E-02	1.50E-01	11.2
Iron	7439-89-6	0.47301923	1.30E-02	7.00E-01	1.85E-02	1.38
Lead	7439-92-1	0.000710361	1.95E-05	--	--	
Lithium	7439-93-2	0.0083	2.27E-04	2.00E-03	1.14E-01	8.5
Manganese	7439-96-5	0.011254937	3.08E-04	2.40E-02	1.28E-02	0.96
Methanol	67-56-1	1.1	3.01E-02	5.00E-01	6.03E-02	4.5
Methylene chloride	75-09-2	0.000852962	2.34E-05	6.00E-02	3.89E-04	0.029
Molybdenum	7439-98-7	0.0015	4.11E-05	5.00E-03	8.22E-03	0.61
Nickel	7440-02-0	0.003603478	9.87E-05	2.00E-02	4.94E-03	0.37
Nitrate	14797-55-8	23.756902	6.51E-01	7.10E+00	9.17E-02	6.8
Nitrite	14797-65-0	0.079227256	2.17E-03	3.00E-01	7.24E-03	0.54
o-Xylene	95-47-6	0.000210551	5.77E-06	2.00E-01	2.88E-05	2.15E-03
Silver	7440-22-4	0.005341496	1.46E-04	5.00E-03	2.93E-02	2.18
Strontium	7440-24-6	0.36357229	9.96E-03	6.00E-01	1.66E-02	1.24
Sulfate	14808-79-8	45.069738	1.23E+00	--	--	
Tetrachloroethene	127-18-4	0.000993146	2.72E-05	1.00E-02	2.72E-03	0.203
Toluene	108-88-3	0.000274725	7.53E-06	8.00E-02	9.41E-05	0.0070
Tributyl phosphate	126-73-8	0.040836371	1.12E-03	2.00E-01	5.59E-03	0.417
Trichloroethene	79-01-6	0.000492361	1.35E-05	--	--	
Trichloromonofluoromethane	75-69-4	0.00058	1.59E-05	3.00E-01	5.30E-05	0.0039
Uranium	7440-61-1	0.016251153	4.45E-04	3.00E-03	1.48E-01	11.1
Vanadium	7440-62-2	0.013487657	3.70E-04	5.00E-03	7.39E-02	5.5
Vinyl chloride	75-01-4	0.0018	4.93E-05	3.00E-03	1.64E-02	1.224
Zinc	7440-66-6	0.10896358	2.99E-03	3.00E-01	9.95E-03	0.741
Total HI					1.34	100

*EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.
COPC = contaminant of potential concern.
HQ = hazard quotient.
HI = hazard index.
EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

Cancer risk calculation

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF_o* $(mg/kg\text{-}day)^{-1}$	Risk (unitless)	% Contribution
(m+p)-Xylene	179601-23-1	0.0005	7.44E-06	--	--	
1,1,1-Trichloroethane	71-55-6	0.001204711	1.79E-05	--	--	
1,1-Dichloroethane	75-34-3	0.000389235	5.79E-06	--	--	
1,1-Dichloroethene	75-35-4	0.000164225	2.44E-06	--	--	
1,2-Dichlorobenzene	95-50-1	0.003	4.46E-05	--	--	
1,2-Dichloroethane	107-06-2	0.000305426	4.54E-06	9.10E-02	4.13E-07	0.39
1,4-Dichlorobenzene	106-46-7	0.000130994	1.95E-06	5.40E-03	1.05E-08	0.010
1,4-Dioxane	123-91-1	0.0081	1.20E-04	1.10E-02	1.33E-06	1.3
2-Butanone	78-93-3	0.0029	4.31E-05	--	--	
2-Pentanone, 4-Methyl	108-10-1	0.00064	9.52E-06	--	--	
Acetone	67-64-1	0.00128316	1.91E-05	--	--	
Aluminum	7429-90-5	0.041755539	6.21E-04	--	--	
Arsenic	7440-38-2	0.003060574	4.55E-05	1.50E+00	6.83E-05	65
Barium	7440-39-3	0.068082679	1.01E-03	--	--	
Benzene	71-43-2	0.0019	2.83E-05	5.50E-02	1.55E-06	1.47
Benzyl alcohol	100-51-6	0.0027	4.02E-05	--	--	
Beryllium	7440-41-7	0.000360659	5.36E-06	--	--	
Bis(2-ethylhexyl) phthalate	117-81-7	0.001271216	1.89E-05	1.40E-02	2.65E-07	0.25
Cadmium	7440-43-9	0.0045	6.69E-05	--	--	
Carbon disulfide	75-15-0	0.00039	5.80E-06	--	--	
Carbon tetrachloride	56-23-5	0.000164414	2.45E-06	1.30E-01	3.18E-07	0.3
Chloride	16887-00-6	9.821328	1.46E-01	--	--	
Chlorobenzene	108-90-7	0.00041	6.10E-06	--	--	
Chloroform	67-66-3	0.00022061	3.28E-06	3.10E-02	1.02E-07	0.10
Chromium	7440-47-3	0.007505402	1.12E-04	--	--	
cis-1,2-Dichloroethylene	156-59-2	0.0002	2.97E-06	--	--	
Copper	7440-50-8	0.002993571	4.45E-05	--	--	
Fluoride	16984-48-8	0.32861624	4.89E-03	--	--	
Iron	7439-89-6	0.47301923	7.04E-03	--	--	
Lead	7439-92-1	0.000710361	1.06E-05	--	--	
Lithium	7439-93-2	0.0083	1.23E-04	--	--	
Manganese	7439-96-5	0.011254937	1.67E-04	--	--	
Methanol	67-56-1	1.1	1.64E-02	--	--	
Methylene chloride	75-09-2	0.000852962	1.27E-05	7.50E-03	9.51E-08	0.09
Molybdenum	7439-98-7	0.0015	2.23E-05	--	--	
Nickel	7440-02-0	0.003603478	5.36E-05	--	--	
Nitrate	14797-55-8	23.756902	3.53E-01	--	--	
Nitrite	14797-65-0	0.079227256	1.18E-03	--	--	
o-Xylene	95-47-6	0.000210551	3.13E-06	--	--	
Silver	7440-22-4	0.005341496	7.94E-05	--	--	
Strontium	7440-24-6	0.36357229	5.41E-03	--	--	
Sulfate	14808-79-8	45.069738	6.70E-01	--	--	
Tetrachloroethene	127-18-4	0.000993146	1.48E-05	5.40E-01	7.98E-06	8
Toluene	108-88-3	0.000274725	4.09E-06	--	--	
Tributyl phosphate	126-73-8	0.040836371	6.07E-04	9.20E-03	5.59E-06	5.3
Trichloroethene	79-01-6	0.000492361	7.32E-06	8.90E-02	6.52E-07	0.62
Trichloromonofluoromethane	75-69-4	0.00058	8.63E-06	--	--	
Uranium	7440-61-1	0.016251153	2.42E-04	--	--	
Vanadium	7440-62-2	0.013487657	2.01E-04	--	--	
Vinyl chloride[b]	75-01-4	0.0018	2.68E-05	7.20E-01	1.93E-05	18.21
Zinc	7440-66-6	0.10896358	1.62E-03	--	--	
Total ELCR					1.06E-04	100

*EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
[b] For the purposed of this exercise, the mutagenic exposure equations where not used for vinyl chloride
-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)
Far-field Exposure Area

Inhalation of Volatile Nonradioactive COPCs in Drinking Water

Intake Parameter Values				
Parameter	Symbol	Value	Unit	Source
Inhalation Chronic Daily Intake	CDI	Calculated	mg/m^3 for noncarcinogens, $\mu g/m^3$ for carcinogens	Calculated
Contaminant Concentration	C_w	COPC-specific	mg/L	ECF-200PO1-09-2027
Exposure Time	ET	0.58	hours/day	EPA/540/R/99/005
Exposure Frequency	EF	350	days/year	EPA/540/R-92/003
Exposure Duration	ED	30	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70	years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30	years	EPA/540/R-92/003
Andelman Volatilization Factor	VF	0.5	L/m^3	EPA/540/R-92/003
Inhalation Reference Concentration	RfC	COPC-specific	mg/m^3	EPA, 2009
Inhalation Unit Risk	IUR	COPC-specific	$(\mu g/m^3)^{-1}$	EPA, 2009
Conversion Factor	CF1	365	days/year	365 days = 1 year
Conversion Factor	CF2	1/24	days/hour	1 day = 24 hours

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.
EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*
EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors* .
EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Nonradioactive COPC	CAS #	Volatile[a]	C_w (mg/L)	CDI (noncarcinogen) (mg/m^3)	RfC[a] (mg/m^3)	HQ (unitless)	% Contribution
(m+p)-Xylene	179601-23-1	Yes	0.0005	5.79E-06	7.00E-01	8.28E-06	0.54
1,1,1-Trichloroethane	71-55-6	Yes	0.001204711	1.40E-05	5.00E+00	2.79E-06	0.18
1,1-Dichloroethane	75-34-3	Yes	0.000389235	4.51E-06	7.00E-01	6.44E-06	0.4
1,1-Dichloroethene	75-35-4	Yes	0.000164225	1.90E-06	2.00E-01	9.51E-06	0.6
1,2-Dichlorobenzene	95-50-1	Yes	0.003	3.48E-05	2.00E-01	1.74E-04	11.4
1,2-Dichloroethane	107-06-2	Yes	0.000305426	3.54E-06	2.40E+00	1.47E-06	0.10
1,4-Dichlorobenzene	106-46-7	Yes	0.000130994	1.52E-06	8.00E-01	1.90E-06	0.12
1,4-Dioxane	123-91-1	--	0.0081	--(b)	3.60E+00	--(b)	
2-Butanone	78-93-3	Yes	0.0029	3.36E-05	5.00E+00	6.72E-06	0.44
2-Pentanone, 4-Methyl	108-10-1	Yes	0.00064	7.42E-06	3.00E+00	2.47E-06	0.16
Acetone	67-64-1	Yes	0.00128316	1.49E-05	3.10E+01	4.80E-07	0.031
Aluminum	7429-90-5	--	0.041755539	--(b)	5.00E-03	--(b)	
Arsenic	7440-38-2	--	0.003060574	--(b)	1.50E-05	--(b)	
Barium	7440-39-3	--	0.068082679	--(b)	5.00E-04	--(b)	
Benzene	71-43-2	Yes	0.0019	2.20E-05	3.00E-02	7.34E-04	48
Benzyl alcohol	100-51-6	--	0.0027	--(b)	--	--(b)	
Beryllium	7440-41-7	--	0.000360659	--(b)	2.00E-05	--(b)	
Bis(2-ethylhexyl) phthalate	117-81-7	--	0.001271216	--(b)	--	--(b)	
Cadmium	7440-43-9	--	0.0045	--(b)	1.00E-05	--(b)	
Carbon disulfide	75-15-0	Yes	0.00039	4.52E-06	7.00E-01	6.46E-06	0.4
Carbon tetrachloride	56-23-5	Yes	0.000164414	1.91E-06	1.90E-01	1.00E-05	0.7
Chloride	16887-00-6	--	9.821328	--(b)	--	--(b)	
Chlorobenzene	108-90-7	Yes	0.00041	4.75E-06	5.00E-02	9.50E-05	6
Chloroform	67-66-3	Yes	0.00022061	2.56E-06	9.80E-02	2.61E-05	1.7
Chromium	7440-47-3	--	0.007505402	--(b)	--	--(b)	
cis-1,2-Dichloroethylene	156-59-2	Yes	0.0002	2.32E-06	--	--	
Copper	7440-50-8	--	0.002993571	--(b)	--	--(b)	
Fluoride	16984-48-8	--	0.32861624	--(b)	1.30E-02	--(b)	
Iron	7439-89-6	--	0.47301923	--(b)	--	--(b)	
Lead	7439-92-1	--	0.000710361	--(b)	--	--(b)	
Lithium	7439-93-2	--	0.0083	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.011254937	--(b)	5.00E-05	--(b)	
Methanol	67-56-1	--	1.1	--(b)	4.00E+00	--(b)	
Methylene chloride	75-09-2	Yes	0.000852962	9.88E-06	1.00E+00	9.88E-06	0.6
Molybdenum	7439-98-7	--	0.0015	--(b)	--	--(b)	
Nickel	7440-02-0	--	0.003603478	--(b)	9.00E-05	--(b)	
Nitrate	14797-55-8	--	23.756902	--(b)	--	--(b)	
Nitrite	14797-65-0	--	0.079227256	--(b)	--	--(b)	
o-Xylene	95-47-6	Yes	0.000210551	2.44E-06	7.00E-01	3.49E-06	0.23
Silver	7440-22-4	--	0.005341496	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.36357229	--(b)	--	--(b)	
Sulfate	14808-79-8	--	45.069738	--(b)	--	--(b)	
Tetrachloroethene	127-18-4	Yes	0.000993146	1.15E-05	2.70E-01	4.26E-05	2.8
Toluene	108-88-3	Yes	0.000274725	3.18E-06	5.00E+00	6.37E-07	0.04
Tributyl phosphate	126-73-8	--	0.040836371	--(b)	--	--(b)	
Trichloroethene	79-01-6	Yes	0.000492361	5.70E-06	3.50E-02	1.63E-04	11
Trichloromonofluoromethane	75-69-4	Yes	0.00058	6.72E-06	7.00E-01	9.60E-06	0.6
Uranium	7440-61-1	--	0.016251153	--(b)	3.00E-04	--(b)	
Vanadium	7440-62-2	--	0.013487657	--(b)	--	--(b)	
Vinyl chloride	75-01-4	Yes	0.0018	2.09E-05	1.00E-01	2.09E-04	13.69
Zinc	7440-66-6	--	0.10896358	--(b)	--	--(b)	
Total HI						1.52E-03	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
[b]Nonvolatile constituents are not considered in the inhalation exposure route
-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.
COPC = contaminant of potential concern.
HQ = hazard quotient.
HI = hazard index.
EPA-540-R-070-002, *Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment).*

Cancer risk calculation

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Nonradioactive COPC	CAS #	Volatile[a]	C_w (mg/L)	CDI (carcinogen) ($\mu g/m^3$)	IUR[a] $(\mu g/m^3)^{-1}$	Risk (unitless)	% Contribution
(m+p)-Xylene	179601-23-1	Yes	0.0005	2.48E-03	--	--	
1,1,1-Trichloroethane	71-55-6	Yes	0.001204711	5.98E-03	--	--	
1,1-Dichloroethane	75-34-3	Yes	0.000389235	1.93E-03	--	--	
1,1-Dichloroethene	75-35-4	Yes	0.000164225	8.16E-04	--	--	
1,2-Dichlorobenzene	95-50-1	Yes	0.003	1.49E-02	--	--	
1,2-Dichloroethane	107-06-2	Yes	0.000305426	1.52E-03	2.60E-05	3.94E-08	14
1,4-Dichlorobenzene	106-46-7	Yes	0.000130994	6.50E-04	1.10E-05	7.16E-09	2.5
1,4-Dioxane	123-91-1	--	0.0081	--(b)	7.70E-06	--(b)	
2-Butanone	78-93-3	Yes	0.0029	1.44E-02	--	--	
2-Pentanone, 4-Methyl	108-10-1	Yes	0.00064	3.18E-03	--	--	
Acetone	67-64-1	Yes	0.00128316	6.37E-03	--	--	
Aluminum	7429-90-5	--	0.041755539	--(b)	--	--(b)	
Arsenic	7440-38-2	--	0.003060574	--(b)	4.30E-03	--(b)	
Barium	7440-39-3	--	0.068082679	--(b)	--	--(b)	
Benzene	71-43-2	Yes	0.0019	9.43E-03	7.80E-06	7.36E-08	25.5
Benzyl alcohol	100-51-6	--	0.0027	--(b)	--	--(b)	
Beryllium	7440-41-7	--	0.000360659	--(b)	2.40E-03	--(b)	
Bis(2-ethylhexyl) phthalate	117-81-7	--	0.001271216	--(b)	2.40E-06	--(b)	
Cadmium	7440-43-9	--	0.0045	--(b)	1.80E-03	--(b)	
Carbon disulfide	75-15-0	Yes	0.00039	1.94E-03	--	--	
Carbon tetrachloride	56-23-5	Yes	0.000164414	8.16E-04	1.50E-05	1.22E-08	4
Chloride	16887-00-6	--	9.821328	--(b)	--	--(b)	
Chlorobenzene	108-90-7	Yes	0.00041	2.04E-03	--	--	
Chloroform	67-66-3	Yes	0.00022061	1.10E-03	2.30E-05	2.52E-08	9
Chromium	7440-47-3	--	0.007505402	--(b)	--	--(b)	
cis-1,2-Dichloroethylene	156-59-2	Yes	0.0002	9.93E-04	--	--	
Copper	7440-50-8	--	0.002993571	--(b)	--	--(b)	
Fluoride	16984-48-8	--	0.32861624	--(b)	--	--(b)	
Iron	7439-89-6	--	0.47301923	--(b)	--	--(b)	
Lead	7439-92-1	--	0.000710361	--(b)	--	--(b)	
Lithium	7439-93-2	--	0.0083	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.011254937	--(b)	--	--(b)	
Methanol	67-56-1	--	1.1	--(b)	--	--(b)	
Methylene chloride	75-09-2	Yes	0.000852962	4.24E-03	4.70E-07	1.99E-09	0.69
Molybdenum	7439-98-7	--	0.0015	--(b)	--	--(b)	
Nickel	7440-02-0	--	0.003603478	--(b)	2.60E-04	--(b)	
Nitrate	14797-55-8	--	23.756902	--(b)	--	--(b)	
Nitrite	14797-65-0	--	0.079227256	--(b)	--	--(b)	
o-Xylene	95-47-6	Yes	0.000210551	1.05E-03	--	--	
Silver	7440-22-4	--	0.005341496	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.36357229	--(b)	--	--(b)	
Sulfate	14808-79-8	--	45.069738	--(b)	--	--(b)	
Tetrachloroethene	127-18-4	Yes	0.000993146	4.93E-03	5.90E-06	2.91E-08	10.1
Toluene	108-88-3	Yes	0.000274725	1.36E-03	--	--	
Tributyl phosphate	126-73-8	--	0.040836371	--(b)	--	--(b)	
Trichloroethene	79-01-6	Yes	0.000492361	2.44E-03	2.50E-05	6.11E-08	21
Trichloromonofluoromethane	75-69-4	Yes	0.00058	2.88E-03	--	--	
Uranium	7440-61-1	--	0.016251153	--(b)	--	--(b)	
Vanadium	7440-62-2	--	0.013487657	--(b)	--	--(b)	
Vinyl chloride[c]	75-01-4	Yes	0.0018	8.94E-03	4.40E-06	3.93E-08	13.60
Zinc	7440-66-6	--	0.10896358	--(b)	--	--(b)	
Total ELCR						2.89E-07	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
[b]Nonvolatile constituents are not considered in the inhalation exposure route
[c]For the purposed of this exercise, the mutagenic exposure equations where not used for vinyl chloride
-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
EPA-540-R-070-002, *Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment).*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)
Near-field Exposure Area

Dermal Absorption of Nonradioactive COPCs in Drinking Water

Intake Parameter Values		Value			
Parameter	Symbol	Adult	Child	Unit	Source
Chronic Daily Intake	CDI	calculated		mg/kg-day	Calculated
Contaminant Concentration	C_w	COPC-specific		mg/L	ECF-200PO1-09-0027
Average Body Weight	BW	70	15	kg	EPA/540/R-92/003
Exposure Time	ET	0.58	1	hours/event	EPA/540/R/99/005
Exposure Time (Age-Adjusted)	ET_{aa}	0.664		hours/event	Calculated
Surface Area	SA	18,000	6,600	cm^2	EPA/540/R/99/005
Age-Adjusted Surface Area	SA_{aa}	8,811		(cm^2-year-event)/(kg/day)	Calculated
Event Frequency	EV	1		event/day	EPA/540/R/99/005
Exposure Frequency	EF	350		days/year	EPA/540/R-92/003
Exposure Duration	ED	30	6	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70		years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30		years	EPA/540/R-92/003
Oral Reference Dose	RfD_o	COPC-specific		mg/kg-day	EPA, 2009
Oral Cancer Slope Factor	CSF_o	COPC-specific		$(mg/kg\text{-}day)^{-1}$	EPA, 2009
Conversion Factor	CF1	365		days/year	365 days = 1 year
Conversion Factor	CF3	0.001		L/cm^3	$1 L = 1000 cm^3$
The constant pi	π	3.14159		unitless	–
Time to reach steady state	t^*	COPC-specific		hours	EPA/540/R/99/005
Dermal Partitioning Constant	B	COPC-specific		unitless	EPA/540/R/99/005
Absorbed Dose per Event	DA	Calculated		mg/cm^2-event	Calculated
Dermal Permeability Constant	K_p	COPC-specific		cm/hour	EPA/540/R/99/005
Fraction Absorbed	FA	COPC-specific		unitless	EPA/540/R/99/005
Lag Time	τ	COPC-specific		hours/event	EPA/540/R/99/005
Fraction of Contaminant Absorbed in Gastrointestinal Tract	GIABS	COPC-specific		unitless	EPA, 2009

ECF-200PO1-09-0027, Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit, CHPRC 2010.
EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Interim.*
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final.*
EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Absorbed Dermal Dose Calculation

Contaminant of Potential Concern	CAS #	C_w (mg/L)	Inorganic/organic[a]	FA[a] (unitless)	K_p[a] (cm/hour)	B[b] (unitless)	t^*[b] (hours/event)	τ[a] (hours)	DA (noncancer) (mg/cm^2-event)	DA (cancer) (mg/cm^2-event)
(m+p)-Xylene[c]	179601-23-1	0.0005	--	1.00E+00	0.053	0.2	0.42	1.01	3.62E-08	3.87E-08
1,1,1-Trichloroethane	71-55-6	0.001204711	--	1.00E+00	0.013	0.1	0.6	1.43	2.55E-08	2.73E-08
1,1-Dichloroethane	75-34-3	0.000389235	--	1.00E+00	0.0067	0	0.38	0.92	3.38E-09	3.62E-09
1,1-Dichloroethene	75-35-4	0.000164225	--	1.00E+00	0.012	0	0.37	0.89	2.52E-09	2.70E-09
1,2-Dichlorobenzene	95-50-1	0.003	--	1.00E+00	0.041	0.2	0.71	1.71	2.18E-07	2.33E-07
1,2-Dichloroethane	107-06-2	0.000305426	--	1.00E+00	0.0042	0	0.38	0.92	1.66E-09	1.78E-09
1,4-Dichlorobenzene	106-46-7	0.000130994	--	1.00E+00	0.042	0.2	0.71	1.71	9.76E-09	1.04E-08
1,4-Dioxane	123-91-1	0.0081	--	1.00E+00	0.00033	0	0.33	0.8	3.23E-09	3.46E-09
2-Butanone	78-93-3	0.0029	--	1.00E+00	0.00096	0	0.27	0.65	3.05E-09	3.35E-09
2-Pentanone, 4-Methyl	108-10-1	0.00064	--	1.00E+00	0.0027	0	0.39	0.93	2.27E-09	2.43E-09
Acetone[c]	67-64-1	0.00128316	--	--	0.000512	--	--	--	--	--
Aluminum	7429-90-5	0.041755539	INORGANIC	--	0.001	--	--	--	2.42E-08	2.77E-08
Arsenic	7440-38-2	0.003060574	INORGANIC	--	0.001	--	--	--	1.78E-09	2.03E-09
Barium	7440-39-3	0.068082679	INORGANIC	--	0.001	--	--	--	3.95E-08	4.52E-08
Benzene	71-43-2	0.0019	--	1.00E+00	0.015	0.1	0.29	0.7	3.23E-08	5.46E-08
Benzyl alcohol[c]	100-51-6	0.0027	--	--	0.00209	--	--	--	--	--
Beryllium	7440-41-7	0.000360659	INORGANIC	--	0.001	--	--	--	2.09E-10	2.39E-10
Bis(2-ethylhexyl) phthalate	117-81-7	0.001371216	--	8.00E-01	0.035	0.2	16.64	39.93	2.18E-07	2.34E-07
Cadmium	7440-43-9	0.0045	INORGANIC	--	0.001	--	--	--	2.61E-09	2.99E-09
Carbon disulfide	75-15-0	0.00039	--	1.00E+00	0.017	0.1	0.3	0.72	3.44E-09	8.18E-09
Carbon tetrachloride	56-23-5	0.000164414	--	1.00E+00	0.018	0.1	0.78	1.86	4.89E-09	5.21E-09
Chloride	16887-00-6	9.821328	INORGANIC	--	0.001	--	--	--	5.70E-06	6.52E-06
Chlorobenzene	108-90-7	0.00041	--	1.00E+00	0.038	0.1	0.44	1.09	1.64E-08	1.75E-08
Chloroform	67-66-3	0.00022061	--	1.00E+00	0.0068	0	0.5	1.19	2.23E-09	2.39E-09
Chromium	7440-47-3	0.007505402	INORGANIC	--	0.001	--	--	--	4.35E-09	4.98E-09
cis-1,2-Dichloroethylene[d]	156-59-2	0.0002	--	1.00E+00	0.0077	0	0.37	0.89	1.97E-09	2.11E-09
Copper	7440-50-8	0.002993571	INORGANIC	--	0.001	--	--	--	1.74E-09	1.99E-09
Fluoride	16984-48-8	0.32861624	INORGANIC	--	0.001	--	--	--	1.91E-07	2.18E-07
Iron	7439-89-6	0.47301923	INORGANIC	--	0.001	--	--	--	2.74E-07	3.14E-07
Lead	7439-92-1	0.000710361	INORGANIC	--	0.0001	--	--	--	4.12E-11	4.72E-11
Lithium	7439-93-2	0.0083	INORGANIC	--	0.001	--	--	--	4.81E-09	5.51E-09
Manganese	7439-96-5	0.011254937	INORGANIC	--	0.001	--	--	--	6.53E-09	7.47E-09
Methanol	67-56-1	1.1	--	1.00E+00	0.000112	0	0.16	0.39	3.17E-07	3.46E-07
Methylene chloride	75-09-2	0.000852962	--	1.00E+00	0.0035	0	0.32	0.76	3.55E-09	3.80E-09
Molybdenum	7439-98-7	0.0015	INORGANIC	--	0.001	--	--	--	8.70E-10	9.96E-10
Nickel	7440-02-0	0.003603478	INORGANIC	--	0.0002	--	--	--	4.18E-10	4.79E-10
Nitrate	14797-55-8	23.756902	INORGANIC	--	0.001	--	--	--	1.38E-05	1.58E-05
Nitrite	14797-65-0	0.079227256	INORGANIC	--	0.001	--	--	--	4.60E-08	5.26E-08
o-Xylene[c]	95-47-6	0.000210551	--	1.00E+00	0.054	0.2	0.42	1.01	1.55E-08	1.66E-08
Silver	7440-22-4	0.005341496	INORGANIC	--	0.0006	--	--	--	1.86E-09	2.13E-09
Strontium	7440-24-6	0.16357229	INORGANIC	--	0.001	--	--	--	2.11E-07	2.41E-07
Sulfate	14808-79-8	45.069738	INORGANIC	--	0.001	--	--	--	2.61E-05	2.99E-05
Tetrachloroethene	127-18-4	0.000993146	--	1.00E+00	0.033	0.2	0.91	2.18	6.58E-08	7.04E-08
Toluene	108-88-3	0.000274725	--	1.00E+00	0.031	0.1	0.35	0.84	1.06E-08	1.13E-08
Tributyl phosphate[c]	126-73-8	0.040836371	--	--	0.0228	--	--	--	--	--
Trichloroethene	79-01-6	0.000492361	--	1.00E+00	0.012	0.1	0.58	1.39	9.47E-09	1.01E-08
Trichloromonofluoromethane	75-69-4	0.00058	--	1.00E+00	0.013	0.1	0.63	1.51	1.24E-08	1.35E-08
Uranium	7440-61-1	0.016251153	INORGANIC	--	0.001	--	--	--	9.43E-09	1.08E-08
Vanadium	7440-62-2	0.011487657	INORGANIC	--	0.001	--	--	--	7.82E-09	8.96E-09
Vinyl chloride[d]	75-01-4	0.0018	--	1.00E+00	0.0056	0	0.24	0.57	1.07E-08	1.15E-08
Zinc	7440-66-6	0.10896358	INORGANIC	--	0.0006	--	--	--	1.75E-08	4.34E-08

[a] EPA/540/R/99/005, Exhibit 3-1 (inorganics) and Exhibit B-3 (organics)
[b] EPA/540/R/99/005, Exhibit B-1
[c] the K_p value was taken from ORNL, 2010, The Risk Assessment Information System (RAIS).
[d] For the purposed of this exercise, the mutagenic exposure equations where not used for vinyl chloride
[e] for cis-1,2-dichloroethylene the chemical-specific inputs are assummed to be the same as trans-1,2-dichloroethylene
[f] for (m+p) xylenes and o-xylene the chemical-specific inputs are assummed to be the same as m-xylene

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (noncancerogen) (mg/kg-day)	RfD_o[a] (mg/kg-day)	GIABS[b] (unitless)	HQ (unitless)	% Contribution
(m+p)-Xylene	179601-23-1	0.0005	8.91E-06	2.00E-01	1	4.46E-05	0.090
1,1,1-Trichloroethane	71-55-6	0.001204711	6.30E-06	2.00E+00	1	3.15E-06	0.0064
1,1-Dichloroethane	75-34-3	0.000389235	8.34E-07	2.00E-01	1	4.17E-06	0.0085
1,1-Dichloroethene	75-35-4	0.000164225	6.22E-07	5.00E-02	1	1.24E-05	0.025
1,2-Dichlorobenzene	95-50-1	0.003	5.38E-05	9.00E-02	1	5.98E-04	1.21
1,2-Dichloroethane	107-06-2	0.000305426	4.10E-07	2.00E-02	1	2.05E-05	0.042
1,4-Dichlorobenzene	106-46-7	0.000130994	2.41E-06	7.00E-02	1	3.44E-05	0.07
1,4-Dioxane	123-91-1	0.0081	7.97E-07	1.00E-01	1	7.97E-06	0.0162
2-Butanone	78-93-3	0.0029	7.51E-07	6.00E-01	1	1.25E-06	2.54E-03
2-Pentanone, 4-Methyl	108-10-1	0.00064	5.60E-07	8.00E-02	1	7.00E-06	0.0142
Acetone	67-64-1	0.00128316	--	9.00E-01	1	--	--
Aluminum	7429-90-5	0.041755539	5.97E-06	1.00E+00	1	5.97E-06	0.0121
Arsenic	7440-38-2	0.003060574	4.38E-07	3.00E-04	1	1.46E-03	3.0
Barium	7440-39-3	0.068082679	9.74E-06	2.00E-01	0.07	6.95E-04	1.41
Benzene	71-43-2	0.0019	7.97E-06	4.00E-03	1	1.99E-03	4.04
Benzyl alcohol	100-51-6	0.0027	--	1.00E-01	1	--	--
Beryllium	7440-41-7	0.000360659	5.16E-08	2.00E-03	0.007	3.68E-03	7
Bis(2-ethylhexyl) phthalate	117-81-7	0.001371216	5.38E-05	2.00E-02	1	2.69E-03	5.5
Cadmium	7440-43-9	0.0045	6.44E-07	5.00E-04	0.05	2.57E-02	52.3
Carbon disulfide	75-15-0	0.00039	1.88E-06	1.00E-01	1	1.88E-05	0.038
Carbon tetrachloride	56-23-5	0.000164414	1.21E-06	7.00E-04	1	1.72E-03	3.5
Chloride	16887-00-6	9.821328	1.40E-03	--	1	--	--
Chlorobenzene	108-90-7	0.00041	4.04E-06	2.00E-02	1	2.02E-04	0.41
Chloroform	67-66-3	0.00022061	5.51E-07	1.00E-02	1	5.51E-05	0.11
Chromium	7440-47-3	0.007505402	1.07E-06	1.50E+00	0.013	5.50E-05	0.112
cis-1,2-Dichloroethylene	156-59-2	0.0002	4.86E-07	1.00E-02	1	4.86E-05	0.10
Copper	7440-50-8	0.002993571	4.28E-07	4.00E-02	1	1.07E-05	0.0217
Fluoride	16984-48-8	0.32861624	4.70E-05	6.00E-02	1	7.83E-04	1.59
Iron	7439-89-6	0.47301923	6.76E-05	7.00E-01	1	9.66E-05	0.196
Lead	7439-92-1	0.000710361	1.02E-08	--	1	--	--
Lithium	7439-93-2	0.0083	1.19E-06	2.00E-03	1	5.94E-04	1.20
Manganese	7439-96-5	0.011254937	1.61E-06	2.40E-02	0.04	1.68E-03	3.40
Methanol	67-56-1	1.1	7.81E-05	5.00E-01	1	1.56E-04	0.317
Methylene chloride	75-09-2	0.000852962	8.77E-07	6.00E-02	1	1.46E-05	0.030
Molybdenum	7439-98-7	0.0015	2.15E-07	5.00E-03	1	4.29E-05	0.087
Nickel	7440-02-0	0.003603478	1.03E-07	2.00E-02	0.04	1.29E-04	0.26
Nitrate	14797-55-8	23.756902	3.40E-03	7.10E+00	1	4.79E-04	0.97
Nitrite	14797-65-0	0.079227256	1.13E-05	3.00E-01	1	3.78E-05	0.077
o-Xylene	95-47-6	0.000210551	3.82E-06	2.00E-01	1	1.91E-05	0.039
Silver	7440-22-4	0.005341496	4.58E-07	5.00E-03	0.04	2.29E-03	4.7
Strontium	7440-24-6	0.16357229	5.20E-05	6.00E-01	1	8.67E-05	0.176
Sulfate	14808-79-8	45.069738	6.45E-03	--	--	--	--
Tetrachloroethene	127-18-4	0.000993146	1.62E-05	1.00E-02	1	1.62E-03	3.3
Toluene	108-88-3	0.000274725	2.62E-06	8.00E-02	1	3.27E-05	0.066
Tributyl phosphate	126-73-8	0.040836371	--	2.00E-01	1	--	--
Trichloroethene	79-01-6	0.000492361	2.34E-06	--	1	--	--
Trichloromonofluoromethane	75-69-4	0.00058	3.11E-06	3.00E-01	1	1.04E-05	0.021
Uranium	7440-61-1	0.016251153	2.32E-06	1.50E-03	1	1.75E-04	1.57
Vanadium	7440-62-2	0.011487657	1.93E-06	5.00E-03	1	3.86E-04	0.78
Vinyl chloride	75-01-4	0.0018	2.63E-06	1.00E-03	1	8.78E-04	1.783
Zinc	7440-66-6	0.10896358	9.35E-06	3.00E-01	1	3.12E-05	0.063
Total HI						0.05	100

[a] EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.
COPC = contaminant of potential concern.
HI = hazard index
HQ = hazard quotient.
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final.*

Cancer risk calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF_o[a] $(mg/kg\text{-}day)^{-1}$	GIABS[b] (unitless)	Risk (unitless)	% Contribution
(m+p)-Xylene	179601-23-1	0.0005	4.67E-06	--	1	--	
1,1,1-Trichloroethane	71-55-6	0.001204711	3.30E-06	--	1	--	
1,1-Dichloroethane	75-34-3	0.000389235	4.37E-07	--	1	--	
1,1-Dichloroethene	75-35-4	0.000164225	3.26E-07	--	1	--	
1,2-Dichlorobenzene	95-50-1	0.003	2.82E-05	--	1	--	
1,2-Dichloroethane	107-06-2	0.000305426	2.15E-07	9.10E-02	1	1.96E-08	0.29
1,4-Dichlorobenzene	106-46-7	0.000130994	1.26E-06	5.40E-03	1	6.81E-09	0.10
1,4-Dioxane	123-91-1	0.0081	4.17E-07	1.10E-02	1	4.59E-09	0.067
2-Butanone	78-93-3	0.0029	4.05E-07	--	1	--	
2-Pentanone, 4-Methyl	108-10-1	0.00064	2.93E-07	--	1	--	
Acetone	67-64-1	0.00128316	--	--	1	--	
Aluminum	7429-90-5	0.041755539	3.35E-06	--	1	--	
Arsenic	7440-38-2	0.003060574	2.45E-07	1.50E+00	1	3.68E-07	5.4
Barium	7440-39-3	0.068082679	5.46E-06	--	0.07	--	
Benzene	71-43-2	0.0019	4.17E-06	5.50E-02	1	2.29E-07	3.37
Benzyl alcohol	100-51-6	0.0027	--	--	1	--	
Beryllium	7440-41-7	0.000360659	2.89E-08	--	0.007	--	
Bis(2-ethylhexyl) phthalate	117-81-7	0.001371216	2.82E-05	1.40E-02	1	3.95E-07	5.8
Cadmium	7440-43-9	0.0045	3.61E-07	--	0.05	--	
Carbon disulfide	75-15-0	0.00039	9.87E-07	--	1	--	
Carbon tetrachloride	56-23-5	0.000164414	6.32E-07	1.30E-01	1	8.21E-08	1.2
Chloride	16887-00-6	9.821328	7.87E-04	--	1	--	
Chlorobenzene	108-90-7	0.00041	2.12E-06	--	1	--	
Chloroform	67-66-3	0.00022061	2.88E-07	3.10E-02	1	8.94E-09	0.13
Chromium	7440-47-3	0.007505402	6.02E-07	--	0.013	--	
cis-1,2-Dichloroethylene	156-59-2	0.0002	2.55E-07	--	1	--	
Copper	7440-50-8	0.002993571	2.40E-07	--	1	--	
Fluoride	16984-48-8	0.32861624	2.63E-05	--	1	--	
Iron	7439-89-6	0.47301923	3.79E-05	--	1	--	
Lead	7439-92-1	0.000710361	5.69E-09	--	1	--	
Lithium	7439-93-2	0.0083	6.66E-07	--	1	--	
Manganese	7439-96-5	0.011254937	9.02E-07	--	0.04	--	
Methanol	67-56-1	1.1	4.18E-05	--	1	--	
Methylene chloride	75-09-2	0.000852962	4.59E-07	7.50E-03	1	3.44E-09	0.051
Molybdenum	7439-98-7	0.0015	1.20E-07	--	1	--	
Nickel	7440-02-0	0.003603478	5.78E-08	--	0.04	--	
Nitrate	14797-55-8	23.756902	1.90E-03	--	1	--	
Nitrite	14797-65-0	0.079227256	6.35E-06	--	1	--	
o-Xylene	95-47-6	0.000210551	2.00E-06	--	1	--	
Silver	7440-22-4	0.005341496	2.57E-07	--	0.04	--	
Strontium	7440-24-6	0.16357229	2.91E-05	--	1	--	
Sulfate	14808-79-8	45.069738	3.61E-03	--	--	--	
Tetrachloroethene	127-18-4	0.000993146	8.50E-06	5.40E-01	1	4.59E-06	67
Toluene	108-88-3	0.000274725	1.37E-06	--	1	--	
Tributyl phosphate	126-73-8	0.040836371	--	9.20E-03	1	--	
Trichloroethene	79-01-6	0.000492361	1.22E-06	8.90E-02	1	1.09E-07	1.6
Trichloromonofluoromethane	75-69-4	0.00058	1.63E-06	--	1	--	
Uranium	7440-61-1	0.016251153	1.30E-06	--	1	--	
Vanadium	7440-62-2	0.011487657	1.08E-06	--	1	--	
Vinyl chloride	75-01-4	0.0018	1.39E-06	7.20E-01	1	1.00E-06	14.70
Zinc	7440-66-6	0.10896358	5.24E-06	--	1	--	
Total ELCR						6.82E-06	100

[a] EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
[b] For the purposed of this exercise, the mutagenic exposure equations where not used for vinyl chloride
-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)
Far-field Exposure Area

Inhalation of Volatile Radioactive COPCs in Drinking Water

Intake Parameter Values		Value			
Factor	Symbol	Adult	Child	Unit	Reference
Chronic Daily Intake	CDI	Calculated		pCi	Calculated
Contaminant Concentration	C_w	COPC-specific		pCi/L	ECF-200PO1-09-2027
Exposure frequency	EF	350		days/year	EPA/540/R-92/003
Exposure duration	ED	30	6	years	EPA/540/R-92/003
Inhalation Rate	INH	20	10	m^3/day	OSWER Directive 9285.6-03 EPA/600/P-95/002Fa
Exposure time	ET	0.58	1	hours/day	EPA/540/R/99/005
Age Adjusted Exposure Time	ET_{adj}	0.664		hours/day	Calculated
Radiation Age-adjusted Inhalation Rate	INH_RAD_{adj}	540		m^3-year/day	Calculated
Andelman Volatilization Factor	VF	0.5		L/m^3	EPA/540/R-92/003
Slope Factor - Inhalation	SF_i	COPC-specific		risk/pCi	EPA, 2001
Conversion Factor	CF2	1/24		days/hour	1 day = 24 hours

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010
EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*
EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*
EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."
OSWER Directive 9285.6-03, *Risk Assessment Guidance For Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance "Standard Default Exposure Factors Interim Final"*

Inhalation of Volatile Radioactive Constituents in Groundwater

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Radioactive COPC	CAS #	Volatile[a]	C_w (pCi/L)	CDi (radiological inhalation) (pCi)	SF_i (risk/pCi)	Risk (unitless)	% Contribution
Carbon-14	14762-75-5	--	15.2	--(b)	7.07E-12	--(b)	
Gross alpha	12587-46-1	--	5.9880167	--(b)	--	--(b)	
Gross beta	12587-47-2	--	26.717649	--(b)	--	--(b)	
Iodine-129	15046-84-1	--	1.7529182	--(b)	6.07E-11	--(b)	
Nickel-63	13981-37-8	--	7.66125	--(b)	1.64E-12	--(b)	
Protactinium-231	14331-85-2	--	0.308	--(b)	4.55E-08	--(b)	
Strontium-90	10098-97-2	--	0.611	--(b)	1.05E-10	--(b)	
Technetium-99	14133-76-7	--	75.671084	--(b)	1.41E-11	--(b)	
Tritium	10028-17-8	Yes	497899.63	1.30E+09	5.62E-14	7.32E-05	100
Total ELCR						7.32E-05	100

[a]Volatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."
[b]Nonvolatile constituents are not considered in the inhalation exposure route
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)
Far-field Exposure Area

Ingestion of Radioactive COPCs in Drinking Water

Intake Parameter Values		Value			
Factor	Symbol	Adult	Child	Unit	Reference
Chronic Daily Intake	CDI	Calculated		pCi	Calculated
Contaminant Concentration	C_w	COPC-specific		pCi/L	ECF-200PO1-09-2027
Exposure frequency	EF	350		days/year	EPA/540/R-92/003
Exposure duration	ED	30	6	years	EPA/540/R-92/003
Drinking Water Ingestion Rate	IRW	2	1	L/day	EPA/540/R-92/003 EPA/600/P-95/002Fa
Radiation Age-adjusted Drinking Water Ingestion Rate	IRW_RAD_{adj}	54		L-year/day	Calculated
Slope Factor - Oral	SF_o	COPC-specific		risk/pCi	EPA, 2001

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.
EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*
EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*
EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

Ingestion of Radioactive Constituents in Groundwater

200-PO-1 Groundwater Operable Unit Far-Field Exposure Area Radioactive COPC	CAS #	C_w (pCi/L)	CDI (radiological ingestion) (pCi)	SF_o (risk/pCi)	Risk (unitless)	% Contribution
Carbon-14	14762-75-5	15.2	2.87E+05	1.55E-12	4.45E-07	0.09
Gross alpha	12587-46-1	5.9880167	1.13E+05	--	--	
Gross beta	12587-47-2	26.717649	5.05E+05	--	--	
Iodine-129	15046-84-1	1.7529182	3.31E+04	1.48E-10	4.90E-06	1.0
Nickel-63	13981-37-8	7.66125	1.45E+05	6.70E-13	9.70E-08	0.020
Protactinium-231	14331-85-2	0.308	5.82E+03	1.73E-10	1.01E-06	0.21
Strontium-90	10098-97-2	0.611	1.15E+04	5.59E-11	6.46E-07	0.132
Technetium-99	14133-76-7	75.671084	1.43E+06	2.75E-12	3.93E-06	0.8
Tritium	10028-17-8	497899.63	9.41E+09	5.07E-14	4.77E-04	98
Total ELCR					4.88E-04	100

COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Tap Water Risk Assessment (10 year)--Summary of Tap Water Exposure Pathway Noncancer Hazard Results for Nonradioactive COPCs in Groundwater.

Nonradioactive COPCs	Contaminant Concentration in Groundwater C_w (mg/L)	Volatile[a]	HQ (Inhalation) (unitless)	HQ (Ingestion) (unitless)	HQ (Dermal) (unitless)	Total HQ (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	3.734E-09	--	--(b)	--	--	--	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	5.6E-09	--	--(b)	--	--	--	
1,2,3,4,7,8-Hexachlorodibenzofuran	2.9E-09	--	--(b)	--	--	--	
1,2,3,6,7,8-Hexachlorodibenzofuran	2.1E-09	--	--(b)	--	--	--	
1,2-Dichloroethane	0.00064	Yes	3.09E-06	8.77E-04	4.30E-05	9.23E-04	0.0162
2,3,4,6-Tetrachlorophenol	0.0077	--	--(b)	7.03E-03	--	7.03E-03	0.123
2-Methylphenol (cresol, o-)	0.0075	--	--(b)	4.11E-03	3.93E-04	4.50E-03	0.079
4-Nitrophenol	0.0072	--	--(b)	2.47E-02	1.79E-03	2.65E-02	0.46
Aluminum	0.11217909	--	--(b)	3.07E-03	1.60E-05	3.09E-03	0.054
Arsenic	0.005765062	--	--(b)	5.26E-01	2.75E-03	5.29E-01	9.3
Barium	0.052626075	--	--(b)	7.21E-03	5.38E-04	7.75E-03	0.14
Beryllium	0.00034431	--	--(b)	4.72E-03	3.52E-03	8.23E-03	0.1
Bis(2-ethylhexyl) phthalate	0.011	--	--(b)	1.51E-02	2.33E-02	3.84E-02	0.673
Cadmium	0.018	--	--(b)	9.86E-01	1.03E-01	1.09E+00	19.1
Carbon tetrachloride	0.0018	Yes	1.10E-04	7.05E-02	1.89E-02	8.94E-02	1.569
Chloride	11.439962	--	--(b)	--	--	--	
Chloroform	0.00038106	Yes	4.51E-05	1.04E-03	9.51E-05	1.18E-03	0.021
Chromium	0.015609389	--	--(b)	2.85E-04	1.14E-04	4.00E-04	0.0070
Cobalt	0.004378857	--	--(b)	4.00E-01	8.35E-04	4.01E-01	7.0
Copper	0.004482187	--	--(b)	3.07E-03	1.60E-05	3.09E-03	0.054
Dinoseb(2-secButyl-4,6-dinitrophenol)	0.005506461	--	--(b)	1.51E-01	--	1.51E-01	2.6
Fluoride	0.31715504	--	--(b)	1.45E-01	7.56E-04	1.46E-01	2.6
Hexavalent Chromium	0.191	--	--(b)	1.74E+00	7.28E-01	2.47E+00	43
Iron	0.14355212	--	--(b)	5.62E-03	2.93E-05	5.65E-03	0.099
Lead	0.00142074	--	--(b)	--	--	--	
Manganese	0.009635007	--	--(b)	1.10E-02	1.44E-03	1.24E-02	0.22
Nickel	0.010760715	--	--(b)	1.47E-02	3.85E-04	1.51E-02	0.27
Nitrate	31.205071	--	--(b)	1.20E-01	6.29E-04	1.21E-01	2.1
Nitrite	0.034429846	--	--(b)	3.14E-03	1.64E-05	3.16E-03	0.055
Nitrogen in Nitrite and Nitrate	14.7	--	--(b)	2.52E-01	1.31E-03	2.53E-01	4.4
Octachlorodibenzofuran	9.9649E-09	--	--(b)	--	--	--	
Octachlorodibenzo-p-dioxin	5.6857E-09	--	--(b)	--	--	--	
Silver	0.005650889	--	--(b)	3.10E-02	2.42E-03	3.34E-02	0.59
Strontium	0.26495344	--	--(b)	1.21E-02	6.32E-05	1.22E-02	0.21
Sulfate	56.164035	--	--(b)	--	--	--	
Toluene	0.000065	Yes	1.51E-07	2.23E-05	7.73E-06	3.01E-05	5.29E-04
Total petroleum hydrocarbons - gasoline range	0.05	--	--(b)	--	--	--	
Trichloroethene	0.000570461	Yes	1.89E-04	--	--	1.89E-04	0.0033
Uranium	0.014879201	--	--(b)	1.36E-01	7.09E-04	1.37E-01	2.4
Vanadium	0.021937779	--	--(b)	1.20E-01	6.27E-04	1.21E-01	2.1
Zinc	0.092316084	--	--(b)	8.43E-03	2.64E-05	8.46E-03	0.148
Total HI			3.47E-04	4.81	0.89	5.70	100

[a]Volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HI = hazard index.

HQ = hazard quotient.

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Tap Water Risk Assessment (10 year)--Summary of Tap Water Exposure Pathway Cancer Risk Results for Nonradioactive COPCs in Groundwater.

Nonradioactive COPCs	Contaminant Concentration in Groundwater C_w (mg/L)	Volatile[a]	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Risk (Dermal) (unitless)	Total Risk (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	3.734E-09	--	--(b)	7.22E-08	--	7.22E-08	0.051
1,2,3,4,6,7,8-Heptachlorodibenzofuran	5.6E-09	--	--(b)	1.08E-07	--	1.08E-07	0.076
1,2,3,4,7,8-Hexachlorodibenzofuran	2.9E-09	--	--(b)	5.61E-07	--	5.61E-07	0.39
1,2,3,6,7,8-Hexachlorodibenzofuran	2.1E-09	--	--(b)	4.06E-07	--	4.06E-07	0.28
1,2-Dichloroethane	0.00064	Yes	8.26E-08	8.66E-07	4.10E-08	9.90E-07	0.69
2,3,4,6-Tetrachlorophenol	0.0077	--	--(b)	--	--	--	
2-Methylphenol (cresol, o-)	0.0075	--	--(b)	--	--	--	
4-Nitrophenol	0.0072	--	--(b)	--	--	--	
Aluminum	0.11217909	--	--(b)	--	--	--	
Arsenic	0.005765062	--	--(b)	1.29E-04	6.93E-07	1.29E-04	91
Barium	0.052626075	--	--(b)	--	--	--	
Beryllium	0.00034431	--	--(b)	--	--	--	
Bis(2-ethylhexyl) phthalate	0.011	--	--(b)	2.29E-06	3.42E-06	5.71E-06	3.99
Cadmium	0.018	--	--(b)	--	--	--	
Carbon tetrachloride	0.0018	Yes	1.34E-07	3.48E-06	8.99E-07	4.51E-06	3.16
Chloride	11.439962	--	--(b)	--	--	--	
Chloroform	0.00038106	Yes	4.35E-08	1.76E-07	1.54E-08	2.35E-07	0.16
Chromium	0.015609389	--	--(b)	--	--	--	
Cobalt	0.004378857	--	--(b)	--	--	--	
Copper	0.004482187	--	--(b)	--	--	--	
Dinoseb(2-secButyl-4,6-dinitrophenol)	0.005506461	--	--(b)	--	--	--	
Fluoride	0.31715504	--	--(b)	--	--	--	
Hexavalent Chromium	0.191	--	--(b)	--	--	--	
Iron	0.14355212	--	--(b)	--	--	--	
Lead	0.00142074	--	--(b)	--	--	--	
Manganese	0.009635007	--	--(b)	--	--	--	
Nickel	0.010760715	--	--(b)	--	--	--	
Nitrate	31.205071	--	--(b)	--	--	--	
Nitrite	0.034429846	--	--(b)	--	--	--	
Nitrogen in Nitrite and Nitrate	14.7	--	--(b)	--	--	--	
Octachlorodibenzofuran	9.9649E-09	--	--(b)	5.78E-09	--	5.78E-09	0.0040
Octachlorodibenzo-p-dioxin	5.6857E-09	--	--(b)	3.30E-09	--	3.30E-09	0.0023
Silver	0.005650889	--	--(b)	--	--	--	
Strontium	0.26495344	--	--(b)	--	--	--	
Sulfate	56.164035	--	--(b)	--	--	--	
Toluene	0.000065	Yes	--	--	--	--	
Total petroleum hydrocarbons - gasoline range	0.05	--	--(b)	--	--	--	
Trichloroethene	0.000570461	Yes	7.08E-08	7.55E-07	1.26E-07	9.52E-07	0.67
Uranium	0.014879201	--	--(b)	--	--	--	
Vanadium	0.021937779	--	--(b)	--	--	--	
Zinc	0.092316084	--	--(b)	--	--	--	
Total ELCR			3.31E-07	1.37E-04	5.19E-06	1.43E-04	100

[a]Volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Tap Water Risk Assessment (10 year)--Summary of Tap Water Exposure Pathway Cancer Risk Results for Radioactive COPCs in Groundwater.

Radioactive COPCs	Contaminant Concentration in Groundwater C_w (pCi/L)	Volatile[a]	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Total Risk (unitless)	% Contribution
Gross alpha	4.8703439	--	--(b)	--	--	
Iodine-129	3.1689247	--	--(b)	8.86E-06	8.86E-06	2.9
Plutonium-239/240	0.029	--	--(b)	7.40E-08	7.40E-08	0.024
Protactinium-231	0.28	--	--(b)	9.16E-07	9.16E-07	0.30
Strontium-90	4.5802399	--	--(b)	4.84E-06	4.84E-06	1.6
Technetium-99	1567.7398	--	--(b)	8.15E-05	8.15E-05	26
Tritium	192557.5	Yes	2.83E-05	1.85E-04	2.13E-04	69
Total ELCR			2.83E-05	2.81E-04	3.09E-04	100

[a]Volatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates radionuclide toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)
Near-field Exposure Area

Ingestion of Nonradioactive COPCs in Drinking Water

Intake Parameter Values		Value			
Parameter	Symbol	Adult	Child	Unit	Source
Ingestion Chronic Daily Intake	CDI	Calculated		mg/kg-day	Calculated
Contaminant Concentration	C_w	COPC-specific		mg/L	ECF-200PO1-09-2027
Average Body Weight	BW	70	15	kg	EPA/540/R-92/003
Drinking Water Ingestion Rate	IRW	2	1	L/day	EPA/540/R-92/003 EPA/600/P-95/002Fa
Age-Adjusted Drinking Water Ingestion Rate	IRW_{adj}	1.086		L-year/kg-day	Calculated
Exposure Frequency	EF	350		days/year	EPA/540/R-92/003
Exposure Duration	ED	30	6	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70		years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30		years	EPA/540/R-92/003
Oral Reference Dose	RfD_o	COPC-specific		mg/kg-day	EPA, 2009
Oral Cancer Slope Factor	CSF_o	COPC-specific		$(mg/kg\text{-}day)^{-1}$	EPA, 2009
Conversion Factor	CF1	365		days/year	365 days = 1 year

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors* .

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD_o[a] (mg/kg-day)	HQ (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	3.734E-09	1.02E-10	--	--	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	5.6E-09	1.53E-10	--	--	
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	2.9E-09	7.95E-11	--	--	
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	2.1E-09	5.75E-11	--	--	
1,2-Dichloroethane	107-06-2	0.00064	1.75E-05	2.00E-02	8.77E-04	0.0182
2,3,4,6-Tetrachlorophenol	58-90-2	0.0077	2.11E-04	3.00E-02	7.03E-03	0.146
2-Methylphenol (cresol, o-)	95-48-7	0.0075	2.05E-04	5.00E-02	4.11E-03	0.085
4-Nitrophenol	100-02-7	0.0072	1.97E-04	8.00E-03	2.47E-02	0.51
Aluminum	7429-90-5	0.11217909	3.07E-03	1.00E+00	3.07E-03	0.064
Arsenic	7440-38-2	0.005765062	1.58E-04	3.00E-04	5.26E-01	10.9
Barium	7440-39-3	0.052626075	1.44E-03	2.00E-01	7.21E-03	0.15
Beryllium	7440-41-7	0.00034431	9.43E-06	2.00E-03	4.72E-03	0.10
Bis(2-ethylhexyl) phthalate	117-81-7	0.011	3.01E-04	2.00E-02	1.51E-02	0.313
Cadmium	7440-43-9	0.018	4.93E-04	5.00E-04	9.86E-01	20.5
Carbon tetrachloride	56-23-5	0.0018	4.93E-05	7.00E-04	7.05E-02	1.465
Chloride	16887-00-6	11.439962	3.13E-01	--	--	
Chloroform	67-66-3	0.00038106	1.04E-05	1.00E-02	1.04E-03	0.022
Chromium	7440-47-3	0.015609389	4.28E-04	1.50E+00	2.85E-04	0.0059
Cobalt	7440-48-4	0.004378857	1.20E-04	3.00E-04	4.00E-01	8.3
Copper	7440-50-8	0.004482187	1.23E-04	4.00E-02	3.07E-03	0.064
Dinoseb(2-secButyl-4,6-dinitrophenol)	88-85-7	0.005506461	1.51E-04	1.00E-03	1.51E-01	3.1
Fluoride	16984-48-8	0.31715504	8.69E-03	6.00E-02	1.45E-01	3.0
Hexavalent Chromium	18540-29-9	0.191	5.23E-03	3.00E-03	1.74E+00	36
Iron	7439-89-6	0.14355212	3.93E-03	7.00E-01	5.62E-03	0.117
Lead	7439-92-1	0.00142074	3.89E-05	--	--	
Manganese	7439-96-5	0.009635007	2.64E-04	2.40E-02	1.10E-02	0.23
Nickel	7440-02-0	0.010760715	2.95E-04	2.00E-02	1.47E-02	0.31
Nitrate	14797-55-8	31.205071	8.55E-01	7.10E+00	1.20E-01	2.5
Nitrite	14797-65-0	0.034429846	9.43E-04	3.00E-01	3.14E-03	0.065
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	14.7	4.03E-01	1.60E+00	2.52E-01	5.2
Octachlorodibenzofuran	39001-02-0	9.9649E-09	2.73E-10	--	--	
Octachlorodibenzo-p-dioxin	3268-87-9	5.6857E-09	1.56E-10	--	--	
Silver	7440-22-4	0.005650889	1.55E-04	5.00E-03	3.10E-02	0.64
Strontium	7440-24-6	0.26495344	7.26E-03	6.00E-01	1.21E-02	0.25
Sulfate	14808-79-8	56.164035	1.54E+00	--	--	
Toluene	108-88-3	0.000065	1.78E-06	8.00E-02	2.23E-05	4.63E-04
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	0.05	1.37E-03	--	--	
Trichloroethene	79-01-6	0.000570461	1.56E-05	--	--	
Uranium	7440-61-1	0.014879201	4.08E-04	3.00E-03	1.36E-01	2.8
Vanadium	7440-62-2	0.021937779	6.01E-04	5.00E-03	1.20E-01	2.5
Zinc	7440-66-6	0.092316084	2.53E-03	3.00E-01	8.43E-03	0.175
Total HI					4.81E+00	100

[a] EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HQ = hazard quotient.

U.S. EPA 1989. Risk assessment guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A). EPA/540/1/89/002.

Cancer risk calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF_o[a] $(mg/kg\text{-}day)^{-1}$	Risk (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	3.734E-09	5.55E-11	1.30E+03	7.22E-08	0.053
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	5.6E-09	8.33E-11	1.30E+03	1.08E-07	0.079
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	2.9E-09	4.31E-11	1.30E+04	5.61E-07	0.41
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	2.1E-09	3.12E-11	1.30E+04	4.06E-07	0.30
1,2-Dichloroethane	107-06-2	0.00064	9.52E-06	9.10E-02	8.66E-07	0.63
2,3,4,6-Tetrachlorophenol	58-90-2	0.0077	1.15E-04	--	--	
2-Methylphenol (cresol, o-)	95-48-7	0.0075	1.12E-04	--	--	
4-Nitrophenol	100-02-7	0.0072	1.07E-04	--	--	
Aluminum	7429-90-5	0.11217909	1.67E-03	--	--	
Arsenic	7440-38-2	0.005765062	8.57E-05	1.50E+00	1.29E-04	94
Barium	7440-39-3	0.052626075	7.83E-04	--	--	
Beryllium	7440-41-7	0.00034431	5.12E-06	--	--	
Bis(2-ethylhexyl) phthalate	117-81-7	0.011	1.64E-04	1.40E-02	2.29E-06	1.67
Cadmium	7440-43-9	0.018	2.68E-04	--	--	
Carbon tetrachloride	56-23-5	0.0018	2.68E-05	1.30E-01	3.48E-06	2.53
Chloride	16887-00-6	11.439962	1.70E-01	--	--	
Chloroform	67-66-3	0.00038106	5.67E-06	3.10E-02	1.76E-07	0.13
Chromium	7440-47-3	0.015609389	2.32E-04	--	--	
Cobalt	7440-48-4	0.004378857	6.51E-05	--	--	
Copper	7440-50-8	0.004482187	6.67E-05	--	--	
Dinoseb(2-secButyl-4,6-dinitrophenol)	88-85-7	0.005506461	8.19E-05	--	--	
Fluoride	16984-48-8	0.31715504	4.72E-03	--	--	
Hexavalent Chromium	18540-29-9	0.191	2.84E-03	--	--	
Iron	7439-89-6	0.14355212	2.14E-03	--	--	
Lead	7439-92-1	0.00142074	2.11E-05	--	--	
Manganese	7439-96-5	0.009635007	1.43E-04	--	--	
Nickel	7440-02-0	0.010760715	1.60E-04	--	--	
Nitrate	14797-55-8	31.205071	4.64E-01	--	--	
Nitrite	14797-65-0	0.034429846	5.12E-04	--	--	
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	14.7	2.19E-01	--	--	
Octachlorodibenzofuran	39001-02-0	9.9649E-09	1.48E-10	3.90E+01	5.78E-09	0.0042
Octachlorodibenzo-p-dioxin	3268-87-9	5.6857E-09	8.46E-11	3.90E+01	3.30E-09	0.0024
Silver	7440-22-4	0.005650889	8.40E-05	--	--	
Strontium	7440-24-6	0.26495344	3.94E-03	--	--	
Sulfate	14808-79-8	56.164035	8.35E-01	--	--	
Toluene	108-88-3	0.000065	9.67E-07	--	--	
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	0.05	7.44E-04	--	--	
Trichloroethene	79-01-6	0.000570461	8.48E-06	8.90E-02	7.55E-07	0.55
Uranium	7440-61-1	0.014879201	2.21E-04	--	--	
Vanadium	7440-62-2	0.021937779	3.26E-04	--	--	
Zinc	7440-66-6	0.092316084	1.37E-03	--	--	
Total ELCR					1.37E-04	100

[a] EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

U.S. EPA 1989. Risk assessment guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A). EPA/540/1/89/002.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)
Near-field Exposure Area

Inhalation of Volatile Nonradioactive COPCs in Drinking Water

Intake Parameter Values				
Parameter	Symbol	Value	Unit	Source
Inhalation Chronic Daily Intake	CDI	Calculated	mg/m^3 for noncarcinogens, $\mu g/m^3$ for carcinogens	Calculated
Contaminant Concentration	C_w	COPC-specific	mg/L	ECF-200PO1-09-2027
Exposure Time	ET	0.58	hours/day	EPA/540/R/99/005
Exposure Frequency	EF	350	days/year	EPA/540/R-92/003
Exposure Duration	ED	30	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70	years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30	years	EPA/540/R-92/003
Andelman Volatilization Factor	VF	0.5	L/m^3	EPA/540/R-92/003
Inhalation Reference Concentration	RfC	COPC-specific	mg/m^3	EPA, 2009
Inhalation Unit Risk	IUR	COPC-specific	$(\mu g/m^3)^{-1}$	EPA, 2009
Conversion Factor	CF1	365	days/year	365 days = 1 year
Conversion Factor	CF2	1/24	days/hour	1 day = 24 hours

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors* .

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	Volatile[a]	C_w (mg/L)	CDI (non-cancer) mg/m^3	RfC[a] (mg/m^3)	HQ (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	--	3.734E-09	--(b)	--	--(b)	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	--	5.6E-09	--(b)	--	--(b)	
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	--	2.9E-09	--(b)	--	--(b)	
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	--	2.1E-09	--(b)	--	--(b)	
1,2-Dichloroethane	107-06-2	Yes	0.00064	7.42E-06	2.40E+00	3.09E-06	0.89
2,3,4,6-Tetrachlorophenol	58-90-2	--	0.0077	--(b)	--	--(b)	
2-Methylphenol (cresol, o-)	95-48-7	--	0.0075	--(b)	6.00E-01	--(b)	
4-Nitrophenol	100-02-7	--	0.0072	--(b)	--	--(b)	
Aluminum	7429-90-5	--	0.11217909	--(b)	5.00E-03	--(b)	
Arsenic	7440-38-2	--	0.005765062	--(b)	1.50E-05	--(b)	
Barium	7440-39-3	--	0.052626075	--(b)	5.00E-04	--(b)	
Beryllium	7440-41-7	--	0.00034431	--(b)	2.00E-05	--(b)	
Bis(2-ethylhexyl) phthalate	117-81-7	--	0.011	--(b)	--	--(b)	
Cadmium	7440-43-9	--	0.018	--(b)	1.00E-05	--(b)	
Carbon tetrachloride	56-23-5	Yes	0.0018	2.09E-05	1.90E-01	1.10E-04	31.6
Chloride	16887-00-6	--	11.439962	--(b)	--	--(b)	
Chloroform	67-66-3	Yes	0.00038106	4.42E-06	9.80E-02	4.51E-05	13
Chromium	7440-47-3	--	0.015609389	--(b)	--	--(b)	
Cobalt	7440-48-4	--	0.004378857	--(b)	6.00E-06	--(b)	
Copper	7440-50-8	--	0.004482187	--(b)	--	--(b)	
Dinoseb(2-secButyl-4,6-dinitrophenol)	88-85-7	--	0.005506461	--(b)	--	--(b)	
Fluoride	16984-48-8	--	0.31715504	--(b)	1.30E-02	--(b)	
Hexavalent Chromium	18540-29-9	--	0.191	--(b)	1.00E-04	--(b)	
Iron	7439-89-6	--	0.14355212	--(b)	--	--(b)	
Lead	7439-92-1	--	0.00142074	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.009635007	--(b)	5.00E-05	--(b)	
Nickel	7440-02-0	--	0.010760715	--(b)	9.00E-05	--(b)	
Nitrate	14797-55-8	--	31.205071	--(b)	--	--(b)	
Nitrite	14797-65-0	--	0.034429846	--(b)	--	--(b)	
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	--	14.7	--(b)	--	--(b)	
Octachlorodibenzofuran	39001-02-0	--	9.9649E-09	--(b)	--	--(b)	
Octachlorodibenzo-p-dioxin	3268-87-9	--	5.6857E-09	--(b)	--	--(b)	
Silver	7440-22-4	--	0.005650889	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.26495344	--(b)	--	--(b)	
Sulfate	14808-79-8	--	56.164035	--(b)	--	--(b)	
Toluene	108-88-3	Yes	0.000065	7.53E-07	5.00E+00	1.51E-07	0.04
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	--	0.05	--(b)	--	--(b)	
Trichloroethene	79-01-6	Yes	0.000570461	6.61E-06	3.50E-02	1.89E-04	54
Uranium	7440-61-1	--	0.014879201	--(b)	3.00E-04	--(b)	
Vanadium	7440-62-2	--	0.021937779	--(b)	--	--(b)	
Zinc	7440-66-6	--	0.092316084	--(b)	--	--(b)	
Total HI						3.47E-04	100

[a] EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b] Nonvolatile constituents are not considered in the inhalation of groundwater in the drinking water pathway

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HQ = hazard quotient.

U.S. EPA 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). EPA-540-R-070-002.

Cancer risk calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	Volatile[a]	C_w (mg/L)	CDI (cancer) $\mu g/m^3$	IUR[a] $(\mu g/m^3)^{-1}$	Risk (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	--	3.734E-09	--(b)	3.80E-01	--(b)	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	--	5.6E-09	--(b)	3.80E-01	--(b)	
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	--	2.9E-09	--(b)	3.80E+00	--(b)	
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	--	2.1E-09	--(b)	3.80E+00	--(b)	
1,2-Dichloroethane	107-06-2	Yes	0.00064	3.18E-03	2.60E-05	8.26E-08	25
2,3,4,6-Tetrachlorophenol	58-90-2	--	0.0077	--(b)	--	--(b)	
2-Methylphenol (cresol, o-)	95-48-7	--	0.0075	--(b)	--	--(b)	
4-Nitrophenol	100-02-7	--	0.0072	--(b)	--	--(b)	
Aluminum	7429-90-5	--	0.11217909	--(b)	--	--(b)	
Arsenic	7440-38-2	--	0.005765062	--(b)	4.30E-03	--(b)	
Barium	7440-39-3	--	0.052626075	--(b)	--	--(b)	
Beryllium	7440-41-7	--	0.00034431	--(b)	2.40E-03	--(b)	
Bis(2-ethylhexyl) phthalate	117-81-7	--	0.011	--(b)	2.40E-06	--(b)	
Cadmium	7440-43-9	--	0.018	--(b)	1.80E-03	--(b)	
Carbon tetrachloride	56-23-5	Yes	0.0018	8.94E-03	1.50E-05	1.34E-07	40.5
Chloride	16887-00-6	--	11.439962	--(b)	--	--(b)	
Chloroform	67-66-3	Yes	0.00038106	1.89E-03	2.30E-05	4.35E-08	13
Chromium	7440-47-3	--	0.015609389	--(b)	--	--(b)	
Cobalt	7440-48-4	--	0.004378857	--(b)	9.00E-03	--(b)	
Copper	7440-50-8	--	0.004482187	--(b)	--	--(b)	
Dinoseb(2-secButyl-4,6-dinitrophenol)	88-85-7	--	0.005506461	--(b)	--	--(b)	
Fluoride	16984-48-8	--	0.31715504	--(b)	--	--(b)	
Hexavalent Chromium	18540-29-9	--	0.191	--(b)	8.40E-02	--(b)	
Iron	7439-89-6	--	0.14355212	--(b)	--	--(b)	
Lead	7439-92-1	--	0.00142074	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.009635007	--(b)	--	--(b)	
Nickel	7440-02-0	--	0.010760715	--(b)	2.60E-04	--(b)	
Nitrate	14797-55-8	--	31.205071	--(b)	--	--(b)	
Nitrite	14797-65-0	--	0.034429846	--(b)	--	--(b)	
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	--	14.7	--(b)	--	--(b)	
Octachlorodibenzofuran	39001-02-0	--	9.9649E-09	--(b)	1.14E-02	--(b)	
Octachlorodibenzo-p-dioxin	3268-87-9	--	5.6857E-09	--(b)	1.14E-02	--(b)	
Silver	7440-22-4	--	0.005650889	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.26495344	--(b)	--	--(b)	
Sulfate	14808-79-8	--	56.164035	--(b)	--	--(b)	
Toluene	108-88-3	Yes	0.000065	3.23E-04	--	--	
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	--	0.05	--(b)	--	--(b)	
Trichloroethene	79-01-6	Yes	0.000570461	2.83E-03	2.50E-05	7.08E-08	21
Uranium	7440-61-1	--	0.014879201	--(b)	--	--(b)	
Vanadium	7440-62-2	--	0.021937779	--(b)	--	--(b)	
Zinc	7440-66-6	--	0.092316084	--(b)	--	--(b)	
Total ELCR						3.31E-07	100

[a] EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b] Nonvolatile constituents are not considered in the inhalation of groundwater in the drinking water pathway

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

U.S. EPA 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). EPA-540-R-070-002.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)
Near-field Exposure Area

Dermal Absorption of Nonradioactive COPCs in Drinking Water

Intake Parameter Values		Value			
Parameter	Symbol	Adult	Child	Unit	Source
Chronic Daily Intake	CDI	Calculated		mg/kg-day	Calculated
Contaminant Concentration	C_w	COPC-specific		mg/L	ECF-200PO1-09-2027
Average Body Weight	BW	70	15	kg	EPA/540/R-92/003
Exposure Time	ET	0.58	1	hours/event	EPA/540/R/99/005
Exposure Time (Age-Adjusted)	ET_{aa}	0.664		hours/event	Calculated
Surface Area	SA	18,000	6,600	cm^2	EPA/540/R/99/005
Age-Adjusted Surface Area	SA_{aa}	8,811		(cm^2-year-event)/(kg/day)	Calculated
Event Frequency	EV	1		event/day	EPA/540/R/99/005
Exposure Frequency	EF	350		days/year	EPA/540/R-92/003
Exposure Duration	ED	30	6	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70		years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30		years	EPA/540/R-92/003
Oral Reference Dose	RfD_o	COPC-specific		mg/kg-day	EPA, 2009
Oral Cancer Slope Factor	CSF_o	COPC-specific		$(mg/kg\text{-}day)^{-1}$	EPA, 2009
Conversion Factor	CF1	365		days/year	365 days = 1 year
Conversion Factor	CF3	0.001		L/cm^3	$1 L = 1000 cm^3$
The constant pi	π	3.14159		unitless	--
Time to reach steady state	t^*	COPC-specific		hours	EPA/540/R/99/005
Dermal Partitioning Constant	B	COPC-specific		unitless	EPA/540/R/99/005
Absorbed Dose per Event	DA	Calculated		mg/cm^2-event	Calculated
Dermal Permeability Constant	K_p	COPC-specific		cm/hour	EPA/540/R/99/005
Fraction Absorbed	FA	COPC-specific		unitless	EPA/540/R/99/005
Lag Time	τ	COPC-specific		hours/event	EPA/540/R/99/005
Fraction of Contaminant Absorbed in Gastrointestinal Tract	GIABS	COPC-specific		unitless	EPA, 2009

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.
EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*
EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Absorbed Dermal Dose Calculation

Contaminant of Potential Concern	CAS #	C_w (mg/L)	Inorganic/organic[a]	FA[b] (unitless)	K_p[c] (cm/hour)	B[b] (unitless)	τ[b] (hours/event)	t*[b] (hours)	DA (noncancer) (mg/cm^2-event)	DA (cancer) (mg/cm^2-event)
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	3.734E-09	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	5.6E-09	--	--	--	1.45	--	--	--	--
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	2.9E-09	--	--	--	2.25	--	--	--	--
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	2.1E-09	--	--	--	2.25	--	--	--	--
1,2-Dichloroethane	107-06-2	0.00064	--	1.0	0.0042	0	0.38	0.92	3.49E-09	3.73E-09
2,3,4,6-Tetrachlorophenol	58-90-2	0.0077	--	--	0.071	--	--	--	--	--
2-Methylphenol (cresol, o-)	95-48-7	0.0075	--	1.0	0.0077	0	0.43	1.03	7.97E-08	8.53E-08
4-Nitrophenol	100-02-7	0.0072	--	1.0	0.0048	0	0.64	1.54	5.82E-08	6.23E-08
Aluminum	7429-90-5	0.11217909	INORGANIC	--	0.001	--	--	--	6.51E-08	7.45E-08
Arsenic	7440-38-2	0.005765062	INORGANIC	--	0.001	--	--	--	3.34E-09	3.83E-09
Barium	7440-39-3	0.052626075	INORGANIC	--	0.001	--	--	--	3.05E-08	3.49E-08
Beryllium	7440-41-7	0.00034431	INORGANIC	--	0.001	--	--	--	2.00E-10	2.29E-10
Bis(2-ethylhexyl) phthalate	117-81-7	0.011	--	0.8	0.025	0.2	16.64	39.93	1.89E-06	2.02E-06
Cadmium	7440-43-9	0.018	INORGANIC	--	0.001	--	--	--	1.04E-08	1.20E-08
Carbon tetrachloride	56-23-5	0.0018	--	1.0	0.016	0.1	0.78	1.86	5.35E-08	5.73E-08
Chloride	16887-00-6	11.439962	INORGANIC	--	0.001	--	--	--	6.64E-06	7.60E-06
Chloroform	67-66-3	0.00038106	--	1.0	0.0068	0	0.50	1.19	3.86E-09	4.13E-09
Chromium	7440-47-3	0.015609389	INORGANIC	--	0.001	--	--	--	9.05E-09	1.04E-08
Cobalt	7440-48-4	0.004378857	INORGANIC	--	0.0004	--	--	--	1.02E-09	1.16E-09
Copper	7440-50-8	0.004482187	INORGANIC	--	0.001	--	--	--	2.60E-09	2.98E-09
Dinoseb(2-secButyl-4,6-dinitrophenol)[c]	88-85-7	0.005506461	--	--	0.0163	--	--	--	--	--
Fluoride	16984-48-8	0.31715504	INORGANIC	--	0.001	--	--	--	1.84E-07	2.11E-07
Hexavalent Chromium	18540-29-9	0.191	INORGANIC	--	0.002	--	--	--	2.22E-07	2.54E-07
Iron	7439-89-6	0.14355212	INORGANIC	--	0.001	--	--	--	8.33E-08	9.53E-08
Lead	7439-92-1	0.00142074	INORGANIC	--	0.0001	--	--	--	8.24E-11	9.43E-11
Manganese	7439-96-5	0.009635007	INORGANIC	--	0.001	--	--	--	5.59E-09	6.40E-09
Nickel	7440-02-0	0.010760715	INORGANIC	--	0.0002	--	--	--	1.25E-09	1.43E-09
Nitrate	14797-55-8	31.205071	INORGANIC	--	0.001	--	--	--	1.81E-05	2.07E-05
Nitrite	14797-65-0	0.034429846	INORGANIC	--	0.001	--	--	--	2.00E-08	2.29E-08
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	14.7	INORGANIC	--	0.001	--	--	--	8.53E-06	9.76E-06
Octachlorodibenzofuran	39001-02-0	9.9649E-09	--	--	2.63	--	--	--	--	--
Octachlorodibenzo-p-dioxin	3268-87-9	5.6857E-09	--	--	1.16	--	--	--	--	--
Silver	7440-22-4	0.005650889	INORGANIC	--	0.0006	--	--	--	1.97E-09	2.25E-09
Strontium	7440-24-6	0.26495344	INORGANIC	--	0.001	--	--	--	1.54E-07	1.76E-07
Sulfate	14808-79-8	56.164035	INORGANIC	--	0.001	--	--	--	3.26E-05	3.73E-05
Toluene	108-88-3	0.000065	--	1.0	0.031	0.1	0.35	0.84	2.51E-09	2.68E-09
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	0.05	--	--	--	--	--	--	--	--
Trichloroethene	79-01-6	0.000570461	--	1.0	0.012	0.1	0.58	1.39	1.10E-08	1.17E-08
Uranium	7440-61-1	0.014879201	INORGANIC	--	0.001	--	--	--	8.63E-09	9.88E-09
Vanadium	7440-62-2	0.021937779	INORGANIC	--	0.001	--	--	--	1.27E-08	1.46E-08
Zinc	7440-66-6	0.092316084	INORGANIC	--	0.0006	--	--	--	1.21E-08	3.68E-08

[a]EPA/540/R/99/005, Exhibit 3-1 (inorganics) and Exhibit B-3 (organics)
[b]EPA/540/R/99/005, Exhibit B-3
[c]the K_p value was taken from ORNL, 2010. The Risk Assessment Information System (RAIS)

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit Near-field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD_o[a] (mg/kg-day)	GIABS[a] (unitless)	HQ (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	3.734E-09	--	--	1	--	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	5.6E-09	--	--	1	--	
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	2.9E-09	--	--	1	--	
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	2.1E-09	--	--	1	--	
1,2-Dichloroethane	107-06-2	0.00064	8.60E-07	2.00E-02	1	4.30E-05	0.0048
2,3,4,6-Tetrachlorophenol	58-90-2	0.0077	--	3.00E-02	1	--	
2-Methylphenol (cresol, o-)	95-48-7	0.0075	1.97E-05	5.00E-02	1	3.93E-04	0.044
4-Nitrophenol	100-02-7	0.0072	1.44E-05	8.00E-03	1	1.79E-03	0.201
Aluminum	7429-90-5	0.11217909	1.60E-05	1.00E+00	1	1.60E-05	0.0018
Arsenic	7440-38-2	0.005765062	8.24E-07	3.00E-04	1	2.75E-03	0.31
Barium	7440-39-3	0.052626075	7.53E-06	2.00E-01	0.07	5.38E-04	0.060
Beryllium	7440-41-7	0.00034431	4.92E-08	2.00E-03	0.007	3.52E-03	0.4
Bis(2-ethylhexyl) phthalate	117-81-7	0.011	4.66E-04	2.00E-02	1	2.33E-02	2.61
Cadmium	7440-43-9	0.018	2.57E-06	5.00E-04	0.05	1.03E-01	11.5
Carbon tetrachloride	56-23-5	0.0018	1.32E-05	7.00E-04	1	1.89E-02	2.11
Chloride	16887-00-6	11.439962	1.64E-03	--	1	--	
Chloroform	67-66-3	0.00038106	9.51E-07	1.00E-02	1	9.51E-05	0.011
Chromium	7440-47-3	0.015609389	2.23E-06	1.50E+00	0.013	1.14E-04	0.013
Cobalt	7440-48-4	0.004378857	2.50E-07	3.00E-04	1	8.35E-04	0.09
Copper	7440-50-8	0.004482187	6.41E-07	4.00E-02	1	1.60E-05	0.0018
Dinoseb(2-secButyl-4,6-dinitrophenol)	88-85-7	0.005506461	--	1.00E-03	1	--	
Fluoride	16984-48-8	0.31715504	4.54E-05	6.00E-02	1	7.56E-04	0.08
Hexavalent Chromium	18540-29-9	0.191	5.46E-05	3.00E-03	0.025	7.28E-01	82
Iron	7439-89-6	0.14355212	2.05E-05	7.00E-01	1	2.93E-05	0.0033
Lead	7439-92-1	0.00142074	2.03E-08	--	1	--	
Manganese	7439-96-5	0.009635007	1.38E-06	2.40E-02	0.04	1.44E-03	0.16
Nickel	7440-02-0	0.010760715	3.08E-07	2.00E-02	0.04	3.85E-04	0.043
Nitrate	14797-55-8	31.205071	4.46E-03	7.10E+00	1	6.29E-04	0.07
Nitrite	14797-65-0	0.034429846	4.92E-06	3.00E-01	1	1.64E-05	0.0018
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	14.7	2.10E-03	1.60E+00	1	1.31E-03	0.15
Octachlorodibenzofuran	39001-02-0	9.9649E-09	--	--	1	--	
Octachlorodibenzo-p-dioxin	3268-87-9	5.6857E-09	--	--	1	--	
Silver	7440-22-4	0.005650889	4.85E-07	5.00E-03	0.04	2.42E-03	0.27
Strontium	7440-24-6	0.26495344	3.79E-05	6.00E-01	1	6.32E-05	0.0071
Sulfate	14808-79-8	56.164035	8.03E-03	--	--	--	
Toluene	108-88-3	0.000065	6.19E-07	8.00E-02	1	7.73E-06	0.0009
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	0.05	--	--	--	--	
Trichloroethene	79-01-6	0.000570461	2.71E-06	--	1	--	
Uranium	7440-61-1	0.014879201	2.13E-06	3.00E-03	1	7.09E-04	0.08
Vanadium	7440-62-2	0.021937779	3.14E-06	5.00E-03	1	0.0006	0.070
Zinc	7440-66-6	0.092316084	7.92E-06	3.00E-01	1	2.64E-05	2.96E-03
Total HI						0.89	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
-- = indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.
COPC = contaminant of potential concern
HI = hazard index
HQ = hazard quotient.
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

Cancer risk calculation

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF_o[a] $(mg/kg\text{-}day)^{-1}$	GIABS[a] (unitless)	Risk (unitless)	% Contribution
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	3.734E-09	--	1.30E+03	1	--	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	5.6E-09	--	1.30E+03	1	--	
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	2.9E-09	--	1.30E+04	1	--	
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	2.1E-09	--	1.30E+04	1	--	
1,2-Dichloroethane	107-06-2	0.00064	4.50E-07	9.10E-02	1	4.10E-08	0.79
2,3,4,6-Tetrachlorophenol	58-90-2	0.0077	--	--	1	--	
2-Methylphenol (cresol, o-)	95-48-7	0.0075	1.03E-05	--	1	--	
4-Nitrophenol	100-02-7	0.0072	7.52E-06	--	1	--	
Aluminum	7429-90-5	0.11217909	8.99E-06	--	1	--	
Arsenic	7440-38-2	0.005765062	4.62E-07	1.50E+00	1	6.93E-07	13
Barium	7440-39-3	0.052626075	4.22E-06	--	0.07	--	
Beryllium	7440-41-7	0.00034431	2.76E-08	--	0.007	--	
Bis(2-ethylhexyl) phthalate	117-81-7	0.011	2.44E-04	1.40E-02	1	3.42E-06	66
Cadmium	7440-43-9	0.018	1.44E-06	--	0.05	--	
Carbon tetrachloride	56-23-5	0.0018	6.91E-06	1.30E-01	1	8.99E-07	17.3
Chloride	16887-00-6	11.439962	9.17E-04	--	1	--	
Chloroform	67-66-3	0.00038106	4.98E-07	3.10E-02	1	1.54E-08	0.3
Chromium	7440-47-3	0.015609389	1.25E-06	--	0.013	--	
Cobalt	7440-48-4	0.004378857	1.40E-07	--	1	--	
Copper	7440-50-8	0.004482187	3.59E-07	--	1	--	
Dinoseb(2-secButyl-4,6-dinitrophenol)	88-85-7	0.005506461	--	--	1	--	
Fluoride	16984-48-8	0.31715504	2.54E-05	--	1	--	
Hexavalent Chromium	18540-29-9	0.191	3.06E-05	--	0.025	--	
Iron	7439-89-6	0.14355212	1.15E-05	--	1	--	
Lead	7439-92-1	0.00142074	1.14E-08	--	1	--	
Manganese	7439-96-5	0.009635007	7.72E-07	--	0.04	--	
Nickel	7440-02-0	0.010760715	1.72E-07	--	0.04	--	
Nitrate	14797-55-8	31.205071	2.50E-03	--	1	--	
Nitrite	14797-65-0	0.034429846	2.76E-06	--	1	--	
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	14.7	1.18E-03	--	1	--	
Octachlorodibenzofuran	39001-02-0	9.9649E-09	--	3.90E+01	1	--	
Octachlorodibenzo-p-dioxin	3268-87-9	5.6857E-09	--	3.90E+01	1	--	
Silver	7440-22-4	0.005650889	2.72E-07	--	0.04	--	
Strontium	7440-24-6	0.26495344	2.12E-05	--	1	--	
Sulfate	14808-79-8	56.164035	4.50E-03	--	--	--	
Toluene	108-88-3	0.000065	3.24E-07	--	1	--	
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	0.05	--	--	--	--	
Trichloroethene	79-01-6	0.000570461	1.42E-06	8.90E-02	1	1.26E-07	2.4
Uranium	7440-61-1	0.014879201	1.19E-06	--	1	--	
Vanadium	7440-62-2	0.021937779	1.76E-06	--	1	--	
Zinc	7440-66-6	0.092316084	4.44E-06	--	1	--	
Total ELCR						5.19E-06	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."
-- = indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.
COPC = contaminant of potential concern
ELCR = excess lifetime cancer risk.
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)

Near-field Exposure Area

Inhalation of Volatile Radioactive COPCs in Drinking Water

Intake Parameter Values		Value			
Factor	Symbol	Adult	Child	Unit	Reference
Chronic Daily Intake	CDI	Calculated		pCi	Calculated
Contaminant Concentration	C_w	COPC-specific		pCi/L	ECF-200PO1-09-2027
Exposure frequency	EF	350		days/year	EPA/540/R-92/003
Exposure duration	ED	30	6	years	EPA/540/R-92/003
Inhalation Rate	INH	20	10	m^3/day	OSWER Directive 9285.6-03 EPA/600/P-
Exposure time	ET	0.58	1	hours/day	EPA/540/R/99/005
Age Adjusted Exposure Time	ET_{adj}	0.664		hours/day	Calculated
Radiation Age-adjusted Inhalation Rate	INH_RAD_{adj}	540		m^3-year/day	Calculated
Andelman Volatilization Factor	VF	0.5		L/m^3	EPA/540/R-92/003
Slope Factor - Inhalation	SF_i	COPC-specific		risk/pCi	EPA, 2001
Conversion Factor	CF2	1/24		days/hour	1 day = 24 hours

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

OSWER Directive 9285.6-03, *Risk Assessment Guidance For Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance "Standard Default Exposure Factors Interim Final"*

Inhalation of Volatile Radioactive Constituents in Groundwater

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Radioactive COPC	CAS #	Volatile[a]	C_w (pCi/L)	CDI (radiological inhalation) (pCi)	SF_i (risk/pCi)	Risk (unitless)	% Contribution
Gross alpha	12587-46-1		4.8703439	--(b)	--	--(b)	
Iodine-129	15046-84-1		3.1689247	--(b)	6.07E-11	--(b)	
Plutonium-239/240	PU-239/240		0.029	--(b)	3.33E-08	--(b)	
Protactinium-231	14331-85-2		0.28	--(b)	4.55E-08	--(b)	
Strontium-90	10098-97-2		4.5802399	--(b)	1.05E-10	--(b)	
Technetium-99	14133-76-7		1567.7398	--(b)	1.41E-11	--(b)	
Tritium	10028-17-8	Yes	192557.5	5.03E+08	5.62E-14	2.83E-05	100
Total ELCR						2.83E-05	100

[a]Volatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)
Near-field Exposure Area

Ingestion of Radioactive COPCs in Drinking Water

Intake Parameter Values		Value			
Factor	Symbol	Adult	Child	Unit	Reference
Chronic Daily Intake	CDI	Calculated		pCi	Calculated
Contaminant Concentration	C_w	COPC-specific		pCi/L	ECF-200PO1-09-2027
Exposure frequency	EF	350		days/year	EPA/540/R-92/003
Exposure duration	ED	30	6	years	EPA/540/R-92/003
Drinking Water Ingestion Rate	IRW	2	1	L/day	EPA/540/R-92/003 EPA/600/P-95/002Fa
Radiation Age-adjusted Drinking Water Ingestion Rate	IRW_RAD_{adj}	54		L-year/day	Calculated
Slope Factor - Oral	SF_o	COPC-specific		risk/pCi	EPA, 2001

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*

EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

Ingestion of Radioactive Constituents in Groundwater

200-PO-1 Groundwater Operable Unit Near-Field Exposure Area Radioactive COPC	CAS #	C_w (pCi/L)	CDI (radiological ingestion) (pCi)	SF_o (risk/pCi)	Risk (unitless)	% Contribution
Gross alpha	12587-46-1	4.8703439	9.20E+04	--	--	
Iodine-129	15046-84-1	3.1689247	5.99E+04	1.48E-10	8.86E-06	3
Plutonium-239/240	PU-239/240	0.029	5.48E+02	1.35E-10	7.40E-08	0.026
Protactinium-231	14331-85-2	0.28	5.29E+03	1.73E-10	9.16E-07	0.3
Strontium-90	10098-97-2	4.5802399	8.66E+04	5.59E-11	4.84E-06	1.7
Technetium-99	14133-76-7	1567.7398	2.96E+07	2.75E-12	8.15E-05	29
Tritium	10028-17-8	192557.5	3.64E+09	5.07E-14	1.85E-04	65.7
Total ELCR					2.81E-04	100

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit River Exposure Area Tap Water Risk Assessment (10 year)--Summary of Tap Water Exposure Pathway Noncancer Hazard Results for Nonradioactive COPCs in Groundwater.

Nonradioactive COPCs	Contaminant Concentration in Groundwater C_w (mg/L)	Volatile[a]	HQ (Inhalation) (unitless)	HQ (Ingestion) (unitless)	HQ (Dermal) (unitless)	Total HQ (unitless)	% Contribution
Acetone	0.0011	Yes	4.11E-07	3.35E-05	--	3.39E-05	0.0031
Arsenic	0.005767892	--	--(b)	5.27E-01	2.75E-03	5.29E-01	48
Barium	0.049451657	--	--(b)	6.77E-03	5.05E-04	7.28E-03	0.66
Carbon tetrachloride	0.00028	Yes	1.71E-05	1.10E-02	2.93E-03	1.39E-02	1.3
Chloride	12.545114	--	--(b)	--	--	--	
Chloroform	0.0023	Yes	2.72E-04	6.30E-03	5.74E-04	7.15E-03	0.65
Chromium	0.0141	--	--(b)	2.58E-04	1.03E-04	3.61E-04	0.033
Copper	0.00597989	--	--(b)	4.10E-03	2.14E-05	4.12E-03	0.37
Fluoride	0.30621978	--	--(b)	1.40E-01	7.30E-04	1.41E-01	13
Iron	0.61057915	--	--(b)	2.39E-02	1.25E-04	2.40E-02	2.2
Lead	0.000663667	--	--(b)	--	--	--	
Manganese	0.040717647	--	--(b)	4.65E-02	6.07E-03	5.25E-02	4.8
Nickel	0.0056	--	--(b)	7.67E-03	2.00E-04	7.87E-03	0.71
Nitrate	28.952	--	--(b)	1.12E-01	5.83E-04	1.12E-01	10
Nitrite	0.46	--	--(b)	4.20E-02	2.19E-04	4.22E-02	3.83
Strontium	0.38963943	--	--(b)	1.78E-02	9.29E-05	1.79E-02	1.6
Sulfate	41.899078	--	--(b)	--	--	--	
Thallium	0.00037	--	--(b)	--	--	--	
Uranium	0.005491757	--	--(b)	5.02E-02	2.62E-04	5.04E-02	4.6
Vanadium	0.0168	--	--(b)	9.21E-02	4.81E-04	9.25E-02	8.4
Zinc	0.006671161	--	--(b)	6.09E-04	1.91E-06	6.11E-04	0.055
Total HI			2.89E-04	1.09	0.02	1.10	100

[a]Volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HI = hazard index.

HQ = hazard quotient.

200-PO-1 Groundwater Operable Unit River Exposure Area Tap Water Risk Assessment (10 year)--Summary of Tap Water Exposure Pathway Cancer Risk Results for Nonradioactive COPCs in Groundwater.

Nonradioactive COPCs	Contaminant Concentration in Groundwater C_w (mg/L)	Volatile[a]	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Risk (Dermal) (unitless)	Total Risk (unitless)	% Contribution
Acetone	0.0011	Yes	--	--	--	--	
Arsenic	0.005767892	--	--(b)	1.29E-04	6.93E-07	1.29E-04	98
Barium	0.049451657	--	--(b)	--	--	--	
Carbon tetrachloride	0.00028	Yes	2.09E-08	5.41E-07	1.40E-07	7.02E-07	0.5
Chloride	12.545114	--	--(b)	--	--	--	
Chloroform	0.0023	Yes	2.63E-07	1.06E-06	9.32E-08	1.42E-06	1.08
Chromium	0.0141	--	--(b)	--	--	--	
Copper	0.00597989	--	--(b)	--	--	--	
Fluoride	0.30621978	--	--(b)	--	--	--	
Iron	0.61057915	--	--(b)	--	--	--	
Lead	0.000663667	--	--(b)	--	--	--	
Manganese	0.040717647	--	--(b)	--	--	--	
Nickel	0.0056	--	--(b)	--	--	--	
Nitrate	28.952	--	--(b)	--	--	--	
Nitrite	0.46	--	--(b)	--	--	--	
Strontium	0.38963943	--	--(b)	--	--	--	
Sulfate	41.899078	--	--(b)	--	--	--	
Thallium	0.00037	--	--(b)	--	--	--	
Uranium	0.005491757	--	--(b)	--	--	--	
Vanadium	0.0168	--	--(b)	--	--	--	
Zinc	0.006671161	--	--(b)	--	--	--	
Total ELCR			2.84E-07	1.30E-04	9.26E-07	1.31E-04	100

[a]Volatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

200-PO-1 Groundwater Operable Unit River Exposure Area Tap Water Risk Assessment (10 year)--Summary of Tap Water Exposure Pathway Cancer Risk Results for Radioactive COPCs in Groundwater.

Radioactive COPCs	Contaminant Concentration in Groundwater C_w (pCi/L)	Volatile[a]	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Total Risk (unitless)	% Contribution
Gross alpha	2.8	--	--(b)	--	--	
Gross beta	22.2	--	--(b)	--	--	
Strontium-90	2.60	--	--(b)	2.75E-06	2.75E-06	3.69
Technetium-99	115	--	--(b)	5.96E-06	5.96E-06	8.0
Tritium	59,534	Yes	8.75E-06	5.70E-05	6.58E-05	88
Total ELCR			8.75E-06	6.58E-05	7.45E-05	100

[a]Volatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope

[b]Nonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates radionuclide toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)
River Exposure Area

Ingestion of Nonradioactive COPCs in Drinking Water

Intake Parameter Values		Value			
Parameter	Symbol	Adult	Child	Unit	Source
Ingestion Chronic Daily Intake	CDI	Calculated		mg/kg-day	Calculated
Contaminant Concentration	C_w	COPC-specific		mg/L	ECF-200PO1-09-2027
Average Body Weight	BW	70	15	kg	EPA/540/R-92/003
Drinking Water Ingestion Rate	IRW	2	1	L/day	EPA/540/R-92/003 EPA/600/P-95/002Fa
Age-Adjusted Drinking Water Ingestion Rate	IRW_{adj}	1.086		L-year/kg-day	Calculated
Exposure Frequency	EF	350		days/year	EPA/540/R-92/003
Exposure Duration	ED	30	6	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70		years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30		years	EPA/540/R-92/003
Oral Reference Dose	RfD_o	COPC-specific		mg/kg-day	EPA, 2009
Oral Cancer Slope Factor	CSF_o	COPC-specific		$(mg/kg\text{-}day)^{-1}$	EPA, 2009
Conversion Factor	CF1	365		days/year	365 days = 1 year

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors .*

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit River Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD_o[a] (mg/kg-day)	HQ (unitless)	% Contribution
Acetone	67-64-1	0.0011	3.01E-05	9.00E-01	3.35E-05	0.0031
Arsenic	7440-38-2	0.005767892	1.58E-04	3.00E-04	5.27E-01	48
Barium	7440-39-3	0.049451657	1.35E-03	2.00E-01	6.77E-03	0.62
Carbon tetrachloride	56-23-5	0.00028	7.67E-06	7.00E-04	1.10E-02	1.0
Chloride	16887-00-6	12.545114	3.44E-01	--	--	
Chloroform	67-66-3	0.0023	6.30E-05	1.00E-02	6.30E-03	0.58
Chromium	7440-47-3	0.0141	3.86E-04	1.50E+00	2.58E-04	0.024
Copper	7440-50-8	0.00597989	1.64E-04	4.00E-02	4.10E-03	0.38
Fluoride	16984-48-8	0.30621978	8.39E-03	6.00E-02	1.40E-01	13
Iron	7439-89-6	0.61057915	1.67E-02	7.00E-01	2.39E-02	2.2
Lead	7439-92-1	0.000663667	1.82E-05	--	--	
Manganese	7439-96-5	0.040717647	1.12E-03	2.40E-02	4.65E-02	4.3
Nickel	7440-02-0	0.0056	1.53E-04	2.00E-02	7.67E-03	0.71
Nitrate	14797-55-8	28.952	7.93E-01	7.10E+00	1.12E-01	10
Nitrite	14797-65-0	0.46	1.26E-02	3.00E-01	4.20E-02	3.86
Strontium	7440-24-6	0.38963943	1.07E-02	6.00E-01	1.78E-02	1.6
Sulfate	14808-79-8	41.899078	1.15E+00	--	--	
Thallium	7440-28-0	0.00037	1.01E-05	--	--	
Uranium	7440-61-1	0.005491757	1.50E-04	3.00E-03	5.02E-02	4.6
Vanadium	7440-62-2	0.0168	4.60E-04	5.00E-03	9.21E-02	8.5
Zinc	7440-66-6	0.006671161	1.83E-04	3.00E-01	6.09E-04	0.056
Total HI					1.1	100

[a] EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HQ = hazard quotient.

U.S. EPA 1989. Risk assessment guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A). EPA/540/1/89/002.

Cancer risk calculation

200-PO-1 Groundwater Operable Unit River Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF_o[a] $(mg/kg\text{-}day)^{-1}$	Risk (unitless)	% Contribution
Acetone	67-64-1	0.0011	1.64E-05	--	--	
Arsenic	7440-38-2	0.005767892	8.58E-05	1.50E+00	1.29E-04	99
Barium	7440-39-3	0.049451657	7.35E-04	--	--	
Carbon tetrachloride	56-23-5	0.00028	4.16E-06	1.30E-01	5.41E-07	0.4
Chloride	16887-00-6	12.545114	1.87E-01	--	--	
Chloroform	67-66-3	0.0023	3.42E-05	3.10E-02	1.06E-06	0.81
Chromium	7440-47-3	0.0141	2.10E-04	--	--	
Copper	7440-50-8	0.00597989	8.89E-05	--	--	
Fluoride	16984-48-8	0.30621978	4.55E-03	--	--	
Iron	7439-89-6	0.61057915	9.08E-03	--	--	
Lead	7439-92-1	0.000663667	9.87E-06	--	--	
Manganese	7439-96-5	0.040717647	6.06E-04	--	--	
Nickel	7440-02-0	0.0056	8.33E-05	--	--	
Nitrate	14797-55-8	28.952	4.31E-01	--	--	
Nitrite	14797-65-0	0.46	6.84E-03	--	--	
Strontium	7440-24-6	0.38963943	5.80E-03	--	--	
Sulfate	14808-79-8	41.899078	6.23E-01	--	--	
Thallium	7440-28-0	0.00037	5.50E-06	--	--	
Uranium	7440-61-1	0.005491757	8.17E-05	--	--	
Vanadium	7440-62-2	0.0168	2.50E-04	--	--	
Zinc	7440-66-6	0.006671161	9.92E-05	--	--	
Total ELCR					1.30E-04	100

[a] EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

U.S. EPA 1989. Risk assessment guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A). EPA/540/1/89/002.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)

River Exposure Area

Inhalation of Volatile Nonradioactive COPCs in Drinking Water

Intake Parameter Values				
Parameter	Symbol	Value	Unit	Source
Inhalation Chronic Daily Intake	CDI	Calculated	mg/m^3 for noncarcinogens, $\mu g/m^3$ for carcinogens	Calculated
Contaminant Concentration	C_w	COPC-specific	mg/L	ECF-200PO1-09-2027
Exposure Time	ET	0.58	hours/day	EPA/540/R/99/005
Exposure Frequency	EF	350	days/year	EPA/540/R-92/003
Exposure Duration	ED	30	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70	years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30	years	EPA/540/R-92/003
Andelman Volatilization Factor	VF	0.5	L/m^3	EPA/540/R-92/003
Inhalation Reference Concentration	RfC	COPC-specific	mg/m^3	EPA, 2009
Inhalation Unit Risk	IUR	COPC-specific	$(\mu g/m^3)^{-1}$	EPA, 2009
Conversion Factor	CF1	365	days/year	365 days = 1 year
Conversion Factor	CF2	1/24	days/hour	1 day = 24 hours

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors* .

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit River Exposure Area Nonradioactive COPC	CAS #	Volatile[a]	C_w (mg/L)	CDI (non-cancer) (mg/m^3)	RfC[a] (mg/m^3)	HQ (unitless)	% Contribution
Acetone	67-64-1	Yes	0.0011	1.27E-05	3.10E+01	4.11E-07	0.14
Arsenic	7440-38-2	--	0.005767892	--(b)	1.50E-05	--(b)	
Barium	7440-39-3	--	0.049451657	--(b)	5.00E-04	--(b)	
Carbon tetrachloride	56-23-5	Yes	0.00028	3.24E-06	1.90E-01	1.71E-05	6
Chloride	16887-00-6	--	12.545114	--(b)	--	--(b)	
Chloroform	67-66-3	Yes	0.0023	2.66E-05	9.80E-02	2.72E-04	94
Chromium	7440-47-3	--	0.0141	--(b)	--	--(b)	
Copper	7440-50-8	--	0.00597989	--(b)	--	--(b)	
Fluoride	16984-48-8	--	0.30621978	--(b)	1.30E-02	--(b)	
Iron	7439-89-6	--	0.61057915	--(b)	--	--(b)	
Lead	7439-92-1	--	0.000663667	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.040717647	--(b)	5.00E-05	--(b)	
Nickel	7440-02-0	--	0.0056	--(b)	9.00E-05	--(b)	
Nitrate	14797-55-8	--	28.952	--(b)	--	--(b)	
Nitrite	14797-65-0	--	0.46	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.38963943	--(b)	--	--(b)	
Sulfate	14808-79-8	--	41.899078	--(b)	--	--(b)	
Thallium	7440-28-0	--	0.00037	--(b)	--	--(b)	
Uranium	7440-61-1	--	0.005491757	--(b)	3.00E-04	--(b)	
Vanadium	7440-62-2	--	0.0168	--(b)	--	--(b)	
Zinc	7440-66-6	--	0.006671161	--(b)	--	--(b)	
Total HI						2.89E-04	100

[a] EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b] Nonvolatile constituents are not considered in the inhalation of groundwater in the drinking water pathway

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HQ = hazard quotient.

U.S. EPA 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). EPA-540-R-070-002.

Cancer risk calculation

200-PO-1 Groundwater Operable Unit River Exposure Area Nonradioactive COPC	CAS #	Volatile[a]	C_w (mg/L)	CDI (cancer) ($\mu g/m^3$)	IUR[a] $(\mu g/m^3)^{-1}$	Risk (unitless)	% Contribution
Acetone	67-64-1	Yes	0.0011	5.46E-03	--	--	
Arsenic	7440-38-2	--	0.005767892	--(b)	4.30E-03	--(b)	
Barium	7440-39-3	--	0.049451657	--(b)	--	--(b)	
Carbon tetrachloride	56-23-5	Yes	0.00028	1.39E-03	1.50E-05	2.09E-08	7
Chloride	16887-00-6	--	12.545114	--(b)	--	--(b)	
Chloroform	67-66-3	Yes	0.0023	1.14E-02	2.30E-05	2.63E-07	93
Chromium	7440-47-3	--	0.0141	--(b)	--	--(b)	
Copper	7440-50-8	--	0.00597989	--(b)	--	--(b)	
Fluoride	16984-48-8	--	0.30621978	--(b)	--	--(b)	
Iron	7439-89-6	--	0.61057915	--(b)	--	--(b)	
Lead	7439-92-1	--	0.000663667	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.040717647	--(b)	--	--(b)	
Nickel	7440-02-0	--	0.0056	--(b)	2.60E-04	--(b)	
Nitrate	14797-55-8	--	28.952	--(b)	--	--(b)	
Nitrite	14797-65-0	--	0.46	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.38963943	--(b)	--	--(b)	
Sulfate	14808-79-8	--	41.899078	--(b)	--	--(b)	
Thallium	7440-28-0	--	0.00037	--(b)	--	--(b)	
Uranium	7440-61-1	--	0.005491757	--(b)	--	--(b)	
Vanadium	7440-62-2	--	0.0168	--(b)	--	--(b)	
Zinc	7440-66-6	--	0.006671161	--(b)	--	--(b)	
Total ELCR						2.84E-07	100

[a] EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

[b] Nonvolatile constituents are not considered in the inhalation of groundwater in the drinking water pathway

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

U.S. EPA 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). EPA-540-R-070-002.

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)

River Exposure Area

Dermal Absorption of Nonradioactive COPCs in Drinking Water

Intake Parameter Values		Value			
Parameter	Symbol	Adult	Child	Unit	Source
Chronic Daily Intake	CDI	Calculated		mg/kg-day	Calculated
Contaminant Concentration	C_w	COPC-specific		mg/L	ECF-200PO1-09-2027
Average Body Weight	BW	70	15	kg	EPA/540/R-92/003
Exposure Time	ET	0.58	1	hours/event	EPA/540/R/99/005
Exposure Time (Age-Adjusted)	ET_{a-a}	0.664		hours/event	Calculated
Surface Area	SA	18,000	6,600	cm^2	EPA/540/R/99/005
Age-Adjusted Surface Area	SA_{a-a}	8,811		(cm^2-year-event)/(kg/day)	Calculated
Event Frequency	EV	1		event/day	EPA/540/R/99/005
Exposure Frequency	EF	350		days/year	EPA/540/R-92/003
Exposure Duration	ED	30	6	years	EPA/540/R-92/003
Averaging Time - Cancer	AT	70		years	EPA/540/R-92/003
Averaging Time - Noncancer	AT	30		years	EPA/540/R-92/003
Oral Reference Dose	RfD_o	COPC-specific		mg/kg-day	EPA, 2009
Oral Cancer Slope Factor	CSF_o	COPC-specific		$(mg/kg\text{-}day)^{-1}$	EPA, 2009
Conversion Factor	CF1	365		days/year	365 days = 1 year
Conversion Factor	CF3	0.001		L/cm^3	$1 L = 1000 cm^3$
The constant pi	π	3.14159		unitless	--
Time to reach steady state	t^*	COPC-specific		hours	EPA/540/R/99/005
Dermal Partitioning Constant	B	COPC-specific		unitless	EPA/540/R/99/005
Absorbed Dose per Event	DA	Calculated		mg/cm^2-event	Calculated
Dermal Permeability Constant	K_p	COPC-specific		cm/hour	EPA/540/R/99/005
Fraction Absorbed	FA	COPC-specific		unitless	EPA/540/R/99/005
Lag Time	τ	COPC-specific		hours/event	EPA/540/R/99/005
Fraction of Contaminant Absorbed in Gastrointestinal Tract	GIABS	COPC-specific		unitless	EPA, 2009

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Absorbed Dermal Dose Calculation

Contaminant of Potential Concern	CAS #	C_w (mg/L)	Inorganic/organic[a]	FA[b] (unitless)	K_p[c] (cm/hour)	B[b] (unitless)	t^*[b] (hours/event)	τ[b] (hours)	DA (noncancer) (mg/cm^2-event)	DA (cancer) (mg/cm^2-event)
Acetone[c]	67-64-1	0.0011	--	--	0.000512	--	--	--	--	--
Arsenic	7440-38-2	0.005767892	INORGANIC	--	0.001	--	--	--	3.35E-09	3.83E-09
Barium	7440-39-3	0.049451657	INORGANIC	--	0.001	--	--	--	2.87E-08	3.28E-08
Carbon tetrachloride	56-23-5	0.00028	--	1	0.016	0.1	0.78	1.86	8.33E-09	8.91E-09
Chloride	16887-00-6	12.545114	INORGANIC	--	0.001	--	--	--	7.28E-06	8.33E-06
Chloroform	67-66-3	0.0023	--	1	0.0068	0	0.5	1.19	2.33E-08	2.49E-08
Chromium	7440-47-3	0.0141	INORGANIC	--	0.001	--	--	--	8.18E-09	9.36E-09
Copper	7440-50-8	0.00597989	INORGANIC	--	0.001	--	--	--	3.47E-09	3.97E-09
Fluoride	16984-48-8	0.30621978	INORGANIC	--	0.001	--	--	--	1.78E-07	2.03E-07
Iron	7439-89-6	0.61057915	INORGANIC	--	0.001	--	--	--	3.54E-07	4.05E-07
Lead	7439-92-1	0.000663667	INORGANIC	--	0.0001	--	--	--	3.85E-11	4.41E-11
Manganese	7439-96-5	0.040717647	INORGANIC	--	0.001	--	--	--	2.36E-08	2.70E-08
Nickel	7440-02-0	0.0056	INORGANIC	--	0.0002	--	--	--	6.50E-10	7.44E-10
Nitrate	14797-55-8	28.952	INORGANIC	--	0.001	--	--	--	1.68E-05	1.92E-05
Nitrite	14797-65-0	0.46	INORGANIC	--	0.001	--	--	--	2.67E-07	3.05E-07
Strontium	7440-24-6	0.38963943	INORGANIC	--	0.001	--	--	--	2.26E-07	2.59E-07
Sulfate	14808-79-8	41.899078	INORGANIC	--	0.001	--	--	--	2.43E-05	2.78E-05
Thallium	7440-28-0	0.00037	INORGANIC	--	0.001	--	--	--	2.15E-10	2.46E-10
Uranium	7440-61-1	0.005491757	INORGANIC	--	0.001	--	--	--	3.19E-09	3.65E-09
Vanadium	7440-62-2	0.0168	INORGANIC	--	0.001	--	--	--	9.74E-09	1.12E-08
Zinc	7440-66-6	0.006671161	INORGANIC	--	0.0006	--	--	--	2.32E-09	2.66E-09

[a]EPA/540/R/99/005, Exhibit 3-1 (inorganics) and Exhibit B-3 (organics)

[b]EPA/540/R/99/005, Exhibit B-3

[c]the K_p value was taken from ORNL, 2010, The Risk Assessment Information System (RAIS).

Non-cancer HQ calculation

200-PO-1 Groundwater Operable Unit River Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD_o[a] (mg/kg-day)	GIABS[a] (unitless)	HQ (unitless)	% Contribution
Acetone	67-64-1	0.0011	--	9.00E-01	1	--	
Arsenic	7440-38-2	0.005767892	8.25E-07	3.00E-04	1	2.75E-03	18
Barium	7440-39-3	0.049451657	7.07E-06	2.00E-01	0.07	5.05E-04	3.2
Carbon tetrachloride	56-23-5	0.00028	2.05E-06	7.00E-04	1	2.93E-03	19
Chloride	16887-00-6	12.545114	1.79E-03	--	1	--	
Chloroform	67-66-3	0.0023	5.74E-06	1.00E-02	1	5.74E-04	3.67
Chromium	7440-47-3	0.0141	2.02E-06	1.50E+00	0.013	1.03E-04	0.66
Copper	7440-50-8	0.00597989	8.55E-07	4.00E-02	1	2.14E-05	0.137
Fluoride	16984-48-8	0.30621978	4.38E-05	6.00E-02	1	7.30E-04	4.7
Iron	7439-89-6	0.61057915	8.73E-05	7.00E-01	1	1.25E-04	0.80
Lead	7439-92-1	0.000663667	9.49E-09	--	1	--	
Manganese	7439-96-5	0.040717647	5.82E-06	2.40E-02	0.04	6.07E-03	39
Nickel	7440-02-0	0.0056	1.60E-07	2.00E-02	0.04	2.00E-04	1.28
Nitrate	14797-55-8	28.952	4.14E-03	7.10E+00	1	5.83E-04	3.7
Nitrite	14797-65-0	0.46	6.58E-05	3.00E-01	1	2.19E-04	1.40
Strontium	7440-24-6	0.38963943	5.57E-05	6.00E-01	1	9.29E-05	0.59
Sulfate	14808-79-8	41.899078	5.99E-03	--	--	--	
Thallium	7440-28-0	0.00037	5.29E-08	--	1	--	
Uranium	7440-61-1	0.005491757	7.85E-07	3.00E-03	1	2.62E-04	1.7
Vanadium	7440-62-2	0.0168	2.40E-06	5.00E-03	1	4.81E-04	3.1
Zinc	7440-66-6	0.006671161	5.72E-07	3.00E-01	1	1.91E-06	0.0122
Total HI						0.016	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HI = hazard index

HQ = hazard quotient

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

Cancer risk calculation

200-PO-1 Groundwater Operable Unit River Exposure Area Nonradioactive COPC	CAS #	C_w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF_o[a] $(mg/kg\text{-}day)^{-1}$	GIABS[a] (unitless)	Risk (unitless)	% Contribution
Acetone	67-64-1	0.0011	--	--	1	--	
Arsenic	7440-38-2	0.005767892	4.62E-07	1.50E+00	1	6.93E-07	75
Barium	7440-39-3	0.049451657	3.96E-06	--	0.07	--	
Carbon tetrachloride	56-23-5	0.00028	1.08E-06	1.30E-01	1	1.40E-07	15
Chloride	16887-00-6	12.545114	1.01E-03	--	1	--	
Chloroform	67-66-3	0.0023	3.01E-06	3.10E-02	1	9.32E-08	10.1
Chromium	7440-47-3	0.0141	1.13E-06	--	0.013	--	
Copper	7440-50-8	0.00597989	4.79E-07	--	1	--	
Fluoride	16984-48-8	0.30621978	2.45E-05	--	1	--	
Iron	7439-89-6	0.61057915	4.89E-05	--	1	--	
Lead	7439-92-1	0.000663667	5.32E-09	--	1	--	
Manganese	7439-96-5	0.040717647	3.26E-06	--	0.04	--	
Nickel	7440-02-0	0.0056	8.98E-08	--	0.04	--	
Nitrate	14797-55-8	28.952	2.32E-03	--	1	--	
Nitrite	14797-65-0	0.46	3.69E-05	--	1	--	
Strontium	7440-24-6	0.38963943	3.12E-05	--	1	--	
Sulfate	14808-79-8	41.899078	3.36E-03	--	--	--	
Thallium	7440-28-0	0.00037	2.97E-08	--	1	--	
Uranium	7440-61-1	0.005491757	4.40E-07	--	1	--	
Vanadium	7440-62-2	0.0168	1.35E-06	--	1	--	
Zinc	7440-66-6	0.006671161	3.21E-07	--	1	--	
Total ELCR						9.26E-07	100

[a]EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)
River Exposure Area

Inhalation of Volatile Radioactive COPCs in Drinking Water

Intake Parameter Values		Value			
Factor	Symbol	Adult	Child	Unit	Reference
Chronic Daily Intake	CDI	Calculated		pCi	Calculated
Contaminant Concentration	C_w	COPC-specific		pCi/L	ECF-200PO1-09-2027
Exposure frequency	EF	350		days/year	EPA/540/R-92/003
Exposure duration	ED	30	6	years	EPA/540/R-92/003
Inhalation Rate	INH	20	10	m^3/day	OSWER Directive 9285.6-03 EPA/600/P-
Exposure time	ET	0.58	1	hours/day	EPA/540/R/99/005
Age Adjusted Exposure Time	ET_{adj}	0.664		hours/day	Calculated
Radiation Age-adjusted Inhalation Rate	INH_RAD_{adj}	540		m^3-year/day	Calculated
Andelman Volatilization Factor	VF	0.5		L/m^3	EPA/540/R-92/003
Slope Factor - Inhalation	SF_i	COPC-specific		risk/pCi	EPA, 2001
Conversion Factor	CF2	1/24		days/hour	1 day = 24 hours

ECF-200PO1-09-2027: Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010
EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*
EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*
EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*
EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."
OSWER Directive 9285.6-03, *Risk Assessment Guidance For Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance "Standard Default Exposure Factors Interim Final"*

Inhalation of Volatile Radioactive Constituents in Groundwater

200-PO-1 Groundwater Operable Unit River Exposure Area Radioactive COPC	CAS #	Volatile[a]	C_w (pCi/L)	CDI (radiological inhalation) (pCi)	SF_i (risk/pCi)	Risk (unitless)	% Contribution
Gross alpha	12587-46-1	--	2.8	--(b)	--	--(b)	
Gross beta	12587-47-2	--	22.2	--(b)	--	--(b)	
Strontium-90	10098-97-2	--	2.60	--(b)	1.05E-10	--(b)	
Technetium-99	14133-76-7	--	115	--(b)	1.41E-11	--(b)	
Tritium	10028-17-8	Yes	59,534	1.56E+08	5.62E-14	8.75E-06	100
Total ELCR						8.75E-06	100

[a]Volatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."
[b]Nonvolatile constituents are not considered in the inhalation exposure route
COPC = contaminant of potential concern.
ELCR = excess lifetime cancer risk.
EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*

200-PO-1 Groundwater Operable Unit - Tap Water Exposure Risk Assessment (10 year)
River Exposure Area

Ingestion of Radioactive COPCs in Drinking Water

Intake Parameter Values		Value			
Factor	Symbol	Adult	Child	Unit	Reference
Chronic Daily Intake	CDI	Calculated		pCi	Calculated
Contaminant Concentration	C_w	COPC-specific		pCi/L	ECF-200PO1-09-2027
Exposure frequency	EF	350		days/year	EPA/540/R-92/003
Exposure duration	ED	30	6	years	EPA/540/R-92/003
Drinking Water Ingestion Rate	IRW	2	1	L/day	EPA/540/R-92/003 EPA/600/P-95/002Fa
Radiation Age-adjusted Drinking Water Ingestion Rate	IRW_RAD_{adj}	54		L-year/day	Calculated
Slope Factor - Oral	SF_o	COPC-specific		risk/pCi	EPA, 2001

ECF-200PO1-09-2027. Exposure Point Concentration for Groundwater Risk Assessment at the 200-PO-1 Operable Unit. CHPRC 2010.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors.*

EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

Ingestion of Radioactive Constituents in Groundwater

200-PO-1 Groundwater Operable Unit River Exposure Area Radioactive COPC	CAS #	C_w (pCi/L)	CDI (radiological ingestion) (pCi)	SF_o (risk/pCi)	Risk (unitless)	% Contribution
Gross alpha	12587-46-1	2.8	5.24E+04	--	--	
Gross beta	12587-47-2	22.2	4.20E+05	--	--	
Strontium-90	10098-97-2	2.60	4.91E+04	5.59E-11	2.75E-06	4.2
Technetium-99	14133-76-7	115	2.17E+06	2.75E-12	5.96E-06	9.1
Tritium	10028-17-8	59,534	1.13E+09	5.07E-14	5.70E-05	87
Total ELCR					6.58E-05	100

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.*