ECF-100KR4-17-0082
Revision 0

Well-Specific Tap Water Risk Assessment for the 100-KR-4 Groundwater Operable Unit

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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Well-Specific Tap Water Risk Assessment for the 100-KR-4 Groundwater Operable Unit

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Assistant Secretary for Environmental Management

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APPROVED
By Mary P. Curry at 11:09 am, Jul 30, 2018

Release Approval Date

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ENVIRONMENTAL CALCULATION COVER PAGE

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Qualifications Summary

ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

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ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

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ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

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ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

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Alaa Aly	Risk & Modeling Manager		23 JUL 18
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Terms

ATSDR	Agency for Toxic Substances and Disease Registry
CalEPA	California Environmental Protection Agency
CDI	chronic daily intake
Cr(VI)	hexavalent chromium
DA_{event}	dermally absorbed dose per event
ECF	environmental calculation file
ELCR	excess lifetime cancer risk
EPA	Environmental Protection Agency
EPC	exposure point concentration
ERMA	Environmental Risk Management Archive
ET	exposure time
GIABS	gastrointestinal absorption factor
HEAST	Health Effects Assessment Summary Tables
HEIS	Hanford Environmental Information System
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
IUR	inhalation unit risk
MRL	minimal risk level
MTCA	Model Toxics Control Act
NJDEP	New Jersey Department of Environmental Protection
OEHHA	Office of Environmental Health Hazard Assessment
ORNL	Oak Ridge National Laboratory
OSWER	Office of Solid Waste and Emergency Response (EPA)
OU	operable unit
pCi	picocurie
PPRTVs	Provisional Peer Reviewed Toxicity Values
RAIS	Risk Assessment Information System
RfC	reference concentration
RfD	reference dose
RME	reasonable maximum exposure

RUM	Ringold Formation upper mud
TCE	trichloroethene
UCL	upper confidence limit
VF	volatilization factor
WAC	*Washington Administrative Code*

1 Purpose

The purpose of this environmental calculation file (ECF) 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 groundwater under a residential tap water exposure scenario. It is assumed that the source of tap water is groundwater obtained from the 100-KR-4 Groundwater Operable Unit (OU). Potential health risks and hazards are calculated for ingestion, dermal or immersion, and inhalation exposure routes associated with the tap water exposure scenario. 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 for both radionuclide and nonradionuclide analytes, and HI for nonradionuclide analytes. For this calculation, any analyte with available toxicity values and detected at least once in groundwater at the 100-KR-4 Groundwater OU is included in the calculations.

Cancer risks and noncancer hazards are calculated and presented separately for each of the 82 groundwater wells evaluated in 100-KR-4 Groundwater OU. In total, 79 wells are evaluated individually, and 3 wells (199-K-35, 199-K-195, and 199-K-205) are evaluated collectively. Wells 199-K-35, 199-K-195, and 199-K-205 were drilled near the 183.1KW Head House area and sequentially replaced each other during the time period evaluated. The analytical data for these three wells were combined to represent one location. Twenty monitoring wells and one extraction well are screened at the top of the unconfined aquifer, 20 monitoring wells and nine extraction wells are screened across the upper unconfined aquifer, three monitoring wells are screened across the lower unconfined aquifer, one monitoring well is screened in the upper and lower unconfined aquifer, nine monitoring wells and 14 extraction wells are screened across the entire aquifer, and two monitoring wells are screened in the Ringold Upper Mud (RUM). Wells 199-K-35, 199-K-195, and 199-K-205 were combined for evaluation purposes are screened across the upper unconfined aquifer. The 82 wells are listed in Table 1. This risk assessment supports DOE/RL-2010-97, *Remedial Investigation/Feasibility Study for the 100-KR-1, 100-KR-2, and 100-KR-4 Operable Units*.

Table 1. 100-KR-4 Groundwater OU Monitoring and Extraction Wells by Screen Interval

Monitoring Wells Screened Across Top of the Unconfined Aquifer		
199-K-106A	199-K-140	199-K-29
199-K-107A	199-K-18	199-K-30
199-K-108A	199-K-19	199-K-32A
199-K-110A	199-K-200	199-K-34
199-K-111A	199-K-201	199-K-36
199-K-132	199-K-22	699-73-61
199-K-139	199-K-23	--
Extraction Well Screened Across Top of the Unconfined Aquifer		
199-K-137	--	--
Monitoring Wells Screened Across Upper Unconfined Aquifer		
199-K-11	199-K-186	199-K-21
199-K-117A	199-K-187	199-K-221
199-K-125A	199-K-188	199-K-222
199-K-138	199-K-191	199-K-31
199-K-142	199-K-194	199-K-37
199-K-173	199-K-20	699-72-73

Table 1. 100-KR-4 Groundwater OU Monitoring and Extraction Wells by Screen Interval

199-K-183	199-K-204	--
Combined Wells Screened Across Upper Unconfined Aquifer		
199-K-35	199-K-195	199-K-205
Extraction Wells Screened Across Upper Unconfined Aquifer		
199-K-113A	199-K-144	199-K-148
199-K-114A	199-K-146	199-K-161
199-K-141	199-K-147	199-K-178
Monitoring Wells Screened Across Lower Unconfined Aquifer		
199-K-168	199-K-184	199-K-190
Monitoring Well Screened Across Upper and Lower Unconfined Aquifer		
199-K-193	--	--
Monitoring Wells Screened Across Entire Aquifer		
199-K-151	199-K-189	199-K-207
199-K-157	199-K-202	199-K-209
199-K-185	199-K-203	199-K-223
Extraction Wells Screened Across Entire Aquifer		
199-K-116A	199-K-154	199-K-182
199-K-120A	199-K-163	199-K-208
199-K-145	199-K-165	199-K-210
199-K-152	199-K-166	199-K-224
199-K-153	199-K-171	--
Monitoring Wells Screened Across Ringold Formation Upper Mud		
199-K-192	199-K-32B	--

2 Background

The following subsections provide brief descriptions of cancer risks and noncancer health hazards, the exposure routes included with the tap water exposure scenario, and the references used in this environmental calculation.

2.1 Carcinogenic Effects

The potential for carcinogenic effects is evaluated by estimating incremental increases in the probability of developing cancer over a lifetime (ELCR), above the background probability of developing cancer (that is, if no exposure to site contaminants occurs). Cancer slope factors developed by the U.S. Environmental Protection Agency (EPA) are considered to be plausible upper bound estimates of the cancer potencies of contaminants. Using these cancer slope factors in calculating risks results in plausible, upper-bound estimates of risk; there is reasonable confidence that the actual cancer risks will not exceed the estimated risks 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, in this assessment, cancer risks are treated as independent and additive within an exposure route. 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]). The ratio of the chronic daily intake (CDI) divided by the RfD is termed the hazard quotient (HQ).

When the HQ for a contaminant exceeds 1 (that is, exposure exceeds the RfD), there is a concern for potential noncarcinogenic health effects. To assess the potential for noncarcinogenic effects posed by exposure to multiple contaminants, an HI approach is used, in accordance with EPA guidance (EPA/540/1-89/002). This approach assumes that the noncancer hazards associated with exposure to multiple contaminants are simply additive; synergistic or antagonistic interactions between contaminants, which are largely unknown, are not accounted for.

2.3 Exposure Routes

Potentially complete exposure routes associated with the residential tap water exposure scenario are:

- Ingestion of tap water
- Inhalation of volatiles as a result of household use of tap water
- Dermal contact with or immersion in tap water while showering or bathing

2.4 References

For the tap water exposure scenario, 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;
- 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, 2017, 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

This section provides the equations (and their applicable bases) used to calculate the intake, cancer risks and noncancer hazards associated with exposure to analytes in groundwater via the exposure routes associated with the tap water exposure scenario. Definitions of variables and input values for the equations are provided in Table 2.

Table 2. Summary of Exposure Assumptions Used for the Tap Water Exposure Scenario for the 100-KR-4 Groundwater Operable Unit

Exposure Factor	Symbol	Value	Units	Source
Averaging Time – Cancer Risk	AT_{can}	70	Years	EPA/540/R-92/003 (Part B) U.S. EPA 1989 (pg. 6-22) EPA/540/1-89/002 (part A)
Averaging Time – Noncancer Hazard Index	AT_{nc}	6	Years	EPA, 2011
Partitioning constant derived by Bunge Model	B	Analyte-Specific	Unitless	See Table 6
Body Weight—Adult	BW_a	80	kg	EPA/600/R-090/052F OSWER Directive 9200.1-120
Body Weight—Child	BW_c	15	kg	EPA/600/R-090/052F OSWER Directive 9200.1-120
Conversion Factor	CF1	365	Days/year	1 year = 365 days
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	Analyte Specific	$(mg/kg\text{-}day)^{-1}$	See Table 6
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	ug/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 16
Chronic Daily Intake – noncarcinogen dermal	CDI	Calculated Value	mg/kg-day	Equation 19
Chronic Daily Intake – radiological immersion	CDI	Calculated Value	pCi-yrs/L	Equation 25

Table 2. Summary of Exposure Assumptions Used for the Tap Water Exposure Scenario for the 100-KR-4 Groundwater Operable Unit

Exposure Factor	Symbol	Value	Units	Source
Contaminant concentration in groundwater	C_w	Analyte Specific	mg/L or pCi/L	ECF-100KR4-17-0081
Absorbed dose per event	DA_{event}	Calculated Value	mg/cm^2-event	Equation 22, 23, and 24
Exposure Duration - resident	ED_r	26	Years	EPA/600/R-090/052F
Exposure Duration - child	ED_c	6	Year	OSWER Directive 9285.6-03
Exposure Frequency	EF	350	Days/year	OSWER Directive 9285.6-03
Exposure Time – resident inhalation	ET_r	24	Hours/day	OSWER Directive 9200.1-120
Exposure Time – adult dermal	ET_a	0.71	Hours/day	EPA/600/R-090/052F OSWER Directive 9200.1-120
Exposure Time – child dermal	ET_c	0.54	Hours/day	EPA/600/R-090/052F OSWER Directive 9200.1-120
Age-Adjusted Exposure Time – dermal	ET_{adj}	Calculated Value	Hours/event	Equation 21
Age-Adjusted Exposure Time – radiological immersion	ET_{RADadj}	Calculated Value	Hours-year/day	Equation 26
Event frequency	EV	1	Event/day	EPA/540/R/99/05
Fraction of absorbed water	FA	Analyte Specific	Unitless	See Table 6
Gastrointestinal absorption factor	GIABS	Analyte Specific	Unitless	See Table 6
Age-Adjusted Inhalation Rate - radiological	INH_{RADadj}	Calculated Value	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	2.5	L/day	EPA/600/R-090/052F OSWER Directive 9200.1-120
Water Ingestion Rate - child	IRW_c	0.78	L/day	EPA/600/P-95/002F OSWER Directive 9200.1-120
Age-adjusted Water Ingestion Rate – nonradiological	IRW_{adj}	Calculated Value	L-year/kg-day	Equation 2
Age-adjusted Water Ingestion Rate – radiological	IRW_{RADadj}	Calculated Value	L-year/day	Equation 7
Inhalation Unit Risk	IUR	Analyte Specific	(ug/m^3)$^{-1}$	See Table 6
Dermal permeability coefficient	k_p	Analyte Specific	cm/hour	See Table 6
The constant pi	π	3.14159	Unitless	--
Reference Concentration	RfC	Analyte Specific	mg/m^3	See Table 6
Oral Chronic Reference Dose	RfD_o	Analyte Specific	mg/kg-day	See Table 6
Age-adjusted Skin Surface Area	SA_{adj}	Calculated Value	cm^2-year-event/kg-day	Equation 17

Table 2. Summary of Exposure Assumptions Used for the Tap Water Exposure Scenario for the 100-KR-4 Groundwater Operable Unit

Exposure Factor	Symbol	Value	Units	Source
Skin Surface Area - adult	SA_a	19,652	cm^2	EPA/600/R-090/052F OSWER Directive 9200.1-120
Skin Surface Area - child	SA_c	6,365	cm^2	EPA/600/R-090/052F OSWER Directive 9200.1-120
Slope Factor - inhalation	SF_i	Analyte Specific	Risk/pCi	See Table 6
Slope Factor - oral	SF_o	Analyte Specific	Risk/pCi	See Table 6
Time to reach steady state conditions	t*	Analyte Specific	Hour	See Table 6
Lag time	τ	Analyte Specific	Hours/event	See Table 6
Volatilization Factor	VF	0.5	L/m^3	EPA/540/R-92/003

ECF-100KR4-17-0081, Rev. 0, Calculation of Exposure Point Concentrations for the 100-KR-4 Groundwater Operable Unit.
EPA, 2011, November 2011 updates to EPA Regional Screening Level equations (http://www.epa.gov/risk/regional-screening-table-whats-new)
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/R-090/052F, Exposure Factors Handbook 2011 Edition (Final).
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 9200.1-120, Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure 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.
EPA/600/P-95/002Fa, Exposure Factors Handbook Volume 1: General Factors.

3.1 Intake and Risk Equations for Water Ingestion

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

Table 3. Calculated Values and Reference Bases Used for the Water Ingestion Exposure Route

Effect	Symbol for Calculated Value	Reference
Carcinogenic	CDI IRW_{adj}	RAIS Risk Exposure Models for Chemicals User's Guide (ORNL, 2017)
	Risk	EPA/540/R-92/003
Noncarcinogenic	CDI	RAIS Risk Exposure Models for Chemicals User's Guide (ORNL, 2017)
	HQ	EPA/540/R-92/003
Radionuclide	CDI IRW_{RADadj}	RAIS Risk Exposure Models for Radionuclides User's Guide (ORNL, 2017)
	Risk	EPA/540/R-92/003

Notes:

CDI= chronic daily intake
HQ= hazard quotient
IRW_{adj} = age-adjusted water ingestion rate.
IRW_{RADadj} = 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, 2017, The Risk Assessment Information System (RAIS).

3.1.1 Ingestion of Water —Carcinogenic Effects

For ingestion of carcinogens, the CDI is calculated using the following equations:

$$CDI = \frac{C_w \times IRW_{adj} \times EF}{AT_{can} \times CF1} \quad (1)$$

where:

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

Cancer risk is calculated using the following equation:

$$Risk = CDI \times CSF_o \quad (3)$$

3.1.2 Ingestion of Water —Noncarcinogenic Effects

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

$$CDI = \frac{C_w \times IRW_c \times EF \times ED_c}{BW_c \times AT_{nc} \times CF1} \quad (4)$$

Noncancer hazard is calculated using the following equation:

$$HQ = \frac{CDI}{RfD_o} \quad (5)$$

3.1.3 Ingestion of Water —Radionuclides

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

$$CDI = C_W \times IRW_{RADadj} \times EF \quad (6)$$

Where:

$$IRW_{RADadj} = (ED_c \times IRW_c) + ([ED_r - ED_c] \times IRW_a) \quad (7)$$

Radiological cancer risk is calculated using the following equation:

$$Risk = CDI \times SF_o \quad (8)$$

3.2 Intake and Risk Equations for 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 4. Equations are provided in the following subsections.

Table 4. Calculated Values and Reference Bases Used for the Tap Water Scenario Inhalation of Volatiles Exposure Route

Effect	Symbol for Calculated Value	Reference
Carcinogenic	CDI	RAIS Risk Exposure Models for Chemicals User's Guide (ORNL, 2017)
	Risk	EPA/540/R-070/002
Noncarcinogenic	CDI	RAIS Risk Exposure Models for Chemicals User's Guide (ORNL, 2017)
	HQ	EPA/540/R-070/002
Radionuclide	CDI INH_{RADadj}	RAIS Risk Exposure Models for Radionuclides User's Guide (ORNL, 2017)
	Risk	EPA/540/R-92/003

Notes:

CDI= chronic daily intake
HQ= hazard quotient
INH_{RADadj} = age-adjusted radionuclide inhalation rate.
EPA/540/R-070/002, Risk Assessment Guidance for Superfund: Volume I – 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.
ORNL,2017, The Risk Assessment Information System (RAIS).

3.2.1 Inhalation of Volatiles—Carcinogenic Effects

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

$$CDI = \frac{C_w \times ED_r \times EF \times ET_r \times CF2 \times VF \times (1000^{\mu g}/_{mg})}{AT_{can} \times CF1} \quad (9)$$

Cancer risk is calculated with the following equation:

$$Risk = CDI \times IUR \quad (10)$$

3.2.2 Inhalation of Volatiles— Noncarcinogenic Effects

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

$$CDI = \frac{C_w \times ED_c \times EF \times ET_r \times CF2 \times VF}{AT_{nc} \times CF1} \quad (11)$$

Noncancer hazard is calculated using the following equation:

$$HQ = \frac{CDI}{RfC} \quad (12)$$

3.2.3 Inhalation of Volatiles— Radionuclides

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

$$CDI = C_w \times INH_{RADadj} \times VF \times EF \times ET_r \times CF2 \quad (13)$$

where:

$$INH_{RADadj} = (ED_c \times INH_c) + ([ED_r - ED_c] \times INH_a) \quad (14)$$

Radiological cancer risk is calculated using the following equation:

$$Risk = CDI \times SF_i \quad (15)$$

3.3 Intake and Risk Equations for Dermal Contact with and Immersion in Water

The bases for the equations used to calculate intake, risk, and hazard associated with the tap water dermal absorption exposure route are provided in Table 5. The equations are presented in the following subsections

Table 5. Calculated Values and Reference Bases Used for the Tap Water Scenario Dermal Contact and Immersion Exposure Routes

Effect	Symbol for 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

Table 5. Calculated Values and Reference Bases Used for the Tap Water Scenario Dermal Contact and Immersion Exposure Routes

Effect	Symbol for Calculated Value	Reference
Radionuclide	CDI	RAIS Risk Exposure Models for Radionuclides User's Guide (ORNL, 2017)
	ET_{RADadj}	RAIS Risk Exposure Models for Radionuclides User's Guide (ORNL, 2017)
	Risk	EPA/540/R-92/003

Notes:

CDI= chronic daily intake
DA_{event} = absorbed dose per event.
ET_{adj} = age-adjusted exposure time.
ET_{RADadj} = radiation age-adjusted exposure time.
HQ= hazard quotient
SA_{adj} = age-adjusted skin surface area

ORNL, 2017, The Risk Assessment Information System (RAIS).

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/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.

3.3.1 Tap Water Dermal Absorption— Carcinogenic Effects

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

$$CDI = \frac{DA_{event} \times SA_{adj} \times EF}{AT_{can} \times CF1} \quad (16)$$

where:

$$SA_{adj} = \frac{ED_c \times SA_c \times EV}{BW_c} + \frac{(ED_r - ED_c) \times SA_a \times EV}{BW_a} \quad (17)$$

Cancer risk is calculated using the following equation:

$$Risk = CDI \times \frac{CSF_o}{GIABS} \quad (18)$$

3.3.2 Tap Water Dermal Absorption— Noncarcinogenic Effects

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

$$CDI = \frac{DA_{event} \times SA_c \times EF \times ED_c \times EV}{BW_c \times AT_{nc} \times CF1} \quad (19)$$

Noncancer hazard is calculated using the following equation:

$$HQ = \frac{CDI}{RfD_o \times GIABS} \quad (20)$$

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

The exposure time used in the risk calculations is health effect-dependent. For noncarcinogens, the exposure time is not age-adjusted ($ET = ET_c$). For carcinogens, an age-adjusted exposure time is calculated using the following equation:

$$ET_{adj} = \frac{(ED_c \times ET_c) + ([ED_r - ED_c] \times ET_a)}{ED_r} \quad (21)$$

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 child exposure time for noncarcinogenic effects and the age-adjusted exposure time (as calculated above) for carcinogenic effects:

If ET ≤ t*, the following nonsteady-state equation is used:

$$DA_{event} = 2 \times FA \times K_p \times C_w \times CF3 \times \sqrt{\frac{6 \times \tau \times ET}{\pi}} \quad (22)$$

If ET > t*, the following pseudosteady-state equation is used:

$$DA_{event} = FA \times K_p \times C_w \times CF3 \times \left[\frac{ET}{1+B} + 2 \times \tau \times \left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right] \quad (23)$$

where:

ET = ET_c or ET_{adj}, for noncarcinogenic and carcinogenic effects, respectively.

For inorganics, the following steady-state equation is used to estimate DA_{event}:

$$DA_{event} = K_p \times C_w \times ET \times CF3 \quad (24)$$

where:

ET = ET_c or ET_{adj}, for noncarcinogenic and carcinogenic effects, respectively.

3.3.5 Tap Water Immersion—Radionuclides

For exposure to radionuclides via the immersion pathway, the CDI is calculated using the following equation:

$$CDI = \frac{C_w \times ET_{RADadj} \times EF}{CF4} \quad (25)$$

where:

$$ET_{RADadj} = (ED_c \times ET_c \times EV) + ([ED_r - ED_c] \times ET_a \times EV) \quad (26)$$

Cancer risk is calculated using the following equation:

$$Risk = CDI \times SF_{imm} \quad (27)$$

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.

$$Risk_T = \sum_1^N Risk_i \quad (28)$$

where:

$Risk_T$	=	Total cancer risk from route of exposure
$Risk_i$	=	Cancer risk for the i^{th} chemical
N=	Number of chemicals	

3.5 Hazard Index—Noncancer

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

$$HI = \sum_1^N \left(\frac{CDI_i}{RfD_i}\right) \quad (29)$$

where:

HI	=	hazard index
CDI_i	=	chronic daily intake of the i^{th} chemical (mg/kg-day)
RfD_i	=	reference dose of the i^{th} chemical (mg/kg-day)
N=	Number of chemicals	

4 Assumptions and Inputs

Assumptions and inputs associated with the tap water exposure scenario, the human health toxicity values used to characterize risk and hazards, and the groundwater analytes and associated exposure point concentrations (EPCs) are described below.

4.1 Exposure Inputs and Assumptions

- Exposure routes evaluated for the tap water exposure scenario are ingestion, inhalation, dermal contact with water (for nonradionuclides), and immersion in water (for radionuclides).
- Exposure assumptions for the tap water exposure scenario are consistent with EPA guidance and provide a reasonable maximum exposure (RME) estimate as defined in OSWER Directive 9285.6 03, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance, "Standard Default Exposure Factors"*.
- RME assumptions used to quantify contaminant intake (CDI) for the tap water exposure scenario are provided in Table 2.
- 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 scenario, inhalation intake is quantified only for volatile contaminants as defined in the downloadable table "Summary Table," dated June 2017, available online at EPA, 2017b, "Regional Screening Levels for Chemical Contaminants at Superfund Sites" website (http://www.epa.gov/risk/regional-screening-table).
- For the RME residential scenario, the EPA-recommended values for showering/bathing exposure times for dermal exposure to tap water are 0.71 hours for an adult and 0.54 hours for a child (EPA/600/R-090/052F). Exposure times for inhalation of volatiles in water is assumed to be 24 hours per day.

4.2 Groundwater Analytes and Exposure Point Concentrations

The analytes evaluated in this environmental calculation were obtained from the 100-KR-4 Groundwater OU analytical data set in the Hanford Environmental Information System (HEIS) database. The data set was first processed and reduced as described in ECF-100KR4-17-0081, Calculation of Exposure Point Concentrations for the 100-KR-4 Groundwater Operable Unit.

Following the data processing and reduction, any analyte with at least one reported detection and available toxicity values was included in the risk and hazards calculations.

The EPCs used for the risk calculations are the analyte-specific 95 percent upper confidence limit (UCL) or ProUCL values calculated from the analytical data set, as described in ECF-100KR4-17-0081. The identified analytes and their associated EPCs are presented in Appendix A, Table A-1 through Table A-10 for the 82 wells evaluated individually in the 100-KR-4 Groundwater OU and Table A-11 for the 82 wells combined.

4.3 Toxicity Values

The toxicity criteria used for the human health risk calculations are provided in Table 6. The sources for these criteria are discussed below.

4.3.1 Toxicity Values for Nonradionuclides

For nonradionuclides, the analyte-specific toxicity values shown in Table 6 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 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, 2017b).

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) 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.

For this environmental calculation, nitrate and nitrite toxicity values required conversion to a different concentration basis as follows:

- **Nitrate**. A derived RfD for nitrate (NO_3^-) was calculated from the RfD reported in IRIS, which is given as 1.6 mg/kg-day for nitrate as nitrogen (NO_3^- as N). Conversion from nitrate as nitrogen to nitrate was made 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^- as N/kg-day) × (1 mg NO_3^-/0.226 mg NO_3^- as N) = 7.1 mg NO_3^-/kg-day.
- **Nitrite**. A derived RfD for nitrate (NO_2^-) was calculated from the RfD reported in IRIS, which is given as 0.1 mg/kg-day for nitrite as nitrogen (NO_2^- as N). Conversion from nitrite as nitrogen to nitrite was made 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^- as N/kg-day) × (1 mg NO_2^-/0.304 mg NO_2^- as N) = 0.3 mg NO_2^-/kg-day.

For several nonradionuclide analytes, 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.

- The RfD for uranium that is published in IRIS (0.003 mg/kg-day) was used for hazard calculations in this risk assessment. The reference dose value (0.0002 mg/kg-day) published in the memorandum dated December 21, 2016, Considering a Noncancer Oral Reference Dose for Uranium for Superfund Human Health Risk Assessments and referenced in in the "Regional Screening Levels for Chemical Contaminants at Superfund Sites" web site is not published in IRIS and an maximum concentration level using this value has not been promulgated. As such, the RfD value of 0.0002 mg/kg-day for uranium was not used in this risk assessment.
- For hexavalent chromium (Cr(VI)), the current assessment does not consider carcinogenic effects. An oral cancer slope factor has been published by the New Jersey Department of Environmental Protection (NJDEP). The oral cancer slope factor derived by NJDEP is 0.5 $(mg/kg\ day)^{-1}$, 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. Not assessing carcinogenic effects from Cr(VI) has the potential to under-estimate cancer risk.

4.3.2 Toxicity Values for Radionuclides

The cancer slope factors for radionuclides in Table 6 were obtained from the downloadable table "Resident Tapwater Table", dated November, 2014, (EPA, 2017a). For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except cesium-137, neptunium-237, radium-228, strontium-90, uranium-235, uranium-238, which have risks from associated short-lived radioactive daughter products that are also included. The intention of this designation is to make realistic risk estimates by including the contributions from their short-lived daughter products, assuming equal activity concentrations (i.e., secular equilibrium) with the principal or parent nuclide in the environment.

Table 6. Toxicity Criteria for 100-KR-4 Groundwater Analytes

Analyte name[a]	CAS Num	Oral Reference Dose (RfD_o)[b] (mg/kg-day)	RfD_o Key	Oral Cancer Slope Factor (CSF_o)[b](mg/kg-day)$^{-1}$or Oral Slope Factor (SF_o)[c] (Risk/pCi)	CSF_o Key	Inhalation Reference Concentration (RfC)[b] (mg/m^3)	RfCKey	Inhalation Unit Risk (IUR)[b] ($\mu g/m^3$)$^{-1}$	IUR Key	Immersion Slope Factor (SF_{imm})[c] (risk/yr per pCi/L)	Inhalation Cancer Slope Factor (SF_i)[c] (Risk/pCi)	SF_i Key	Volatile Nonradionuclides[b] Radionuclides[c]	GIABS Nonradionuclides[b] (unitless)	K_p[d] (cm/hr)	B[d] (unitless)	τ[d] (hours/ event)	t^*[d] (hours)	FA[d] (unitless)
1,2,4-Trichlorobenzene	120-82-1	0.01	I	0.029	P	0.002	P	--	--	--	--	--	V	1	0.07	0.37	1.1	2.6	1
1,2-Dichlorobenzene	95-50-1	0.09	I	--	--	0.2	H	--	--	--	--	--	V	1	0.045	0.21	0.7	1.7	1
2-Butanol	78-92-2	2	P	--	--	30	P	--	--	--	--	--	V	1	0.0015	0.0051	0.27	0.66	1
2-Butanone	78-93-3	0.6	I	--	--	5	I	--	--	--	--	--	V	1	0.00096	0.0031	0.27	0.64	1
2-Propanol	67-63-0	2	P	--	--	0.2	P	--	--	--	--	--	V	1	0.00078	0.0023	0.23	0.55	1
Acetone	67-64-1	0.9	I	--	--	31	A	--	--	--	--	--	V	1	0.00051	0.0015	0.22	0.53	1
Aldrin	309-00-2	3E-05	I	17	I	--	--	0.0049	I	--	--	--	V	1	0.29	2.2	12	48	1
Aluminum	7429-90-5	1	P	--	--	0.005	P	--	--	--	--	--	--	1	0.001	0.002	0.15	0.36	1
Antimony	7440-36-0	0.0004	I	--	--	--	--	--	--	--	--	--	--	0.15	0.001	0.0042	0.51	1.2	1
Arsenic	7440-38-2	0.0003	I	1.5	I	1.5E-05	C	0.0043	I	--	--	--	--	1	0.001	0.0033	0.28	0.66	1
Barium	7440-39-3	0.2	I	--	--	0.0005	H	--	--	--	--	--	--	0.07	0.001	0.0045	0.62	1.5	1
Beryllium	7440-41-7	0.002	I	--	--	2E-05	I	0.0024	I	--	--	--	--	0.007	0.001	0.0012	0.12	0.28	1
Bis(2-ethylhexyl) phthalate	117-81-7	0.02	I	0.014	I	--	--	2.4E-06	C	--	--	--	--	1	1.1	8.6	16	73	0.8
Boron	7440-42-8	0.2	I	--	--	0.02	H	--	--	--	--	--	--	1	0.001	0.0014	0.13	0.3	1
Bromodichloromethane	75-27-4	0.02	I	0.062	I	--	--	3.7E-05	C	--	--	--	V	1	0.004	0.02	0.87	2.1	1
Bromomethane	74-83-9	0.0014	I	--	--	0.005	I	--	--	--	--	--	V	1	0.0028	0.011	0.36	0.86	1
Cadmium	7440-43-9	0.0005	I	--	--	1E-05	A	0.0018	I	--	--	--	--	0.05	0.001	0.0041	0.45	1.1	1
Carbon disulfide	75-15-0	0.1	I	--	--	0.7	I	--	--	--	--	--	V	1	0.011	0.038	0.28	0.67	1
Carbon tetrachloride	56-23-5	0.004	I	0.07	I	0.1	I	6E-06	I	--	--	--	V	1	0.016	0.078	0.76	1.8	1
Carbon-14	14762-75-5	--	--	1.55E-12	--	--	--	--	--	5.8E-17	1.7E-11	--	V	--	--	--	--	--	--
Cesium-137	10045-97-3	--	--	3.05E-11	--	--	--	--	--	5.16E-12	1.1E-10	--	--	--	--	--	--	--	--
Chlorobenzene	108-90-7	0.02	I	--	--	0.05	P	--	--	--	--	--	V	1	0.028	0.12	0.45	1.1	1
Chloroform	67-66-3	0.01	I	0.031	C	0.098	A	2.3E-05	I	--	--	--	V	1	0.0068	0.029	0.49	1.2	1
Chloromethane	74-87-3	--	--	--	--	0.09	I	--	--	--	--	--	V	1	0.0033	0.009	0.2	0.48	1
Chromium	7440-47-3	1.5	I	--	--	--	--	--	--	--	--	--	--	0.013	0.001	0.0028	0.21	0.49	1
Cobalt	7440-48-4	0.0003	P	--	--	6E-06	P	0.009	P	--	--	--	--	1	0.0004	0.0012	0.22	0.54	1
Cobalt-60	10198-40-0	--	--	1.58E-11	--	--	--	--	--	2.44E-11	1E-10	--	--	--	--	--	--	--	--
Copper	7440-50-8	0.04	H	--	--	--	--	--	--	--	--	--	--	1	0.001	0.0031	0.24	0.57	1
Cyanide	57-12-5	0.0006	I	--	--	0.0008	S	--	--	--	--	--	V	1	0.001	0.002	0.15	0.35	1
Diethylphthalate	84-66-2	0.8	I	--	--	--	--	--	--	--	--	--	--	1	0.0036	0.021	1.8	4.4	1
Ethylbenzene	100-41-4	0.1	I	0.011	C	1	I	2.5E-06	C	--	--	--	V	1	0.049	0.2	0.41	0.99	1
Fluoride	16984-48-8	0.06	I	--	--	0.013	C	--	--	--	--	--	--	1	0.001	0.0024	0.17	0.41	1

Table 6. Toxicity Criteria for 100-KR-4 Groundwater Analytes

Analyte name[a]	CAS Num	Oral Reference Dose (RfD_o)[b] (mg/kg-day)	RfD_o Key	Oral Cancer Slope Factor (CSF_o)[b](mg/kg-day)$^{-1}$or Oral Slope Factor (SF_o)[c] (Risk/pCi)	CSF_o Key	Inhalation Reference Concentration (RfC)[b] (mg/m^3)	RfCKey	Inhalation Unit Risk (IUR)[b] ($\mu g/m^3$)$^{-1}$	IUR Key	Immersion Slope Factor (SF_{imm})[c] (risk/yr per pCi/L)	Inhalation Cancer Slope Factor (SF_i)[c] (Risk/pCi)	SF_i Key	Volatile Nonradionuclides[b] Radionuclides[c]	GIABS Nonradionuclides[b] (unitless)	K_p[d] (cm/hr)	B[d] (unitless)	τ[d] (hours/ event)	t^*[d] (hours)	FA[d] (unitless)
Hexane	110-54-3	--	--	--	--	0.7	I	--	--	--	--	--	V	1	0.2	0.72	0.32	1.2	1
Cr(VI)	18540-29-9	0.003	I	--	--	0.0001	I	0.084	S	--	--	--	--	0.025	0.002	0.0055	0.21	0.49	1
Iron	7439-89-6	0.7	P	--	--	--	--	--	--	--	--	--	--	1	0.001	0.0029	0.22	0.52	1
Lithium	7439-93-2	0.002	P	--	--	--	--	--	--	--	--	--	--	1	0.001	0.001	0.12	0.28	1
Manganese	7439-96-5	0.024	S	--	--	5E-05	I	--	--	--	--	--	--	0.04	0.001	0.0029	0.21	0.51	1
Mercury	7439-97-6	0.0003	I	--	--	0.0003	S	--	--	--	--	--	--	0.07	0.001	0.0063	3.5	8.4	1
Methylene chloride	75-09-2	0.006	I	0.002	I	0.6	I	1E-08	I	--	--	--	V	1	0.0035	0.013	0.31	0.75	1
Molybdenum	7439-98-7	0.005	I	--	--	--	--	--	--	--	--	--	--	1	0.001	0.0038	0.36	0.87	1
Nickel	7440-02-0	0.02	I	--	--	9E-05	A	0.00026	C	--	--	--	--	0.04	0.0002	0.00059	0.22	0.54	1
Nickel-63	13981-37-8	--	--	6.81E-13	--	--	--	--	--	0	5.9E-12	--	--	--	--	--	--	--	--
Nitrate	14797-55-8	7.1	I	--	--	--	--	--	--	--	--	--	--	1	0.001	0.003	0.23	0.56	1
Nitrite	14797-65-0	0.3	I	--	--	--	--	--	--	--	--	--	--	1	0.001	0.0026	0.19	0.46	1
o-Xylene	95-47-6	0.2	S	--	--	0.1	S	--	--	--	--	--	V	1	0.047	0.19	0.41	0.99	1
Selenium	7782-49-2	0.005	I	--	--	0.02	C	--	--	--	--	--	--	1	0.001	0.0034	0.29	0.7	1
Selenium-79	15758-45-9	--	--	6.92E-12	--	--	--	--	--	6.74E-17	1.9E-11	--	--	--	--	--	--	--	--
Silver	7440-22-4	0.005	I	--	--	--	--	--	--	--	--	--	--	0.04	0.0006	0.0024	0.42	1	1
Strontium	7440-24-6	0.6	I	--	--	--	--	--	--	--	--	--	--	1	0.001	0.0036	0.33	0.78	1
Strontium-90	10098-97-2	--	--	7.4E-11	--	--	--	--	--	3.97E-14	4.3E-10	--	--	--	--	--	--	--	--
Styrene	100-42-5	0.2	I	--	--	1	I	--	--	--	--	--	V	1	0.037	0.15	0.4	0.97	1
Technetium-99	14133-76-7	--	--	2.75E-12	--	--	--	--	--	5.62E-16	3.8E-11	--	--	--	--	--	--	--	--
Tetrahydrofuran	109-99-9	0.9	I	--	--	2	I	--	--	--	--	--	V	1	0.0013	0.0041	0.27	0.64	1
Thallium	7440-28-0	1E-05	X	--	--	--	--	--	--	--	--	--	--	1	0.001	0.0055	1.5	3.5	1
Tin	7440-31-5	0.6	H	--	--	--	--	--	--	--	--	--	--	1	0.001	0.0042	0.49	1.2	1
Toluene	108-88-3	0.08	I	--	--	5	I	--	--	--	--	--	V	1	0.031	0.11	0.35	0.83	1
Trichloroethene	79-01-6	0.0005	I	0.046	I	0.002	I	4.1E-06	I	--	--	--	V	1	0.012	0.051	0.57	1.4	1
Tritium	10028-17-8	--	--	5.07E-14	--	--	--	--	--	0	8.5E-13	--	V	--	--	--	--	--	--
Uranium	7440-61-1	0.003	I	--	--	4E-05	A	--	--	--	--	--	--	1	0.001	0.0059	2.3	5.4	1

Table 6. Toxicity Criteria for 100-KR-4 Groundwater Analytes

Analyte name[a]	CAS Num	Oral Reference Dose (RfD_o)[b] (mg/kg-day)	RfD_o Key	Oral Cancer Slope Factor (CSF_o)[b](mg/kg-day)$^{-1}$or Oral Slope Factor (SF_o)[c] (Risk/pCi)	CSF_o Key	Inhalation Reference Concentration (RfC)[b] (mg/m^3)	RfCKey	Inhalation Unit Risk (IUR)[b] ($\mu g/m^3$)$^{-1}$	IUR Key	Immersion Slope Factor (SF_{imm})[c] (risk/yr per pCi/L)	Inhalation Cancer Slope Factor (SF_i)[c] (Risk/pCi)	SF_i Key	Volatile Nonradionuclides[b] Radionuclides[c]	GIABS Nonradionuclides[b] (unitless)	K_p[d] (cm/hr)	B[d] (unitless)	τ[d] (hours/ event)	t*[d] (hours)	FA[d] (unitless)
Uranium-233/234	U-233/234	--	--	7.07E-11	--	--	--	--	--	1.17E-15	2.8E-08	--	--	--	--	--	--	--	--
Uranium-235	15117-96-1	--	--	7.18E-11	--	--	--	--	--	1.48E-12	2.5E-08	--	--	--	--	--	--	--	--
Uranium-238	U-238	--	--	8.7E-11	--	--	--	--	--	2.69E-13	2.4E-08	--	--	--	--	--	--	--	--
Vanadium	7440-62-2	0.005	S	--	--	0.0001	A	--	--	--	--	--	--	0.026	0.001	0.0027	0.2	0.49	1
Xylenes (total)	1330-20-7	0.2	I	--	--	0.1	I	--	--	--	--	--	V	1	0.05	0.2	0.41	0.99	1
Zinc	7440-66-6	0.3	I	--	--	--	--	--	--	--	--	--	--	1	0.0006	0.0019	0.24	0.59	1

Notes:
[a] Source = ECF-100KR4-17-0081, Rev. 0, Calculation of Exposure Point Concentrations for the 100-KR-4 Groundwater Operable Unit.
[b] Source = EPA, 2017b, "Summary Table", dated June, 2017, available online at "Regional Screening Levels for Chemical Contaminants at Superfund Sites.", http://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-2017.
[c] Source = EPA, 2017a, "Resident Tapwater Table", dated November, 2014, available online at "Preliminary Remediation Goals for Radionuclides (PRG)", http://epa-prgs.ornl.gov/radionuclides.
[d] Source = EPA, 2017b, "Parameters Table", dated June, 2017 , available online at "Regional Screening Levels for Chemical Contaminants at Superfund Sites.", http://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-2017.
-- = indicates toxicity value not available for this contaminant and exposure route.
+D = Indicates radionuclide whose slope factors include contributions from ingrowth of short-lived radioactive decay products.
A = ATSDR
B = partitioning constant.
C = Cal EPA
E = see user guide Section 2.3.5
FA = fraction absorbed.
GIABS = gastrointestinal absorption factor.
H = HEAST
I = IRIS
K^p = dermal permeability constant.
P = PPRTV
S = See user guide section
X = APPENDIX PPRTV SCREEN
t* = time to reach steady-state conditions.
τ = lag time
V = volatile

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5 Software Applications

The approved software application POSTAL v3.0 is the primary software program used for calculations reported in this document. The required information about POSTAL v3.0 is provided in this section.

5.1 POSTAL Description

The following presents the description of POSTAL used for this report. See CHPRC-03486, *POSTAL Software Management Plan, Rev. 0* for further details regarding the use of this software.

- Software Title: POSTAL
- Software Version: 3.0
- HISI Identification Number: 4198

Workstation type and description (from which software is run): POSTAL was executed on a Lenovo ThinkPad computer (property tag INTERA-00798) running Windows 10. Computer details are:

- Intel® Core™[1] i7-6600U CPU @ 2.60GHz
- 16 GB RAM
- Windows®[2] 10 Pro 64-bit Operating System

Additional workstation type and description: POSTAL was executed on a Lenovo ThinkPad computer (property tag INTERA-00707) running Windows 10. Computer details are:

- Intel® Core™ i7-4600U CPU @ 2.10GHz
- 8 GB RAM
- Windows® 10 Pro 64-bit Operating System

5.1.1 Software Installation and Checkout

The software installation and checkout forms for POSTAL v3.0 are attached in Appendix B.

5.1.2 Statement of Valid Software Installation

The following presents the statement that POSTAL v3.0 is a valid software application.

- POSTAL was developed by INTERA, Inc., to provide automated execution of ProUCL and automated generation of UCL-, EPC- and risk tables in support of risk assessment activities.
- Acceptance tests were performed that demonstrated POSTAL correctly controlled the execution of ProUCL v5.1 and built UCL-95 and EPC tables from the ProUCL output and established EPC selection rules.
- POSTAL as it has been used in this activity has been implemented within the range of its limitations.

6 Calculation

6.1 Tap Water Exposure Scenario Results

Cancer risks and noncancer hazards for groundwater wells using the methodologies presented in Section 3, and the inputs and assumptions described in Section 4. Results for each groundwater well are summarized in the text and tables presented in Section 7. The input files used with and the output files generated by POSTAL are archived in the Environmental Risk Management Archive (ERMA) under this ECF number.

[1] A trademark of Intel Corporation, Santa Clara, California.
[2] A trademark of Microsoft Corporation, Redmond, Washington.

6.2 Verification of Risk and Hazard Calculations

Verification of the tap water risk assessment calculations were performed by comparing the POSTAL v3.0-generated results against results independently generated by a GoldSim®[3] model of the tap water risk assessment calculations. The comparisons were verified to ensure any discrepancies were within acceptable limits. Additionally, POSTAL results were generated and compared against results generated by Excel®[4] spreadsheets and results generated by hand calculations for a selected subset of wells and analytes. The verification of the calculations is documented in the software quality assurance documentation for POSTAL v3.0.

7 Results/Conclusions

This section summarizes the risk assessment results for the tap water exposure scenario for the 100-KR-4 Groundwater OU. Exposure to groundwater as a tap water source is evaluated using the following potential exposure routes: ingestion, dermal contact (nonradionuclides) and immersion (radionuclides), and inhalation of volatiles under a residential exposure scenario. Table 7 through Table 86 provide a summary of the risk and hazard estimates by exposure route for each well evaluated in the 100-KR-4 Groundwater OU.

Table 87 provides a summary of the risk and hazard estimates by exposure route for the data set consisting of all wells evaluated in the 100-KR-4 Groundwater OU. It is noted that the risk and hazard estimates for this dataset is provided for comparison to the Native American exposure scenarios only.

7.1 Monitoring Wells Screened Across the Top of Unconfined Aquifer

Well 199-K-106A. Table 7 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-106A.

Table 7. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-106A – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.2×10^{-5}	Arsenic, (ELCR = 7.0×10^{-5}, 0.20%) Carbon-14, (ELCR = 3.2×10^{-2}, 90%) Chloroform, (ELCR = 3.3×10^{-6}, 0.01%) TCE, (ELCR = 4.8×10^{-6}, 0.01%) Tritium, (ELCR = 3.3×10^{-3}, 9.4%)	5.3	2-Propanol, (HQ = 0.90, 12%) Arsenic, (HQ = 0.61, 8.3%) Bromomethane, (HQ = 0.21, 2.9%) Fluoride, (HQ = 0.21, 2.8%) Lithium, (HQ = 0.73, 9.9%) Nitrate, (HQ = 0.45, 6.2%) Thallium, (HQ = 2.5, 34%) TCE, (HQ = 1.2, 16%) Uranium, (HQ = 0.14, 1.9%) Vanadium, (HQ = 0.13, 1.8%)
	Dermal Contact	7.3×10^{-7}		0.11	
	Inhalation of Volatiles	5.4×10^{-6}		1.9	
	Total Risk	**7.9×10^{-5}**		**Total HI**	**7.3**
	Ingestion	7.3×10^{-4}		--	

[3] GoldSim is a registered trademark of GoldSim Techologies, Issaquah, Washington.

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

Table 7. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-106A – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Radionuclides	Immersion	1.1×10^{-12}			
	Inhalation of Volatiles	3.5×10^{-2}			
	Total Risk	**3.5×10^{-2}**			
Total Cumulative ELCR		**3.5×10^{-2}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-106A is 3.5×10^{-2}. The total ELCR for nonradiological analytes is 7.9×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 3.5×10^{-2}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 3.2×10^{-2}, 90 percent contribution), chloroform (ELCR = 3.3×10^{-6}, 0.01 percent contribution), trichloroethene (TCE) (ELCR = 4.8×10^{-6}, 0.01 percent contribution), and tritium (ELCR = 3.3×10^{-3}, 9.4 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.0×10^{-5}, 0.20 percent contribution) where the EPC (3.6 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-106A without contribution from arsenic is 8.1×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-106A is 7.3, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are 2-propanol (HQ = 0.90, 12 percent contribution), arsenic (HQ = 0.61, 8.3 percent contribution), bromomethane (HQ = 0.21, 2.9 percent contribution), fluoride (HQ = 0.21, 2.8 percent contribution), lithium (HQ = 0.73, 9.9 percent contribution), nitrate (HQ = 0.45, 6.2 percent contribution), thallium (HQ = 2.5, 34 percent contribution), TCE (HQ = 1.2, 16 percent contribution), uranium (HQ = 0.14, 1.9 percent contribution), and vanadium (HQ = 0.13, 1.8 percent contribution). Contribution to HI is elevated for thallium (HQ = 2.5) where the EPC (0.50 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-106A without contribution from arsenic and thallium is 4.2, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- 2-Propanol: decreased fetal body weight
- Bromomethane: degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Lithium: nervous system and kidney effects
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Uranium: initial body weight loss and moderate nephrotoxicity
- Vanadium: decreased hair cysteine

With the exception of 2-propanol, TCE, uranium and lithium, exposure to each of the analytes that contribute to the HI of 4.2 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for uranium and lithium results in an HI of 0.87, which is less than the target HI of 1. Combining the HQs for 2-propanol and TCE results in a HI of 2.1, which is greater than the target HI of 1; evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-107A. Table 8 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-107A.

Table 8. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-107A – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	6.1×10^{-5}	Arsenic, (ELCR = 5.9×10^{-5}, 5.1%) Carbon-14, (ELCR = 9.6×10^{-4}, 83%) Chloroform, (ELCR = 1.8×10^{-6}, 0.16%) TCE, (ELCR = 5.1×10^{-6}, 0.44%)	1.8	2-Propanol, (HQ = 0.34, 11%) Arsenic, (HQ = 0.51, 16%) Fluoride, (HQ = 0.15, 4.7%) Cr(VI), (HQ = 0.28, 8.9%) Nitrate, (HQ = 0.22, 6.8%) TCE, (HQ = 1.3, 40%) Vanadium, (HQ = 0.10, 3.1%)
	Dermal Contact	6.7×10^{-7}		0.16	
	Inhalation of Volatiles	4.3×10^{-6}		1.2	
	Total Risk	**6.6×10^{-5}**		**Total HI**	**3.2**
Radionuclides	Ingestion	5.2×10^{-5}		--	
	Immersion	5.9×10^{-13}			
	Inhalation of Volatiles	1.0×10^{-3}			
	Total Risk	**1.1×10^{-3}**			
Total Cumulative ELCR		**1.2×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-107A is 1.2×10^{-3}. The total ELCR for nonradiological analytes is 6.6×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.1×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 9.6×10^{-4}, 83 percent contribution), chloroform (ELCR = 1.8×10^{-6}, 0.16 percent contribution), and TCE (ELCR = 5.1×10^{-6}, 0.44 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 5.9×10^{-5}, 5.1 percent contribution) where the EPC (3.0 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-107A without contribution from arsenic is 6.9×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-107A is 3.2, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are 2-propanol (HQ = 0.34, 11 percent contribution), arsenic (HQ = 0.51, 16 percent contribution), fluoride (HQ = 0.15, 4.7 percent contribution), Cr(VI) (HQ = 0.28, 8.9 percent contribution), nitrate (HQ = 0.22, 6.8 percent contribution), TCE (HQ = 1.3, 40 percent contribution), and vanadium (HQ = 0.10, 3.1 percent contribution). The HI for well 199-K-107A without contribution from arsenic is 2.7, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- 2-Propanol: decreased fetal body weight
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of 2-propanol and TCE, exposure to each of the analytes that contribute to the HI of 2.7 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for 2-propanol and TCE results in an HI of 1.6, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-108A. Table 9 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-108A.

Table 9. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-108A – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	5.3×10^{-5}	Arsenic, (ELCR = 5.1×10^{-5}, 4.1%) Carbon-14, (ELCR = 1.2×10^{-3}, 92%) Chloroform, (ELCR = 2.0×10^{-6}, 0.16%) TCE, (ELCR = 4.7×10^{-6}, 0.37%)	3.5	Arsenic, (HQ = 0.44, 9.7%) Bromomethane, (HQ = 0.15, 3.2%) Fluoride, (HQ = 0.24, 5.4%) Lithium, (HQ = 0.60, 13%) Nitrate, (HQ = 0.34, 7.6%) Thallium, (HQ = 0.93, 21%) TCE, (HQ = 1.2, 26%) Uranium, (HQ = 0.13, 2.8%)
	Dermal Contact	6.1×10^{-7}		0.11	
	Inhalation of Volatiles	4.3×10^{-6}		0.90	
	Total Risk	**5.8×10^{-5}**		**Total HI**	**4.5**
Radionuclides	Ingestion	2.8×10^{-5}		--	
	Immersion	6.8×10^{-14}			
	Inhalation of Volatiles	1.2×10^{-3}			
	Total Risk	**1.2×10^{-3}**			
Total Cumulative ELCR		**1.3×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-108A is 1.3×10^{-3}. The total ELCR for nonradiological analytes is 5.8×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of $1 \times 10^{-}$

^{5}. The total ELCR for radiological analytes is 1.2×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 1.2×10^{-3}, 92 percent contribution), chloroform (ELCR = 2.0×10^{-6}, 0.16 percent contribution), and TCE (ELCR = 4.7×10^{-6}, 0.37 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 5.1×10^{-5}, 4.1 percent contribution) where the EPC (2.6 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-108A without contribution from arsenic is 6.7×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-108A is 4.5, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.44, 9.7 percent contribution), bromomethane (HQ = 0.15, 3.2 percent contribution), fluoride (HQ = 0.24, 5.4 percent contribution), lithium (HQ = 0.60, 13 percent contribution), nitrate (HQ = 0.34, 7.6 percent contribution), thallium (HQ = 0.93, 21 percent contribution), TCE (HQ = 1.2, 26 percent contribution), and uranium (HQ = 0.13, 2.8 percent contribution). Contribution to HI is elevated for thallium where the EPC (0.19 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-108A without contribution from arsenic and thallium is 3.2, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Bromomethane: degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Lithium: nervous system and kidney effects
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Uranium: initial body weight loss and moderate nephrotoxicity

With the exception of TCE, uranium and lithium, exposure to each of the analytes that contribute to the HI of 3.2 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for uranium and lithium results in an HI of 0.73, which is less than the target HI of 1. TCE reports an individual HQ of 1.2, which is greater than the target HI of 1; evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-110A. Table 10 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-110A.

Table 10. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-110A – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	3.6×10^{-5}	Arsenic, (ELCR = 3.6×10^{-5}, 65%)	1.8	Arsenic, (HQ = 0.31, 17%) Cobalt, (HQ = 0.64, 35%) Cr(VI), (HQ = 0.17, 9.3%) Nickel, (HQ = 0.16, 8.6%) Nitrate, (HQ = 0.13, 6.9%)
	Dermal Contact	1.9×10^{-7}		0.07	
	Inhalation of Volatiles	--		--	
	Total Risk	**3.6×10^{-5}**		**Total HI**	**1.8**
Radionuclides	Ingestion	2.7×10^{-7}		**--**	
	Immersion	--			

Table 10. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-110A – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Inhalation of Volatiles	1.9×10^{-5}			
	Total Risk	**1.9×10^{-5}**			
Total Cumulative ELCR		**5.5×10^{-5}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-110A is 5.5×10^{-5}. The total ELCR for nonradiological analytes is 3.6×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.9×10^{-5}, which is within the EPA risk threshold range of 1×10^{-4} to 1×10^{-6}.

Contribution to ELCR is elevated for arsenic (ELCR = 3.6×10^{-5}, 65 percent contribution) where the EPC (1.8 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-110A when contribution from arsenic is not included.

The HI for well 199-K-110A is 1.8, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.31, 17 percent contribution), cobalt (HQ = 0.64, 35 percent contribution), Cr(VI) (HQ = 0.17, 9.3 percent contribution), nickel (HQ = 0.16, 8.6 percent contribution), and nitrate (HQ = 0.13, 6.9 percent contribution). The HI for well 199-K-110A without contribution from arsenic is 1.5, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Cobalt: thyroid, decreased iodine uptake
- Cr(VI): nasal septum atrophy
- Nickel: decreased body and organ weights
- Nitrate: early clinical signs of methemoglobinemia

Exposure to each of the analytes that contribute to the HI of 1.5 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-111A. Table 11 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-111A.

Table 11. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-111A – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.5×10^{-5}	Arsenic, (ELCR = 7.5×10^{-5}, 0.79%) Carbon-14, (ELCR = 3.2×10^{-4}, 3.4%) Chloroform, (ELCR = 2.4×10^{-6},	12	Antimony, (HQ = 0.10, 0.77%) Arsenic, (HQ = 0.65, 4.8%) Fluoride, (HQ = 0.19, 1.4%) Cr(VI), (HQ = 6.9, 51%) Nitrate, (HQ = 0.26, 1.9%)
	Dermal Contact	4.2×10^{-7}		1.8	

Table 11. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-111A – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Inhalation of Volatiles	2.1×10^{-6}	0.02%) Tritium, (ELCR = 9.1×10^{-3}, 96%)	< 0.01	Thallium, (HQ = 5.0, 37%) Vanadium, (HQ = 0.16, 1.2%)
	Total Risk	**7.8×10^{-5}**		**Total HI**	**13**
Radionuclides	**Ingestion**	1.4×10^{-4}			
	Immersion	4.5×10^{-14}			
	Inhalation of Volatiles	9.3×10^{-3}			--
	Total Risk	**9.4×10^{-3}**			
Total Cumulative ELCR		**9.5×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-111A is 9.5×10^{-3}. The total ELCR for nonradiological analytes is 7.8×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 9.4×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 3.2×10^{-4}, 3.4 percent contribution), chloroform (ELCR = 2.4×10^{-6}, 0.02 percent contribution), and tritium (ELCR = 9.1×10^{-3}, 96 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.5×10^{-5}, 0.79 percent contribution) where the EPC (3.9 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-111A without contribution from arsenic is 2.4×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-111A is 13, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are antimony (HQ = 0.10, 0.77 percent contribution), arsenic (HQ = 0.65, 4.8 percent contribution), fluoride (HQ = 0.19, 1.4 percent contribution), Cr(VI) (HQ = 6.9, 51 percent contribution), nitrate (HQ = 0.26, 1.9 percent contribution), thallium (HQ = 5.0, 37 percent contribution), and vanadium (HQ = 0.16, 1.2 percent contribution). Contribution to HI is elevated for thallium (HQ = 5.0) where the EPC (1.0 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-111A without contribution from arsenic and thallium is 7.8, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Antimony: longevity, blood glucose, and cholesterol
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

With the exception of nitrate and antimony, exposure to each of the analytes that contribute to the HI of 7.8 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for nitrate and antimony results in an HI of 0.36, which is less than the target HI of 1. Cr(VI) reports an individual HQ of 6.9, which is greater than the target HI of 1; evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-132. Table 12 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-132.

Table 12. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-132 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	4.9×10^{-5}	Arsenic, (ELCR = 4.6×10^{-5}, 0.73%) Carbon-14, (ELCR = 6.0×10^{-3}, 94%) Chloroform, (ELCR = 1.8×10^{-6}, 0.03%) TCE, (ELCR = 6.3×10^{-6}, 0.10%) Tritium, (ELCR = 3.4×10^{-4}, 5.4%)	2.3	2-Propanol, (HQ = 0.19, 3.1%) Arsenic, (HQ = 0.40, 6.3%) Cyanide, (HQ = 2.9, 45%) Fluoride, (HQ = 0.13, 2.1%) Cr(VI), (HQ = 0.38, 6.0%) Methylene chloride, (HQ = 0.13, 2.1%) Nitrate, (HQ = 0.33, 5.2%) TCE, (HQ = 1.6, 25%)
	Dermal Contact	7.0×10^{-7}		0.19	
	Inhalation of Volatiles	4.9×10^{-6}		3.8	
	Total Risk	**5.5×10^{-5}**		Total HI	**6.3**
Radionuclides	Ingestion	1.4×10^{-4}		--	
	Immersion	4.9×10^{-13}			
	Inhalation of Volatiles	6.2×10^{-3}			
	Total Risk	**6.3×10^{-3}**			
Total Cumulative ELCR		**6.4×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-132 is 6.4×10^{-3}. The total ELCR for nonradiological analytes is 5.5×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 6.3×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 6.0×10^{-3}, 94 percent contribution), chloroform (ELCR = 1.8×10^{-6}, 0.03 percent contribution), TCE (ELCR = 6.3×10^{-6}, 0.10 percent contribution), and tritium (ELCR = 3.4×10^{-4}, 5.4 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 4.6×10^{-5}, 0.73 percent contribution) where the EPC (2.4 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-132 without contribution from arsenic is 8.5×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-132 is 6.3, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are 2-propanol (HQ = 0.19, 3.1 percent contribution), arsenic (HQ = 0.40, 6.3 percent contribution), cyanide (HQ = 2.9, 45 percent contribution), fluoride (HQ = 0.13, 2.1 percent contribution), Cr(VI) (HQ = 0.38, 6.0 percent contribution), methylene chloride (HQ = 0.13, 2.1 percent contribution), nitrate (HQ = 0.33, 5.2 percent contribution), and TCE (HQ = 1.6, 25 percent contribution). The HI for well 199-K-132 without contribution from arsenic is 5.9, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- 2-Propanol: decreased fetal body weight
- Cyanide: thyroid enlargement and altered iodide uptake
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Methylene chloride: hepatic effects (hepatic vacuolation, liver foci)
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity

With the exception of 2-propanol and TCE, exposure to each of the analytes that contribute to the HI of 5.9 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for 2-propanol and TCE results in an HI of 1.8, which is greater than the target HI of 1. Cyanide reports an individual HQ of 2.9, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-139. Table 13 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-139.

Table 13. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-139 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	3.1×10^{-6}	Carbon-14, (ELCR = 1.8×10^{-3}, 90%) Tritium, (ELCR = 1.8×10^{-4}, 9.0%)	2.0	Fluoride, (HQ = 0.19, 5.1%) Cr(VI), (HQ = 1.2, 32%) Nitrate, (HQ = 0.22, 6.1%) Silver, (HQ = 0.11, 2.9%) TCE, (HQ = 1.8, 49%)
	Dermal Contact	4.9×10^{-7}		0.40	
	Inhalation of Volatiles	5.3×10^{-6}		1.2	
	Total Risk	**8.9×10^{-6}**		**Total HI**	**3.6**
Radionuclides	Ingestion	6.3×10^{-5}		--	
	Immersion	4.6×10^{-13}			
	Inhalation of Volatiles	2.0×10^{-3}			
	Total Risk	**2.0×10^{-3}**			
Total Cumulative ELCR		**2.0×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-139 is 2.0×10^{-3}. The total ELCR for nonradiological analytes is 8.9×10^{-6}, which is less than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.0×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 1.8×10^{-3}, 90 percent contribution) and tritium (ELCR = 1.8×10^{-4}, 9.0 percent contribution). Arsenic was not reported at well 199-K-139.

The HI for well 199-K-139 is 3.6, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are fluoride (HQ = 0.19, 5.1 percent contribution), Cr(VI) (HQ = 1.2, 32 percent contribution), nitrate (HQ = 0.22, 6.1 percent contribution), silver (HQ = 0.11, 2.9 percent contribution), and TCE (HQ = 1.8, 49 percent contribution).

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Silver: argyia (dermal)
- TCE: developmental immunotoxicity

Exposure to each of the analytes that contribute to the HI of 3.6 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Cr(VI) reports an individual HQ of 1.2, which is greater than the target HI of 1. TCE reports an individual HQ of 1.8, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-140. Table 14 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-140.

Table 14. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-140 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	6.5×10^{-5}	Arsenic, (ELCR = 6.3×10^{-5}, 5.9%) Carbon-14, (ELCR = 8.7×10^{-4}, 82%) Chloroform, (ELCR = 1.8×10^{-6}, 0.17%) TCE, (ELCR = 6.3×10^{-6}, 0.59%) Tritium, (ELCR = 1.2×10^{-4}, 11%)	1.9	2-Propanol, (HQ = 0.23, 7.0%) Arsenic, (HQ = 0.54, 16%) Fluoride, (HQ = 0.14, 4.3%) Cr(VI), (HQ = 0.30, 9.1%) Nitrate, (HQ = 0.18, 5.4%) TCE, (HQ = 1.6, 47%) Vanadium, (HQ = 0.12, 3.6%)
	Dermal Contact	7.8×10^{-7}		0.17	
	Inhalation of Volatiles	4.9×10^{-6}		1.3	
	Total Risk	**7.1×10^{-5}**		**Total HI**	**3.4**
Radionuclides	Ingestion	2.3×10^{-5}		--	
	Immersion	7.8×10^{-14}			
	Inhalation of Volatiles	9.7×10^{-4}			
	Total Risk	**9.9×10^{-4}**			

Table 14. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-140 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Total Cumulative ELCR		**1.1×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-140 is 1.1×10^{-3}. The total ELCR for nonradiological analytes is 7.1×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 9.9×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 8.7×10^{-4}, 82 percent contribution), chloroform (ELCR = 1.8×10^{-6}, 0.17 percent contribution), TCE (ELCR = 6.3×10^{-6}, 0.59 percent contribution), and tritium (ELCR = 1.2×10^{-4}, 11 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 6.3×10^{-5}, 5.9 percent contribution) where the EPC (3.2 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-140 without contribution from arsenic is 8.1×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-140 is 3.4, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are 2-propanol (HQ = 0.23, 7.0 percent contribution), arsenic (HQ = 0.54, 16 percent contribution), fluoride (HQ = 0.14, 4.3 percent contribution), Cr(VI) (HQ = 0.30, 9.1 percent contribution), nitrate (HQ = 0.18, 5.4 percent contribution), TCE (HQ = 1.6, 47 percent contribution), and vanadium (HQ = 0.12, 3.6 percent contribution). The HI for well 199-K-140 without contribution from arsenic is 2.8, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- 2-Propanol: decreased fetal weight
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of 2-propanol and TCE, exposure to each of the analytes that contribute to the HI of 2.8 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for 2-propanol and TCE results in an HI of 1.8, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-18. Table 15 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-18.

Table 15. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-18 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Ingestion	4.9×10^{-5}	Arsenic, (ELCR = 4.8×10^{-5}, 0.45%) Chloroform, (ELCR = 9.5×10^{-6}, 0.09%) Tritium, (ELCR = 1.1×10^{-2}, 99%)	3.7	Arsenic, (HQ = 0.42, 9.3%) Bromomethane, (HQ = 0.13, 3.0%) Cr(VI), (HQ = 2.5, 57%) Lithium, (HQ = 0.63, 14%)

Table 15. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-18 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Dermal Contact	3.3×10^{-7}		0.69	Nitrate, (HQ = 0.32, 7.2%) Vanadium, (HQ = 0.10, 2.3%)
	Inhalation of Volatiles	8.6×10^{-6}		0.11	
	Total Risk	**5.8×10^{-5}**		**Total HI**	**4.5**
Radionuclides	Ingestion	1.5×10^{-4}		--	
	Immersion	2.3×10^{-14}			
	Inhalation of Volatiles	1.1×10^{-2}			
	Total Risk	**1.1×10^{-2}**			
Total Cumulative ELCR		**1.1×10^{-2}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-18 is 1.1×10^{-2}. The total ELCR for nonradiological analytes is 5.8×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.1×10^{-2}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are chloroform (ELCR = 9.5×10^{-6}, 0.09 percent contribution) and tritium (ELCR = 1.1×10^{-2}, 99 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 4.8×10^{-5}, 0.45 percent contribution) where the EPC (2.5 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-18 without contribution from arsenic is 9.5×10^{-6}, which is equal to the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-18 is 4.5, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.42, 9.3 percent contribution), bromomethane (HQ = 0.13, 3.0 percent contribution), Cr(VI) (HQ = 2.5, 57 percent contribution), lithium (HQ = 0.63, 14 percent contribution), nitrate (HQ = 0.32, 7.2 percent contribution), and vanadium (HQ = 0.10, 2.3 percent contribution). The HI for well 199-K-18 without contribution from arsenic is 4.1, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Bromomethane: degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

With the exception of Cr(VI) and bromomethane, exposure to each of the analytes that contribute to the HI of 4.1 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for Cr(VI) and bromomethane results in an HI of 2.7, which is greater than the target HI of 1; evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-19. Table 16 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-19.

Table 16. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-19 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.9×10^{-5}	Arsenic, (ELCR = 1.9×10^{-5}, 5.4%) Tritium, (ELCR = 2.8×10^{-4}, 80%)	0.93	--
	Dermal Contact	1.0×10^{-7}		0.06	
	Inhalation of Volatiles	--		--	
	Total Risk	**1.9×10^{-5}**		**Total HI**	**0.98**
Radionuclides	Ingestion	2.6×10^{-5}		**--**	
	Immersion	4.1×10^{-13}			
	Inhalation of Volatiles	3.0×10^{-4}			
	Total Risk	**3.3×10^{-4}**			
Total Cumulative ELCR		**3.5×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-19 is 3.5×10^{-4}. The total ELCR for nonradiological analytes is 1.9×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 3.3×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are tritium (ELCR = 2.8×10^{-4}, 80 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 1.9×10^{-5}, 5.4 percent contribution) where the EPC (0.98 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-19 when contribution from arsenic is not included.

The HI for well 199-K-19 is 0.98, which is less than the MTCA (WAC 173-340-708(5)) target HI of 1.

Well 199-K-200. Table 17 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-200.

Table 17. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-200 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	5.6×10^{-7}	Strontium-90, (ELCR = 2.8×10^{-4}, 54%) Tritium, (ELCR = 2.0×10^{-4}, 39%)	0.74	--
	Dermal Contact	4.1×10^{-8}		0.09	
	Inhalation of Volatiles	4.3×10^{-6}		< 0.01	

Table 17. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-200 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Total Risk	**4.9×10^{-6}**		**Total HI**	**0.85**
Radionuclides	**Ingestion**	2.9×10^{-4}		--	
	Immersion	5.5×10^{-12}			
	Inhalation of Volatiles	2.3×10^{-4}			
	Total Risk	**5.2×10^{-4}**			
Total Cumulative ELCR		**5.3×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-200 is 5.3×10^{-4}. The total ELCR for nonradiological analytes is 4.9×10^{-6}, which is less than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 5.2×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are strontium-90 (ELCR = 2.8×10^{-4}, 54 percent contribution) and tritium (ELCR = 2.0×10^{-4}, 39 percent contribution). Arsenic was not reported at well 199-K-200.

The HI for well 199-K-200 is 0.85, which is less than the MTCA (WAC 173-340-708(5)) target HI of 1.

Well 199-K-201. Table 18 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-201.

Table 18. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-201 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	**Ingestion**	4.1×10^{-5}	Arsenic, (ELCR = 4.1×10^{-5}, 26%) Chloroform, (ELCR = 3.7×10^{-6}, 2.4%)	2.4	Arsenic, (HQ = 0.35, 12%) Fluoride, (HQ = 0.10, 3.3%) Cr(VI), (HQ = 2.1, 70%) Nitrate, (HQ = 0.22, 7.4%)
	Dermal Contact	2.4×10^{-7}		0.56	
	Inhalation of Volatiles	3.4×10^{-6}		< 0.01	
	Total Risk	**4.4×10^{-5}**		**Total HI**	**3.0**
Radionuclides	**Ingestion**	2.1×10^{-5}		--	
	Immersion	3.7×10^{-13}			
	Inhalation of Volatiles	9.3×10^{-5}			

Table 18. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-201 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Total Risk	**1.1×10^{-4}**			
Total Cumulative ELCR		**1.6×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-201 is 1.6×10^{-4}. The total ELCR for nonradiological analytes is 4.4×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.1×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is chloroform (ELCR = 3.7×10^{-6}, 2.4 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 4.1×10^{-5}, 26 percent contribution) where the EPC (2.1 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-201 without contribution from arsenic is 3.8×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-201 is 3.0, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.35, 12 percent contribution), fluoride (HQ = 0.10, 3.3 percent contribution), Cr(VI) (HQ = 2.1, 70 percent contribution), and nitrate (HQ = 0.22, 7.4 percent contribution). The HI for well 199-K-201 without contribution from arsenic is 2.6, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia

Exposure to each of the analytes that contribute to the HI of 2.6 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Cr(VI) has an HQ of 2.1, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-22. Table 19 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-22.

Table 19. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-22 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	**Ingestion**	3.1×10^{-7}	Tritium, (ELCR = 1.1×10^{-4}, 68%)	2.7	Bromomethane, (HQ = 0.13, 3.9%) Cr(VI), (HQ = 1.7, 52%) Lithium, (HQ = 0.53, 16%) Manganese, (HQ = 0.14, 4.4%) Nitrate, (HQ = 0.19, 5.8%) Vanadium, (HQ = 0.16, 4.7%)
	Dermal Contact	2.7×10^{-8}		0.50	
	Inhalation of Volatiles	3.2×10^{-6}		0.10	
	Total Risk	**3.6×10^{-6}**		**Total HI**	**3.3**

Table 19. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-22 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Radionuclides	Ingestion	2.9×10^{-5}		--	
	Immersion	3.9×10^{-13}			
	Inhalation of Volatiles	1.3×10^{-4}			
	Total Risk	**1.6×10^{-4}**			
Total Cumulative ELCR		**1.6×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-22 is 1.6×10^{-4}. The total ELCR for nonradiological analytes is 3.6×10^{-6}, which is less than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.6×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is tritium (ELCR = 1.1×10^{-4}, 68 percent contribution). Arsenic was not reported at well 199-K-22.

The HI for well 199-K-22 is 3.3, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are bromomethane (HQ = 0.13, 3.9 percent contribution), Cr(VI) (HQ = 1.7, 52 percent contribution), lithium (HQ = 0.53, 16 percent contribution), manganese (HQ = 0.14, 4.4 percent contribution), nitrate (HQ = 0.19, 5.8 percent contribution), and vanadium (HQ = 0.16, 4.7 percent contribution).

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Bromomethane: degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Manganese: nervous system effects
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

With the exception of Cr(VI), bromomethane, manganese, and lithium, exposure to each of the analytes that contribute to the HI of 3.3 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for Cr(VI) and bromomethane results in an HI of 1.9, which is greater than the target HI of 1. Combining the HQs for manganese and lithium results in an HI of 0.67, which is less than the target HI of 1. Evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-23. Table 20 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-23.

Table 20. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-23 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Ingestion	6.3×10^{-5}	Arsenic, (ELCR = 6.4×10^{-5}, 34%) Carbon-14, (ELCR = 1.1×10^{-4},	14	Arsenic, (HQ = 0.55, 3.9%) Cobalt, (HQ = 0.10, 0.73%)

Table 20. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-23 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Dermal Contact	3.4×10^{-7}	60%)	0.42	Fluoride, (HQ = 0.12, 0.84%) Cr(VI), (HQ = 1.3, 8.9%) Manganese, (HQ = 0.13, 0.94%) Nitrate, (HQ = 0.43, 3.0%) Thallium, (HQ = 11, 78%) Uranium, (HQ = 0.11, 0.76%)
	Inhalation of Volatiles	--		--	
	Total Risk	**6.4×10^{-5}**		**Total HI**	**14**
Radionuclides	Ingestion	4.3×10^{-6}		**--**	
	Immersion	3.8×10^{-14}			
	Inhalation of Volatiles	1.2×10^{-4}			
	Total Risk	**1.2×10^{-4}**			
Total Cumulative ELCR		**1.9×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-23 is 1.9×10^{-4}. The total ELCR for nonradiological analytes is 6.4×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.2×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is carbon-14 (ELCR = 1.1×10^{-4}, 60 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 6.4×10^{-5}, 34 percent contribution) where the EPC (3.3 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-23 when contribution from arsenic is not included.

The HI for well 199-K-23 is 14, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.55, 3.9 percent contribution), cobalt (HQ = 0.10, 0.73 percent contribution), fluoride (HQ = 0.12, 0.84 percent contribution), Cr(VI) (HQ = 1.3, 8.9 percent contribution), manganese (HQ = 0.13, 0.94 percent contribution), nitrate (HQ = 0.43, 3.0 percent contribution), thallium (HQ = 11, 78 percent contribution), and uranium (HQ = 0.11, 0.76 percent contribution). Contribution to HI is elevated for thallium (HQ = 11) where the EPC (2.2 µg/L) is greater than the range of background concentrations (minimum, maximum, and 90th percentile) of 0.883, 1.73, and 1.67 µg/L for filtered groundwater samples. Thallium was detected in one of six samples from this well and all filtered thallium sample results were less than the 90th percentile value. The HI for well 199-K-23 without contribution from arsenic and thallium is 2.6, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Cobalt: thyroid, decreased iodine uptake
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy

- Manganese: nervous system effects
- Nitrate: early clinical signs of methemoglobinemia
- Uranium: initial body weight loss and moderate nephrotoxicity

Exposure to each of the analytes that contribute to the HI of 2.6 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Cr(VI) reports an individual HQ of 1.3, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-29. Table 21 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-29.

Table 21. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-29 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	--	Carbon-14, (ELCR = 4.4×10^{-3}, 33%) Tritium, (ELCR = 9.0×10^{-3}, 67%)	0.60	--
	Dermal Contact	--		0.01	
	Inhalation of Volatiles	--		--	
	Total Risk	--		Total HI	**0.61**
Radionuclides	Ingestion	2.2×10^{-4}		--	
	Immersion	1.3×10^{-13}			
	Inhalation of Volatiles	1.3×10^{-2}			
	Total Risk	**1.3×10^{-2}**			
Total Cumulative ELCR		**1.3×10^{-2}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-29 is 1.3×10^{-2}. There were no carcinogenic nonradiological analytes measured; therefore, nonradiological cancer risks are not reported for this well. The total ELCR for radiological analytes is 1.3×10^{-2}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 4.4×10^{-3}, 33 percent contribution) and tritium (ELCR = 9.0×10^{-3}, 67 percent contribution). Arsenic was not analyzed for in well 199-K-29.

The HI for well 199-K-29 is 0.61, which is less than the MTCA (WAC 173-340-708(5)) target HI of 1.

Well 199-K-30. Table 22 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-30.

Table 22. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-30 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	--	Carbon-14, (ELCR = 5.7×10^{-3}, 23%) Tritium, (ELCR = 1.9×10^{-2}, 77%)	0.84	--
	Dermal Contact	--		0.05	
	Inhalation of Volatiles	--		--	
	Total Risk	--		Total HI	**0.89**
Radionuclides	Ingestion	4.0×10^{-4}		--	
	Immersion	2.0×10^{-10}			
	Inhalation of Volatiles	2.5×10^{-2}			
	Total Risk	**2.5×10^{-2}**			
Total Cumulative ELCR		**2.5×10^{-2}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-30 is 2.5×10^{-2}. There were no carcinogenic nonradiological analytes measured; therefore, nonradiological cancer risks are not reported for this well. The total ELCR for radiological analytes is 2.5×10^{-2}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 5.7×10^{-3}, 23 percent contribution) and tritium (ELCR = 1.9×10^{-2}, 77 percent contribution).

The HI for well 199-K-30 is 0.89, which is less than the MTCA (WAC 173-340-708(5)) target HI of 1.

Well 199-K-32A. Table 23 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-32A.

Table 23. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-32A – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	3.1×10^{-5}	Arsenic, (ELCR = 3.0×10^{-5}, 2.9%) Bromodichloromethane, (ELCR = 1.2×10^{-6}, 0.11%) Carbon-14, (ELCR = 3.8×10^{-4}, 36%)	1.6	Arsenic, (HQ = 0.26, 14%) Bromomethane, (HQ = 0.13, 6.8%) Cr(VI), (HQ = 0.29, 15%) Lithium, (HQ = 0.40, 21%)
	Dermal Contact	2.7×10^{-7}		0.10	

Table 23. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-32A – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Inhalation of Volatiles	1.1×10^{-5}	Chloroform, (ELCR = 1.0×10^{-5}, 0.99%) Tritium, (ELCR = 6.2×10^{-4}, 59%)	0.16	Nitrate, (HQ = 0.21, 11%) Silver, (HQ = 0.13, 7.0%)
	Total Risk	**4.2×10^{-5}**		**Total HI**	**1.9**
Radionuclides	Ingestion	2.1×10^{-5}		--	
	Immersion	9.1×10^{-14}			
	Inhalation of Volatiles	9.9×10^{-4}			
	Total Risk	**1.0×10^{-3}**			
Total Cumulative ELCR		**1.1×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-32A is 1.1×10^{-3}. The total ELCR for nonradiological analytes is 4.2×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.0×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are bromodichloromethane (ELCR = 1.2×10^{-6}, 0.11 percent contribution), carbon-14 (ELCR = 3.8×10^{-4}, 36 percent contribution), chloroform (ELCR = 1.0×10^{-5}, 0.99 percent contribution), and tritium (ELCR = 6.2×10^{-4}, 59 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 3.0×10^{-5}, 2.9 percent contribution) where the EPC (1.6 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-32A without contribution from arsenic is 1.2×10^{-5}, which is greater than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-32A is 1.9, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.26, 14 percent contribution), bromomethane (HQ = 0.13, 6.8 percent contribution), Cr(VI) (HQ = 0.29, 15 percent contribution), lithium (HQ = 0.40, 21 percent contribution), nitrate (HQ = 0.21, 11 percent contribution), and silver (HQ = 0.13, 7.0 percent contribution). The HI for well 199-K-32A without contribution from arsenic is 1.6, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Bromomethane: degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Nitrate: early clinical signs of methemoglobinemia
- Silver: argyia (dermal)

With the exception of Cr(VI) and bromomethane, exposure to each of the analytes that contribute to the HI of 1.6 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for Cr(VI) and bromomethane results in an HI of 0.42, which is less than the target HI of 1. Evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-34. Table 24 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-34.

Table 24. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-34 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	4.2×10^{-5}	Arsenic, (ELCR = 4.0×10^{-5}, 0.70%) Carbon-14, (ELCR = 5.5×10^{-3}, 95%) Chloroform, (ELCR = 1.9×10^{-6}, 0.03%) TCE, (ELCR = 3.5×10^{-6}, 0.06%) Tritium, (ELCR = 1.6×10^{-4}, 2.7%)	3.5	2-Propanol, (HQ = 0.31, 6.9%) Arsenic, (HQ = 0.35, 7.7%) Cobalt, (HQ = 0.74, 16%) Fluoride, (HQ = 0.19, 4.2%) Cr(VI), (HQ = 0.44, 9.8%) Lithium, (HQ = 0.50, 11%) Nickel, (HQ = 0.43, 9.4%) Nitrate, (HQ = 0.32, 7.0%) TCE, (HQ = 0.87, 19%) Uranium, (HQ = 0.10, 2.2%)
	Dermal Contact	4.7×10^{-7}		0.19	
	Inhalation of Volatiles	3.5×10^{-6}		0.90	
	Total Risk	**4.6×10^{-5}**		**Total HI**	**4.6**
Radionuclides	Ingestion	1.8×10^{-4}		--	
	Immersion	1.3×10^{-12}			
	Inhalation of Volatiles	5.5×10^{-3}			
	Total Risk	**5.7×10^{-3}**			
Total Cumulative ELCR		**5.7×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-34 is 5.7×10^{-3}. The total ELCR for nonradiological analytes is 4.6×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 5.7×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 5.5×10^{-3}, 95 percent contribution), chloroform (ELCR = 1.9×10^{-6}, 0.03 percent contribution), TCE (ELCR = 3.5×10^{-6}, 0.06 percent contribution), and tritium (ELCR = 1.6×10^{-4}, 2.7 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 4.0×10^{-5}, 0.70 percent contribution) where the EPC (2.1 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-34 without contribution from arsenic is 5.3×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-34 is 4.6, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are 2-propanol (HQ = 0.31, 6.9 percent contribution), arsenic (HQ = 0.35, 7.7 percent contribution), cobalt (HQ = 0.74, 16 percent contribution), fluoride (HQ = 0.19, 4.2 percent contribution), Cr(VI) (HQ = 0.44, 9.8 percent contribution), lithium (HQ = 0.50, 11 percent contribution), nickel (HQ = 0.43, 9.4 percent contribution), nitrate (HQ = 0.32, 7.0 percent contribution), TCE (HQ = 0.87, 19 percent contribution), and uranium (HQ = 0.10, 2.2 percent contribution). The HI for well 199-K-34 without contribution from arsenic is 4.2, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- 2-Propanol: decreased fetal weight
- Cobalt: thyroid, decreased iodine uptake
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Nickel: decreased body and organ weights
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Uranium: initial body weight loss and moderate nephrotoxicity

With the exception of 2-propanol, TCE, uranium, lithium, and nickel, exposure to each of the analytes that contribute to the HI of 4.2 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for uranium and lithium results in an HI of 0.60, which is less than the target HI of 1. Combining the HQs for uranium and nickel results in an HI of 0.53, which is less than the target HI of 1. Combining the HQs for 2-propanol and TCE results in a HI of 1.2, which is greater than the target HI of 1. Evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-36. Table 25 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-36.

Table 25. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-36 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.1×10^{-4}	Arsenic, (ELCR = 1.1×10^{-4}, 35%) Carbon-14, (ELCR = 1.7×10^{-4}, 53%) Chloroform, (ELCR = 3.2×10^{-6}, 1.0%)	6.3	Arsenic, (HQ = 0.94, 12%) Bromomethane, (HQ = 0.13, 1.7%) Cobalt, (HQ = 0.24, 3.0%) Fluoride, (HQ = 0.30, 3.8%) Cr(VI), (HQ = 4.6, 59%) Lithium, (HQ = 0.50, 6.4%) Nickel, (HQ = 0.20, 2.5%) Nitrate, (HQ = 0.20, 2.5%) TCE, (HQ = 0.21, 2.7%) Vanadium, (HQ = 0.15, 1.9%)
	Dermal Contact	6.6×10^{-7}		1.3	
	Inhalation of Volatiles	3.3×10^{-6}		0.24	
	Total Risk	**1.1×10^{-4}**		**Total HI**	**7.8**
	Ingestion	7.8×10^{-6}		--	

Table 25. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-36 – Monitoring Well Screened Across the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Radionuclides	Immersion	6.8×10^{-14}			
	Inhalation of Volatiles	1.9×10^{-4}			
	Total Risk	**2.0×10^{-4}**			
Total Cumulative ELCR		**3.1×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-36 is 3.1×10^{-4}. The total ELCR for nonradiological analytes is 1.1×10^{-4}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.0×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 1.7×10^{-4}, 53 percent contribution) and chloroform (ELCR = 3.2×10^{-6}, 1.0 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 1.1×10^{-4}, 35 percent contribution) where the EPC (5.6 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-36 without contribution from arsenic is 4.0×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-36 is 7.8, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.94, 12 percent contribution), bromomethane (HQ = 0.13, 1.7 percent contribution), cobalt (HQ = 0.24, 3.0 percent contribution), fluoride (HQ = 0.30, 3.8 percent contribution), Cr(VI) (HQ = 4.6, 59 percent contribution), lithium (HQ = 0.50, 6.4 percent contribution), nickel (HQ = 0.20, 2.5 percent contribution), nitrate (HQ = 0.20, 2.5 percent contribution), TCE (HQ = 0.21, 2.7 percent contribution), and vanadium (HQ = 0.15, 1.9 percent contribution). The HI for well 199-K-36 without contribution from arsenic is 6.8, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Bromomethane: degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity
- Cobalt: thyroid, decreased iodine uptake
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Nickel: decreased body and organ weights
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of Cr(VI) and bromomethane, exposure to each of the analytes that contribute to the HI of 6.8 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for Cr(VI) and bromomethane results in an HI of 4.7, which is greater than the target HI of 1; evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 699-73-61. Table 26 provides a summary of the cancer risks and noncancer hazards by exposure route for well 699-73-61.

Table 26. Summary of Cancer Risks and Noncancer Hazards for Well 699-73-61 – Monitoring Well Screened at the Top of the Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	3.6×10^{-5}	Arsenic, (ELCR = 3.6×10^{-5}, 63%)	1.6	Arsenic, (HQ = 0.31, 18%) Fluoride, (HQ = 0.19, 11%) Lithium, (HQ = 0.25, 14%) Manganese, (HQ = 0.13, 7.7%) TCE, (HQ = 0.15, 9.0%) Vanadium, (HQ = 0.17, 9.8%) Zinc, (HQ = 0.20, 11%)
	Dermal Contact	2.4×10^{-7}		0.05	
	Inhalation of Volatiles	9.2×10^{-7}		0.11	
	Total Risk	**3.7×10^{-5}**		**Total HI**	**1.7**
Radionuclides	Ingestion	2.8×10^{-6}		--	
	Immersion	1.5×10^{-13}			
	Inhalation of Volatiles	1.7×10^{-5}			
	Total Risk	**2.0×10^{-5}**			
Total Cumulative ELCR		**5.7×10^{-5}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 699-73-61 is 5.7×10^{-5}. The total ELCR for nonradiological analytes is 3.7×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.0×10^{-5}, which is within the EPA risk threshold range of 1×10^{-4} to 1×10^{-6}.

There are no major risk contributors. Contribution to ELCR is elevated for arsenic (ELCR = 3.6×10^{-5}, 63 percent contribution) where the EPC (1.8 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 699-73-61 without contribution from arsenic is 1.3×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 699-73-61 is 1.7, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.31, 18 percent contribution), fluoride (HQ = 0.19, 11 percent contribution), lithium (HQ = 0.25, 14 percent contribution), manganese (HQ = 0.13, 7.7 percent contribution), TCE (HQ = 0.15, 9.0 percent contribution), vanadium (HQ = 0.17, 9.8 percent contribution), and zinc (HQ = 0.20, 11 percent contribution). The HI for well 699-73-61 without contribution from arsenic is 1.4, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Lithium: nervous system and kidney effects
- Manganese: nervous system effects
- TCE: developmental immunotoxicity

- Vanadium: decreased hair cysteine
- Zinc: decreases in erythrocyte Cu, Zn-superoxide dismutase (ESOD) activity in healthy adult male and female volunteers

With the exception of manganese, lithium, TCE, and zinc, exposure to each of the analytes that contribute to the HI of 1.4 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for manganese and lithium results in an HI of 0.38, which is less than the target HI of 1. Combining the HQs for TCE and zinc results in an HI of 0.35, which is less than the target HI of 1. Evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

7.2 Extraction Well 199-K-137 Screened Across Top of the Unconfined Aquifer

Well 199-K-137. Table 27**Error! Reference source not found.** provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-137.

Table 27. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-137 – Extraction Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	5.1×10^{-5}	Arsenic, (ELCR = 4.8×10^{-5}, 3.2%) Carbon-14, (ELCR = 1.4×10^{-3}, 89%) Chloroform, (ELCR = 2.4×10^{-6}, 0.16%) TCE, (ELCR = 6.2×10^{-6}, 0.41%)	2.5	Arsenic, (HQ = 0.42, 10%) Fluoride, (HQ = 0.16, 4.0%) Cr(VI), (HQ = 1.3, 33%) Nitrate, (HQ = 0.19, 4.8%) TCE, (HQ = 1.6, 39%) Vanadium, (HQ = 0.14, 3.6%)
	Dermal Contact	7.0×10^{-7}		0.45	
	Inhalation of Volatiles	5.4×10^{-6}		1.1	
	Total Risk	**5.7×10^{-5}**		**Total HI**	**4.0**
Radionuclides	Ingestion	3.2×10^{-5}		--	
	Immersion	5.3×10^{-14}			
	Inhalation of Volatiles	1.4×10^{-3}			
	Total Risk	**1.5×10^{-3}**			
Total Cumulative ELCR		**1.5×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-137 is 1.5×10^{-3}. The total ELCR for nonradiological analytes is 5.7×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.5×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 1.4×10^{-3}, 89 percent contribution), chloroform (ELCR = 2.4×10^{-6}, 0.16 percent contribution), and TCE (ELCR = 6.2×10^{-6}, 0.41 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 4.8×10^{-5}, 3.2 percent contribution) where the EPC (2.5 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-

K-137 without contribution from arsenic is 8.6×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-137 is 4.0, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.42, 10 percent contribution), fluoride (HQ = 0.16, 4.0 percent contribution), Cr(VI) (HQ = 1.3, 33 percent contribution), nitrate (HQ = 0.19, 4.8 percent contribution), TCE (HQ = 1.6, 39 percent contribution), and vanadium (HQ = 0.14, 3.6 percent contribution). The HI for well 199-K-137 without contribution from arsenic is 3.6, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 3.6 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Cr(VI) reports an individual HQ of 1.3, which is greater than the target HI of 1. TCE reports an individual HQ of 1.6, which is greater than the target HI of 1. Evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

7.3 Monitoring Wells Screened Across the Upper Unconfined Aquifer

Well 199-K-11. Table 28 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-11.

Table 28. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-11– Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.3×10^{-4}	Arsenic, (ELCR = 1.3×10^{-4}, 36%) Carbon-14, (ELCR = 1.8×10^{-4}, 51%) Chloroform, (ELCR = 4.8×10^{-6}, 1.3%) TCE, (ELCR = 6.8×10^{-6}, 1.9%)	3.3	Arsenic, (HQ = 1.1, 24%) Bromomethane, (HQ = 0.13, 2.7%) Fluoride, (HQ = 0.20, 4.1%) Cr(VI), (HQ = 0.38, 8.0%) Lithium, (HQ = 0.40, 8.4%) Nitrate, (HQ = 0.32, 6.8%) TCE, (HQ = 1.7, 36%) Uranium, (HQ = 0.10, 2.0%) Vanadium, (HQ = 0.24, 5.1%)
	Dermal Contact	1.2×10^{-6}		0.22	
	Inhalation of Volatiles	7.9×10^{-6}		1.2	
	Total Risk	**1.4×10^{-4}**		**Total HI**	**4.8**
Radionuclides	Ingestion	6.0×10^{-6}		--	
	Immersion	1.8×10^{-14}			
	Inhalation of Volatiles	2.1×10^{-4}			

Table 28. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-11– Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Total Risk	2.2×10^{-4}			
Total Cumulative ELCR		3.6×10^{-4}			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-11 is 3.6×10^{-4}. The total ELCR for nonradiological analytes is 1.4×10^{-4}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.2×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 1.8×10^{-4}, 51 percent contribution), chloroform (ELCR = 4.8×10^{-6}, 1.3 percent contribution), and TCE (ELCR = 6.8×10^{-6}, 1.9 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 1.3×10^{-4}, 36 percent contribution) where the EPC (6.7 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-11 without contribution from arsenic is 1.2×10^{-5}, which is greater than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-11 is 4.8, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 1.1, 24 percent contribution), bromomethane (HQ = 0.13, 2.7 percent contribution), fluoride (HQ = 0.20, 4.1 percent contribution), Cr(VI) (HQ = 0.38, 8.0 percent contribution), lithium (HQ = 0.40, 8.4 percent contribution), nitrate (HQ = 0.32, 6.8 percent contribution), TCE (HQ = 1.7, 36 percent contribution), uranium (HQ = 0.10, 2.0 percent contribution), and vanadium (HQ = 0.24, 5.1 percent contribution). The HI for well 199-K-11 without contribution from arsenic is 3.6, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Bromomethane: degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Uranium: initial body weight loss and moderate nephrotoxicity
- Vanadium: decreased hair cysteine

With the exception of Cr(VI), bromomethane, uranium, and lithium, exposure to each of the analytes that contribute to the HI of 3.6 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for Cr(VI) and bromomethane results in an HI of 0.51, which is less than the target HI of 1. Combining the HQs for uranium and lithium results in an HI of 0.50, which is less than the target HI of 1. TCE reports an individual HQ of 1.7, which is greater than the target HI of 1; evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-117A. Table 29 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-117A.

Table 29. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-117A – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.9×10^{-5}	Arsenic, (ELCR = 1.9×10^{-5}, 47%)	12	Arsenic, (HQ = 0.16, 1.3%) Bromomethane, (HQ = 0.15, 1.2%) Thallium, (HQ = 12, 95%)
	Dermal Contact	9.9×10^{-8}		0.08	
	Inhalation of Volatiles	--		0.11	
	Total Risk	**1.9×10^{-5}**		**Total HI**	**13**
Radionuclides	Ingestion	3.7×10^{-6}		--	
	Immersion	6.7×10^{-14}			
	Inhalation of Volatiles	1.7×10^{-5}			
	Total Risk	**2.1×10^{-5}**			
Total Cumulative ELCR		**3.9×10^{-5}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-117A is 3.9×10^{-5}. The total ELCR for nonradiological analytes is 1.9×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.1×10^{-5}, which is within the EPA risk threshold range of 1×10^{-4} to 1×10^{-6}.

There are no major risk contributors. Contribution to ELCR is elevated for arsenic (ELCR = 1.9×10^{-5}, 47 percent contribution) where the EPC (0.97 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-117A when contribution from arsenic is not included.

The HI for well 199-K-117A is 13, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.16, 1.3 percent contribution), bromomethane (HQ = 0.15, 1.2 percent contribution), and thallium (HQ = 12, 95 percent contribution). Contribution to HI is elevated for thallium (HQ = 12) where the EPC (2.4 µg/L) is greater than the range of background concentrations (minimum, maximum, and 90th percentile) of 0.883, 1.73, and 1.67 µg/L for filtered groundwater samples. Thallium was detected in one of 28 unfiltered samples and 2 of 28 filtered samples from this well. The presence of thallium is likely naturally occurring due to the sporadic nature of the detections and because only one sample result was greater than the 90th percentile value. The HI for well 199-K-117A without contribution from arsenic and thallium is 0.45, which is less than the target HI of 1.

Well 199-K-125A. Table 30 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-125A.

Table 30. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-125A – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	8.3×10^{-5}	Arsenic, (ELCR = 8.4×10^{-5}, 15%) Tritium, (ELCR = 4.1×10^{-4}, 75%)	4.5	Arsenic, (HQ = 0.72, 16%) Fluoride, (HQ = 0.13, 2.9%) Iron, (HQ = 0.11, 2.4%) Nitrate, (HQ = 0.10, 2.2%) Thallium, (HQ = 2.9, 64%) Vanadium, (HQ = 0.16, 3.6%)
	Dermal Contact	4.4×10^{-7}		0.07	
	Inhalation of Volatiles	--		--	
	Total Risk	**8.4×10^{-5}**		Total HI	**4.5**
Radionuclides	Ingestion	9.5×10^{-6}		--	
	Immersion	5.4×10^{-14}			
	Inhalation of Volatiles	4.6×10^{-4}			
	Total Risk	**4.6×10^{-4}**			
Total Cumulative ELCR		**5.5×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-125A is 5.5×10^{-4}. The total ELCR for nonradiological analytes is 8.4×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 4.6×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is tritium (ELCR = 4.1×10^{-4}, 75 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 8.4×10^{-5}, 15 percent contribution) where the EPC (4.3 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-125A when contribution from arsenic is not included.

The HI for well 199-K-125A is 4.5, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.72, 16 percent contribution), fluoride (HQ = 0.13, 2.9 percent contribution), iron (HQ = 0.11, 2.4 percent contribution), nitrate (HQ = 0.10, 2.2 percent contribution), thallium (HQ = 2.9, 64 percent contribution), and vanadium (HQ = 0.16, 3.6 percent contribution). Contribution to HI is elevated for thallium (HQ = 5.0) where the EPC (0.58 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-125A without contribution from arsenic and thallium is 0.90, which is less than the target HI of 1.

Well 199-K-138. Table 31 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-138.

Table 31. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-138 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	4.5×10^{-5}	Arsenic, (ELCR = 4.3×10^{-5}, 4.7%) Carbon-14, (ELCR = 7.6×10^{-4}, 84%) Chloroform, (ELCR = 2.0×10^{-6}, 0.21%) TCE, (ELCR = 5.9×10^{-6}, 0.65%) Tritium, (ELCR = 9.6×10^{-5}, 11%)	1.6	2-Propanol, (HQ = 0.31, 10%) Arsenic, (HQ = 0.37, 12%) Fluoride, (HQ = 0.16, 5.3%) Cr(VI), (HQ = 0.33, 11%) Nitrate, (HQ = 0.18, 5.8%) TCE, (HQ = 1.5, 48%) Vanadium, (HQ = 0.12, 3.9%)
	Dermal Contact	6.4×10^{-7}		0.17	
	Inhalation of Volatiles	4.8×10^{-6}		1.3	
	Total Risk	**5.0×10^{-5}**		**Total HI**	**3.1**
Radionuclides	Ingestion	2.2×10^{-5}		--	
	Immersion	7.3×10^{-14}			
	Inhalation of Volatiles	8.4×10^{-4}			
	Total Risk	**8.6×10^{-4}**			
Total Cumulative ELCR		**9.1×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-138 is 9.1×10^{-4}. The total ELCR for nonradiological analytes is 5.0×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 8.6×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 7.6×10^{-4}, 84 percent contribution), chloroform (ELCR = 2.0×10^{-6}, 0.21 percent contribution), TCE (ELCR = 5.9×10^{-6}, 0.65 percent contribution), and tritium (ELCR = 9.6×10^{-5}, 11 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 4.3×10^{-5}, 4.7 percent contribution) where the EPC (2.2 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-138 without contribution from arsenic is 7.9×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-138 is 3.1, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are 2-propanol (HQ = 0.31, 10 percent contribution), arsenic (HQ = 0.37, 12 percent contribution), fluoride (HQ = 0.16, 5.3 percent contribution), Cr(VI) (HQ = 0.33, 11 percent contribution), nitrate (HQ = 0.18, 5.8 percent contribution), TCE (HQ = 1.5, 48 percent contribution), and vanadium (HQ = 0.12, 3.9 percent contribution). The HI for well 199-K-138 without contribution from arsenic is 2.7, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- 2-Propanol: decreased fetal body weight
- Fluoride: objectionable dental fluorosis, a cosmetic effect

- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of 2-propanol and TCE, exposure to each of the analytes that contribute to the HI of 2.7 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for 2-propanol and TCE results in an HI of 1.8, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-142. Table 32 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-142.

Table 32. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-142 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	9.6×10^{-5}	Arsenic, (ELCR = 9.6×10^{-5}, 22%) Carbon-14, (ELCR = 3.1×10^{-4}, 71%) Chloroform, (ELCR = 5.4×10^{-6}, 1.3%)	5.0	Arsenic, (HQ = 0.83, 16%) Bromomethane, (HQ = 0.13, 2.4%) Fluoride, (HQ = 0.20, 3.8%) Cr(VI), (HQ = 0.23, 4.5%) Thallium, (HQ = 3.3, 63%) Vanadium, (HQ = 0.26, 4.9%)
	Dermal Contact	5.6×10^{-7}		0.12	
	Inhalation of Volatiles	5.6×10^{-6}		0.10	
	Total Risk	**1.0×10^{-4}**		**Total HI**	**5.2**
Radionuclides	Ingestion	1.3×10^{-5}		--	
	Immersion	4.9×10^{-14}			
	Inhalation of Volatiles	3.2×10^{-4}			
	Total Risk	**3.3×10^{-4}**			
Total Cumulative ELCR		**4.3×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-142 is 4.3×10^{-4}. The total ELCR for nonradiological analytes is 1.0×10^{-4}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 3.3×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 3.1×10^{-4}, 71 percent contribution) and chloroform (ELCR = 5.4×10^{-6}, 1.3 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 9.6×10^{-5}, 22 percent contribution) where the EPC (4.9 µg/L) is less than the 90th percentile Hanford Site background

value of 7.85 µg/L. The nonradiological ELCR for well 199-K-142 without contribution from arsenic is 6.3×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-142 is 5.2, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.83, 16 percent contribution), bromomethane (HQ = 0.13, 2.4 percent contribution), fluoride (HQ = 0.20, 3.8 percent contribution), Cr(VI) (HQ = 0.23, 4.5 percent contribution), thallium (HQ = 3.3, 63 percent contribution), and vanadium (HQ = 0.26, 4.9 percent contribution). Contribution to HI is elevated for thallium (HQ = 3.3) where the EPC (0.66 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-142 without contribution from arsenic and thallium is 1.1, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Bromomethane: degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Vanadium: decreased hair cysteine

With the exception of Cr(VI) and bromomethane, exposure to each of the analytes that contribute to the HI of 1.1 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for Cr(VI) and bromomethane results in an HI of 0.36, which is less than the target HI of 1. Evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-173. Table 33 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-173.

Table 33. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-173 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.3×10^{-5}	Arsenic, (ELCR = 7.1×10^{-5}, 8.4%) Carbon-14, (ELCR = 6.7×10^{-4}, 79%) Chloroform, (ELCR = 1.5×10^{-6}, 0.17%) TCE, (ELCR = 5.8×10^{-6}, 0.68%) Tritium, (ELCR = 9.5×10^{-5}, 11%)	17	Antimony, (HQ = 0.15, 0.70%) Arsenic, (HQ = 0.61, 3.0%) Fluoride, (HQ = 0.18, 0.85%) Cr(VI), (HQ = 9.0, 44%) Nitrate, (HQ = 0.16, 0.78%) Thallium, (HQ = 8.5, 41%) TCE, (HQ = 1.4, 7.0%) Vanadium, (HQ = 0.15, 0.71%)
	Dermal Contact	7.8×10^{-7}		2.5	
	Inhalation of Volatiles	4.3×10^{-6}		1.1	
	Total Risk	**7.8×10^{-5}**		**Total HI**	**21**
Radionuclides	Ingestion	2.0×10^{-5}		--	
	Immersion	8.3×10^{-14}			
	Inhalation of Volatiles	7.5×10^{-4}			
	Total Risk	**7.7×10^{-4}**			
Total Cumulative ELCR		**8.5×10^{-4}**			

Table 33. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-173 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-173 is 8.5×10^{-4}. The total ELCR for nonradiological analytes is 7.8×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 7.7×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 6.7×10^{-4}, 79 percent contribution), chloroform (ELCR = 1.5×10^{-6}, 0.17 percent contribution), TCE (ELCR = 5.8×10^{-6}, 0.68 percent contribution), and tritium (ELCR = 9.5×10^{-5}, 11 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.1×10^{-5}, 8.4 percent contribution) where the EPC (3.7 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-173 without contribution from arsenic is 7.3×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-173 is 21, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are antimony (HQ = 0.15, 0.70 percent contribution), arsenic (HQ = 0.61, 3.0 percent contribution), fluoride (HQ = 0.18, 0.85 percent contribution), Cr(VI) (HQ = 9.0, 44 percent contribution), nitrate (HQ = 0.16, 0.78 percent contribution), thallium (HQ = 8.5, 41 percent contribution), TCE (HQ = 1.4, 7.0 percent contribution), and vanadium (HQ = 0.15, 0.71 percent contribution). Contribution to HI is elevated for thallium (HQ = 8.5) where the EPC (1.7 µg/L) is within the range of background concentrations (minimum, maximum, and 90th percentile) of 0.883, 1.73, and 1.67 µg/L for filtered groundwater samples. The HI for well 199-K-173 without contribution from arsenic and thallium is 11, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Antimony: longevity, blood glucose, and cholesterol
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of nitrate and antimony, exposure to each of the analytes that contribute to the HI of 12 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for nitrate and antimony results in an HI of 0.31, which is less than the target HI of 1. Cr(VI) reports an individual HQ of 9.0, which is greater than the target HI of 1. TCE reports an individual HQ of 1.4, which is greater than the target HI of 1. Evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-183. Table 34 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-183.

Table 34. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-183 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.6×10^{-5}	Arsenic, (ELCR = 7.4×10^{-5}, 8.7%) Carbon-14, (ELCR = 6.5×10^{-4}, 77%) Chloroform, (ELCR = 1.6×10^{-6}, 0.19%)	9.3	Arsenic, (HQ = 0.64, 6.1%) Fluoride, (HQ = 0.14, 1.3%) Cr(VI), (HQ = 0.18, 1.7%) Nitrate, (HQ = 0.18, 1.7%) Thallium, (HQ = 7.5, 72%)
	Dermal Contact	8.1×10^{-7}		0.17	

Table 34. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-183 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Inhalation of Volatiles	4.5×10^{-6}	TCE, (ELCR = 6.0×10^{-6}, 0.70%) Tritium, (ELCR = 1.1×10^{-4}, 13%)	1.0	TCE, (HQ = 1.5, 14%) Vanadium, (HQ = 0.13, 1.2%)
	Total Risk	**8.1×10^{-5}**		**Total HI**	**10**
Radionuclides	**Ingestion**	1.9×10^{-5}		**--**	
	Immersion	6.3×10^{-14}			
	Inhalation of Volatiles	7.5×10^{-4}			
	Total Risk	**7.7×10^{-4}**			
Total Cumulative ELCR		**8.5×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-183 is 8.5×10^{-4}. The total ELCR for nonradiological analytes is 8.1×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 7.7×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 6.5×10^{-4}, 77 percent contribution), chloroform (ELCR = 1.6×10^{-6}, 0.19 percent contribution), TCE (ELCR = 6.0×10^{-6}, 0.70 percent contribution), and tritium (ELCR = 1.1×10^{-4}, 13 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.4×10^{-5}, 8.7 percent contribution) where the EPC (3.8 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-183 without contribution from arsenic is 7.6×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-183 is 10, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.64, 6.1 percent contribution), fluoride (HQ = 0.14, 1.3 percent contribution), Cr(VI) (HQ = 0.18, 1.7 percent contribution), nitrate (HQ = 0.18, 1.7 percent contribution), thallium (HQ = 7.5, 72 percent contribution), TCE (HQ = 1.5, 14 percent contribution), and vanadium (HQ = 0.13, 1.2 percent contribution). Contribution to HI is elevated for thallium (HQ = 7.5) where the EPC (1.5 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-183 without contribution from arsenic and thallium is 2.3, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 2.3 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. TCE reports an individual HQ of 1.5, which is

greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-186. Table 35 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-186.

Table 35. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-186 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	8.4×10^{-5}	Arsenic, (ELCR = 8.4×10^{-5}, 32%) Carbon-14, (ELCR = 1.4×10^{-4}, 55%) Chloroform, (ELCR = 6.0×10^{-6}, 2.3%)	1.9	Arsenic, (HQ = 0.72, 32%) Cobalt, (HQ = 0.19, 8.2%) Fluoride, (HQ = 0.16, 7.2%) Cr(VI), (HQ = 0.48, 21%) TCE, (HQ = 0.23, 10%) Vanadium, (HQ = 0.15, 6.8%)
	Dermal Contact	5.5×10^{-7}		0.17	
	Inhalation of Volatiles	5.9×10^{-6}		0.16	
	Total Risk	**9.1×10^{-5}**		**Total HI**	**2.3**
Radionuclides	Ingestion	4.5×10^{-6}		--	
	Immersion	2.4×10^{-14}			
	Inhalation of Volatiles	1.7×10^{-4}			
	Total Risk	**1.7×10^{-4}**			
Total Cumulative ELCR		**2.6×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-186 is 2.6×10^{-4}. The total ELCR for nonradiological analytes is 9.1×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.7×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 1.4×10^{-4}, 55 percent contribution) and chloroform (ELCR = 6.0×10^{-6}, 2.3 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 8.4×10^{-5}, 32 percent contribution) where the EPC (4.3 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-186 without contribution from arsenic is 6.9×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-186 is 2.3, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.72, 32 percent contribution), cobalt (HQ = 0.19, 8.2 percent contribution), fluoride (HQ = 0.16, 7.2 percent contribution), Cr(VI) (HQ = 0.48, 21 percent contribution), TCE (HQ = 0.23, 10 percent contribution), and vanadium (HQ = 0.15, 6.8 percent contribution). The HI for well 199-K-186 without contribution from arsenic is 1.6, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Cobalt: thyroid, decreased iodine uptake

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.6 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-187. Table 36 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-187.

Table 36. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-187 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	9.3×10^{-5}	Arsenic, (ELCR = 9.2×10^{-5}, 61%) Chloroform, (ELCR = 9.5×10^{-7}, 0.62%) TCE, (ELCR = 2.2×10^{-6}, 1.4%)	5.2	Arsenic, (HQ = 0.80, 14%) Fluoride, (HQ = 0.20, 3.5%) Cr(VI), (HQ = 0.35, 6.0%) Nitrate, (HQ = 0.16, 2.7%) Thallium, (HQ = 3.2, 55%) TCE, (HQ = 0.55, 9.6%) Vanadium, (HQ = 0.16, 2.7%)
	Dermal Contact	6.5×10^{-7}		0.17	
	Inhalation of Volatiles	2.0×10^{-6}		0.37	
	Total Risk	**9.6×10^{-5}**		Total HI	**5.8**
Radionuclides	Ingestion	5.8×10^{-6}		--	
	Immersion	6.7×10^{-14}			
	Inhalation of Volatiles	5.1×10^{-5}			
	Total Risk	**5.7×10^{-5}**			
Total Cumulative ELCR		**1.5×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-187 is 1.5×10^{-4}. The total ELCR for nonradiological analytes is 9.6×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 5.7×10^{-5}, which is within the EPA risk threshold range of 1×10^{-4} to 1×10^{-6}.

The major contributors to the total cumulative ELCR are chloroform (ELCR = 9.5×10^{-7}, 0.62 percent contribution) and TCE (ELCR = 2.2×10^{-6}, 1.4 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 9.2×10^{-5}, 61 percent contribution) where the EPC (4.8 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-187 without contribution from arsenic is 3.2×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-187 is 5.8, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.80, 14 percent contribution), fluoride (HQ = 0.20, 3.5 percent contribution), Cr(VI) (HQ = 0.35, 6.0 percent contribution), nitrate (HQ = 0.16, 2.7 percent contribution), thallium (HQ = 3.2, 55 percent contribution), TCE (HQ = 0.55, 9.6 percent contribution), and vanadium (HQ = 0.16, 2.7 percent contribution). Contribution to HI is elevated for thallium (HQ = 3.2) where the EPC (0.63 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-187 without contribution from arsenic and thallium is 1.8, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.8 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1 for each contributor.

Well 199-K-188. Table 37 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-188.

Table 37. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-188 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	8.0×10^{-5}	Arsenic, (ELCR = 7.9×10^{-5}, 32%) Carbon-14, (ELCR = 1.2×10^{-4}, 51%) Chloroform, (ELCR = 1.4×10^{-6}, 0.59%) TCE, (ELCR = 2.7×10^{-6}, 1.1%)	2.1	Arsenic, (HQ = 0.68, 25%) Fluoride, (HQ = 0.35, 13%) Cr(VI), (HQ = 0.68, 24%) Nitrate, (HQ = 0.14, 5.2%) TCE, (HQ = 0.67, 24%) Vanadium, (HQ = 0.15, 5.3%)
	Dermal Contact	6.1×10^{-7}		0.24	
	Inhalation of Volatiles	2.7×10^{-6}		0.45	
	Total Risk	**8.3×10^{-5}**		**Total HI**	**2.8**
Radionuclides	Ingestion	5.6×10^{-6}		--	
	Immersion	3.5×10^{-14}			
	Inhalation of Volatiles	1.6×10^{-4}			
	Total Risk	**1.6×10^{-4}**			
Total Cumulative ELCR		**2.4×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-188 is 2.4×10^{-4}. The total ELCR for nonradiological analytes is 8.3×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.6×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 1.2×10^{-4}, 51 percent contribution), chloroform (ELCR = 1.4×10^{-6}, 0.59 percent contribution), and TCE (ELCR = 2.7×10^{-6}, 1.1 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.9×10^{-5}, 32 percent contribution) where the EPC (4.1 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-188 without contribution from arsenic is 4.1×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-188 is 2.8, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.68, 25 percent contribution), fluoride (HQ = 0.35, 13 percent contribution), Cr(VI) (HQ = 0.68, 24 percent contribution), nitrate (HQ = 0.14, 5.2 percent contribution), TCE (HQ = 0.67, 24 percent contribution), and vanadium (HQ = 0.15, 5.3 percent contribution). The HI for well 199-K-188 without contribution from arsenic is 2.1, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 2.1 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-191. Table 38 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-191.

Table 38. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-191 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.9×10^{-5}	Arsenic, (ELCR = 7.9×10^{-5}, 15%) Chloroform, (ELCR = 3.3×10^{-6}, 0.63%) Tritium, (ELCR = 4.2×10^{-4}, 82%)	1.7	Arsenic, (HQ = 0.68, 39%) Fluoride, (HQ = 0.23, 13%) Cr(VI), (HQ = 0.13, 7.5%) Nitrate, (HQ = 0.11, 6.3%) Thallium, (HQ = 0.10, 5.7%) Vanadium, (HQ = 0.13, 7.7%)
	Dermal Contact	4.5×10^{-7}		0.07	
	Inhalation of Volatiles	3.0×10^{-6}		< 0.01	
	Total Risk	**8.3×10^{-5}**		**Total HI**	**1.7**
Radionuclides	Ingestion	7.5×10^{-6}		--	
	Immersion	2.9×10^{-14}			

Table 38. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-191 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Inhalation of Volatiles	4.2×10^{-4}			
	Total Risk	**4.3×10^{-4}**			
Total Cumulative ELCR		**5.2×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-191 is 5.2×10^{-4}. The total ELCR for nonradiological analytes is 8.3×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 4.3×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are chloroform (ELCR = 3.3×10^{-6}, 0.63 percent contribution) and tritium (ELCR = 4.2×10^{-4}, 82 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.9×10^{-5}, 15 percent contribution) where the EPC (4.1 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-191 without contribution from arsenic is 3.3×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-191 is 1.7, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.68, 39 percent contribution), fluoride (HQ = 0.23, 13 percent contribution), Cr(VI) (HQ = 0.13, 7.5 percent contribution), nitrate (HQ = 0.11, 6.3 percent contribution), thallium (HQ = 0.10, 5.7 percent contribution), and vanadium (HQ = 0.13, 7.7 percent contribution). Contribution to HI is elevated for thallium (HQ = 0.10) where the EPC (0.02 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-191 without contribution from arsenic and thallium is 0.96, which is less than the target HI of 1.

Well 199-K-194. Table 39 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-194.

Table 39. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-194 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	9.9×10^{-5}	Arsenic, (ELCR = 9.9×10^{-5}, 53%) Chloroform, (ELCR = 4.1×10^{-6}, 2.2%)	3.3	1,2,4-Trichlorobenzene, (HQ = 0.16, 4.5%) Arsenic, (HQ = 0.86, 24%) Cobalt, (HQ = 0.88, 25%) Fluoride, (HQ = 0.24, 6.6%) Cr(VI), (HQ = 0.27, 7.4%) Thallium, (HQ = 0.65, 18%) Vanadium, (HQ = 0.20, 5.5%)
	Dermal Contact	8.8×10^{-7}		0.11	
	Inhalation of Volatiles	3.7×10^{-6}		0.16	
	Total Risk	**1.0×10^{-4}**		**Total HI**	**3.6**

Table 39. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-194 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Radionuclides	Ingestion	2.5×10^{-6}		--	
	Immersion	2.5×10^{-14}			
	Inhalation of Volatiles	8.1×10^{-5}			
	Total Risk	**8.3×10^{-5}**			
Total Cumulative ELCR		**1.9×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-194 is 1.9×10^{-4}. The total ELCR for nonradiological analytes is 1.0×10^{-4}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 8.3×10^{-5}, which is within the EPA risk threshold range of 1×10^{-4} to 1×10^{-6}.

The major contributor to the total cumulative ELCR is chloroform (ELCR = 4.1×10^{-6}, 2.2 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 9.9×10^{-5}, 53 percent contribution) where the EPC (5.1 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-194 without contribution from arsenic is 4.7×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-194 is 3.6, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are 1,2,4-trichlorobenzene (HQ = 0.16, 4.5 percent contribution), arsenic (HQ = 0.86, 24 percent contribution), cobalt (HQ = 0.88, 25 percent contribution), fluoride (HQ = 0.24, 6.6 percent contribution), Cr(VI) (HQ = 0.27, 7.4 percent contribution), thallium (HQ = 0.65, 18 percent contribution), and vanadium (HQ = 0.20, 5.5 percent contribution). Contribution to HI is elevated for thallium (HQ = 0.65) where the EPC (0.13 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-194 without contribution from arsenic and thallium is 2.1, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- 1,2,4-Trichlorobenzene: increased adrenal weights; vacuolization of zona fasciculata in the cortex
- Cobalt: thyroid, decreased iodine uptake
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 2.1 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-20. Table 40 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-20.

Table 40. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-20 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	4.6×10^{-5}	Arsenic, (ELCR = 4.6×10^{-5}, 6.2%) Chloroform, (ELCR = 3.3×10^{-6}, 0.45%) Tritium, (ELCR = 6.5×10^{-4}, 88%)	2.7	Arsenic, (HQ = 0.40, 14%) Iron, (HQ = 0.43, 15%) Lithium, (HQ = 0.13, 4.8%) Manganese, (HQ = 0.12, 4.4%) Nitrate, (HQ = 0.11, 3.9%) Thallium, (HQ = 1.1, 39%) Vanadium, (HQ = 0.12, 4.2%)
	Dermal Contact	2.7×10^{-7}		0.06	
	Inhalation of Volatiles	3.0×10^{-6}		< 0.01	
	Total Risk	**5.0×10^{-5}**		**Total HI**	**2.8**
Radionuclides	Ingestion	2.4×10^{-5}		--	
	Immersion	2.8×10^{-13}			
	Inhalation of Volatiles	6.7×10^{-4}			
	Total Risk	**6.9×10^{-4}**			
Total Cumulative ELCR		**7.4×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-20 is 7.4×10^{-4}. The total ELCR for nonradiological analytes is 5.0×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 6.9×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are chloroform (ELCR = 3.3×10^{-6}, 0.45 percent contribution) and tritium (ELCR = 6.5×10^{-4}, 88 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 4.6×10^{-5}, 6.2 percent contribution) where the EPC (2.4 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-20 without contribution from arsenic is 3.3×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-20 is 2.8, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.40, 14 percent contribution), iron (HQ = 0.43, 15 percent contribution), lithium (HQ = 0.13, 4.8 percent contribution), manganese (HQ = 0.12, 4.4 percent contribution), nitrate (HQ = 0.11, 3.9 percent contribution), thallium (HQ = 1.1, 39 percent contribution), and vanadium (HQ = 0.12, 4.2 percent contribution). Contribution to HI is elevated for thallium (HQ = 1.1) where the EPC (0.22 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-20 without contribution from arsenic and thallium is 1.3, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Iron: GI tract; adverse gastrointestinal effects
- Lithium: nervous system and kidney effects
- Manganese: nervous system effects
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

With the exception of manganese and lithium, exposure to each of the analytes that contribute to the HI of 1.3 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for manganese and lithium results in an HI of 0.26, which is less than the target HI of 1. Evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-204. Table 41 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-204.

Table 41. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-204 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	4.1×10^{-5}	Arsenic, (ELCR = 3.9×10^{-5}, 0.15%) Carbon-14, (ELCR = 2.5×10^{-2}, 98%) Chloroform, (ELCR = 2.5×10^{-6}, 0.01%) TCE, (ELCR = 5.0×10^{-6}, 0.02%) Tritium, (ELCR = 4.2×10^{-4}, 1.6%)	2.6	Arsenic, (HQ = 0.33, 4.5%) Cyanide, (HQ = 4.4, 60%) Fluoride, (HQ = 0.20, 2.7%) Manganese, (HQ = 0.28, 3.7%) Nitrate, (HQ = 0.30, 4.1%) TCE, (HQ = 1.2, 17%) Uranium, (HQ = 0.12, 1.6%) Vanadium, (HQ = 0.17, 2.3%)
	Dermal Contact	5.6×10^{-7}		0.14	
	Inhalation of Volatiles	4.9×10^{-6}		4.8	
	Total Risk	**4.6×10^{-5}**		**Total HI**	**7.5**
Radionuclides	Ingestion	5.3×10^{-4}		--	
	Immersion	7.2×10^{-13}			
	Inhalation of Volatiles	2.5×10^{-2}			
	Total Risk	**2.5×10^{-2}**			
Total Cumulative ELCR		**2.5×10^{-2}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-204 is 2.5×10^{-2}. The total ELCR for nonradiological analytes is 4.6×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.5×10^{-2}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 2.5×10^{-2}, 98 percent contribution), chloroform (ELCR = 2.5×10^{-6}, 0.01 percent contribution), TCE (ELCR = 5.0×10^{-6}, 0.02 percent contribution), and

tritium (ELCR = 4.2×10^{-4}, 1.6 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 3.9×10^{-5}, 0.15 percent contribution) where the EPC (2.0 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-204 without contribution from arsenic is 7.5×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-204 is 7.5, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.33, 4.5 percent contribution), cyanide (HQ = 4.4, 60 percent contribution), fluoride (HQ = 0.20, 2.7 percent contribution), manganese (HQ = 0.28, 3.7 percent contribution), nitrate (HQ = 0.30, 4.1 percent contribution), TCE (HQ = 1.2, 17 percent contribution), uranium (HQ = 0.12, 1.6 percent contribution), and vanadium (HQ = 0.17, 2.3 percent contribution). The HI for well 199-K-204 without contribution from arsenic is 7.1, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Cyanide: thyroid enlargement and altered iodide uptake
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Manganese: nervous system effects
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Uranium: initial body weight loss and moderate nephrotoxicity
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 7.1 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Cyanide reports an individual HQ of 4.4, which is greater than the target HI of 1. TCE reports an individual HQ of 1.2, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-21. Table 42 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-21.

Table 42. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-21 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.9×10^{-5}	Arsenic, (ELCR = 1.9×10^{-5}, 12%)	7.4	Arsenic, (HQ = 0.17, 2.2%) Cobalt, (HQ = 0.11, 1.4%) Cr(VI), (HQ = 0.28, 3.7%) Manganese, (HQ = 0.49, 6.4%) Nitrate, (HQ = 0.15, 1.9%) Thallium, (HQ = 6.0, 80%)
	Dermal Contact	1.0×10^{-7}		0.16	
	Inhalation of Volatiles	--		--	
	Total Risk	**1.9×10^{-5}**		**Total HI**	**7.5**
Radionuclides	Ingestion	4.6×10^{-5}		**--**	
	Immersion	1.3×10^{-12}			
	Inhalation of Volatiles	1.0×10^{-4}			
	Total Risk	**1.5×10^{-4}**			

Table 42. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-21 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Total Cumulative ELCR		**1.7×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-21 is 1.7×10^{-4}. The total ELCR for nonradiological analytes is 1.9×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.5×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

There are no major risk contributors. Contribution to ELCR is elevated for arsenic (ELCR = 1.9×10^{-5}, 12 percent contribution) where the EPC (1.0 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-21 when contribution from arsenic is not included.

The HI for well 199-K-21 is 7.5, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.17, 2.2 percent contribution), cobalt (HQ = 0.11, 1.4 percent contribution), Cr(VI) (HQ = 0.28, 3.7 percent contribution), manganese (HQ = 0.49, 6.4 percent contribution), nitrate (HQ = 0.15, 1.9 percent contribution), and thallium (HQ = 6.0, 80 percent contribution). Contribution to HI is elevated for thallium (HQ = 6.0) where the EPC (1.2 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-21 without contribution from arsenic and thallium is 1.4, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Cobalt: thyroid, decreased iodine uptake
- Cr(VI): nasal septum atrophy
- Manganese: nervous system effects
- Nitrate: early clinical signs of methemoglobinemia

Exposure to each of the analytes that contribute to the HI of 1.4 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each analyte individually results in an HI less than 1 for each contributor.

Well 199-K-221. Table 43 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-221.

Table 43. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-221 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	**Ingestion**	4.4×10^{-5}	Arsenic, (ELCR = 4.5×10^{-5}, 1.0%) Carbon-14, (ELCR = 2.6×10^{-3}, 57%) Tritium, (ELCR = 1.9×10^{-3}, 41%)	1.6	Arsenic, (HQ = 0.38, 21%) Fluoride, (HQ = 0.15, 8.3%) Cr(VI), (HQ = 0.67, 37%) Nitrate, (HQ = 0.22, 12%) Uranium, (HQ = 0.24, 13%)
	Dermal Contact	2.4×10^{-7}		0.19	
	Inhalation of Volatiles	--		--	
	Total Risk	**4.5×10^{-5}**		**Total HI**	**1.8**

Table 43. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-221 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Radionuclides	Ingestion	9.3×10^{-5}		--	
	Immersion	2.8×10^{-13}			
	Inhalation of Volatiles	4.3×10^{-3}			
	Total Risk	**4.4×10^{-3}**			
Total Cumulative ELCR		**4.5×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-221 is 4.5×10^{-3}. The total ELCR for nonradiological analytes is 4.5×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 4.4×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 2.6×10^{-3}, 57 percent contribution) and tritium (ELCR = 1.9×10^{-3}, 41 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 4.5×10^{-5}, 1.0 percent contribution) where the EPC (2.3 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-221 when contribution from arsenic is not included.

The HI for well 199-K-221 is 1.8, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.38, 21 percent contribution), fluoride (HQ = 0.15, 8.3 percent contribution), Cr(VI) (HQ = 0.67, 37 percent contribution), nitrate (HQ = 0.22, 12 percent contribution), and uranium (HQ = 0.24, 13 percent contribution). The HI for well 199-K-221 without contribution from arsenic is 1.4, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Uranium: initial body weight loss and moderate nephrotoxicity

Exposure to each of the analytes that contribute to the HI of 1.4 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-222. Table 44 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-222.

Table 44. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-222 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Ingestion	5.0×10^{-5}	Arsenic, (ELCR = 5.0×10^{-5}, 9.3%) Carbon-14, (ELCR = 3.0×10^{-4},	1.4	Arsenic, (HQ = 0.43, 28%)

Table 44. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-222 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Dermal Contact	2.7×10^{-7}	56%) Strontium-90, (ELCR = 1.6×10^{-4}, 30%)	0.13	Fluoride, (HQ = 0.15, 9.7%) Cr(VI), (HQ = 0.44, 28%) Nitrate, (HQ = 0.17, 11%)
	Inhalation of Volatiles	--		--	
	Total Risk	**5.0×10^{-5}**		**Total HI**	**1.5**
Radionuclides	Ingestion	1.7×10^{-4}		--	
	Immersion	3.1×10^{-12}			
	Inhalation of Volatiles	3.2×10^{-4}			
	Total Risk	**4.9×10^{-4}**			
Total Cumulative ELCR		**5.4×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-222 is 5.4×10^{-4}. The total ELCR for nonradiological analytes is 5.0×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 4.9×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 3.0×10^{-4}, 56 percent contribution) and strontium-90 (ELCR = 1.6×10^{-4}, 30 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 5.0×10^{-5}, 9.3 percent contribution) where the EPC (2.6 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-222 when contribution from arsenic is not included.

The HI for well 199-K-222 is 1.5, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.43, 28 percent contribution), fluoride (HQ = 0.15, 9.7 percent contribution), Cr(VI) (HQ = 0.44, 28 percent contribution), and nitrate (HQ = 0.17, 11 percent contribution). The HI for well 199-K-222 without contribution from arsenic is 1.1, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia

Exposure to each of the analytes that contribute to the HI of 1.1 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-31. Table 45 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-31.

Table 45. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-31 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	5.1×10^{-5}	Arsenic, (ELCR = 4.9×10^{-5}, 7.1%) Carbon-14, (ELCR = 5.1×10^{-4}, 74%) Chloroform, (ELCR = 1.5×10^{-6}, 0.21%) TCE, (ELCR = 5.1×10^{-6}, 0.75%) Tritium, (ELCR = 1.2×10^{-4}, 17%)	11	Arsenic, (HQ = 0.42, 3.4%) Bromomethane, (HQ = 0.13, 1.0%) Fluoride, (HQ = 0.17, 1.4%) Cr(VI), (HQ = 0.15, 1.2%) Lithium, (HQ = 0.43, 3.5%) Nitrate, (HQ = 0.18, 1.5%) Thallium, (HQ = 9.0, 74%) TCE, (HQ = 1.3, 10%) Vanadium, (HQ = 0.15, 1.2%)
	Dermal Contact	6.2×10^{-7}		0.17	
	Inhalation of Volatiles	4.0×10^{-6}		0.96	
	Total Risk	**5.5×10^{-5}**		**Total HI**	**12**
Radionuclides	Ingestion	1.8×10^{-5}		--	
	Immersion	7.5×10^{-14}			
	Inhalation of Volatiles	6.1×10^{-4}			
	Total Risk	**6.3×10^{-4}**			
Total Cumulative ELCR		**6.8×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-31 is 6.8×10^{-4}. The total ELCR for nonradiological analytes is 5.5×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 6.3×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 5.1×10^{-4}, 74 percent contribution), chloroform (ELCR = 1.5×10^{-6}, 0.21 percent contribution), TCE (ELCR = 5.1×10^{-6}, 0.75 percent contribution), and tritium (ELCR = 1.2×10^{-4}, 17 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 4.9×10^{-5}, 7.1 percent contribution) where the EPC (2.5 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-31 without contribution from arsenic is 6.6×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-31 is 12, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.42, 3.4 percent contribution), bromomethane (HQ = 0.13, 1.0 percent contribution), fluoride (HQ = 0.17, 1.4 percent contribution), Cr(VI) (HQ = 0.15, 1.2 percent contribution), lithium (HQ = 0.43, 3.5 percent contribution), nitrate (HQ = 0.18, 1.5 percent contribution), thallium (HQ = 9.0, 74 percent contribution), TCE (HQ = 1.3, 10 percent contribution), and vanadium (HQ = 0.15, 1.2 percent contribution). Contribution to HI is elevated for thallium (HQ = 9.0) where the EPC (1.8 µg/L) is greater than the range of background concentrations (minimum, maximum, and 90th percentile) of 0.883, 1.73, and 1.67 µg/L for filtered groundwater samples. Thallium was detected in one of 17 unfiltered samples and 1 of 17 filtered samples from this

well. The presence of thallium is likely naturally occurring due to the sporadic nature of the detections. The HI for well 199-K-31 without contribution from arsenic and thallium is 2.8, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Bromomethane: degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of Cr(VI) and bromomethane, exposure to each of the analytes that contribute to the HI of 2.8 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for Cr(VI) and bromomethane results in an HI of 0.27, which is less than the target HI of 1. TCE reports an individual HQ of 1.3, which is greater than the target HI of 1; evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-37. Table 46 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-37.

Table 46. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-37 – Monitoring Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.2×10^{-5}	Arsenic, (ELCR = 7.2×10^{-5}, 57%) Bis(2-ethylhexyl) phthalate, (ELCR = 1.4×10^{-5}, 11%) Chloroform, (ELCR = 2.5×10^{-6}, 2.0%)	1.8	Arsenic, (HQ = 0.62, 28%) Bis(2-ethylhexyl) phthalate, (HQ = 0.18, 8.0%) Fluoride, (HQ = 0.14, 6.3%) Cr(VI), (HQ = 0.73, 33%) Lithium, (HQ = 0.15, 6.8%) Vanadium, (HQ = 0.15, 6.8%)
	Dermal Contact	1.4×10^{-5}		0.39	
	Inhalation of Volatiles	2.3×10^{-6}		< 0.01	
	Total Risk	**8.8×10^{-5}**		**Total HI**	**2.2**
Radionuclides	Ingestion	8.8×10^{-6}		--	
	Immersion	3.4×10^{-13}			
	Inhalation of Volatiles	3.0×10^{-5}			
	Total Risk	**3.8×10^{-5}**			
Total Cumulative ELCR		**1.3×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-37 is 1.3×10^{-4}. The total ELCR for nonradiological analytes is 8.8×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 3.8×10^{-5}, which is within the EPA risk threshold range of 1×10^{-4} to 1×10^{-6}.

The major contributors to the total cumulative ELCR are bis(2-ethylhexyl) phthalate (ELCR = 1.4×10^{-5}, 11 percent contribution) and chloroform (ELCR = 2.5×10^{-6}, 2.0 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.2×10^{-5}, 57 percent contribution) where the EPC (3.7 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. Bis(2-ethylhexyl) phthalate was detected in one of two samples collected, the single occurrence (1.2 µg/L) was reported with a "J" flag indicating that it is an estimated concentration. Additionally, bis(2-ethylhexyl) phthalate is a common laboratory contaminant that is introduced in the laboratory and is not associated with a site release or groundwater plume. The nonradiological ELCR for well 199-K-37 without contribution from arsenic and bis(2-ethylhexyl) phthalate is 2.5×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-37 is 2.2, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.62, 28 percent contribution), bis(2-ethylhexyl) phthalate (HQ = 0.18, 8.0 percent contribution), fluoride (HQ = 0.14, 6.3 percent contribution), Cr(VI) (HQ = 0.73, 33 percent contribution), lithium (HQ = 0.15, 6.8 percent contribution), and vanadium (HQ = 0.15, 6.8 percent contribution). The HI for well 199-K-37 without contribution from arsenic and bis(2-ethylhexyl) phthalate is 1.4, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.4 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 699-72-73. Table 47 provides a summary of the cancer risks and noncancer hazards by exposure route for well 699-72-73.

Table 47. Summary of Cancer Risks and Noncancer Hazards for Well 699-72-73 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	8.3×10^{-5}	Arsenic, (ELCR = 8.3×10^{-5}, 9.4%) TCE, (ELCR = 1.4×10^{-6}, 0.16%) Tritium, (ELCR = 8.0×10^{-4}, 90%)	6.6	Arsenic, (HQ = 0.72, 10%) Bromomethane, (HQ = 0.13, 1.8%) Fluoride, (HQ = 0.32, 4.5%) Cr(VI), (HQ = 0.17, 2.5%) Lithium, (HQ = 0.48, 6.8%) Nitrate, (HQ = 0.15, 2.1%) Thallium, (HQ = 4.3, 61%) TCE, (HQ = 0.35, 4.9%) Vanadium, (HQ = 0.17, 2.5%)
	Dermal Contact	5.4×10^{-7}		0.12	
	Inhalation of Volatiles	7.2×10^{-7}		0.33	
	Total Risk	**8.5×10^{-5}**		**Total HI**	**7.0**

Table 47. Summary of Cancer Risks and Noncancer Hazards for Well 699-72-73 – Monitoring Well Screened Across Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Radionuclides	Ingestion	1.3×10^{-5}		--	
	Immersion	1.4×10^{-14}			
	Inhalation of Volatiles	7.9×10^{-4}			
	Total Risk	**8.0×10^{-4}**			
Total Cumulative ELCR		**8.9×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 699-72-73 is 8.9×10^{-4}. The total ELCR for nonradiological analytes is 8.5×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 8.0×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are TCE (ELCR = 1.4×10^{-6}, 0.16 percent contribution) and tritium (ELCR = 8.0×10^{-4}, 90 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 8.3×10^{-5}, 9.4 percent contribution) where the EPC (4.3 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 699-72-73 without contribution from arsenic is 1.4×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 699-72-73 is 7.0, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.72, 10 percent contribution), bromomethane (HQ = 0.13, 1.8 percent contribution), fluoride (HQ = 0.32, 4.5 percent contribution), Cr(VI) (HQ = 0.17, 2.5 percent contribution), lithium (HQ = 0.48, 6.8 percent contribution), nitrate (HQ = 0.15, 2.1 percent contribution), thallium (HQ = 4.3, 61 percent contribution), TCE (HQ = 0.35, 4.9 percent contribution), and vanadium (HQ = 0.17, 2.5 percent contribution). Contribution to HI is elevated for thallium (HQ = 4.3) where the EPC (0.86 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 699-72-73 without contribution from arsenic and thallium is 2.0, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Bromomethane: degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of Cr(VI) and bromomethane, exposure to each of the analytes that contribute to the HI of 2.0 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for Cr(VI) and bromomethane results in an HI of 0.30, which is less than the target HI of 1. Evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-35, K-195, K-205. Table 48**Error! Reference source not found.** provides a summary of the cancer risks and noncancer hazards by exposure route for wells 199-K-35, K-195, K-205.

Table 48. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-35, K-195, K-205 – Combined Wells Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	8.1×10^{-5}	Arsenic, (ELCR = 7.8×10^{-5}, 13%) Carbon-14, (ELCR = 4.2×10^{-4}, 69%) Chloroform, (ELCR = 1.8×10^{-6}, 0.29%) TCE, (ELCR = 6.7×10^{-6}, 1.1%)	8.6	Arsenic, (HQ = 0.67, 5.5%) Fluoride, (HQ = 0.20, 1.7%) Cr(VI), (HQ = 9.0, 74%) Nitrate, (HQ = 0.21, 1.7%) Silver, (HQ = 0.10, 0.79%) TCE, (HQ = 1.7, 14%) Vanadium, (HQ = 0.12, 0.99%)
	Dermal Contact	8.9×10^{-7}		2.4	
	Inhalation of Volatiles	5.1×10^{-6}		1.1	
	Total Risk	**8.7×10^{-5}**		**Total HI**	**12**
Radionuclides	Ingestion	1.8×10^{-5}		--	
	Immersion	1.2×10^{-13}			
	Inhalation of Volatiles	5.0×10^{-4}			
	Total Risk	**5.2×10^{-4}**			
Total Cumulative ELCR		**6.1×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-35, K-195, K-205 is 6.1×10^{-4}. The total ELCR for nonradiological analytes is 8.7×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 5.2×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 4.2×10^{-4}, 69 percent contribution), chloroform (ELCR = 1.8×10^{-6}, 0.29 percent contribution), and TCE (ELCR = 6.7×10^{-6}, 1.1 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.8×10^{-5}, 13 percent contribution) where the EPC (4.0 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-35, K-195, K-205 without contribution from arsenic is 8.5×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-35, K-195, K-205 is 12, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.67, 5.5 percent contribution), fluoride (HQ = 0.20, 1.7 percent contribution), Cr(VI) (HQ = 9.0, 74 percent contribution), nitrate (HQ = 0.21, 1.7 percent contribution), silver (HQ = 0.10, 0.79 percent contribution), TCE (HQ = 1.7, 14 percent contribution), and vanadium (HQ = 0.12, 0.99 percent contribution). The HI for well 199-K-35, K-195, K-205 without contribution from arsenic is 12, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy

- Nitrate: early clinical signs of methemoglobinemia
- Silver: argria (dermal)
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of silver and vanadium, exposure to each of the analytes that contribute to the HI of 12 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for silver and vanadium results in a HI of 0.22, which is less than the target HI of 1. Cr(VI) and TCE report individual HQs of 9 and 1.7 respectively, which are greater than the target HI of 1. Evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

7.9 Extraction Wells Screened Across the Upper Unconfined Aquifer

Well 199-K-113A. Table 49**Error! Reference source not found.** provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-113A.

Table 49. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-113A – Extraction Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	2.7×10^{-5}	Arsenic, (ELCR = 2.7×10^{-5}, 21%)	0.96	Arsenic, (HQ = 0.24, 24%) Uranium, (HQ = 0.45, 45%)
	Dermal Contact	1.5×10^{-7}		0.03	
	Inhalation of Volatiles	--		--	
	Total Risk	**2.7×10^{-5}**		**Total HI**	**1.0**
Radionuclides	Ingestion	1.0×10^{-5}		--	
	Immersion	1.7×10^{-13}			
	Inhalation of Volatiles	9.2×10^{-5}			
	Total Risk	**1.0×10^{-4}**			
Total Cumulative ELCR		**1.3×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-113A is 1.3×10^{-4}. The total ELCR for nonradiological analytes is 2.7×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.0×10^{-4}, which is equal to the EPA upper risk threshold of 1×10^{-4}.

There are no major risk contributors. Contribution to ELCR is elevated for arsenic (ELCR = 2.7×10^{-5}, 21 percent contribution) where the EPC (1.4 µg/L) is less than the 90thh percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-113A when contribution from arsenic is not included.

The HI for well 199-K-113A is 1.0, which is equal to the MTCA (WAC 173-340-708(5)) target HI of 1.

Well 199-K-114A. Table 50**Error! Reference source not found.** provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-114A.

Table 50. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-114A – Extraction Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.6×10^{-5}	Arsenic, (ELCR = 1.6×10^{-5}, 55%)	0.32	--
	Dermal Contact	8.5×10^{-8}		0.02	
	Inhalation of Volatiles	--		--	
	Total Risk	**1.6×10^{-5}**		**Total HI**	**0.33**
Radionuclides	Ingestion	1.3×10^{-5}		**--**	
	Immersion	2.5×10^{-13}			
	Inhalation of Volatiles	--			
	Total Risk	**1.3×10^{-5}**			
Total Cumulative ELCR		**2.9×10^{-5}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-114A is 2.9×10^{-5}. The total ELCR for nonradiological analytes is 1.6×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.3×10^{-5}, which is within the EPA risk threshold range of 1×10^{-4} to 1×10^{-6}.

There are no major risk contributors. Contribution to ELCR is elevated for arsenic (ELCR = 1.6×10^{-5}, 55 percent contribution) where the EPC (0.83 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-114A when contribution from arsenic is not included.

The HI for well 199-K-114A is 0.33, which is less than the MTCA (WAC 173-340-708(5)) target HI of 1.

Well 199-K-141. Table 51**Error! Reference source not found.** provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-141.

Table 51. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-141 – Extraction Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.3×10^{-5}	Arsenic, (ELCR = 7.3×10^{-5}, 8.8%) Carbon-14, (ELCR = 3.5×10^{-4}, 42%) Tritium, (ELCR = 3.5×10^{-4}, 42%)	1.6	Arsenic, (HQ = 0.63, 35%) Fluoride, (HQ = 0.12, 6.9%) Cr(VI), (HQ = 0.65, 36%) Nitrate, (HQ = 0.10, 5.3%) Vanadium, (HQ = 0.12, 6.7%)
	Dermal Contact	3.9×10^{-7}		0.19	
	Inhalation of Volatiles	--		--	
	Total Risk	**7.3×10^{-5}**		**Total HI**	**1.8**
Radionuclides	Ingestion	7.9×10^{-5}		--	
	Immersion	8.1×10^{-12}			
	Inhalation of Volatiles	6.8×10^{-4}			
	Total Risk	**7.6×10^{-4}**			
Total Cumulative ELCR		**8.3×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-141 is 8.3×10^{-4}. The total ELCR for nonradiological analytes is 7.3×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 7.6×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 3.5×10^{-4}, 42 percent contribution) and tritium (ELCR = 3.5×10^{-4}, 42 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.3×10^{-5}, 8.8 percent contribution) where the EPC (3.8 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-141 when contribution from arsenic is not included.

The HI for well 199-K-141 is 1.8, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.63, 35 percent contribution), fluoride (HQ = 0.12, 6.9 percent contribution), Cr(VI) (HQ = 0.65, 36 percent contribution), nitrate (HQ = 0.10, 5.3 percent contribution), and vanadium (HQ = 0.12, 6.7 percent contribution). The HI for well 199-K-141 without contribution from arsenic is 1.2, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.2 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-144. Table 52 **Error! Reference source not found.** provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-144.

Table 52. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-144 – Extraction Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.1×10^{-5}	Arsenic, (ELCR = 7.2×10^{-5}, 3.3%) Tritium, (ELCR = 2.0×10^{-3}, 94%)	1.7	Arsenic, (HQ = 0.62, 32%) Fluoride, (HQ = 0.14, 7.2%) Cr(VI), (HQ = 0.69, 36%) Nickel, (HQ = 0.14, 7.1%) Nitrate, (HQ = 0.12, 6.1%) Vanadium, (HQ = 0.16, 8.2%)
	Dermal Contact	3.8×10^{-7}		0.21	
	Inhalation of Volatiles	--		--	
	Total Risk	**7.2×10^{-5}**		**Total HI**	**1.9**
Radionuclides	Ingestion	3.4×10^{-5}		--	
	Immersion	9.1×10^{-14}			
	Inhalation of Volatiles	2.0×10^{-3}			
	Total Risk	**2.1×10^{-3}**			
Total Cumulative ELCR		**2.1×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-144 is 2.1×10^{-3}. The total ELCR for nonradiological analytes is 7.2×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.1×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is tritium (ELCR = 2.0×10^{-3}, 94 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.2×10^{-5}, 3.3 percent contribution) where the EPC (3.7 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-144 when contribution from arsenic is not included.

The HI for well 199-K-144 is 1.9, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.62, 32 percent contribution), fluoride (HQ = 0.14, 7.2 percent contribution), Cr(VI) (HQ = 0.69, 36 percent contribution), nickel (HQ = 0.14, 7.1 percent contribution), nitrate (HQ = 0.12, 6.1 percent contribution), and vanadium (HQ = 0.16, 8.2 percent contribution). The HI for well 199-K-144 without contribution from arsenic is 1.3, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nickel: decreased body and organ weights
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.3 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-146. Table 53**Error! Reference source not found.** provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-146.

Table 53. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-146 – Extraction Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	--	--	0.48	--
	Dermal Contact	--		0.09	
	Inhalation of Volatiles	--		--	
	Total Risk	--		Total HI	**0.57**
Radionuclides	Ingestion	--		--	
	Immersion	--			
	Inhalation of Volatiles	--			
	Total Risk	--			
Total Cumulative ELCR		--			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

There were no radiological or carcinogenic nonradiological analytes measured in well 199-K-146; therefore, cancer risks are not reported for this well.

The HI for well 199-K-146 is 0.57, which is less than the MTCA (WAC 173-340-708(5)) target HI of 1.

Well 199-K-147. Table 54**Error! Reference source not found.** provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-147.

Table 54. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-147 – Extraction Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	4.2×10^{-5}	Arsenic, (ELCR = 4.3×10^{-5}, 27%)	1.2	Arsenic, (HQ = 0.37, 28%) Fluoride, (HQ = 0.15, 12%) Cr(VI), (HQ = 0.48, 36%)
	Dermal Contact	2.3×10^{-7}		0.15	

Table 54. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-147 – Extraction Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Inhalation of Volatiles	--		--	Vanadium, (HQ = 0.13, 9.7%)
	Total Risk	**4.3×10^{-5}**		**Total HI**	**1.3**
Radionuclides	Ingestion	1.4×10^{-5}		--	
	Immersion	2.4×10^{-13}			
	Inhalation of Volatiles	1.0×10^{-4}			
	Total Risk	**1.2×10^{-4}**			
Total Cumulative ELCR		**1.6×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-147 is 1.6×10^{-4}. The total ELCR for nonradiological analytes is 4.3×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.2×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

There are no major risk contributors. Contribution to ELCR is elevated for arsenic (ELCR = 4.3×10^{-5}, 27 percent contribution) where the EPC (2.2 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-147 when contribution from arsenic is not included.

The HI for well 199-K-147 is 1.3, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.37, 28 percent contribution), fluoride (HQ = 0.15, 12 percent contribution), Cr(VI) (HQ = 0.48, 36 percent contribution), and vanadium (HQ = 0.13, 9.7 percent contribution). The HI for well 199-K-147 without contribution from arsenic is 0.97, which is less than the target HI of 1.

Well 199-K-148. Table 55**Error! Reference source not found.** provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-148.

Table 55. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-148 – Extraction Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.0×10^{-4}	Arsenic, (ELCR = 1.0×10^{-4}, 31%) Tritium, (ELCR = 1.7×10^{-4}, 52%)	2.0	Arsenic, (HQ = 0.87, 39%) Fluoride, (HQ = 0.24, 11%) Cr(VI), (HQ = 0.76, 34%) Nitrate, (HQ = 0.11, 4.8%) Vanadium, (HQ = 0.19, 8.5%)
	Dermal Contact	5.3×10^{-7}		0.23	
	Inhalation of Volatiles	--		--	

Table 55. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-148 – Extraction Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Total Risk	**1.0×10^{-4}**		**Total HI**	**2.2**
Radionuclides	**Ingestion**	4.7×10^{-6}			
	Immersion	1.1×10^{-14}			
	Inhalation of Volatiles	2.1×10^{-4}			
	Total Risk	**2.2×10^{-4}**			
Total Cumulative ELCR		**3.2×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-148 is 3.2×10^{-4}. The total ELCR for nonradiological analytes is 1.0×10^{-4}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.2×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is tritium (ELCR = 1.7×10^{-4}, 52 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 1.0×10^{-4}, 31 percent contribution) where the EPC (5.2 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-148 when contribution from arsenic is not included.

The HI for well 199-K-148 is 2.2, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.87, 39 percent contribution), fluoride (HQ = 0.24, 11 percent contribution), Cr(VI) (HQ = 0.76, 34 percent contribution), nitrate (HQ = 0.11, 4.8 percent contribution), and vanadium (HQ = 0.19, 8.5 percent contribution). The HI for well 199-K-148 without contribution from arsenic is 1.4, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.4 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-161. Table 56**Error! Reference source not found.** provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-161.

Table 56. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-161 – Extraction Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	3.3×10^{-5}	Arsenic, (ELCR = 3.3×10^{-5}, 58%)	7.8	Arsenic, (HQ = 0.29, 3.6%) Cr(VI), (HQ = 0.17, 2.1%) Thallium, (HQ = 7.0, 89%)
	Dermal Contact	1.8×10^{-7}		0.09	
	Inhalation of Volatiles	--		--	
	Total Risk	**3.3×10^{-5}**		**Total HI**	**7.9**
Radionuclides	Ingestion	1.5×10^{-5}		--	
	Immersion	3.5×10^{-13}			
	Inhalation of Volatiles	8.5×10^{-6}			
	Total Risk	**2.4×10^{-5}**			
Total Cumulative ELCR		**5.7×10^{-5}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-161 is 5.7×10^{-5}. The total ELCR for nonradiological analytes is 3.3×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.4×10^{-5}, which is within the EPA risk threshold range of 1×10^{-4} to 1×10^{-6}.

There are no major risk contributors. Contribution to ELCR is elevated for arsenic (ELCR = 3.3×10^{-5}, 58 percent contribution) where the EPC (1.7 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-161 when contribution from arsenic is not included.

The HI for well 199-K-161 is 7.9, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.29, 3.6 percent contribution), Cr(VI) (HQ = 0.17, 2.1 percent contribution), and thallium (HQ = 7.0, 89 percent contribution). Contribution to HI is elevated for thallium (HQ = 7.0) where the EPC (1.4 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-161 without contribution from arsenic and thallium is 0.59, which is less than the target HI of 1.

Well 199-K-178. Table 57**Error! Reference source not found.** provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-178.

Table 57. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-178 – Extraction Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Ingestion	--	Carbon-14, (ELCR = 4.2×10^{-4}, 73%)	0.99	Fluoride, (HQ = 0.10, 7.8%)

Table 57. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-178 – Extraction Well Screened Across the Upper Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Dermal Contact	--	Tritium, (ELCR = 1.5×10^{-4}, 26%)	0.24	Cr(VI), (HQ = 0.89, 72%) Nitrate, (HQ = 0.12, 9.3%)
	Inhalation of Volatiles	--		--	
	Total Risk	--		Total HI	**1.2**
Radionuclides	Ingestion	1.5×10^{-5}		--	
	Immersion	8.4×10^{-14}			
	Inhalation of Volatiles	5.6×10^{-4}			
	Total Risk	**5.8×10^{-4}**			
Total Cumulative ELCR		**5.8×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-178 is 5.8×10^{-4}. There were no carcinogenic nonradiological analytes measured; therefore, nonradiological cancer risks are not reported for this well. The total ELCR for radiological analytes is 5.8×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 4.2×10^{-4}, 73 percent contribution) and tritium (ELCR = 1.5×10^{-4}, 26 percent contribution).

The HI for well 199-K-178 is 1.2, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are fluoride (HQ = 0.10, 7.8 percent contribution), Cr(VI) (HQ = 0.89, 72 percent contribution), and nitrate (HQ = 0.12, 9.3 percent contribution).

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia

Exposure to each of the analytes that contribute to the HI of 1.2 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

7.3 Monitoring Wells Screened Across Lower Unconfined Aquifer

Well 199-K-168. Table 58 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-168.

Table 58. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-168 – Monitoring Well Screened Across Lower Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	5.1×10^{-5}	Arsenic, (ELCR = 4.8×10^{-5}, 5.7%) Carbon-14, (ELCR = 6.9×10^{-4}, 81%) Chloroform, (ELCR = 1.9×10^{-6}, 0.22%) TCE, (ELCR = 6.3×10^{-6}, 0.74%)	2.0	Arsenic, (HQ = 0.42, 12%) Fluoride, (HQ = 0.15, 4.4%) Cr(VI), (HQ = 0.80, 23%) Nitrate, (HQ = 0.16, 4.5%) TCE, (HQ = 1.6, 46%) Vanadium, (HQ = 0.15, 4.2%)
	Dermal Contact	7.0×10^{-7}		0.31	
	Inhalation of Volatiles	5.0×10^{-6}		1.1	
	Total Risk	**5.7×10^{-5}**		**Total HI**	**3.4**
Radionuclides	Ingestion	2.4×10^{-5}		--	
	Immersion	1.4×10^{-13}			
	Inhalation of Volatiles	7.7×10^{-4}			
	Total Risk	**8.0×10^{-4}**			
Total Cumulative ELCR		**8.5×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-168 is 8.5×10^{-4}. The total ELCR for nonradiological analytes is 5.7×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 8.0×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 6.9×10^{-4}, 81 percent contribution), chloroform (ELCR = 1.9×10^{-6}, 0.22 percent contribution), and TCE (ELCR = 6.3×10^{-6}, 0.74 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 4.8×10^{-5}, 5.7 percent contribution) where the EPC (2.5 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-168 without contribution from arsenic is 8.2×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-168 is 3.4, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.42, 12 percent contribution), fluoride (HQ = 0.15, 4.4 percent contribution), Cr(VI) (HQ = 0.80, 23 percent contribution), nitrate (HQ = 0.16, 4.5 percent contribution), TCE (HQ = 1.6, 46 percent contribution), and vanadium (HQ = 0.15, 4.2 percent contribution). The HI for well 199-K-168 without contribution from arsenic is 3.0, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 3.0 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. TCE has an HQ of 1.6, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-184. Table 59 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-184.

Table 59. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-184 – Monitoring Well Screened Across Lower Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	6.6×10^{-5}	Arsenic, (ELCR = 6.3×10^{-5}, 6.4%) Carbon-14, (ELCR = 8.1×10^{-4}, 82%) Chloroform, (ELCR = 1.7×10^{-6}, 0.17%) TCE, (ELCR = 5.7×10^{-6}, 0.58%) Tritium, (ELCR = 9.8×10^{-5}, 9.9%)	2.0	Arsenic, (HQ = 0.55, 17%) Fluoride, (HQ = 0.14, 4.4%) Cr(VI), (HQ = 0.34, 11%) Nitrate, (HQ = 0.16, 5.0%) Nitrite, (HQ = 0.17, 5.2%) TCE, (HQ = 1.4, 45%) Vanadium, (HQ = 0.15, 4.7%)
	Dermal Contact	7.4×10^{-7}		0.18	
	Inhalation of Volatiles	4.4×10^{-6}		1.0	
	Total Risk	**7.1×10^{-5}**		**Total HI**	**3.2**
Radionuclides	Ingestion	2.4×10^{-5}		--	
	Immersion	1.8×10^{-13}			
	Inhalation of Volatiles	8.9×10^{-4}			
	Total Risk	**9.2×10^{-4}**			
Total Cumulative ELCR		**9.9×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-184 is 9.9×10^{-4}. The total ELCR for nonradiological analytes is 7.1×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 9.2×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 8.1×10^{-4}, 82 percent contribution), chloroform (ELCR = 1.7×10^{-6}, 0.17 percent contribution), TCE (ELCR = 5.7×10^{-6}, 0.58 percent contribution), and tritium (ELCR = 9.8×10^{-5}, 9.9 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 6.3×10^{-5}, 6.4 percent contribution) where the EPC (3.3 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-184 without contribution from arsenic is 7.4×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-184 is 3.2, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.55, 17 percent contribution), fluoride (HQ = 0.14, 4.4 percent contribution), Cr(VI) (HQ = 0.34, 11 percent contribution), nitrate (HQ = 0.16, 5.0 percent contribution), nitrite (HQ = 0.17, 5.2 percent contribution), TCE (HQ = 1.4, 45 percent contribution), and vanadium (HQ = 0.15, 4.7 percent

contribution). The HI for well 199-K-184 without contribution from arsenic is 2.6, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Nitrite: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of nitrite and nitrate, exposure to each of the analytes that contribute to the HI of 2.6 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for nitrite and nitrate results in an HI of 0.32, which is less than the target HI of 1. TCE reports an individual HQ of 1.4, which is greater than the target HI of 1; evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-190. Table 60 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-190.

Table 60. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-190 – Monitoring Well Screened Across Lower Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	9.2×10^{-5}	Arsenic, (ELCR = 8.9×10^{-5}, 20%) Carbon-14, (ELCR = 2.9×10^{-4}, 66%) Chloroform, (ELCR = 2.7×10^{-6}, 0.61%) TCE, (ELCR = 7.6×10^{-6}, 1.7%)	3.8	Arsenic, (HQ = 0.77, 14%) Cobalt, (HQ = 0.11, 2.0%) Fluoride, (HQ = 0.19, 3.6%) Cr(VI), (HQ = 0.29, 5.5%) Nitrate, (HQ = 0.24, 4.4%) Thallium, (HQ = 1.4, 26%) TCE, (HQ = 1.9, 36%) Vanadium, (HQ = 0.18, 3.4%)
	Dermal Contact	1.0×10^{-6}		0.20	
	Inhalation of Volatiles	6.4×10^{-6}		1.3	
	Total Risk	**1.0×10^{-4}**		**Total HI**	**5.3**
Radionuclides	Ingestion	1.0×10^{-5}		--	
	Immersion	6.0×10^{-14}			
	Inhalation of Volatiles	3.3×10^{-4}			
	Total Risk	**3.4×10^{-4}**			
Total Cumulative ELCR		**4.4×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-190 is 4.4×10^{-4}. The total ELCR for nonradiological analytes is 1.0×10^{-4}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 3.4×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 2.9×10^{-4}, 66 percent contribution), chloroform (ELCR = 2.7×10^{-6}, 0.61 percent contribution), and TCE (ELCR = 7.6×10^{-6}, 1.7 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 8.9×10^{-5}, 20 percent contribution) where the EPC (4.6 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-190 without contribution from arsenic is 1.0×10^{-5}, which is equal to the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-190 is 5.3, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.77, 14 percent contribution), cobalt (HQ = 0.11, 2.0 percent contribution), fluoride (HQ = 0.19, 3.6 percent contribution), Cr(VI) (HQ = 0.29, 5.5 percent contribution), nitrate (HQ = 0.24, 4.4 percent contribution), thallium (HQ = 1.4, 26 percent contribution), TCE (HQ = 1.9, 36 percent contribution), and vanadium (HQ = 0.18, 3.4 percent contribution). Contribution to HI is elevated for thallium (HQ = 1.4) where the EPC (0.28 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L The HI for well 199-K-190 without contribution from arsenic and thallium is 3.2, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Cobalt: thyroid, decreased iodine uptake
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 3.2 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte.TCE reports an individual HQ of 1.9, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

7.4 Monitoring Well Screened Across Upper and Lower Unconfined Aquifer

Well 199-K-193. Table 61 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-193.

Table 61. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-193 – Monitoring Well Screened Across Upper and Lower Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	9.4×10^{-5}	Arsenic, (ELCR = 9.4×10^{-5}, 46%) Chloroform, (ELCR = 1.5×10^{-6}, 0.72%) Ethylbenzene, (ELCR = 1.7×10^{-6}, 0.82%)	14	Arsenic, (HQ = 0.81, 5.9%) Fluoride, (HQ = 0.24, 1.7%) Cr(VI), (HQ = 0.52, 3.8%) Thallium, (HQ = 12, 84%) Vanadium, (HQ = 0.15, 1.1%)
	Dermal Contact	7.1×10^{-7}		0.22	
	Inhalation of Volatiles	2.4×10^{-6}		0.02	
	Total Risk	**9.7×10^{-5}**		**Total HI**	**14**
	Ingestion	4.0×10^{-6}		--	

Table 61. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-193 – Monitoring Well Screened Across Upper and Lower Unconfined Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Radionuclides	Immersion	5.0×10^{-14}			
	Inhalation of Volatiles	1.0×10^{-4}			
	Total Risk	**1.1×10^{-4}**			
Total Cumulative ELCR		**2.0×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-193 is 2.0×10^{-4}. The total ELCR for nonradiological analytes is 9.7×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.1×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are chloroform (ELCR = 1.5×10^{-6}, 0.72 percent contribution) and ethylbenzene (ELCR = 1.7×10^{-6}, 0.82 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 9.4×10^{-5}, 46 percent contribution) where the EPC (4.8 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-193 without contribution from arsenic is 3.1×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-193 is 14, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.81, 5.9 percent contribution), fluoride (HQ = 0.24, 1.7 percent contribution), Cr(VI) (HQ = 0.52, 3.8 percent contribution), thallium (HQ = 12, 84 percent contribution), and vanadium (HQ = 0.15, 1.1 percent contribution). Contribution to HI is elevated for thallium (HQ = 12) where the EPC (2.3 µg/L) is greater than the range of background concentrations (minimum, maximum, and 90th percentile) of 0.883, 1.73, and 1.67 µg/L for filtered groundwater samples. Thallium was detected in one of 21 unfiltered samples and two of 21 filtered samples (both less than background) from this well. The presence of thallium is likely naturally occurring due to the sporadic nature of the detections. The HI for well 199-K-193 without contribution from arsenic and thallium is 1.4, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.4 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating the analytes individually results in an HI less than 1 for each contributor.

7.5 Monitoring Wells Screened Across Entire Aquifer

Well 199-K-151. Table 62 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-151.

Table 62. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-151 – Monitoring Wells Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.3×10^{-4}	Aldrin, (ELCR = 6.0×10^{-4}, 57%) Arsenic, (ELCR = 1.0×10^{-4}, 9.5%) Bis(2-ethylhexyl) phthalate, (ELCR = 1.3×10^{-4}, 12%) Bromodichloromethane, (ELCR = 1.2×10^{-6}, 0.11%) Chloroform, (ELCR = 2.3×10^{-5}, 2.2%) Tritium, (ELCR = 1.6×10^{-4}, 15%)	2.5	2-Propanol, (HQ = 0.18, 2.4%) Aldrin, (HQ = 3.5, 45%) Arsenic, (HQ = 0.86, 11%) Bis(2-ethylhexyl) phthalate, (HQ = 1.6, 21%) Fluoride, (HQ = 0.27, 3.5%) Cr(VI), (HQ = 0.29, 3.7%) Lithium, (HQ = 0.20, 2.5%) Vanadium, (HQ = 0.26, 3.3%)
	Dermal Contact	6.0×10^{-4}		5.1	
	Inhalation of Volatiles	1.3×10^{-4}		0.25	
	Total Risk	**8.6×10^{-4}**		**Total HI**	**7.8**
Radionuclides	Ingestion	9.1×10^{-6}		--	
	Immersion	1.9×10^{-13}			
	Inhalation of Volatiles	1.9×10^{-4}			
	Total Risk	**2.0×10^{-4}**			
Total Cumulative ELCR		**1.1×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-151 is 1.1×10^{-3}. The total ELCR for nonradiological analytes is 8.6×10^{-4}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.0×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are aldrin (ELCR = 6.0×10^{-4}, 57 percent contribution), bis(2-ethylhexyl) phthalate (ELCR = 1.3×10^{-4}, 12 percent contribution), bromodichloromethane (ELCR = 1.2×10^{-6}, 0.11 percent contribution), chloroform (ELCR = 2.3×10^{-5}, 2.2 percent contribution), and tritium (ELCR = 1.6×10^{-4}, 15 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 1.0×10^{-4}, 9.5 percent contribution) where the EPC (5.2 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-151 without contribution from arsenic is 7.6×10^{-4}, which is greater than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

Aldrin was detected in one of three samples (0.12 µg/L) collected from well 199-K-151 between June 2010 and January 2011. Biological controls including pesticides and herbicides are applied on the Hanford Site to prevent the spread of contamination by biological vectors and comply with environmental, safety, health and quality principals. The presence of aldrin is likely from application of biological controls and not associated with a groundwater plume.

Bis(2-ethylhexyl) phthalate was detected in one of two samples (11 µg/L) collected from well 199-K-151 between September 2010 and January 2011; this result was qualified with a "J" flag by the laboratory indicating it is an estimated concentration. Bis(2-ethylhexy) phthalate is considered a common laboratory contaminant that is introduced in the laboratory and is not associated with a groundwater plume. As a result, bis(2-ethylhexyl) phthalate was likely introduced into this sample by the laboratory and is not associated with Hanford Site operations or a groundwater plume.

The HI for well 199-K-151 is 7.8, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are 2-propanol (HQ = 0.18, 2.4 percent contribution), aldrin (HQ = 3.5, 45 percent contribution), arsenic (HQ = 0.86, 11 percent contribution), bis(2-ethylhexyl) phthalate (HQ = 1.6, 21 percent contribution), fluoride (HQ = 0.27, 3.5 percent contribution), Cr(VI) (HQ = 0.29, 3.7 percent contribution), lithium (HQ = 0.20, 2.5 percent contribution), and vanadium (HQ = 0.26, 3.3 percent contribution). The HI for well 199-K-151 without contribution from arsenic is 6.9, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- 2-Propanol: decreased fetal body weight
- Aldrin: liver toxicity
- Bis(2-ethylhexyl) phthalate: increased relative liver weight
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Vanadium: decreased hair cysteine

With the exception of aldrin and bis(2-ethylhexyl) phthalate, exposure to each of the analytes that contribute to the HI of 6.9 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for aldrin and bis(2-ethylhexyl) phthalate results in an HI of 5.1, which is greater than the target HI of 1. Evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-157. Table 63 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-157.

Table 63. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-157 – Monitoring Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.7×10^{-4}	Arsenic, (ELCR = 1.7×10^{-4}, 3.3%) Chloroform, (ELCR = 3.9×10^{-6}, 0.07%) Tritium, (ELCR = 5.0×10^{-3}, 95%)	5.4	Antimony, (HQ = 0.72, 12%) Arsenic, (HQ = 1.5, 26%) Beryllium, (HQ = 0.20, 3.4%) Cadmium, (HQ = 0.54, 9.3%) Cobalt, (HQ = 0.83, 14%) Fluoride, (HQ = 0.13, 2.3%) Cr(VI), (HQ = 0.77, 13%) Lithium, (HQ = 0.50, 8.6%) Nitrate, (HQ = 0.17, 2.9%) Vanadium, (HQ = 0.12, 2.0%)
	Dermal Contact	9.5×10^{-7}		0.37	
	Inhalation of Volatiles	3.5×10^{-6}		< 0.01	
	Total Risk	**1.8×10^{-4}**		**Total HI**	**5.8**
	Ingestion	7.7×10^{-5}		--	

Table 63. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-157 – Monitoring Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Radionuclides	Immersion	8.0×10^{-14}			
	Inhalation of Volatiles	5.0×10^{-3}			
	Total Risk	**5.1×10^{-3}**			
Total Cumulative ELCR		**5.2×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-157 is 5.2×10^{-3}. The total ELCR for nonradiological analytes is 1.8×10^{-4}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 5.1×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are chloroform (ELCR = 3.9×10^{-6}, 0.07 percent contribution) and tritium (ELCR = 5.0×10^{-3}, 95 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 1.7×10^{-4}, 3.3 percent contribution) where the EPC (9.0 µg/L) is greater than the range of natural background values for arsenic (0.5 µg/L to 8.8 µg/L). However, the EPC of 9 µg/L is less than the drinking water standard of 10 µg/L. The nonradiological ELCR for well 199-K-157 without contribution from arsenic is 3.9×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-157 is 5.8, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are antimony (HQ = 0.72, 12 percent contribution), arsenic (HQ = 1.5, 26 percent contribution), beryllium (HQ = 0.20, 3.4 percent contribution), cadmium (HQ = 0.54, 9.3 percent contribution), cobalt (HQ = 0.83, 14 percent contribution), fluoride (HQ = 0.13, 2.3 percent contribution), Cr(VI) (HQ = 0.77, 13 percent contribution), lithium (HQ = 0.50, 8.6 percent contribution), nitrate (HQ = 0.17, 2.9 percent contribution), and vanadium (HQ = 0.12, 2.0 percent contribution). The HI for well 199-K-157 without contribution from arsenic is 4.3, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Arsenic: hyperpigmentation, keratosis and possible vascular complications
- Antimony: longevity, blood glucose, and cholesterol
- Beryllium: small intestinal lesions
- Cadmium: significant proteinuria
- Cobalt: thyroid, decreased iodine uptake
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

With the exception of nitrate, antimony, beryllium, and fluoride, exposure to each of the analytes that contribute to the HI of 4.3 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for nitrate and antimony results in an HI of 0.89, which is less than the target HI of 1. Combining the HQs for beryllium and fluoride results in an HI of 0.33, which is less than the target HI of 1. Evaluating the remaining analytes individually results in an HI less than 1 for each contributor. Arsenic reports an individual HQ of 1.5, which is greater than the target HI of 1.

Well 199-K-185. Table 64 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-185.

Table 64. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-185 – Monitoring Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	6.7×10^{-5}	Arsenic, (ELCR = 6.3×10^{-5}, 2.0%) Carbon-14, (ELCR = 3.1×10^{-3}, 96%) Chloroform, (ELCR = 1.6×10^{-6}, 0.05%) TCE, (ELCR = 1.0×10^{-5}, 0.31%)	2.3	2-Propanol, (HQ = 0.18, 4.1%) Arsenic, (HQ = 0.54, 12%) Fluoride, (HQ = 0.15, 3.4%) Cr(VI), (HQ = 0.15, 3.4%) Manganese, (HQ = 0.18, 4.1%) Nitrate, (HQ = 0.26, 5.9%) TCE, (HQ = 2.5, 57%) Vanadium, (HQ = 0.14, 3.3%)
	Dermal Contact	1.0×10^{-6}		0.19	
	Inhalation of Volatiles	6.6×10^{-6}		1.9	
	Total Risk	**7.4×10^{-5}**		**Total HI**	**4.4**
Radionuclides	Ingestion	7.0×10^{-5}		--	
	Immersion	1.4×10^{-13}			
	Inhalation of Volatiles	3.1×10^{-3}			
	Total Risk	**3.1×10^{-3}**			
Total Cumulative ELCR		**3.2×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-185 is 3.2×10^{-3}. The total ELCR for nonradiological analytes is 7.4×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 3.1×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 3.1×10^{-3}, 96 percent contribution), chloroform (ELCR = 1.6×10^{-6}, 0.05 percent contribution), and TCE (ELCR = 1.0×10^{-5}, 0.31 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 6.3×10^{-5}, 2.0 percent contribution) where the EPC (3.2 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-185 without contribution from arsenic is 1.2×10^{-5}, which is greater than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-185 is 4.4, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are 2-propanol (HQ = 0.18, 4.1 percent contribution), arsenic (HQ = 0.54, 12 percent contribution), fluoride (HQ = 0.15, 3.4 percent contribution), Cr(VI) (HQ = 0.15, 3.4 percent contribution), manganese (HQ = 0.18, 4.1 percent contribution), nitrate (HQ = 0.26, 5.9 percent contribution), TCE (HQ = 2.5, 57 percent contribution), and vanadium (HQ = 0.14, 3.3 percent contribution). The HI for well 199-K-185 without contribution from arsenic is 3.8, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- 2-Propanol: decreased fetal body weight
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Manganese: nervous system effects
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of 2-propanol and TCE, exposure to each of the analytes that contribute to the HI of 3.8 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for 2-propanol and TCE results in a HI of 2.7, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-189. Table 65 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-189.

Table 65. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-189 – Monitoring Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.0×10^{-4}	Arsenic, (ELCR = 1.0×10^{-4}, 1.9%) Carbon-14, (ELCR = 2.7×10^{-3}, 51%) Chloroform, (ELCR = 5.0×10^{-6}, 0.09%) Tritium, (ELCR = 2.6×10^{-3}, 47%)	1.8	Arsenic, (HQ = 0.87, 44%) Fluoride, (HQ = 0.15, 7.5%) Cr(VI), (HQ = 0.55, 28%) Nitrate, (HQ = 0.20, 10%) Vanadium, (HQ = 0.13, 6.8%)
	Dermal Contact	5.7×10^{-7}		0.17	
	Inhalation of Volatiles	4.5×10^{-6}		< 0.01	
	Total Risk	**1.1×10^{-4}**		**Total HI**	**2.0**
Radionuclides	Ingestion	9.6×10^{-5}		--	
	Immersion	1.1×10^{-13}			
	Inhalation of Volatiles	5.2×10^{-3}			
	Total Risk	**5.3×10^{-3}**			
Total Cumulative ELCR		**5.4×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-189 is 5.4×10^{-3}. The total ELCR for nonradiological analytes is 1.1×10^{-4}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 5.3×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 2.7×10^{-3}, 51 percent contribution), chloroform (ELCR = 5.0×10^{-6}, 0.09 percent contribution), and tritium (ELCR = 2.6×10^{-3}, 47 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 1.0×10^{-4}, 1.9 percent contribution) where the EPC (5.2 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-

K-189 without contribution from arsenic is 5.0×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-189 is 2.0, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.87, 44 percent contribution), fluoride (HQ = 0.15, 7.5 percent contribution), Cr(VI) (HQ = 0.55, 28 percent contribution), nitrate (HQ = 0.20, 10 percent contribution), and vanadium (HQ = 0.13, 6.8 percent contribution). The HI for well 199-K-189 without contribution from arsenic is 1.1, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.1 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-202. Table 66 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-202.

Table 66. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-202 – Monitoring Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.5×10^{-5}	Arsenic, (ELCR = 7.4×10^{-5}, 1.3%) Carbon tetrachloride, (ELCR = 2.4×10^{-6}, 0.04%) Carbon-14, (ELCR = 3.1×10^{-3}, 55%) Chloroform, (ELCR = 4.1×10^{-6}, 0.07%) Tritium, (ELCR = 2.4×10^{-3}, 43%)	5.2	Arsenic, (HQ = 0.63, 12%) Cobalt, (HQ = 0.10, 1.8%) Fluoride, (HQ = 0.38, 6.9%) Cr(VI), (HQ = 0.20, 3.7%) Iron, (HQ = 0.11, 2.1%) Nitrate, (HQ = 0.20, 3.7%) Thallium, (HQ = 3.2, 59%) Vanadium, (HQ = 0.13, 2.4%)
	Dermal Contact	6.9×10^{-7}		0.11	
	Inhalation of Volatiles	5.1×10^{-6}		0.07	
	Total Risk	**8.0×10^{-5}**		**Total HI**	**5.4**
Radionuclides	Ingestion	1.2×10^{-4}		--	
	Immersion	3.4×10^{-13}			
	Inhalation of Volatiles	5.4×10^{-3}			
	Total Risk	**5.5×10^{-3}**			
Total Cumulative ELCR		**5.6×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-202 is 5.6×10^{-3}. The total ELCR for nonradiological analytes is 8.0×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 5.5×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon tetrachloride (ELCR = 2.4×10^{-6}, 0.04 percent contribution), carbon-14 (ELCR = 3.1×10^{-3}, 55 percent contribution), chloroform (ELCR = 4.1×10^{-6}, 0.07 percent contribution), and tritium (ELCR = 2.4×10^{-3}, 43 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.4×10^{-5}, 1.3 percent contribution) where the EPC (3.8 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-202 without contribution from arsenic is 6.9×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-202 is 5.4, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.63, 12 percent contribution), cobalt (HQ = 0.10, 1.8 percent contribution), fluoride (HQ = 0.38, 6.9 percent contribution), Cr(VI) (HQ = 0.20, 3.7 percent contribution), iron (HQ = 0.11, 2.1 percent contribution), nitrate (HQ = 0.20, 3.7 percent contribution), thallium (HQ = 3.2, 59 percent contribution), and vanadium (HQ = 0.13, 2.4 percent contribution). Contribution to HI is elevated for thallium (HQ = 3.2) where the EPC (0.64 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L The HI for well 199-K-202 without contribution from arsenic and thallium is 1.6, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Cobalt: thyroid, decreased iodine uptake
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Iron: GI tract; adverse gastrointestinal effects
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

With the exception of iron and fluoride, exposure to each of the analytes that contribute to the HI of 1.6 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for iron and fluoride results in an HI of 0.49, which is less than the target HI of 1. Evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-203. Table 67 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-203.

Table 67. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-203 – Monitoring Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.7×10^{-5}	Arsenic, (ELCR = 7.7×10^{-5}, 9.3%) Carbon-14, (ELCR = 6.8×10^{-4}, 81%)	1.8	Arsenic, (HQ = 0.67, 34%) Fluoride, (HQ = 0.18, 9.0%) Cr(VI), (HQ = 0.58, 30%) Nitrate, (HQ = 0.12, 6.0%) Vanadium, (HQ = 0.15, 7.7%)
	Dermal Contact	4.1×10^{-7}		0.18	
	Inhalation of Volatiles	--		--	
	Total Risk	**7.7×10^{-5}**		**Total HI**	**1.9**
Radionuclides	Ingestion	1.8×10^{-5}		**--**	
	Immersion	3.0×10^{-13}			

Table 67. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-203 – Monitoring Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Inhalation of Volatiles	7.4×10^{-4}			
	Total Risk	**7.6×10^{-4}**			
Total Cumulative ELCR		**8.4×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-203 is 8.4×10^{-4}. The total ELCR for nonradiological analytes is 7.7×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 7.6×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}. The major contributor to the total cumulative ELCR is carbon-14 (ELCR = 6.8×10^{-4}, 81 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.7×10^{-5}, 9.3 percent contribution) where the EPC (4.0 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-203 when contribution from arsenic is not included.

The HI for well 199-K-203 is 1.9, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.67, 34 percent contribution), fluoride (HQ = 0.18, 9.0 percent contribution), Cr(VI) (HQ = 0.58, 30 percent contribution), nitrate (HQ = 0.12, 6.0 percent contribution), and vanadium (HQ = 0.15, 7.7 percent contribution). The HI for well 199-K-203 without contribution from arsenic is 1.3, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.3 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-207. Table 68 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-207.

Table 68. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-207 – Monitoring Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	9.0×10^{-5}	Arsenic, (ELCR = 9.0×10^{-5}, 0.17%) Tritium, (ELCR = 5.3×10^{-2}, 100%)	3.7	Arsenic, (HQ = 0.78, 18%) Boron, (HQ = 0.21, 4.9%) Fluoride, (HQ = 0.24, 5.4%) Cr(VI), (HQ = 2.4,
	Dermal Contact	4.8×10^{-7}		0.65	

Table 68. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-207 – Monitoring Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Inhalation of Volatiles	--		--	55%) Nitrate, (HQ = 0.33, 7.6%) Vanadium, (HQ = 0.13, 3.1%)
	Total Risk	**9.0×10^{-5}**		**Total HI**	**4.3**
Radionuclides	Ingestion	7.4×10^{-4}			
	Immersion	3.3×10^{-14}			
	Inhalation of Volatiles	5.2×10^{-2}			
	Total Risk	**5.3×10^{-2}**			
Total Cumulative ELCR		**5.3×10^{-2}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-207 is 5.3×10^{-2}. The total ELCR for nonradiological analytes is 9.0×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 5.3×10^{-2}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is tritium (ELCR = 5.3×10^{-2}, 100 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 9.0×10^{-5}, 0.17 percent contribution) where the EPC (4.7 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-207 when contribution from arsenic is not included.

The HI for well 199-K-207 is 4.3, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.78, 18 percent contribution), boron (HQ = 0.21, 4.9 percent contribution), fluoride (HQ = 0.24, 5.4 percent contribution), Cr(VI) (HQ = 2.4, 55 percent contribution), nitrate (HQ = 0.33, 7.6 percent contribution), and vanadium (HQ = 0.13, 3.1 percent contribution). The HI for well 199-K-207 without contribution from arsenic is 3.6, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Boron: decreased fetal weight (developmental)
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 3.6 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Cr(VI) has an HQ of 2.4, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-209. Table 69 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-209.

Table 69. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-209 – Monitoring Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.2×10^{-4}	Arsenic, (ELCR = 1.2×10^{-4}, 100%)	1.9	Arsenic, (HQ = 1.0, 53%) Fluoride, (HQ = 0.28, 15%) Vanadium, (HQ = 0.23, 12%)
	Dermal Contact	6.3×10^{-7}		0.06	
	Inhalation of Volatiles	--		--	
	Total Risk	**1.2×10^{-4}**		**Total HI**	**1.9**
Radionuclides	Ingestion	--		**--**	
	Immersion	--			
	Inhalation of Volatiles	--			
	Total Risk	--			
Total Cumulative ELCR		**1.2×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-209 is 1.2×10^{-4}. The total ELCR for nonradiological analytes is 1.2×10^{-4}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. Radiological analytes were not measured; therefore, a total ELCR for radiological analytes is not reported.

There are no major risk contributors. Contribution to ELCR is elevated for arsenic (ELCR = 1.2×10^{-4}, 100 percent contribution) where the EPC (6.1 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-209 when contribution from arsenic is not included.

The HI for well 199-K-209 is 1.9, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 1.0, 53 percent contribution), fluoride (HQ = 0.28, 15 percent contribution), and vanadium (HQ = 0.23, 12 percent contribution). The HI for well 199-K-209 without contribution from arsenic is 0.90, which is less than the target HI of 1.

Well 199-K-223. Table 70 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-223.

Table 70. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-223 – Monitoring Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Ingestion	3.1×10^{-6}	Carbon-14, (ELCR = 2.2×10^{-4}, 64%)	1.3	Fluoride, (HQ = 0.17, 6.5%) Cr(VI), (HQ = 0.24, 9.3%)

Table 70. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-223 – Monitoring Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Dermal Contact	4.9×10^{-7}	Tritium, (ELCR = 1.2×10^{-4}, 33%)	0.16	Nitrate, (HQ = 0.17, 6.4%) Nitrite, (HQ = 0.14, 5.2%) TCE, (HQ = 1.7, 66%) Vanadium, (HQ = 0.11, 4.2%)
	Inhalation of Volatiles	5.3×10^{-6}		1.2	
	Total Risk	**8.8×10^{-6}**		**Total HI**	**2.6**
Radionuclides	Ingestion	6.3×10^{-6}		--	
	Immersion	6.4×10^{-15}			
	Inhalation of Volatiles	3.3×10^{-4}			
	Total Risk	**3.4×10^{-4}**			
Total Cumulative ELCR		**3.4×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-223 is 3.4×10^{-4}. The total ELCR for nonradiological analytes is 8.8×10^{-6}, which is less than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 3.4×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 2.2×10^{-4}, 64 percent contribution) and tritium (ELCR = 1.2×10^{-4}, 33 percent contribution). Arsenic was not reported at well 199-K-223.

The HI for well 199-K-223 is 2.6, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are fluoride (HQ = 0.17, 6.5 percent contribution), Cr(VI) (HQ = 0.24, 9.3 percent contribution), nitrate (HQ = 0.17, 6.4 percent contribution), nitrite (HQ = 0.14, 5.2 percent contribution), TCE (HQ = 1.7, 66 percent contribution), and vanadium (HQ = 0.11, 4.2 percent contribution).

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Nitrite: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of nitrite and nitrate, exposure to each of the analytes that contribute to the HI of 2.6 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for nitrite and nitrate results in an HI of 0.31, which is less than the target HI of 1. TCE reports an individual HQ of 1.7, which is greater than the target HI of 1; evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

7.10 Extraction Wells Screened Across Entire Aquifer

Well 199-K-116A. Table 71 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-116A.

Table 71. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-116A – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.4×10^{-5}	Arsenic, (ELCR = 7.4×10^{-5}, 21%) Tritium, (ELCR = 2.3×10^{-4}, 65%)	1.3	Arsenic, (HQ = 0.64, 47%) Fluoride, (HQ = 0.11, 8.4%) Cr(VI), (HQ = 0.16, 12%) Lithium, (HQ = 0.10, 7.4%) Vanadium, (HQ = 0.11, 8.4%)
	Dermal Contact	3.9×10^{-7}		0.06	
	Inhalation of Volatiles	--		--	
	Total Risk	**7.4×10^{-5}**		**Total HI**	**1.4**
Radionuclides	Ingestion	9.5×10^{-6}		**--**	
	Immersion	1.0×10^{-13}			
	Inhalation of Volatiles	2.7×10^{-4}			
	Total Risk	**2.8×10^{-4}**			
Total Cumulative ELCR		**3.6×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-116A is 3.6×10^{-4}. The total ELCR for nonradiological analytes is 7.4×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.8×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is tritium (ELCR = 2.3×10^{-4}, 65 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.4×10^{-5}, 21 percent contribution) where the EPC (3.8 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-116A when contribution from arsenic is not included.

The HI for well 199-K-116A is 1.4, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.64, 47 percent contribution), fluoride (HQ = 0.11, 8.4 percent contribution), Cr(VI) (HQ = 0.16, 12 percent contribution), lithium (HQ = 0.10, 7.4 percent contribution), and vanadium (HQ = 0.11, 8.4 percent contribution). The HI for well 199-K-116A without contribution from arsenic is 0.72, which is less than the target HI of 1.

Well 199-K-120A. Table 72 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-120A.

Table 72. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-120A – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	5.9×10^{-5}	Arsenic, (ELCR = 6.0×10^{-5}, 11%) Tritium, (ELCR = 4.6×10^{-4}, 85%)	4.3	Arsenic, (HQ = 0.51, 12%) Fluoride, (HQ = 0.10, 2.2%) Cr(VI), (HQ = 0.11, 2.5%) Nitrate, (HQ = 0.10, 2.3%) Thallium, (HQ = 3.2, 74%) Vanadium, (HQ = 0.11, 2.6%)
	Dermal Contact	3.2×10^{-7}		0.06	
	Inhalation of Volatiles	--		--	
	Total Risk	**6.0×10^{-5}**		Total HI	**4.3**
Radionuclides	Ingestion	9.3×10^{-6}		--	
	Immersion	4.8×10^{-14}			
	Inhalation of Volatiles	4.8×10^{-4}			
	Total Risk	**4.9×10^{-4}**			
Total Cumulative ELCR		**5.5×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-120A is 5.5×10^{-4}. The total ELCR for nonradiological analytes is 6.0×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 4.9×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is tritium (ELCR = 4.6×10^{-4}, 85 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 6.0×10^{-5}, 11 percent contribution) where the EPC (3.1 µg/L) is is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-120A when contribution from arsenic is not included.

The HI for well 199-K-120A is 4.3, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.51, 12 percent contribution), fluoride (HQ = 0.10, 2.2 percent contribution), Cr(VI) (HQ = 0.11, 2.5 percent contribution), nitrate (HQ = 0.10, 2.3 percent contribution), thallium (HQ = 3.2, 74 percent contribution), and vanadium (HQ = 0.11, 2.6 percent contribution). Contribution to HI is elevated for thallium (HQ = 3.2) where the EPC (0.64 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L The HI for well 199-K-120A without contribution from arsenic and thallium is 0.61, which is less than the target HI of 1.

Well 199-K-145. Table 73 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-145.

Table 73. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-145 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	5.2×10^{-5}	Arsenic, (ELCR = 5.2×10^{-5}, 1.9%) Tritium, (ELCR = 2.6×10^{-3}, 96%)	1.5	Arsenic, (HQ = 0.45, 27%) Fluoride, (HQ = 0.14, 8.4%) Cr(VI), (HQ = 0.72, 43%) Nitrate, (HQ = 0.12, 7.3%) Vanadium, (HQ = 0.15, 9.3%)
	Dermal Contact	2.8×10^{-7}		0.21	
	Inhalation of Volatiles	--		--	
	Total Risk	**5.2×10^{-5}**		**Total HI**	**1.7**
Radionuclides	Ingestion	3.8×10^{-5}		--	
	Immersion	4.1×10^{-15}			
	Inhalation of Volatiles	2.6×10^{-3}			
	Total Risk	**2.7×10^{-3}**			
Total Cumulative ELCR		**2.7×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-145 is 2.7×10^{-3}. The total ELCR for nonradiological analytes is 5.2×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.7×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is tritium (ELCR = 2.6×10^{-3}, 96 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 5.2×10^{-5}, 1.9 percent contribution) where the EPC (2.7 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-145 when contribution from arsenic is not included.

The HI for well 199-K-145 is 1.7, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.45, 27 percent contribution), fluoride (HQ = 0.14, 8.4 percent contribution), Cr(VI) (HQ = 0.72, 43 percent contribution), nitrate (HQ = 0.12, 7.3 percent contribution), and vanadium (HQ = 0.15, 9.3 percent contribution). The HI for well 199-K-145 without contribution from arsenic is 1.2, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.2 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-152. Table 74 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-152.

Table 74. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-152 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	2.3×10^{-4}	Aldrin, (ELCR = 3.3×10^{-3}, 94%) Arsenic, (ELCR = 9.1×10^{-5}, 2.6%) Chloroform, (ELCR = 8.2×10^{-6}, 0.23%)	3.8	Aldrin, (HQ = 19, 85%) Arsenic, (HQ = 0.78, 3.5%) Bromomethane, (HQ = 0.15, 0.65%) Fluoride, (HQ = 0.18, 0.81%) Cr(VI), (HQ = 1.3, 5.9%) Lithium, (HQ = 0.13, 0.56%) Molybdenum, (HQ = 0.16, 0.72%) Nitrate, (HQ = 0.10, 0.43%) Vanadium, (HQ = 0.23, 1.0%)
	Dermal Contact	2.6×10^{-3}		18	
	Inhalation of Volatiles	5.7×10^{-4}		0.12	
	Total Risk	**3.4×10^{-3}**		**Total HI**	**22**
Radionuclides	Ingestion	5.9×10^{-6}		--	
	Immersion	2.6×10^{-13}			
	Inhalation of Volatiles	9.2×10^{-5}			
	Total Risk	**9.8×10^{-5}**			
Total Cumulative ELCR		**3.5×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-152 is 3.5×10^{-3}. The total ELCR for nonradiological analytes is 3.4×10^{-3}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 9.8×10^{-5}, which is equal to the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are aldrin (ELCR = 3.3×10^{-3}, 94 percent contribution) and chloroform (ELCR = 8.2×10^{-6}, 0.23 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 9.1×10^{-5}, 2.6 percent contribution) where the EPC (4.7 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-152 without contribution from arsenic is 3.3×10^{-3}, which is greater than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

Aldrin was detected in one of three samples (0.65 µg/L) collected from well 199-K-152 between June 2010 and January 2011. This result was flagged with a "B" laboratory qualifier indicating that aldrin was detected in the associated method blank and the sample. As a result, aldrin was introduced into this sample by the laboratory and is not associated with a groundwater plume.

The HI for well 199-K-152 is 22, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are aldrin (HQ = 19, 85 percent contribution), arsenic (HQ = 0.78, 3.5 percent

contribution), bromomethane (HQ = 0.15, 0.65 percent contribution), fluoride (HQ = 0.18, 0.81 percent contribution), Cr(VI) (HQ = 1.3, 5.9 percent contribution), lithium (HQ = 0.13, 0.56 percent contribution), molybdenum (HQ = 0.16, 0.72 percent contribution), nitrate (HQ = 0.10, 0.43 percent contribution), and vanadium (HQ = 0.23, 1.0 percent contribution). The HI for well 199-K-152 without contribution from arsenic is 22, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Aldrin: liver toxicity
- Bromomethane: degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Molybdenum: increased uric acid levels
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

With the exception of Cr(VI), bromomethane, fluoride, molybdenum, and lithium, exposure to each of the analytes that contribute to the HI of 22 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for Cr(VI) and bromomethane results in an HI of 1.5, which is greater than the target HI of 1. Combining the HQs for bromomethane and lithium results in an HI of 0.28, which is less than the target HI of 1. Combining the HQs for bromomethane and fluoride results in a HI of 0.33, which is less than the target HI of 1. Aldrin reports an individual HQ of 19, which is greater than the target HI of 1. Evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-153. Table 75 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-153.

Table 75. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-153 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	4.6×10^{-5}	Arsenic, (ELCR = 4.6×10^{-5}, 31%)	1.3	Arsenic, (HQ = 0.40, 27%) Fluoride, (HQ = 0.18, 12%) Cr(VI), (HQ = 0.54, 37%) Vanadium, (HQ = 0.17, 11%)
	Dermal Contact	2.5×10^{-7}		0.17	
	Inhalation of Volatiles	--		--	
	Total Risk	**4.6×10^{-5}**		Total HI	**1.5**
Radionuclides	Ingestion	1.7×10^{-6}		--	
	Immersion	9.4×10^{-16}			
	Inhalation of Volatiles	1.0×10^{-4}			
	Total Risk	**1.0×10^{-4}**			
Total Cumulative ELCR		**1.5×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-153 is 1.5×10^{-4}. The total ELCR for nonradiological analytes is 4.6×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.0×10^{-4}, which is equal to the EPA upper risk threshold of 1×10^{-4}.

There are no major risk contributors. Contribution to ELCR is elevated for arsenic (ELCR = 4.6×10^{-5}, 31 percent contribution) where the EPC (2.4 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-153 when contribution from arsenic is not included.

The HI for well 199-K-153 is 1.5, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.40, 27 percent contribution), fluoride (HQ = 0.18, 12 percent contribution), Cr(VI) (HQ = 0.54, 37 percent contribution), and vanadium (HQ = 0.17, 11 percent contribution). The HI for well 199-K-153 without contribution from arsenic is 1.1, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.1 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-154. Table 76 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-154.

Table 76. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-154 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	8.5×10^{-5}	Arsenic, (ELCR = 8.5×10^{-5}, 46%)	2.5	Arsenic, (HQ = 0.73, 25%) Fluoride, (HQ = 0.22, 7.7%) Cr(VI), (HQ = 1.6, 54%) Vanadium, (HQ = 0.17, 6.0%)
	Dermal Contact	4.5×10^{-7}		0.44	
	Inhalation of Volatiles	--		--	
	Total Risk	**8.5×10^{-5}**		Total HI	**2.9**
Radionuclides	Ingestion	1.4×10^{-6}		--	
	Immersion	--			
	Inhalation of Volatiles	10.0×10^{-5}			
	Total Risk	**1.0×10^{-4}**			
Total Cumulative ELCR		**1.9×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-154 is 1.9×10^{-4}. The total ELCR for nonradiological analytes is 8.5×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.0×10^{-4}, which is equal to the EPA upper risk threshold of 1×10^{-4}.

Contribution to ELCR is elevated for arsenic (ELCR = 8.5×10^{-5}, 46 percent contribution) where the EPC (4.4 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-154 when contribution from arsenic is not included.

The HI for well 199-K-154 is 2.9, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.73, 25 percent contribution), fluoride (HQ = 0.22, 7.7 percent contribution), Cr(VI) (HQ = 1.6, 54 percent contribution), and vanadium (HQ = 0.17, 6.0 percent contribution). The HI for well 199-K-154 without contribution from arsenic is 2.2, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 2.2 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Cr(VI) has an HQ of 1.6, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-163. Table 77 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-163.

Table 77. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-163 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.3×10^{-5}	Arsenic, (ELCR = 7.4×10^{-5}, 20%) Tritium, (ELCR = 2.4×10^{-4}, 66%)	1.8	Arsenic, (HQ = 0.63, 31%) Fluoride, (HQ = 0.22, 11%) Cr(VI), (HQ = 0.85, 42%) Nitrate, (HQ = 0.10, 5.0%) Vanadium, (HQ = 0.17, 8.1%)
	Dermal Contact	3.9×10^{-7}		0.25	
	Inhalation of Volatiles	--		--	
	Total Risk	**7.4×10^{-5}**		**Total HI**	**2.0**
Radionuclides	Ingestion	4.9×10^{-6}		--	
	Immersion	4.3×10^{-15}			
	Inhalation of Volatiles	2.9×10^{-4}			
	Total Risk	**2.9×10^{-4}**			
Total Cumulative ELCR		**3.7×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-163 is 3.7×10^{-4}. The total ELCR for nonradiological analytes is 7.4×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.9×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is tritium (ELCR = 2.4×10^{-4}, 66 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.4×10^{-5}, 20 percent contribution) where the EPC (3.8 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-163 when contribution from arsenic is not included.

The HI for well 199-K-163 is 2.0, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.63, 31 percent contribution), fluoride (HQ = 0.22, 11 percent contribution), Cr(VI) (HQ = 0.85, 42 percent contribution), nitrate (HQ = 0.10, 5.0 percent contribution), and vanadium (HQ = 0.17, 8.1 percent contribution). The HI for well 199-K-163 without contribution from arsenic is 1.4, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.4 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-165. Table 78 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-165.

Table 78. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-165 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	4.3×10^{-5}	Arsenic, (ELCR = 4.1×10^{-5}, 4.6%) Carbon-14, (ELCR = 7.3×10^{-4}, 84%) Chloroform, (ELCR = 1.8×10^{-6}, 0.20%) TCE, (ELCR = 5.8×10^{-6}, 0.66%)	4.0	2-Propanol, (HQ = 0.29, 4.7%) Arsenic, (HQ = 0.35, 5.6%) Fluoride, (HQ = 0.15, 2.4%) Cr(VI), (HQ = 3.5, 56%) Nitrate, (HQ = 0.16, 2.5%) TCE, (HQ = 1.4, 23%) Vanadium, (HQ = 0.16, 2.6%)
	Dermal Contact	6.2×10^{-7}		1.0	
	Inhalation of Volatiles	4.6×10^{-6}		1.3	
	Total Risk	**4.8×10^{-5}**		Total HI	**6.2**
Radionuclides	Ingestion	1.9×10^{-5}		--	
	Immersion	3.5×10^{-14}			
	Inhalation of Volatiles	8.1×10^{-4}			
	Total Risk	**8.3×10^{-4}**			

Table 78. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-165 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Total Cumulative ELCR		8.8×10^{-4}			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-165 is 8.8×10^{-4}. The total ELCR for nonradiological analytes is 4.8×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 8.3×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 7.3×10^{-4}, 84 percent contribution), chloroform (ELCR = 1.8×10^{-6}, 0.20 percent contribution), and TCE (ELCR = 5.8×10^{-6}, 0.66 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 4.1×10^{-5}, 4.6 percent contribution) where the EPC (2.1 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-165 without contribution from arsenic is 7.6×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-165 is 6.2, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are 2-propanol (HQ = 0.29, 4.7 percent contribution), arsenic (HQ = 0.35, 5.6 percent contribution), fluoride (HQ = 0.15, 2.4 percent contribution), Cr(VI) (HQ = 3.5, 56 percent contribution), nitrate (HQ = 0.16, 2.5 percent contribution), TCE (HQ = 1.4, 23 percent contribution), and vanadium (HQ = 0.16, 2.6 percent contribution). The HI for well 199-K-165 without contribution from arsenic is 5.9, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- 2-Propanol: decreased fetal body weight
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of 2-propanol and TCE, exposure to each of the analytes that contribute to the HI of 5.9 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for 2-propanol and TCE results in an HI of 1.7, which is greater than the target HI of 1. Cr(VI) reports an individual HQ of 3.5, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-166. Table 79 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-166.

Table 79. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-166 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
	Ingestion	5.1×10^{-5}	Arsenic, (ELCR = 4.8×10^{-5}, 4.9%) Carbon-14, (ELCR = 8.3×10^{-4}, 83%) Chloroform, (ELCR = 1.7×10^{-6}, 0.17%) TCE, (ELCR = 6.2×10^{-6}, 0.62%)	1.7	Arsenic, (HQ = 0.42, 14%) Fluoride, (HQ = 0.15, 5.1%) Cr(VI), (HQ = 0.42, 14%) Nitrate, (HQ = 0.17,

Table 79. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-166 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Dermal Contact	6.9×10^{-7}	Tritium, (ELCR = 1.1×10^{-4}, 11%)	0.20	5.7%) TCE, (HQ = 1.5, 52%) Vanadium, (HQ = 0.10, 3.5%)
	Inhalation of Volatiles	4.7×10^{-6}		1.0	
	Total Risk	**5.6×10^{-5}**		**Total HI**	**2.9**
Radionuclides	Ingestion	2.4×10^{-5}		--	
	Immersion	8.9×10^{-14}			
	Inhalation of Volatiles	9.1×10^{-4}			
	Total Risk	**9.4×10^{-4}**			
Total Cumulative ELCR		**9.9×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-166 is 9.9×10^{-4}. The total ELCR for nonradiological analytes is 5.6×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 9.4×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 8.3×10^{-4}, 83 percent contribution), chloroform (ELCR = 1.7×10^{-6}, 0.17 percent contribution), TCE (ELCR = 6.2×10^{-6}, 0.62 percent contribution), and tritium (ELCR = 1.1×10^{-4}, 11 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 4.8×10^{-5}, 4.9 percent contribution) where the EPC (2.5 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-166 without contribution from arsenic is 7.9×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-166 is 2.9, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.42, 14 percent contribution), fluoride (HQ = 0.15, 5.1 percent contribution), Cr(VI) (HQ = 0.42, 14 percent contribution), nitrate (HQ = 0.17, 5.7 percent contribution), TCE (HQ = 1.5, 52 percent contribution), and vanadium (HQ = 0.10, 3.5 percent contribution). The HI for well 199-K-166 without contribution from arsenic is 2.5, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 2.5 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. TCE has an HQ of 1.5, which is greater than the target HI of 1; evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-171. Table 80 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-171.

Table 80. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-171 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.3×10^{-5}	Arsenic, (ELCR = 7.4×10^{-5}, 17%) Tritium, (ELCR = 3.5×10^{-4}, 81%)	2.1	Arsenic, (HQ = 0.63, 27%) Fluoride, (HQ = 0.23, 9.8%) Cr(VI), (HQ = 0.96, 40%) Nitrate, (HQ = 0.10, 4.2%) Silver, (HQ = 0.21, 8.9%) Vanadium, (HQ = 0.17, 7.2%)
	Dermal Contact	3.9×10^{-7}		0.29	
	Inhalation of Volatiles	--		--	
	Total Risk	**7.4×10^{-5}**		**Total HI**	**2.4**
Radionuclides	Ingestion	5.0×10^{-6}		--	
	Immersion	2.3×10^{-16}			
	Inhalation of Volatiles	3.5×10^{-4}			
	Total Risk	**3.5×10^{-4}**			
Total Cumulative ELCR		**4.3×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-171 is 4.3×10^{-4}. The total ELCR for nonradiological analytes is 7.4×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 3.5×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is tritium (ELCR = 3.5×10^{-4}, 81 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.4×10^{-5}, 17 percent contribution) where the EPC (3.8 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-171 when contribution from arsenic is not included.

The HI for well 199-K-171 is 2.4, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.63, 27 percent contribution), fluoride (HQ = 0.23, 9.8 percent contribution), Cr(VI) (HQ = 0.96, 40 percent contribution), nitrate (HQ = 0.10, 4.2 percent contribution), silver (HQ = 0.21, 8.9 percent contribution), and vanadium (HQ = 0.17, 7.2 percent contribution). The HI for well 199-K-171 without contribution from arsenic is 1.8, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Silver: argyia (dermal)
- Vanadium: decreased hair cysteine

With the exception of silver and vanadium, exposure to each of the analytes that contribute to the HI of 1.8 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for silver and vanadium results in an HI of 0.38, which is less than the target HI of 1. Evaluating the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-182. Table 81 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-182.

Table 81. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-182 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	9.2×10^{-5}	Arsenic, (ELCR = 9.2×10^{-5}, 31%) Chloroform, (ELCR = 5.0×10^{-6}, 1.7%) Tritium, (ELCR = 1.9×10^{-4}, 65%)	3.0	Arsenic, (HQ = 0.79, 23%) Bromomethane, (HQ = 0.12, 3.6%) Fluoride, (HQ = 0.16, 4.5%) Cr(VI), (HQ = 1.4, 41%) Lithium, (HQ = 0.40, 12%) Nitrate, (HQ = 0.12, 3.5%) Vanadium, (HQ = 0.22, 6.4%)
	Dermal Contact	5.3×10^{-7}		0.42	
	Inhalation of Volatiles	4.5×10^{-6}		0.10	
	Total Risk	**9.7×10^{-5}**		**Total HI**	**3.5**
Radionuclides	Ingestion	8.5×10^{-6}		--	
	Immersion	2.9×10^{-13}			
	Inhalation of Volatiles	1.9×10^{-4}			
	Total Risk	**2.0×10^{-4}**			
Total Cumulative ELCR		**3.0×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-182 is 3.0×10^{-4}. The total ELCR for nonradiological analytes is 9.7×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 2.0×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are chloroform (ELCR = 5.0×10^{-6}, 1.7 percent contribution) and tritium (ELCR = 1.9×10^{-4}, 65 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 9.2×10^{-5}, 31 percent contribution) where the EPC (4.7 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. The nonradiological ELCR for well 199-K-182 without contribution from arsenic is 5.0×10^{-6}, which is less than the MTCA (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}.

The HI for well 199-K-182 is 3.5, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.79, 23 percent contribution), bromomethane (HQ = 0.12, 3.6 percent contribution), fluoride (HQ = 0.16, 4.5 percent contribution), Cr(VI) (HQ = 1.4, 41 percent contribution), lithium (HQ = 0.40, 12 percent contribution), nitrate (HQ = 0.12, 3.5 percent contribution), and vanadium (HQ = 0.22,

6.4 percent contribution). The HI for well 199-K-182 without contribution from arsenic is 2.7, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Bromomethane: degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Lithium: nervous system and kidney effects
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

With the exception of Cr(VI) and bromomethane, exposure to each of the analytes that contribute to the HI of 2.7 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for Cr(VI) and bromomethane results in an HI of 1.6, which is greater than the target HI of 1. Evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

Well 199-K-208. Table 82 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-208.

Table 82. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-208 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	8.3×10^{-5}	Arsenic, (ELCR = 8.3×10^{-5}, 2.7%) Tritium, (ELCR = 3.0×10^{-3}, 97%)	2.0	Arsenic, (HQ = 0.72, 33%) Fluoride, (HQ = 0.20, 9.2%) Cr(VI), (HQ = 0.55, 25%) Nitrate, (HQ = 0.15, 6.8%) Vanadium, (HQ = 0.15, 7.0%)
	Dermal Contact	4.4×10^{-7}		0.17	
	Inhalation of Volatiles	--		--	
	Total Risk	**8.3×10^{-5}**		**Total HI**	**2.2**
Radionuclides	Ingestion	4.3×10^{-5}		--	
	Immersion	1.7×10^{-14}			
	Inhalation of Volatiles	3.0×10^{-3}			
	Total Risk	**3.0×10^{-3}**			
Total Cumulative ELCR		**3.1×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-208 is 3.1×10^{-3}. The total ELCR for nonradiological analytes is 8.3×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 3.0×10^{-3}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributor to the total cumulative ELCR is tritium (ELCR = 3.0×10^{-3}, 97 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 8.3×10^{-5}, 2.7 percent contribution) where the EPC (4.3 µg/L)

is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-208 when contribution from arsenic is not included.

The HI for well 199-K-208 is 2.2, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.72, 33 percent contribution), fluoride (HQ = 0.20, 9.2 percent contribution), Cr(VI) (HQ = 0.55, 25 percent contribution), nitrate (HQ = 0.15, 6.8 percent contribution), and vanadium (HQ = 0.15, 7.0 percent contribution). The HI for well 199-K-208 without contribution from arsenic is 1.5, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.5 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-210. Table 83 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-210.

Table 83. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-210 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	7.3×10^{-5}	Arsenic, (ELCR = 7.4×10^{-5}, 11%) Carbon-14, (ELCR = 3.3×10^{-4}, 50%) Tritium, (ELCR = 2.5×10^{-4}, 38%)	1.5	Arsenic, (HQ = 0.63, 37%) Fluoride, (HQ = 0.15, 8.9%) Cr(VI), (HQ = 0.56, 33%) Nitrate, (HQ = 0.16, 9.4%)
	Dermal Contact	3.9×10^{-7}		0.15	
	Inhalation of Volatiles	--		--	
	Total Risk	**7.4×10^{-5}**		Total HI	**1.7**
Radionuclides	Ingestion	1.2×10^{-5}		--	
	Immersion	4.5×10^{-14}			
	Inhalation of Volatiles	5.7×10^{-4}			
	Total Risk	**5.8×10^{-4}**			
Total Cumulative ELCR		**6.6×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-210 is 6.6×10^{-4}. The total ELCR for nonradiological analytes is 7.4×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 5.8×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 3.3×10^{-4}, 50 percent contribution) and tritium (ELCR = 2.5×10^{-4}, 38 percent contribution). Contribution to ELCR is elevated for arsenic (ELCR = 7.4×10^{-5}, 11 percent contribution) where the EPC (3.8 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-210 when contribution from arsenic is not included.

The HI for well 199-K-210 is 1.7, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.63, 37 percent contribution), fluoride (HQ = 0.15, 8.9 percent contribution), Cr(VI) (HQ = 0.56, 33 percent contribution), and nitrate (HQ = 0.16, 9.4 percent contribution). The HI for well 199-K-210 without contribution from arsenic is 1.1, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia

Exposure to each of the analytes that contribute to the HI of 1.1 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating each of the analytes individually results in an HI less than 1.

Well 199-K-224. Table 84 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-224.

Table 84. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-224 – Extraction Well Screened Across Entire Aquifer

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	3.4×10^{-6}	Carbon-14, (ELCR = 6.4×10^{-4}, 88%) Chloroform, (ELCR = 1.7×10^{-6}, 0.24%) TCE, (ELCR = 7.8×10^{-6}, 1.1%)	3.1	Fluoride, (HQ = 0.18, 3.4%) Cr(VI), (HQ = 2.5, 49%) Nitrate, (HQ = 0.16, 3.2%) Nitrite, (HQ = 0.14, 2.6%) TCE, (HQ = 1.9, 37%) Vanadium, (HQ = 0.15, 2.8%)
	Dermal Contact	5.4×10^{-7}		0.77	
	Inhalation of Volatiles	5.6×10^{-6}		1.3	
	Total Risk	**9.5×10^{-6}**		**Total HI**	**5.2**
Radionuclides	Ingestion	1.6×10^{-5}		--	
	Immersion	5.0×10^{-14}			
	Inhalation of Volatiles	7.0×10^{-4}			
	Total Risk	**7.2×10^{-4}**			
Total Cumulative ELCR		**7.3×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-224 is 7.3×10^{-4}. The total ELCR for nonradiological analytes is 9.5×10^{-6}, which is less than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 7.2×10^{-4}, which is greater than the EPA upper risk threshold of 1×10^{-4}.

The major contributors to the total cumulative ELCR are carbon-14 (ELCR = 6.4×10^{-4}, 88 percent contribution), chloroform (ELCR = 1.7×10^{-6}, 0.24 percent contribution), and TCE (ELCR = 7.8×10^{-6}, 1.1 percent contribution). Arsenic was not reported at well 199-K-224.

The HI for well 199-K-224 is 5.2, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are fluoride (HQ = 0.18, 3.4 percent contribution), Cr(VI) (HQ = 2.5, 49 percent contribution), nitrate (HQ = 0.16, 3.2 percent contribution), nitrite (HQ = 0.14, 2.6 percent contribution), TCE (HQ = 1.9, 37 percent contribution), and vanadium (HQ = 0.15, 2.8 percent contribution).

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Nitrate: early clinical signs of methemoglobinemia
- Nitrite: early clinical signs of methemoglobinemia
- TCE: developmental immunotoxicity
- Vanadium: decreased hair cysteine

With the exception of nitrite and nitrate, exposure to each of the analytes that contribute to the HI of 5.2 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Combining the HQs for nitrite and nitrate results in an HI of 0.30, which is less than the target HI of 1. Cr(VI) and TCE reports an individual HQ of 2.5 and 1.9, respectively, which is greater than the target HI of 1. Evaluating each of the remaining analytes individually results in an HI less than 1 for each contributor.

7.6 Monitoring Wells Screened in the Ringold Upper Mud

Well 199-K-192. Table 85 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-192.

Table 85. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-192 – Monitoring Well Screeened in the Ringold Upper Mud

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.7×10^{-4}	Arsenic, (ELCR = 1.7×10^{-4}, 96%)	9.0	Arsenic, (HQ = 1.5, 16%) Fluoride, (HQ = 0.34, 3.7%) Cr(VI), (HQ = 0.15, 1.6%) Thallium, (HQ = 6.5, 71%) Vanadium, (HQ = 0.30, 3.2%)
	Dermal Contact	9.2×10^{-7}		0.12	
	Inhalation of Volatiles	--		< 0.01	
	Total Risk	**1.7×10^{-4}**		**Total HI**	**9.1**
Radionuclides	Ingestion	6.4×10^{-6}		--	
	Immersion	1.1×10^{-13}			
	Inhalation of Volatiles	--			
	Total Risk	**6.4×10^{-6}**			

Table 85. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-192 – Monitoring Well Screeened in the Ringold Upper Mud

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Total Cumulative ELCR		**1.8×10^{-4}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-192 is 1.8×10^{-4}. The total ELCR for nonradiological analytes is 1.7×10^{-4}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 6.4×10^{-6}, which is within the EPA risk threshold range of 1×10^{-4} to 1×10^{-6}.

There are no major risk contributors. Contribution to ELCR is elevated for arsenic (ELCR = 1.7×10^{-4}, 96 percent contribution) where the EPC (9.0 µg/L) is greater than the range of natural background values for arsenic (0.5 µg/L to 8.8 µg/L). However, the EPC of 9 µg/L is less than the drinking water standard of 10 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-192 when contribution from arsenic is not included.

The HI for well 199-K-192 is 9.1, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 1.5, 16 percent contribution), fluoride (HQ = 0.34, 3.7 percent contribution), Cr(VI) (HQ = 0.15, 1.6 percent contribution), thallium (HQ = 6.5, 71 percent contribution), and vanadium (HQ = 0.30, 3.2 percent contribution). Contribution to HI is elevated for thallium (HQ = 6.5) where the EPC (1.3 µg/L) is less than the 90th percentile Hanford Site background value of 1.67 µg/L. The HI for well 199-K-192 without contribution from arsenic and thallium is 1.1, which is greater than the target HI of 1.

The mechanisms of action (critical effect) for each of the analytes that contribute to the HI are as follows:

- Arsenic: hyperpigmentation, keratosis and possible vascular complications
- Fluoride: objectionable dental fluorosis, a cosmetic effect
- Cr(VI): nasal septum atrophy
- Vanadium: decreased hair cysteine

Exposure to each of the analytes that contribute to the HI of 1.1 results in a different critical effect. As such, it is appropriate to segregate the contribution to the HI for each analyte. Evaluating the analytes individually results in an HI less than 1 for each contributor. Arsenic reports an individual HQ of 1.5, which is greater than the target HI of 1.

Well 199-K-32B. Table 86 provides a summary of the cancer risks and noncancer hazards by exposure route for well 199-K-32B.

Table 86. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-32B – Monitoring Well Screeened in the Ringold Upper Mud

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	**Ingestion**	3.0×10^{-5}	Arsenic, (ELCR = 3.0×10^{-5}, 95%)	1.2	Arsenic, (HQ = 0.26, 21%) Cadmium, (HQ = 0.14, 11%) Fluoride, (HQ = 0.23, 18%) Cr(VI), (HQ = 0.15, 12%)
	Dermal Contact	1.6×10^{-7}		0.07	
	Inhalation of Volatiles	--		--	
	Total Risk	**3.0×10^{-5}**		**Total HI**	**1.2**

Table 86. Summary of Cancer Risks and Noncancer Hazards for Well 199-K-32B – Monitoring Well Screeened in the Ringold Upper Mud

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Radionuclides	Ingestion	1.7×10^{-6}		--	
	Immersion	3.3×10^{-14}			
	Inhalation of Volatiles	--			
	Total Risk	**1.7×10^{-6}**			
Total Cumulative ELCR		**3.1×10^{-5}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

The total cumulative ELCR for well 199-K-32B is 3.1×10^{-5}. The total ELCR for nonradiological analytes is 3.0×10^{-5}, which is greater than the MTCA HHRA Procedures (WAC 173-340-708(5)) cumulative risk threshold of 1×10^{-5}. The total ELCR for radiological analytes is 1.7×10^{-6}, which is within the EPA risk threshold range of 1×10^{-4} to 1×10^{-6}.

There are no major risk contributors. Contribution to ELCR is elevated for arsenic (ELCR = 3.0×10^{-5}, 95 percent contribution) where the EPC (1.5 µg/L) is less than the 90th percentile Hanford Site background value of 7.85 µg/L. A total ELCR for nonradiological analytes is not reported for well 199-K-32B when contribution from arsenic is not included.

The HI for well 199-K-32B is 1.2, which is greater than the MTCA (WAC 173-340-708(5)) target HI of 1. Primary contributors to the noncancer HI are arsenic (HQ = 0.26, 21 percent contribution), cadmium (HQ = 0.14, 11 percent contribution), fluoride (HQ = 0.23, 18 percent contribution), and Cr(VI) (HQ = 0.15, 12 percent contribution). The HI for well 199-K-32B without contribution from arsenic is 0.99, which is less than the target HI of 1.

7.10 All Wells Dataset

A summary of the cancer risks and noncancer hazards by exposure route for the all wells dataset follows. The following information is provided for comparison to the Native American exposure scenarios only. It is not used for decision making purposes.

All Wells. Error! Reference source not found. provides a summary of the cancer risks and noncancer hazards by exposure route for the all wells dataset.

Table 87. **Summary of Cancer Risks and Noncancer Hazards for All Wells Dataset**

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.4×10^{-4}	Aldrin, (ELCR 1.6×10^{-3}, 28%) Arsenic, (ELCR = 6.9×10^{-5}, 1.2%) Bis(2-ethylhexyl) phthalate, (ELCR = 1.2×10^{-4}, 2.2%) Carbon tetrachloride, (ELCR = 2.4 ×	4.6	1,2,4-Trichlorobenzene (HQ = 0.16, 0.91%) 2-Propanol (HQ = 0.25, 1.4%) Aldrin, (HQ = 9.2, 52%) Arsenic, (HQ = 0.59, 3.3%)
	Dermal Contact	1.4×10^{-3}		11	

Table 87. **Summary of Cancer Risks and Noncancer Hazards for All Wells Dataset**

Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
			10^{-6}, 0.043%) Chloroform, (ELCR = 3.3×10^{-6}, 0.059%) Ethylbenzene, (ELCR = 1.7×10^{-6}, 0.030%) TCE, (ELCR = 4.3×10^{-6}, 0.077%) Carbon-14, (ELCR = 2.5×10^{-3}, 44%) Tritium, (ELCR = 1.3×10^{-3}, 23%)		Bis(2-ethylhexyl) phthalate, (HQ = 1.5, 8.6%) Cyanide, (HQ = 1.6, 8.9%) Fluoride, (HQ = 0.15, 0.85%) Cr(VI), (HQ = 1.2, 6.8%) Lithium, (HQ = 0.37, 2.1%) Manganese, (HQ = 0.54, 3.0%) Nitrate, (HQ = 0.17, 0.97%) Thallium, (HQ = 0.39, 2.2%) TCE, (HQ = 1.1, 6.0%) Vanadium, (HQ = 0.12, 0.69%)
	Inhalation of Volatiles	2.8×10^{-4}		2.6	
	Total Risk	**1.8×10^{-3}**		**Total HI**	**18**
Radionuclides	**Ingestion**	1.0×10^{-4}		**--**	
	Immersion	2.1×10^{-10}			
	Inhalation of Volatiles	3.7×10^{-3}			
	Total Risk	**3.8×10^{-3}**			
Total Cumulative ELCR		**5.6×10^{-3}**			

ELCR = excess lifetime cancer risk
HI = hazard index
HQ = hazard quotient

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Appendix A

Well-Specific Exposure Point Concentrations

Table A-1a EPCs for Monitoring Wells Screened Across Top of the Unconfined Aquifer

Analyte	CAS NO	Units	199-K-18	199-K-19	199-K-22	199-K-23	199-K-29	199-K-30	199-K-32A	199-K-34	199-K-36	199-K-106A	199-K-107A	199-K-108A	199-K-110A	199-K-111A	199-K-132
1,2,4-Trichlorobenzene	120-82-1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	95-50-1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Butanol	78-92-2	ug/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	21
2-Butanone	78-93-3	ug/L	NC	NA	NC	NA	NA	NA	NC	NC	NC	NC	0.62	NC	NA	NC	0.82
2-Propanol	67-63-0	ug/L	NA	NA	NA	NA	NA	NA	NA	130	NA	370	140	NC	NA	NA	80
Acetone	67-64-1	ug/L	NC	NA	NC	NA	NA	NA	NC	6.5	NC	1.2	2.4	0.59	NA	1.4	1.1
Aldrin	309-00-2		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum	7429-90-5	ug/L	36	70	14	174	NA	NA	554	88	43	38	110	28	53	86	21
Antimony	7440-36-0	ug/L	NC	0.18	NC	NC	NA	NA	NC	0.55	NC	NC	0.58	0.28	0.2	0.81	0.34
Arsenic	7440-38-2	ug/L	2.5	0.98	NC	3.3	NA	NA	1.6	2.1	5.6	3.6	3	2.6	1.8	3.9	2.4
Barium	7440-39-3	ug/L	34	28	30	45	24	26	30	33	62	42	50	38	31	38	32
Beryllium	7440-41-7	ug/L	0.23	NC	NC	0.71	NA	NA	NC	NC	0.6	NC	0.31	NC	NC	NC	NC
Bis(2-ethylhexyl) phthalate	117-81-7		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boron	7440-42-8	ug/L	NC	11	NC	79	NA	NA	21	36	51	34	17	22	13	22	15
Bromodichloromethane	75-27-4	ug/L	NC	NA	NC	NA	NA	NA	0.16	NC	NC	NC	NA	NC	NA	NA	NA
Bromomethane	74-83-9	ug/L	1	NA	0.97	NA	NA	NA	0.97	NC	1	1.6	NA	1.1	NA	NA	NA
Cadmium	7440-43-9	ug/L	NC	0.13	0.6	NC	NA	NA	NC	NC	NC	NC	NC	NC	NC	NC	NC
Carbon disulfide	75-15-0	ug/L	NC	NA	NC	NA	NA	NA	NC	NC	NC	NC	NC	NC	NA	NC	NC
Carbon tetrachloride	56-23-5	ug/L	NC	NA	NC	NA	NA	NA	NC	NC	NC	NC	NC	NC	NA	NC	NC
Carbon-14	14762-75-5	pCi/L	28	21	15	81	3120	4110	275	3922	119	22900	687	828	NA	230	4270
Cesium-137	10045-97-3	pCi/L	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NA	NC	NC
Chlorobenzene	108-90-7	ug/L	NC	NA	NC	NA	NA	NA	NC	NC	NC	0.17	NC	NC	NA	NC	NC
Chloroform	67-66-3	ug/L	2.1	NA	0.79	NA	NA	NA	2.3	0.41	0.7	0.72	0.4	0.45	NA	0.52	0.4
Chloromethane	74-87-3	ug/L	NC	NA	NC	NA	NA	NA	NC	NC	0.1	0.19	NA	0.11	NA	NA	NA
Chromium	7440-47-3	ug/L	91	10	96	76	NC	NC	18	28	268	8.7	18	26	90	317	19
Cobalt	7440-48-4	ug/L	0.17	0.16	0.12	0.62	NA	NA	0.33	4.5	1.4	0.14	0.2	0.31	3.9	0.19	NC

Table A-1a EPCs for Monitoring Wells Screened Across Top of the Unconfined Aquifer

Analyte	CAS NO	Units	199-K-18	199-K-19	199-K-22	199-K-23	199-K-29	199-K-30	199-K-32A	199-K-34	199-K-36	199-K-106A	199-K-107A	199-K-108A	199-K-110A	199-K-111A	199-K-132
Cobalt-60	10198-40-0	pCi/L	NC	NC	NC	NC	NC	12	NC	NC	NC	NC	NC	NC	NA	NC	NC
Copper	7440-50-8	ug/L	NC	1.1	0.56	2.4	NA	NA	0.89	0.91	2.4	0.86	1.2	1.3	4.5	0.91	15
Cyanide	57-12-5	ug/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NC	NA	NA	NA	NA	4.2
Diethylphthalate	84-66-2		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	100-41-4	ug/L	NC	NA	NC	NA	NA	NA	NC	NC	NC	NC	NC	NC	NA	NC	NC
Fluoride	16984-48-8	ug/L	87	103	112	142	152	211	70	227	358	247	181	290	113	225	157
Hexane	110-54-3	ug/L	NA	NA	NA	NA	NA	NA	NA	0.53	NA	0.46	0.83	NA	NA	NA	NA
Cr(VI)	18540-29-9	ug/L	113	7.5	77	56	NC	7.5	13	20	203	2.8	13	4	7.6	305	17
Iron	7439-89-6	ug/L	355	407	111	1152	731	31	450	138	474	89	212	95	833	85	27
Lithium	7439-93-2	ug/L	25	NA	21	NA	NA	NA	16	20	20	29	NA	24	NA	NA	NA
Manganese	7439-96-5	ug/L	9.3	13	63	58	35	NC	3	20	5.2	2.3	3.8	5.4	14	3	3.2
Mercury	7439-97-6	ug/L	NC	NC	NC	NA	NA	NA	NC	NC	0.07	NC	NA	0.08	NA	NA	NA
Methylene chloride	75-09-2	ug/L	NC	NA	NC	NA	NA	NA	NC	NC	NC	NC	0.31	NC	NA	NC	14
Molybdenum	7439-98-7	ug/L	7	1.7	2.8	1.7	NA	NA	3.2	2.5	4.6	3.9	1.9	4.2	3.3	4.1	1.9
Nickel	7440-02-0	ug/L	3.2	6.1	4.1	18	NC	NC	4.4	168	77	3.5	5	33	62	3.4	3
Nickel-63	13981-37-8	pCi/L	4.2	NC	NC	NA	NC	4.4	NA	NA	NA	NC	NA	NA	NA	NA	NA
Nitrate	14797-55-8	ug/L	45820	25736	26997	60548	46500	58901	30303	45516	28054	64075	30891	48828	18112	36358	46788
Nitrite	14797-65-0	ug/L	64	148	62	325	NC	588	148	73	146	122	83	111	133	139	76
Selenium	7782-49-2	ug/L	1.8	2.1	2.6	1.9	NA	NA	1.1	1.8	1.6	1	2.1	1.7	1.3	3	1.3
Selenium-79	15758-45-9	pCi/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NC
Silver	7440-22-4	ug/L	NC	0.12	NC	0.05	NC	NC	12	0.04	NC	NC	0.07	NC	NC	0.05	NC
Strontium	7440-24-6	ug/L	283	286	299	446	227	270	279	322	341	380	305	299	262	300	318

Table A-1a EPCs for Monitoring Wells Screened Across Top of the Unconfined Aquifer

Analyte	CAS NO	Units	199-K-18	199-K-19	199-K-22	199-K-23	199-K-29	199-K-30	199-K-32A	199-K-34	199-K-36	199-K-106A	199-K-107A	199-K-108A	199-K-110A	199-K-111A	199-K-132
Strontium-90	10098-97-2	pCi/L	NC	15	11	1.2	NC	NC	2.7	41	2	6.3	20	0.93	NA	1	2.2
Styrene	100-42-5	ug/L	NC	NA	NC	NA	NA	NA	NC	NC	NC	0.21	NA	0.12	NA	NA	NA
Technetium-99	14133-76-7	pCi/L	55	NC	220	NC	6.8	NC	11	27	19	NC	37	24	NA	17	28
Tetrahydrofuran	109-99-9	ug/L	NC	NA	NC	NA	NA	NA	NC	NC	NC	NC	NC	1.2	NA	NC	NC
Thallium	7440-28-0	ug/L	NC	NC	NC	2.2	NA	NA	NC	NC	NC	0.5	NC	0.19	NC	1	NC
Tin	7440-31-5	ug/L	0.18	0.95	NC	0.13	NA	NA	NC	NC	NC	0.92	5.2	0.52	1.6	5.7	NC
Toluene	108-88-3	ug/L	NC	NA	NC	NA	NA	NA	NC	NC	NC	0.12	0.11	NC	NA	NC	NC
TCE	79-01-6	ug/L	NC	NA	NC	NA	NA	NA	0.22	2.5	0.6	3.4	3.6	3.3	NA	NC	4.5
Tritium	10028-17-8	pCi/L	154441	4002	1575	129	130000	280000	8991	2274	455	48073	1355	552	279	131278	4956
Uranium	7440-61-1	ug/L	0.79	2.1	2.2	6.4	NA	NA	2.7	5.9	5.4	8.4	3.3	7.5	2	4.4	4.5
Uranium-233/234	U-233/234	pCi/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.3
Uranium-235	15117-96-1	pCi/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NC
Uranium-238	U-238	pCi/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.3
Vanadium	7440-62-2	ug/L	8.8	3.7	13	7.8	NC	NC	1.9	5.1	13	12	8.4	8	6	13	5.3
Xylenes (total)	1330-20-7	ug/L	NC	NA	NC	NA	NA	NA	NC	NC	NC	0.24	NC	NC	NA	NC	NC
Zinc	7440-66-6	ug/L	49	387	565	3.8	6	NC	7	6.5	NC	3.7	7.1	9.6	9.1	5.5	25

Note:
NC = EPC not calculated
NA = Not analyzed

Table A-1b EPCs for Monitoring Wells Screened Across Top of the Unconfined Aquifer

Analyte	CAS NO	Units	199-K-139	199-K-140	199-K-200	199-K-201	699-73-61
1,2,4-Trichlorobenzene	120-82-1	ug/L	NA	NA	NA	NA	NC
1,2-Dichlorobenzene	95-50-1	ug/L	NA	NA	NA	NA	NC

Table A-1b EPCs for Monitoring Wells Screened Across Top of the Unconfined Aquifer

Analyte	CAS NO	Units	199-K-139	199-K-140	199-K-200	199-K-201	699-73-61
2-Butanol	78-92-2	ug/L	NA	27	NA	NA	NA
2-Butanone	78-93-3	ug/L	NC	0.86	NC	0.63	NC
2-Propanol	67-63-0	ug/L	NC	97	NA	NA	NA
Acetone	67-64-1	ug/L	1.8	3.7	NC	1.3	NC
Aldrin	309-00-2	ug/L	NA	NA	NA	NA	NC
Aluminum	7429-90-5	ug/L	NA	22	NA	NA	235
Antimony	7440-36-0	ug/L	NC	0.12	NA	NC	NC
Arsenic	7440-38-2	ug/L	NC	3.2	NA	2.1	1.8
Barium	7440-39-3	ug/L	41	53	46	33	35
Beryllium	7440-41-7	ug/L	NC	NC	NA	NC	NC
Bis(2-ethylhexyl) phthalate	117-81-7	ug/L	NA	NA	NA	NA	NC
Boron	7440-42-8	ug/L	NA	13	NA	NA	8
Bromodichloromethane	75-27-4	ug/L	NA	NA	NA	NA	NC
Bromomethane	74-83-9	ug/L	NA	NA	NA	NA	NC
Cadmium	7440-43-9	ug/L	NC	0.17	NA	NC	0.11
Carbon disulfide	75-15-0	ug/L	NC	NC	NC	0.54	NC
Carbon tetrachloride	56-23-5	ug/L	NC	NC	NC	NC	NC
Carbon-14	14762-75-5	pCi/L	1296	623	25	13	NC
Cesium-137	10045-97-3	pCi/L	NC	NC	NC	NC	NC
Chlorobenzene	108-90-7	ug/L	NC	NC	NC	NC	NC
Chloroform	67-66-3	ug/L	0.41	0.4	1	0.83	0.15
Chloromethane	74-87-3	ug/L	NA	NA	NA	NA	0.14
Chromium	7440-47-3	ug/L	27	281	17	97	6.6
Cobalt	7440-48-4	ug/L	NC	NC	NA	NC	0.1
Cobalt-60	10198-40-0	pCi/L	NC	NC	NC	NC	NC
Copper	7440-50-8	ug/L	2.6	32	NA	3.1	1.9
Cyanide	57-12-5	ug/L	NA	NA	NA	NA	NC
Diethylphthalate	84-66-2	ug/L	NA	NA	NA	NA	NC
Ethylbenzene	100-41-4	ug/L	NC	NC	NC	NC	NC
Fluoride	16984-48-8	ug/L	223	171	88	117	228
Hexane	110-54-3		NA	NA	NA	NA	NA
Cr(VI)	18540-29-9	ug/L	52	14	14	93	NC
Iron	7439-89-6	ug/L	22	83	78	49	1175
Lithium	7439-93-2	ug/L	NA	NA	NA	NA	9.8
Manganese	7439-96-5	ug/L	2	1.8	2.3	1.6	58
Mercury	7439-97-6	ug/L	NA	NA	NA	NA	NC
Methylene chloride	75-09-2	ug/L	NC	1.5	5.6	0.34	NC
Molybdenum	7439-98-7	ug/L	NA	1.5	NA	NA	4.5
Nickel	7440-02-0	ug/L	2.7	1.4	1.9	3.4	0.82
Nickel-63	13981-37-8		NA	NA	NA	NA	NA
Nitrate	14797-55-8	ug/L	31213	25795	30212	31051	9199

Table A-1b EPCs for Monitoring Wells Screened Across Top of the Unconfined Aquifer

Analyte	CAS NO	Units	199-K-139	199-K-140	199-K-200	199-K-201	699-73-61
Nitrite	14797-65-0	ug/L	180	119	147	91	147
Selenium	7782-49-2	ug/L	NA	1.6	NA	NA	1.4
Selenium-79	15758-45-9		NA	NA	NA	NA	NA
Silver	7440-22-4	ug/L	10	NC	3.4	NC	NC
Strontium	7440-24-6	ug/L	281	315	312	328	228
Strontium-90	10098-97-2	pCi/L	14	1.9	200	13	NC
Styrene	100-42-5	ug/L	NA	NA	NA	NA	NC
Technetium-99	14133-76-7	pCi/L	36	NA	NC	7.4	13
Tetrahydrofuran	109-99-9	ug/L	NC	NC	NC	NC	NC
Thallium	7440-28-0	ug/L	NA	NC	NA	NA	NC
Tin	7440-31-5	ug/L	NA	NC	NA	NA	0.1
Toluene	108-88-3	ug/L	NC	NC	NC	NC	NC
TCE	79-01-6	ug/L	5	4.4	NC	NC	0.44
Tritium	10028-17-8	pCi/L	2617	1713	2940	1098	245
Uranium	7440-61-1	ug/L	NA	1.9	2.4	3.4	1.3
Uranium-233/234	U-233/234	pCi/L	NA	NA	NA	NA	0.67
Uranium-235	15117-96-1	pCi/L	NA	NA	NA	NA	0.05
Uranium-238	U-238	pCi/L	NA	NA	NA	NA	0.53
Vanadium	7440-62-2	ug/L	7.2	10	1.7	5.7	14
Xylenes (total)	1330-20-7	ug/L	NC	NC	NC	NC	NC
Zinc	7440-66-6	ug/L	17	89	4.5	4.3	1177

Note:
NC = EPC not calculated
NA = Not analyzed

Table A-2a EPCs for Monitoring Wells Screened Across Upper Unconfined Aquifer

Analyte	CAS NO	Units	199-K-11	199-K-20	199-K-21	199-K-31	199-K-37	199-K-117A	199-K-125A	199-K-138	199-K-142	199-K-173	199-K-183	199-K-186	199-K-187	199-K-188	199-K-191
1,2,4-Trichlorobenzene	120-82-1	ug/L	NA	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	95-50-1	ug/L	NA	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Butanone	78-93-3	ug/L	NC	NC	NA	NC	NC	NC	NA	0.7	NC	NC	0.71	NC	NC	NC	NC
2-Propanol	67-63-0	ug/L	NA	NA	NA	NA	NA	NA	NA	130	NA	34	NA	NA	NA	NA	NA
Acetone	67-64-1	ug/L	NC	NC	NA	NC	1.7	NC	NA	1	NC	1.6	NC	0.61	NC	NC	1.5
Aldrin	309-00-2	ug/L	NA	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A-2a EPCs for Monitoring Wells Screened Across Upper Unconfined Aquifer

Analyte	CAS NO	Units	199-K-11	199-K-20	199-K-21	199-K-31	199-K-37	199-K-117A	199-K-125A	199-K-138	199-K-142	199-K-173	199-K-183	199-K-186	199-K-187	199-K-188	199-K-191
Aluminum	7429-90-5	ug/L	24	56	45	17	233	17	16	NA	90	33	27	71	36	NA	18
Antimony	7440-36-0	ug/L	NC	0.19	NC	0.27	NC	0.17	NC	NC	0.19	1.1	0.51	0.18	NC	NC	0.49
Arsenic	7440-38-2	ug/L	6.7	2.4	1	2.5	3.7	0.97	4.3	2.2	4.9	3.7	3.8	4.3	4.8	4.1	4.1
Barium	7440-39-3	ug/L	40	26	19	35	27	21	38	44	24	41	54	30	36	43	36
Beryllium	7440-41-7	ug/L	NC	NC	0.38	0.3	NC	0.16	NC	NC	NC	0.32	NC	NC	NC	NC	0.3
Bis(2-ethylhexyl) phthalate	117-81-7	ug/L	NA	NA	NA	NA	1.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boron	7440-42-8	ug/L	23	8.8	13	26	NC	18	13	NA	7	14	22	10	15	NA	13
Bromodichloromethane	75-27-4	ug/L	NC	NC	NA	NC	NC	NC	NA	NA	0.11	NA	NA	NA	NA	NA	NA
Bromomethane	74-83-9	ug/L	0.96	NC	NA	0.95	NC	1.1	NA	NA	0.95	NA	NA	NA	NA	NA	NA
Cadmium	7440-43-9	ug/L	NC	0.11	NC	0.1	NC	0.07	NC	NC	NC	NC	NC	NC	NC	NC	NC
Carbon disulfide	75-15-0	ug/L	NC	NC	NA	NC	NC	NC	NA	NC	NC	NC	NC	NC	NC	NC	NC
Carbon tetrachloride	56-23-5	ug/L	NC	NC	NA	NC	NC	NC	NA	NC	NC	NC	NC	NC	NC	NC	NC
Carbon-14	14762-75-5	pCi/L	130	18	9.2	362	4.5	NC	35	546	222	480	464	103	NC	89	7
Cesium-137	10045-97-3	pCi/L	NC	NC	NC	NA	NC	NC	NC	NC	NC	NA	NC	NC	NC	NC	NC
Chlorobenzene	108-90-7	ug/L	NC	NC	NA	NC	NC	NC	NA	NC	NC	NC	NC	NC	NC	NC	NC
Chloroform	67-66-3	ug/L	1.1	0.73	NA	0.32	0.56	NC	NA	0.43	1.2	0.32	0.35	1.3	0.21	0.32	0.72
Chloromethane	74-87-3	ug/L	0.15	NC	NA	0.11	NC	NC	NA	NA	NC	NA	NA	NA	NA	NA	NA
Chromium	7440-47-3	ug/L	11	6.2	73	7.4	35	4.6	7.6	32	6.4	476	8.7	23	12	31	6.5
Cobalt	7440-48-4	ug/L	0.1	0.39	0.65	0.2	NC	0.21	0.14	NC	0.25	0.23	0.11	1.1	0.13	NC	0.09
Cobalt-60	10198-40-0	pCi/L	NC	NC	NC	NA	NC	NC	NC	NC	NC	NA	NC	NC	NC	NC	NC
Copper	7440-50-8	ug/L	0.42	0.9	1.8	1.8	2.2	1	0.56	NC	2.3	20	1.1	0.57	0.5	NC	1.3
Cyanide	57-12-5	ug/L	NA	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	84-66-2	ug/L	NA	NA	NA	NA	2.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	100-41-4	ug/L	NC	NC	NA	NC	NC	NC	NA	NC	NC	NC	NC	NC	NC	NC	NC

Table A-2a EPCs for Monitoring Wells Screened Across Upper Unconfined Aquifer

Analyte	CAS NO	Units	199-K-11	199-K-20	199-K-21	199-K-31	199-K-37	199-K-117A	199-K-125A	199-K-138	199-K-142	199-K-173	199-K-183	199-K-186	199-K-187	199-K-188	199-K-191
Fluoride	16984-48-8	ug/L	235	111	77	202	168	71	158	194	237	211	166	197	242	416	270
Cr(VI)	18540-29-9	ug/L	17	3.1	12	6.6	32	1.7	3.3	15	10	401	8	21	16	30	5.9
Iron	7439-89-6	ug/L	63	5986	741	215	22	84	1504	70	178	27	24	90	786	91	76
Lithium	7439-93-2	ug/L	16	5.3	NA	17	6	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA
Manganese	7439-96-5	ug/L	4.5	53	211	3.2	NC	1.4	23	1.9	1.8	1.6	0.48	40	15	13	18
Mercury	7439-97-6	ug/L	NC	NC	NA	NC	NC	NC	NA	NA	NC	0.1	NA	NA	NA	NA	NA
Methylene chloride	75-09-2	ug/L	NC	NC	NA	NC	NC	NC	NA	NC	NC	0.49	0.58	0.38	NC	NC	1.5
Molybdenum	7439-98-7	ug/L	2.8	1.7	2.2	2.8	4.4	0.59	2.8	NA	4.2	2.6	2.4	3	5.6	NA	8.8
Nickel	7440-02-0	ug/L	NC	1.2	25	0.57	2.1	2.7	4.8	8.7	0.94	2.1	1.2	2.3	7.7	4.3	3.5
Nickel-63	13981-37-8	pCi/L	NA	NC	NC	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	14797-55-8	ug/L	45710	15505	20569	25572	8880	3579	13848	25228	4065	22776	25486	7659	22276	20315	15616
Nitrite	14797-65-0	ug/L	124	74	177	236	149	46	139	182	153	93	96	137	140	172	68
o-Xylene	95-47-6	ug/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.52	NA	NA	NA	NA	NA
Selenium	7782-49-2	ug/L	1.3	1.4	0.72	1.7	1.9	NC	2	NA	1.4	2.4	1.6	1.1	2	NA	1.6
Selenium-79	15758-45-9	pCi/L	NA	NA	NC	NA	NC	NA	NA	NA	24	NA	NA	NA	NA	NA	NA
Silver	7440-22-4	ug/L	1.2	0.08	0.21	NC	NC	0.07	6	NC	NC	NC	NC	0.3	8	NC	0.04
Strontium	7440-24-6	ug/L	286	260	289	264	213	142	315	269	169	257	244	237	202	223	233
Strontium-90	10098-97-2	pCi/L	NC	10	27	1.2	3.7	2.4	1.9	1.2	1.4	1.7	0.8	0.74	1.7	0.76	1
Styrene	100-42-5	ug/L	NC	NC	NA	NC	NC	NC	NA	NA	NC	NA	NA	NA	NA	NA	NA
Technetium-99	14133-76-7	pCi/L	32	NC	NC	70	NC	NC	NC	42	NC	43	56	NC	50	27	NC
Tetrahydrofuran	109-99-9	ug/L	NC	NC	NA	NC	NC	NC	NA	NC	NC	NC	NC	NC	NC	NC	NC

Table A-2a EPCs for Monitoring Wells Screened Across Upper Unconfined Aquifer

Analyte	CAS NO	Units	199-K-11	199-K-20	199-K-21	199-K-31	199-K-37	199-K-117A	199-K-125A	199-K-138	199-K-142	199-K-173	199-K-183	199-K-186	199-K-187	199-K-188	199-K-191
Thallium	7440-28-0	ug/L	NC	0.22	1.2	1.8	NC	2.4	0.58	NA	0.66	1.7	1.5	NC	0.63	NA	0.02
Tin	7440-31-5	ug/L	NC	0.81	NC	5.3	NC	1.6	0.63	NA	0.44	0.63	1.6	0.25	0.39	NA	3
Toluene	108-88-3	ug/L	NC	NC	NA	NC	NC	NC	NA	NC	NC	0.14	NC	NC	NC	NC	NC
TCE	79-01-6	ug/L	4.8	NC	NA	3.6	NC	NC	NA	4.2	NC	4.1	4.2	0.64	1.6	1.9	NC
Tritium	10028-17-8	pCi/L	494	9412	1291	1713	344	248	5952	1388	228	1376	1622	384	746	494	6070
Uranium	7440-61-1	ug/L	5.7	2.5	1.7	2.2	2.8	0.73	3.1	NA	1.3	3.1	1.7	2.5	3	NA	2.4
Uranium-233/234	U-233/234	pCi/L	NA	NA	2.9	NA	1.1	NA	NA	NA	0.74	NA	NA	NA	NA	NA	NA
Uranium-235	15117-96-1	pCi/L	NA	NA	0.38	NA	0.08	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA
Uranium-238	U-238	pCi/L	NA	NA	0.76	NA	0.87	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA
Vanadium	7440-62-2	ug/L	21	10	1.5	12	13	3.5	14	10	22	13	11	13	13	13	12
Xylenes (total)	1330-20-7	ug/L	NC	NC	NA	NC	NC	NC	NA	NC	NC	0.52	NC	NC	NC	NC	NC
Zinc	7440-66-6	ug/L	11	9.2	3.3	12	4	16	27	53	13	6.4	3.4	14	3.9	7.2	10

Note:
NC = EPC not calculated
NA = Not analyzed

Table A-2b EPCs for Monitoring Wells Screened Across Upper Unconfined Aquifer

Analyte	CAS NO	Units	199-K-194	199-K-204	199-K-221	199-K-222	699-72-73
1,2,4-Trichlorobenzene	120-82-1	ug/L	0.65	NA	NA	NA	NA
1,2-Dichlorobenzene	95-50-1	ug/L	0.2	NA	NA	NA	NA
2-Butanone	78-93-3	ug/L	NC	NC	NA	NA	NC
2-Propanol	67-63-0	ug/L	NA	11	NA	NA	NA
Acetone	67-64-1	ug/L	3.1	1.4	NA	NA	NC
Aldrin	309-00-2		NA	NA	NA	NA	NA
Aluminum	7429-90-5	ug/L	27	99	NC	223	28
Antimony	7440-36-0	ug/L	NC	0.24	NC	NC	NC
Arsenic	7440-38-2	ug/L	5.1	2	2.3	2.6	4.3

Table A-2b EPCs for Monitoring Wells Screened Across Upper Unconfined Aquifer

Analyte	CAS NO	Units	199-K-194	199-K-204	199-K-221	199-K-222	699-72-73
Barium	7440-39-3	ug/L	29	48	35	39	30
Beryllium	7440-41-7	ug/L	NC	NC	NC	NC	NC
Bis(2-ethylhexyl) phthalate	117-81-7		NA	NA	NA	NA	NA
Boron	7440-42-8	ug/L	13	11	31	NC	23
Bromodichloromethane	75-27-4	ug/L	NA	NA	NA	NA	NC
Bromomethane	74-83-9	ug/L	NA	NA	NA	NA	0.98
Cadmium	7440-43-9	ug/L	NC	NC	NC	NC	NC
Carbon disulfide	75-15-0	ug/L	NC	NC	NA	NA	NC
Carbon tetrachloride	56-23-5	ug/L	NC	NC	NA	NA	NC
Carbon-14	14762-75-5	pCi/L	6.2	17779	1835	215	NC
Cesium-137	10045-97-3	pCi/L	NA	NC	NC	NC	NA
Chlorobenzene	108-90-7	ug/L	NC	NC	NA	NA	NC
Chloroform	67-66-3	ug/L	0.9	0.56	NA	NA	NC
Chloromethane	74-87-3	ug/L	NA	NA	NA	NA	NC
Chromium	7440-47-3	ug/L	14	11	15	21	9.3
Cobalt	7440-48-4	ug/L	5.3	0.41	NC	NC	0.14
Cobalt-60	10198-40-0	pCi/L	NA	NC	NC	NC	NA
Copper	7440-50-8	ug/L	0.72	0.48	0.72	1.2	0.32
Cyanide	57-12-5	ug/L	NA	6.5	NA	NA	NA
Diethylphthalate	84-66-2		NA	NA	NA	NA	NA
Ethylbenzene	100-41-4	ug/L	NC	NC	NA	NA	NC
Fluoride	16984-48-8	ug/L	285	241	180	180	379
Cr(VI)	18540-29-9	ug/L	12	4	30	19	7.8
Iron	7439-89-6	ug/L	67	168	26	241	162
Lithium	7439-93-2	ug/L	NA	NA	NA	NA	19
Manganese	7439-96-5	ug/L	4.1	120	NC	23	11
Mercury	7439-97-6	ug/L	NA	NA	NA	NA	NC
Methylene chloride	75-09-2	ug/L	1.1	NC	NA	NA	NC
Molybdenum	7439-98-7	ug/L	7.3	1.5	4.1	9.1	5.6
Nickel	7440-02-0	ug/L	4.3	6.2	1.1	2.4	0.51
Nickel-63	13981-37-8		NA	NA	NA	NA	NA
Nitrate	14797-55-8	ug/L	12474	43026	30500	24300	20992
Nitrite	14797-65-0	ug/L	82	282	NC	138	112
o-Xylene	95-47-6		NA	NA	NA	NA	NA
Selenium	7782-49-2	ug/L	2	NC	NC	2.1	2.9
Selenium-79	15758-45-9		NA	NA	NA	NA	NA
Silver	7440-22-4	ug/L	0.1	0.05	NC	NC	NC
Strontium	7440-24-6	ug/L	294	396	315	295	186
Strontium-90	10098-97-2	pCi/L	0.88	NC	6.5	113	NC
Styrene	100-42-5	ug/L	NA	NA	NA	NA	NC

Table A-2b EPCs for Monitoring Wells Screened Across Upper Unconfined Aquifer

Analyte	CAS NO	Units	199-K-194	199-K-204	199-K-221	199-K-222	699-72-73
Technetium-99	14133-76-7	pCi/L	NC	9.9	64	NC	35
Tetrahydrofuran	109-99-9	ug/L	NC	NA	NA	NA	NC
Thallium	7440-28-0	ug/L	0.13	NC	NC	NC	0.86
Tin	7440-31-5	ug/L	1.1	1.4	1.2	NC	3.4
Toluene	108-88-3	ug/L	NC	NC	NA	NA	NC
TCE	79-01-6	ug/L	NC	3.5	NA	NA	0.98
Tritium	10028-17-8	pCi/L	1055	6014	26679	403	11560
Uranium	7440-61-1	ug/L	3.2	7	14	2	2.2
Uranium-233/234	U-233/234		NA	NA	NA	NA	NA
Uranium-235	15117-96-1		NA	NA	NA	NA	NA
Uranium-238	U-238		NA	NA	NA	NA	NA
Vanadium	7440-62-2	ug/L	17	15	4.5	5.6	15
Xylenes (total)	1330-20-7	ug/L	NC	NC	NA	NA	NC
Zinc	7440-66-6	ug/L	4.3	9.7	NC	NC	2

Note:
NC = EPC not calculated
NA = Not analyzed

Table A-3 EPCs for Extraction Wells Screened Across Upper Unconfined Aquifer

Analyte	CAS NO	Units	199-K-113A	199-K-114A	199-K-141	199-K-144	199-K-146	199-K-147	199-K-148	199-K-161	199-K-178
Aluminum	7429-90-5	ug/L	75	27	NC	NA	NA	NA	NA	462	NA
Antimony	7440-36-0	ug/L	0.13	NC	NC	NC	NC	NC	NC	NC	NA
Arsenic	7440-38-2	ug/L	1.4	0.83	3.8	3.7	NC	2.2	5.2	1.7	NA
Barium	7440-39-3	ug/L	15	12	31	34	17	31	34	16	35
Beryllium	7440-41-7	ug/L	NC	NC	NC	NC	0.3	NC	NC	NC	NA
Boron	7440-42-8	ug/L	19	10	18	NA	NA	NA	NA	15	NA
Cadmium	7440-43-9	ug/L	NC	NC	NC	NC	NC	NC	NC	NC	NA
Carbon-14	14762-75-5	pCi/L	25	NC	249	44	NC	27	36	NC	302
Cesium-137	10045-97-3	pCi/L	NA	NA	1.9	NC	NC	NC	NC	NC	NA
Chromium	7440-47-3	ug/L	4.6	2.6	30	31	15	23	31	8.3	45
Cobalt	7440-48-4	ug/L	NC	NC	NC	NC	NC	NC	NC	0.34	NA
Cobalt-60	10198-40-0	pCi/L	NA	NA	NC	NC	NC	NC	NC	NC	NA
Copper	7440-50-8	ug/L	2.9	3.8	20	2.6	8.6	26	7.1	11	NA
Fluoride	16984-48-8	ug/L	92	75	149	167	118	186	286	98	115
Cr(VI)	18540-29-9	ug/L	3.8	2.1	29	31	12	21	34	7.5	39
Iron	7439-89-6	ug/L	31	NC	20	40	21	37	74	NC	41

Table A-3 EPCs for Extraction Wells Screened Across Upper Unconfined Aquifer

Analyte	CAS NO	Units	199-K-113A	199-K-114A	199-K-141	199-K-144	199-K-146	199-K-147	199-K-148	199-K-161	199-K-178
Manganese	7439-96-5	ug/L	NC	NC	NC	NC	NC	10	NC	18	5.3
Molybdenum	7439-98-7	ug/L	0.64	0.35	2.1	NA	NA	NA	NA	1.5	NA
Nickel	7440-02-0	ug/L	1.1	NC	2	54	NC	4.6	NC	0.79	3.9
Nickel-63	13981-37-8	pCi/L	NA	NC	NC	NA	NA	NA	NA	NA	NA
Nitrate	14797-55-8	ug/L	1882	992	13705	16800	2523	10449	15016	2658	16331
Nitrite	14797-65-0	ug/L	68	131	110	77	93	168	72	269	114
Selenium	7782-49-2	ug/L	2.6	NC	2.8	NA	NA	NA	NA	2.6	NA
Selenium-79	15758-45-9	pCi/L	NA	NA	NA	NA	NA	NA	NA	NC	NA
Silver	7440-22-4	ug/L	NC	0.23	NC	NC	NC	NC	NC	NC	NC
Strontium	7440-24-6	ug/L	124	103	251	263	134	231	255	140	291
Strontium-90	10098-97-2	pCi/L	6	9.2	46	3.2	NC	8.8	NC	9.9	2.6
Technetium-99	14133-76-7	pCi/L	NC	NC	9.7	NC	NC	NC	24	NC	NC
Thallium	7440-28-0	ug/L	NC	NC	NC	NA	NA	NA	NA	1.4	NA
Tin	7440-31-5	ug/L	0.84	NC	NC	NA	NA	NA	NA	3.5	NA
Tritium	10028-17-8	pCi/L	840	NC	4995	28974	NC	958	2415	124	2179
Uranium	7440-61-1	ug/L	27	0.11	3.2	NA	NA	NA	NA	0.71	NA
Uranium-233/234	U-233/234	pCi/L	NA	NA	NA	NA	NA	NA	NA	0.42	NA
Uranium-235	15117-96-1	pCi/L	NA	NA	NA	NA	NA	NA	NA	NC	NA
Uranium-238	U-238	pCi/L	NA	NA	NA	NA	NA	NA	NA	0.4	NA
Vanadium	7440-62-2	ug/L	3.7	2.3	10	14	5.4	11	16	5.1	5
Zinc	7440-66-6	ug/L	8.6	8.9	15	91	359	26	34	15	17

Note:
NC = EPC not calculated
NA = Not analyzed

Table A-4 EPCs for Monitoring Wells Screened Across Lower Unconfined Aquifer

Analyte	CAS NO	Units	199-K-168	199-K-184	199-K-190
2-Butanone	78-93-3	ug/L	0.47	0.61	NC
2-Propanol	67-63-0	ug/L	NC	19	NA
Acetone	67-64-1	ug/L	4.8	0.73	9
Aluminum	7429-90-5	ug/L	NA	NC	27
Antimony	7440-36-0	ug/L	NC	NC	NC
Arsenic	7440-38-2	ug/L	2.5	3.3	4.6
Barium	7440-39-3	ug/L	47	65	43
Beryllium	7440-41-7	ug/L	NC	NC	NC
Boron	7440-42-8	ug/L	NA	14	36
Cadmium	7440-43-9	ug/L	NC	NC	0.18

Table A-4 EPCs for Monitoring Wells Screened Across Lower Unconfined Aquifer

Analyte	CAS NO	Units	199-K-168	199-K-184	199-K-190
Carbon disulfide	75-15-0	ug/L	NC	0.31	NC
Carbon tetrachloride	56-23-5	ug/L	NC	NC	NC
Carbon-14	14762-75-5	pCi/L	492	581	208
Cesium-137	10045-97-3	pCi/L	NC	NC	NC
Chlorobenzene	108-90-7	ug/L	NC	NC	NC
Chloroform	67-66-3	ug/L	0.41	0.36	0.6
Chromium	7440-47-3	ug/L	29	22	14
Cobalt	7440-48-4	ug/L	NC	NC	0.65
Cobalt-60	10198-40-0	pCi/L	NC	NC	NC
Copper	7440-50-8	ug/L	6.8	0.38	0.48
Ethylbenzene	100-41-4	ug/L	NC	NC	NC
Fluoride	16984-48-8	ug/L	180	169	227
Cr(VI)	18540-29-9	ug/L	36	15	13
Iron	7439-89-6	ug/L	74	161	50
Manganese	7439-96-5	ug/L	2.7	3.5	2.4
Methylene chloride	75-09-2	ug/L	1.1	0.33	0.34
Molybdenum	7439-98-7	ug/L	NA	1.5	2.8
Nickel	7440-02-0	ug/L	4.5	14	0.59
Nitrate	14797-55-8	ug/L	22057	22418	33573
Nitrite	14797-65-0	ug/L	108	994	86
Selenium	7782-49-2	ug/L	NA	NC	1.6
Selenium-79	15758-45-9	pCi/L	NA	NC	NA
Silver	7440-22-4	ug/L	5	2	4
Strontium	7440-24-6	ug/L	265	318	246
Strontium-90	10098-97-2	pCi/L	3.7	0.92	1.4
Technetium-99	14133-76-7	pCi/L	49	40	32
Tetrahydrofuran	109-99-9	ug/L	NC	NC	NC
Thallium	7440-28-0	ug/L	NA	NC	0.28
Tin	7440-31-5	ug/L	NA	NC	0.66
Toluene	108-88-3	ug/L	NC	NC	NC
TCE	79-01-6	ug/L	4.5	4	5.4
Tritium	10028-17-8	pCi/L	1448	1411	681
Uranium	7440-61-1	ug/L	NA	2.5	3.2
Uranium-233/234	U-233/234	pCi/L	NA	0.84	NA
Uranium-235	15117-96-1	pCi/L	NA	NC	NA
Uranium-238	U-238	pCi/L	NA	0.59	NA
Vanadium	7440-62-2	ug/L	12	13	16
Xylenes (total)	1330-20-7	ug/L	NC	NC	NC
Zinc	7440-66-6	ug/L	89	7.1	3.4

Table A-4 EPCs for Monitoring Wells Screened Across Lower Unconfined Aquifer

Analyte	CAS NO	Units	199-K-168	199-K-184	199-K-190

Note:
NC = EPC not calculated
NA = Not analyzed

Table A-5 EPCs for Monitoring Wells Screened Across Ringold Upper Mud

Analyte	CAS NO	Units	199-K-32B	199-K-192
2-Butanone	78-93-3	ug/L	NA	NC
Acetone	67-64-1	ug/L	NA	2.5
Aluminum	7429-90-5	ug/L	132	13
Antimony	7440-36-0	ug/L	NC	NC
Arsenic	7440-38-2	ug/L	1.5	9
Barium	7440-39-3	ug/L	62	69
Beryllium	7440-41-7	ug/L	NC	NC
Boron	7440-42-8	ug/L	35	26
Cadmium	7440-43-9	ug/L	1.3	NC
Carbon disulfide	75-15-0	ug/L	NA	NC
Carbon tetrachloride	56-23-5	ug/L	NA	NC
Carbon-14	14762-75-5	pCi/L	NC	NC
Cesium-137	10045-97-3	pCi/L	NA	NC
Chlorobenzene	108-90-7	ug/L	NA	NC
Chloroform	67-66-3	ug/L	NA	NC
Chromium	7440-47-3	ug/L	29	6.6
Cobalt	7440-48-4	ug/L	0.32	0.15
Cobalt-60	10198-40-0	pCi/L	NA	NC
Copper	7440-50-8	ug/L	1.1	2
Ethylbenzene	100-41-4	ug/L	NA	NC
Fluoride	16984-48-8	ug/L	274	407
Cr(VI)	18540-29-9	ug/L	6.8	6.5
Iron	7439-89-6	ug/L	133	34
Manganese	7439-96-5	ug/L	3.9	5.2
Methylene chloride	75-09-2	ug/L	NA	NC
Molybdenum	7439-98-7	ug/L	4.2	9.2
Nickel	7440-02-0	ug/L	11	2
Nitrate	14797-55-8	ug/L	10628	7298
Nitrite	14797-65-0	ug/L	210	120
Selenium	7782-49-2	ug/L	2.2	2.2
Silver	7440-22-4	ug/L	0.1	NC

Table A-5 EPCs for Monitoring Wells Screened Across Ringold Upper Mud

Analyte	CAS NO	Units	199-K-32B	199-K-192
Strontium	7440-24-6	ug/L	451	487
Strontium-90	10098-97-2	pCi/L	1.2	3.8
Technetium-99	14133-76-7	pCi/L	NC	20
Tetrahydrofuran	109-99-9	ug/L	NA	NC
Thallium	7440-28-0	ug/L	NC	1.3
Tin	7440-31-5	ug/L	3.1	0.16
Toluene	108-88-3	ug/L	NA	NC
TCE	79-01-6	ug/L	NA	NC
Tritium	10028-17-8	pCi/L	NC	NC
Uranium	7440-61-1	ug/L	3.2	3.3
Vanadium	7440-62-2	ug/L	5.5	25
Xylenes (total)	1330-20-7	ug/L	NA	NC
Zinc	7440-66-6	ug/L	NC	6.3

Note:
NC = EPC not calculated
NA = Not analyzed

Table A-6 EPCs for Monitoring Wells Screened Across Upper and Lower Unconfined Aquifer

Analyte	CAS NO	Units	199-K-193
2-Butanone	78-93-3	ug/L	0.63
Acetone	67-64-1	ug/L	6.3
Aluminum	7429-90-5	ug/L	32
Antimony	7440-36-0	ug/L	0.16
Arsenic	7440-38-2	ug/L	4.8
Barium	7440-39-3	ug/L	27
Beryllium	7440-41-7	ug/L	NC
Boron	7440-42-8	ug/L	13
Cadmium	7440-43-9	ug/L	0.1
Carbon disulfide	75-15-0	ug/L	3.3
Carbon tetrachloride	56-23-5	ug/L	NC
Carbon-14	14762-75-5	pCi/L	NC
Chlorobenzene	108-90-7	ug/L	NC
Chloroform	67-66-3	ug/L	0.32
Chromium	7440-47-3	ug/L	44
Cobalt	7440-48-4	ug/L	0.17
Copper	7440-50-8	ug/L	1.1
Ethylbenzene	100-41-4	ug/L	2.5

Table A-6 EPCs for Monitoring Wells Screened Across Upper and Lower Unconfined Aquifer

Analyte	CAS NO	Units	199-K-193
Fluoride	16984-48-8	ug/L	283
Cr(VI)	18540-29-9	ug/L	23
Iron	7439-89-6	ug/L	469
Manganese	7439-96-5	ug/L	10
Methylene chloride	75-09-2	ug/L	NC
Molybdenum	7439-98-7	ug/L	9.1
Nickel	7440-02-0	ug/L	6.8
Nitrate	14797-55-8	ug/L	13049
Nitrite	14797-65-0	ug/L	97
Selenium	7782-49-2	ug/L	3.1
Silver	7440-22-4	ug/L	NC
Strontium	7440-24-6	ug/L	338
Strontium-90	10098-97-2	pCi/L	1.8
Technetium-99	14133-76-7	pCi/L	NC
Tetrahydrofuran	109-99-9	ug/L	NC
Thallium	7440-28-0	ug/L	2.3
Tin	7440-31-5	ug/L	0.62
Toluene	108-88-3	ug/L	0.6
TCE	79-01-6	ug/L	NC
Tritium	10028-17-8	pCi/L	1490
Uranium	7440-61-1	ug/L	4.3
Vanadium	7440-62-2	ug/L	13
Xylenes (total)	1330-20-7	ug/L	2.8
Zinc	7440-66-6	ug/L	66

Note:
NC = EPC not calculated
NA = Not analyzed

Table A-7 EPCs for Extraction Wells Screened Across Entire Aquifer

Analyte	CAS NO	Units	199-K-116A	199-K-120A	199-K-145	199-K-152	199-K-153	199-K-154	199-K-163	199-K-165	199-K-166	199-K-171	199-K-182	199-K-208	199-K-210	199-K-224
1,2,4-Trichlorobenzene	120-82-1	ug/L	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NC	NA	NA	NA
1,2-Dichlorobenzene	95-50-1	ug/L	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NC	NA	NA	NA
2-Butanol	78-92-2	ug/L	NA	NA	NA	NA	NA	NA	NA	30	NA	NA	NA	NA	NA	NA
2-Butanone	78-93-3	ug/L	NA	NA	NA	NC	NA	NA	NA	0.58	NC	NA	NC	NA	NA	NC
2-Propanol	67-63-0	ug/L	NA	NA	NA	NA	NA	NA	NA	120	NC	NA	NA	NA	NA	10

Table A-7 EPCs for Extraction Wells Screened Across Entire Aquifer

Analyte	CAS NO	Units	199-K-116A	199-K-120A	199-K-145	199-K-152	199-K-153	199-K-154	199-K-163	199-K-165	199-K-166	199-K-171	199-K-182	199-K-208	199-K-210	199-K-224
Acetone	67-64-1	ug/L	NA	NA	NA	NC	NA	NA	NA	1.4	1.4	NA	NC	NA	NA	2
Aldrin	309-00-2	ug/L	NA	NA	NA	0.65	NA	NA	NA	NA	NA	NA	NC	NA	NA	NA
Aluminum	7429-90-5	ug/L	180	NC	NA	272	NA	NA	NA	NA	NA	NA	14	180	46	NA
Antimony	7440-36-0	ug/L	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	0.57	NC	NA
Arsenic	7440-38-2	ug/L	3.8	3.1	2.7	4.7	2.4	4.4	3.8	2.1	2.5	3.8	4.7	4.3	3.8	NA
Barium	7440-39-3	ug/L	26	31	36	31	29	39	35	49	53	24	37	41	39	43
Beryllium	7440-41-7	ug/L	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	0.5	NC	NC	NA
Bis(2-ethylhexyl) phthalate	117-81-7	ug/L	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NC	NA	NA	NA
Boron	7440-42-8	ug/L	7.1	14	NA	NC	NA	NA	NA	NA	NA	NA	NC	258	13	9.7
Bromodichloromethane	75-27-4	ug/L	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NC	NA	NA	NA
Bromomethane	74-83-9	ug/L	NA	NA	NA	1.1	NA	NA	NA	NA	NA	NA	0.94	NA	NA	NA
Cadmium	7440-43-9	ug/L	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	0.19	NA
Carbon disulfide	75-15-0	ug/L	NA	NA	NA	NC	NA	NA	NA	NC	NC	NA	NC	NA	NA	NC
Carbon tetrachloride	56-23-5	ug/L	NA	NA	NA	NC	NA	NA	NA	NC	NC	NA	NC	NA	NA	NC
Carbon-14	14762-75-5	pCi/L	34	15	31	13	23	NC	37	524	591	5.7	NC	NA	236	459
Cesium-137	10045-97-3	pCi/L	NA	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NA	NA	NA
Chlorobenzene	108-90-7	ug/L	NA	NA	NA	NC	NA	NA	NA	NC	NC	NA	NC	NA	NA	NC
Chloroform	67-66-3	ug/L	NA	NA	NA	1.8	NA	NA	NA	0.39	0.37	NA	1.1	NA	NA	0.38
Chloromethane	74-87-3	ug/L	NA	NA	NA	0.21	NA	NA	NA	NA	NA	NA	NC	NA	NA	NA
Chromium	7440-47-3	ug/L	8.3	8.5	33	63	23	70	39	103	18	40	67	12	30	126
Cobalt	7440-48-4	ug/L	NC	NC	NC	0.13	NC	NC	NC	NC	NC	NC	0.08	NC	NC	NA
Cobalt-60	10198-40-0	pCi/L	NA	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NA	NA	NA
Copper	7440-50-8	ug/L	5.4	44	3.8	0.28	26	NC	3.1	11	19	NC	6.9	62	30	NA
Cyanide	57-12-5	ug/L	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NC	NA	NA	NA
Diethylphthalate	84-66-2	ug/L	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NC	NA	NA	NA

Table A-7 EPCs for Extraction Wells Screened Across Entire Aquifer

Analyte	CAS NO	Units	199-K-116A	199-K-120A	199-K-145	199-K-152	199-K-153	199-K-154	199-K-163	199-K-165	199-K-166	199-K-171	199-K-182	199-K-208	199-K-210	199-K-224
Ethylbenzene	100-41-4	ug/L	NA	NA	NA	NC	NA	NA	NA	NC	NC	NA	NC	NA	NA	NC
Fluoride	16984-48-8	ug/L	136	116	168	216	213	267	265	179	180	281	188	240	180	210
Cr(VI)	18540-29-9	ug/L	7.2	4.8	32	59	24	70	38	156	19	43	63	24	25	113
Iron	7439-89-6	ug/L	NC	NC	17	37	44	372	30	101	31	81	22	50	NA	360
Lithium	7439-93-2	ug/L	4	NA	NA	5	NA	NA	NA	NA	NA	NA	16	NA	NA	NA
Manganese	7439-96-5	ug/L	NC	NC	NC	NC	NC	7.3	NC	2.7	2	1	1	0.74	2.5	5.7
Mercury	7439-97-6	ug/L	NA	NA	NA	NC	NA	NA	NA	0.16	NA	NA	NC	NA	NA	NA
Methylene chloride	75-09-2	ug/L	NA	NA	NA	NC	NA	NA	NA	1.1	1.7	NA	NC	NA	NA	NC
Molybdenum	7439-98-7	ug/L	2.9	1.9	NA	16	NA	NA	NA	NA	NA	NA	4.5	4.8	2.9	NA
Nickel	7440-02-0	ug/L	1.4	4.8	4	NC	4.5	3.7	3.7	23	3.5	6.1	3.5	NC	NC	NC
Nickel-63	13981-37-8	pCi/L	NC	NA	NA	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NA
Nitrate	14797-55-8	ug/L	11534	14361	17306	13513	11442	13012	14447	22498	23614	14097	17489	20806	22600	23365
Nitrite	14797-65-0	ug/L	68	128	150	99	74	79	70	107	66	94	NC	NC	NC	821
Selenium	7782-49-2	ug/L	NC	0.72	NA	1.4	NA	NA	NA	NA	NA	NA	1.8	1.6	NC	NA
Silver	7440-22-4	ug/L	NC	NC	NC	4	NC	NC	NC	NC	2.2	20	NC	NC	NC	NC
Strontium	7440-24-6	ug/L	255	276	285	272	267	305	292	283	262	281	289	344	304	NA
Strontium-90	10098-97-2	pCi/L	3.7	1.7	NC	NC	NC	NC	NC	NC	1.8	NC	1.9	0.63	1.3	1.2
Styrene	100-42-5	ug/L	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NC	NA	NA	NA
Technetium-99	14133-76-7	pCi/L	NC	NC	7.3	40	NC	NC	7.2	35	40	NC	NC	NA	NA	NA
Tetrahydrofuran	109-99-9	ug/L	NA	NA	NA	NC	NA	NA	NA	NC	NC	NA	NC	NA	NA	NA
Thallium	7440-28-0	ug/L	NC	0.64	NA	NC	NA	NA	NA	NA	NA	NA	NC	NC	NC	NA

Table A-7 EPCs for Extraction Wells Screened Across Entire Aquifer

Analyte	CAS NO	Units	199-K-116A	199-K-120A	199-K-145	199-K-152	199-K-153	199-K-154	199-K-163	199-K-165	199-K-166	199-K-171	199-K-182	199-K-208	199-K-210	199-K-224
Tin	7440-31-5	ug/L	0.12	0.72	NA	NC	NA	NA	NA	NA	NA	NA	NC	NC	1.7	NA
Toluene	108-88-3	ug/L	NA	NA	NA	0.35	NA	NA	NA	NC	NC	NA	NC	NA	NA	NC
TCE	79-01-6	ug/L	NA	NA	NA	NC	NA	NA	NA	4.1	4.3	NA	NC	NA	NA	5.5
Tritium	10028-17-8	pCi/L	3327	6664	37888	1081	1033	1458	3496	1336	1521	4976	2773	43810	3632	1110
Uranium	7440-61-1	ug/L	3.2	2.4	NA	2	NA	NA	NA	NA	NA	NA	2.3	2.9	2.6	NA
Uranium-233/234	U-233/234	pCi/L	NA	NA	NA	0.77	NA	NA	NA	NA	NA	NA	1.3	NA	NA	NA
Uranium-235	15117-96-1	pCi/L	NA	NA	NA	0.11	NA	NA	NA	NA	NA	NA	0.1	NA	NA	NA
Uranium-238	U-238	pCi/L	NA	NA	NA	0.7	NA	NA	NA	NA	NA	NA	0.74	NA	NA	NA
Vanadium	7440-62-2	ug/L	9.7	9.6	13	20	14	15	14	14	8.9	15	19	13	NA	13
Xylenes (total)	1330-20-7	ug/L	NA	NA	NA	NC	NA	NA	NA	NC	NC	NA	NC	NA	NA	NC
Zinc	7440-66-6	ug/L	12	19	28	18	44	14	35	18	43	56	155	180	75	NC

Note:
NC = EPC not calculated
NA = Not analyzed

Table A-8 EPCs for Monitoring Wells Screened Across Entire Aquifer

Analyte	CAS NO	Units	199-K-151	199-K-157	199-K-185	199-K-189	199-K-202	199-K-203	199-K-207	199-K-209	199-K-223
1,2,4-Trichlorobenzene	120-82-1	ug/L	NC	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	95-50-1	ug/L	NC	NA	NA	NA	NA	NA	NA	NA	NA
2-Butanol	78-92-2	ug/L	NA	NA	21	NA	NA	NA	NA	NA	NA
2-Butanone	78-93-3	ug/L	NC	NC	0.6	NC	NC	NA	NA	NA	NC
2-Propanol	67-63-0	ug/L	76	NA	74	NA	NA	NA	NA	NA	8.8
Acetone	67-64-1	ug/L	NC	NC	1.2	NC	NC	NA	NA	NA	NC
Aldrin	309-00-2	ug/L	0.12	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum	7429-90-5	ug/L	22	NC	58	NA	430	86	16	16	NA
Antimony	7440-36-0	ug/L	0.16	5.6	NC	NC	0.19	0.17	NC	NC	NA
Arsenic	7440-38-2	ug/L	5.2	9	3.2	5.2	3.8	4	4.7	6.1	NA
Barium	7440-39-3	ug/L	32	36	42	30	35	40	42	34	37

Table A-8 EPCs for Monitoring Wells Screened Across Entire Aquifer

Analyte	CAS NO	Units	199-K-151	199-K-157	199-K-185	199-K-189	199-K-202	199-K-203	199-K-207	199-K-209	199-K-223
Beryllium	7440-41-7	ug/L	0.45	4.8	NC	NC	NC	NC	NC	NC	NA
Bis(2-ethylhexyl) phthalate	117-81-7	ug/L	11	NA	NA	NA	NA	NA	NA	NA	NA
Boron	7440-42-8	ug/L	11	155	26	NA	108	7.6	852	NC	NC
Bromodichloromethane	75-27-4	ug/L	0.16	NC	NA	NA	NA	NA	NA	NA	NA
Bromomethane	74-83-9	ug/L	NC	NC	NA	NA	NA	NA	NA	NA	NA
Cadmium	7440-43-9	ug/L	NC	5	NC	NC	NC	NC	NC	NC	NA
Carbon disulfide	75-15-0	ug/L	NC	NC	NC	NC	NC	NA	NA	NA	NC
Carbon tetrachloride	56-23-5	ug/L	NC	NC	NC	NC	1.1	NA	NA	NA	NC
Carbon-14	14762-75-5	pCi/L	24	57	2203	1960	2214	484	NA	NA	158
Cesium-137	10045-97-3	pCi/L	NC	NC	NC	NC	NC	NC	NC	NA	NA
Chlorobenzene	108-90-7	ug/L	NC	NC	NC	NC	NC	NA	NA	NA	NC
Chloroform	67-66-3	ug/L	5	0.86	0.36	1.1	0.91	NA	NA	NA	0.41
Chloromethane	74-87-3	ug/L	NC	NC	NA	NA	NA	NA	NA	NA	NA
Chromium	7440-47-3	ug/L	14	27	7.4	24	160	29	96	4.7	15
Cobalt	7440-48-4	ug/L	0.2	5	0.17	NC	0.58	0.27	0.16	NC	NA
Cobalt-60	10198-40-0	pCi/L	NC	NC	NC	NC	NC	NC	NC	NA	NA
Copper	7440-50-8	ug/L	1.4	5.4	0.93	NC	7.5	1.2	NC	1.4	NA
Cyanide	57-12-5	ug/L	NC	NA	NC	NA	NA	NA	NA	NA	NA
Diethylphthalate	84-66-2	ug/L	NC	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	100-41-4	ug/L	NC	NC	NC	NC	NC	NA	NA	NA	NC
Fluoride	16984-48-8	ug/L	325	157	176	177	450	210	283	336	206
Cr(VI)	18540-29-9	ug/L	13	34	6.5	24	8.9	26	107	3.3	11
Iron	7439-89-6	ug/L	23	114	268	43	1600	178	NC	43	174
Lithium	7439-93-2	ug/L	7.9	20	NA	NA	NA	NA	NA	NA	NA
Manganese	7439-96-5	ug/L	30	4.5	77	0.79	15	20	1.2	9.1	8.4
Mercury	7439-97-6	ug/L	NC	NC	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	75-09-2	ug/L	1.1	NC	1.3	NC	NC	NA	NA	NA	NC
Molybdenum	7439-98-7	ug/L	8	9	2.6	NA	4.1	2.8	4.5	8.8	NA
Nickel	7440-02-0	ug/L	2.6	3.5	5	2.8	10	3.2	0.56	1.9	NC
Nickel-63	13981-37-8	pCi/L	NA	NC	NA	NA	NA	NA	NA	NA	NA
Nitrate	14797-55-8	ug/L	13124	23681	36503	28756	28300	16400	46835	13229	23874
Nitrite	14797-65-0	ug/L	74	64	98	165	174	NC	164	NC	821
Selenium	7782-49-2	ug/L	1.4	2.4	2.4	NA	1.3	1.2	1.9	NC	NA
Selenium-79	15758-45-9	pCi/L	NA	NA	NA	NA	NA	NC	NA	NA	NA
Silver	7440-22-4	ug/L	0.35	1	NC	NC	0.04	NC	NC	NC	NC
Strontium	7440-24-6	ug/L	260	358	290	226	277	240	341	278	NA
Strontium-90	10098-97-2	pCi/L	2.4	2.1	0.98	1.1	8.1	NC	NC	NA	NC
Styrene	100-42-5	ug/L	NC	NC	NA	NA	NA	NA	NA	NA	NA
Technetium-99	14133-76-7	pCi/L	7.7	50	50	9.1	72	NC	84	NA	NA
Tetrahydrofuran	109-99-9	ug/L	NC	NC	NC	NC	NA	NA	NA	NA	NA
Thallium	7440-28-0	ug/L	NC	NC	NC	NA	0.64	NC	NC	NC	NA

Table A-8 EPCs for Monitoring Wells Screened Across Entire Aquifer

Analyte	CAS NO	Units	199-K-151	199-K-157	199-K-185	199-K-189	199-K-202	199-K-203	199-K-207	199-K-209	199-K-223
Tin	7440-31-5	ug/L	1.4	NC	0.66	NA	4.9	NC	NC	NC	NA
Toluene	108-88-3	ug/L	NC	NC	NC	NC	0.13	NA	NA	NA	NC
TCE	79-01-6	ug/L	0.18	NC	7.1	NC	0.25	NA	NA	NC	4.9
Tritium	10028-17-8	pCi/L	2283	71750	742	37092	35137	1152	760768	NA	1660
Uranium	7440-61-1	ug/L	2.9	3.7	4.2	NA	4.1	2.5	5	4.2	NA
Uranium-233/234	U-233/234	pCi/L	1	NA	NA	NA	NA	0.89	NA	NA	NA
Uranium-235	15117-96-1	pCi/L	NC	NA	NA	NA	NA	0.13	NA	NA	NA
Uranium-238	U-238	pCi/L	0.65	NA	NA	NA	NA	0.77	NA	NA	NA
Vanadium	7440-62-2	ug/L	22	10	12	12	11	13	12	19	9.5
Xylenes (total)	1330-20-7	ug/L	NC	NC	NC	NC	NC	NA	NA	NA	NC
Zinc	7440-66-6	ug/L	16	5.7	4.8	9.9	NC	NC	NC	NC	NC

Note:
NC = EPC not calculated
NA = Not analyzed

Table A-9 EPCs for Extraction Wells Screened Across Top of the Unconfined Aquifer

Analyte	CAS NO	Units	199-K-137
2-Butanone	78-93-3	ug/L	NC
2-Propanol	67-63-0	ug/L	NC
Acetone	67-64-1	ug/L	NC
Antimony	7440-36-0	ug/L	NC
Arsenic	7440-38-2	ug/L	2.5
Barium	7440-39-3	ug/L	47
Beryllium	7440-41-7	ug/L	NC
Cadmium	7440-43-9	ug/L	NC
Carbon disulfide	75-15-0	ug/L	NC
Carbon tetrachloride	56-23-5	ug/L	NC
Carbon-14	14762-75-5	pCi/L	966
Cesium-137	10045-97-3	pCi/L	NC
Chlorobenzene	108-90-7	ug/L	NC
Chloroform	67-66-3	ug/L	0.53
Chromium	7440-47-3	ug/L	51
Cobalt	7440-48-4	ug/L	NC
Cobalt-60	10198-40-0	pCi/L	NC
Copper	7440-50-8	ug/L	5.1
Ethylbenzene	100-41-4	ug/L	NC
Fluoride	16984-48-8	ug/L	189

Table A-9 EPCs for Extraction Wells Screened Across Top of the Unconfined Aquifer

Analyte	CAS NO	Units	199-K-137
Cr(VI)	18540-29-9	ug/L	59
Iron	7439-89-6	ug/L	35
Manganese	7439-96-5	ug/L	4
Mercury	7439-97-6	ug/L	0.19
Methylene chloride	75-09-2	ug/L	NC
Nickel	7440-02-0	ug/L	3.7
Nitrate	14797-55-8	ug/L	27000
Nitrite	14797-65-0	ug/L	118
Silver	7440-22-4	ug/L	7
Strontium	7440-24-6	ug/L	301
Strontium-90	10098-97-2	pCi/L	NC
Technetium-99	14133-76-7	pCi/L	37
Toluene	108-88-3	ug/L	NC
TCE	79-01-6	ug/L	4.4
Tritium	10028-17-8	pCi/L	1462
Vanadium	7440-62-2	ug/L	12
Xylenes (total)	1330-20-7	ug/L	NC
Zinc	7440-66-6	ug/L	27

Note:
NC = EPC not calculated
NA = Not analyzed

Table A-10 EPCs for Combined Wells Screened Across Upper Unconfined Aquifer

Analyte	CAS NO	Units	199-K-35, K-195, K-205
2-Butanone	78-93-3	ug/L	NC
Acetone	67-64-1	ug/L	4.1
Aluminum	7429-90-5	ug/L	NC
Antimony	7440-36-0	ug/L	NC
Arsenic	7440-38-2	ug/L	4
Barium	7440-39-3	ug/L	43
Beryllium	7440-41-7	ug/L	NC
Boron	7440-42-8	ug/L	15
Cadmium	7440-43-9	ug/L	NC
Carbon disulfide	75-15-0	ug/L	NC
Carbon tetrachloride	56-23-5	ug/L	NC
Carbon-14	14762-75-5	pCi/L	301
Cesium-137	10045-97-3	pCi/L	NC
Chlorobenzene	108-90-7	ug/L	NC
Chloroform	67-66-3	ug/L	0.39
Chromium	7440-47-3	ug/L	569
Cobalt	7440-48-4	ug/L	NC
Cobalt-60	10198-40-0	pCi/L	NC
Copper	7440-50-8	ug/L	NC
Ethylbenzene	100-41-4	ug/L	NC
Fluoride	16984-48-8	ug/L	241
Cr(VI)	18540-29-9	ug/L	399
Iron	7439-89-6	ug/L	31
Manganese	7439-96-5	ug/L	5.7
Mercury	7439-97-6	ug/L	NC
Methylene chloride	75-09-2	ug/L	NC
Molybdenum	7439-98-7	ug/L	3
Nickel	7440-02-0	ug/L	2.4
Nitrate	14797-55-8	ug/L	29937
Nitrite	14797-65-0	ug/L	363
Selenium	7782-49-2	ug/L	NC
Silver	7440-22-4	ug/L	9
Strontium	7440-24-6	ug/L	296
Strontium-90	10098-97-2	pCi/L	2.7
Technetium-99	14133-76-7	pCi/L	76
Tetrahydrofuran	109-99-9	ug/L	NC
Thallium	7440-28-0	ug/L	NC
Tin	7440-31-5	ug/L	1.1
Toluene	108-88-3	ug/L	NC
TCE	79-01-6	ug/L	4.8
Tritium	10028-17-8	pCi/L	1327
Uranium	7440-61-1	ug/L	1.7
Vanadium	7440-62-2	ug/L	10
Xylenes (total)	1330-20-7	ug/L	NC
Zinc	7440-66-6	ug/L	4.3

Note:
NC = EPC not calculated
NA = Not analyzed

Table A-11. 100-KR-4 Groundwater Operable Unit Grouped Well Exposure Point Concentration Summary

Analyte Name	CAS No.	Units	100-KR-4 Groundwater OU
1,2,4-Trichlorobenzene	120-82-1	ug/L	0.65
1,2-Dichlorobenzene	95-50-1	ug/L	0.20
2-Butanol	78-92-2	ug/L	30
2-Butanone	78-93-3	ug/L	0.50
2-Propanol	67-63-0	ug/L	102
Acetone	67-64-1	ug/L	0.78
Aldrin	309-00-2	ug/L	0.31
Aluminum	7429-90-5	ug/L	44
Antimony	7440-36-0	ug/L	0.32
Arsenic	7440-38-2	ug/L	3.5
Barium	7440-39-3	ug/L	36
Beryllium	7440-41-7	ug/L	0.10
Bis(2-ethylhexyl) phthalate	117-81-7	ug/L	10
Boron	7440-42-8	ug/L	32
Bromodichloromethane	75-27-4	ug/L	0.094
Bromomethane	74-83-9	ug/L	0.63
Cadmium	7440-43-9	ug/L	0.10
Carbon disulfide	75-15-0	ug/L	0.074
Carbon tetrachloride	56-23-5	ug/L	1.1
Chlorobenzene	108-90-7	ug/L	0.17
Chloroform	67-66-3	ug/L	0.73
Chloromethane	74-87-3	ug/L	0.096
Chromium	7440-47-3	ug/L	61
Cobalt	7440-48-4	ug/L	0.33
Copper	7440-50-8	ug/L	2.7
Cyanide	57-12-5	ug/L	2.3
Diethylphthalate	84-66-2	ug/L	2.2
Ethylbenzene	100-41-4	ug/L	2.5
Fluoride	16984-48-8	ug/L	182
Hexane	110-54-3	ug/L	0.83
Cr(VI)	18540-29-9	ug/L	54
Iron	7439-89-6	ug/L	176
Lithium	7439-93-2	ug/L	15
Manganese	7439-96-5	ug/L	235
Mercury	7439-97-6	ug/L	0.040
Methylene chloride	75-09-2	ug/L	0.31
Molybdenum	7439-98-7	ug/L	4.0
Nickel	7440-02-0	ug/L	7.6
Nitrate	14797-55-8	ug/L	24560
Nitrite	14797-65-0	ug/L	64
o-Xylene	95-47-6	ug/L	0.52
Selenium	7782-49-2	ug/L	1.3
Silver	7440-22-4	ug/L	0.28
Strontium	7440-24-6	ug/L	266
Styrene	100-42-5	ug/L	0.051
Tetrahydrofuran	109-99-9	ug/L	1.2
Thallium	7440-28-0	ug/L	0.078
Tin	7440-31-5	ug/L	0.47
Toluene	108-88-3	ug/L	0.066
TCE	79-01-6	ug/L	3.0
Uranium	7440-61-1	ug/L	3.4
Vanadium	7440-62-2	ug/L	10
Xylenes (total)	1330-20-7	ug/L	0.13
Zinc	7440-66-6	ug/L	30
Carbon-14	14762-75-5	pCi/L	1770
Cesium-137	10045-97-3	pCi/L	1.9

Table A-11. 100-KR-4 Groundwater Operable Unit Grouped Well Exposure Point Concentration Summary

Analyte Name	CAS No.	Units	100-KR-4 Groundwater OU
Cobalt-60	10198-40-0	pCi/L	12
Nickel-63	13981-37-8	pCi/L	3.7
Selenium-79	15758-45-9	pCi/L	25
Strontium-90	10098-97-2	pCi/L	13
Technetium-99	14133-76-7	pCi/L	17
Tritium	10028-17-8	pCi/L	18564
Uranium-233/234	U-233/234	pCi/L	1.2
Uranium-235	15117-96-1	pCi/L	0.15
Uranium-238	U-238	pCi/L	0.77

ECF-100KR4-17-0081, Rev. 0, *Calculation of Exposure Point Concentrations for the 100-KR-4 Groundwater Operable Unit.*

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Appendix B

Software Installation and Checkout Form for POSTAL

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CHPRC SOFTWARE INSTALLATION AND CHECKOUT FORM

Software Owner Instructions:

Complete Fields 1-13, then run test cases in Field 14. Compare test case results listed in Field 15 to corresponding Test Report outputs. If results are the same, sign and date Field 19. If not, resolve differences and repeat above steps.

Software Subject Matter Expert Instructions:

Assign test personnel. Approve the installation of the code by signing and dating Field 21, then maintain form as part of the software support documentation.

GENERAL INFORMATION:

1. Software Name: POSTAL Software Version Nu.: 3.0

EXECUTABLE INFORMATION:

2. Executable Name (include path):

[redacted]\POSTAL.exe

3. Executable Size (bytes): 632,832

COMPILATION INFORMATION:

4. Hardware System (i.e., property number or ID):

Lenovo ThinkPad (property tag INTERA-00707)

5. Operating System (include version number):

Windows 10 Pro 64-bit

INSTALLATION AND CHECKOUT INFORMATION:

6. Hardware System (i.e., property number or ID):

Lenovo ThinkPad (property tag INTERA-00707)

7. Operating System (include version number):

Windows 10 Pro 64-bit

8. Open Problem Report? (●) No ( ) Yes PR/CR No.

TEST CASE INFORMATION:

9. Directory/Path:

[redacted]\POSTAL3.0\

10. Procedure(s):

CHPRC-03486 Rev. 0, POSTAL Software Management Plan (Sections 16 and 13.3.3.9)

11. Libraries:

N/A

12. Input Files:

N/A

13. Output Files:

N/A (to screen)

14. Test Cases:

POSTAL-ITC-1

15. Test Case Results:

Passed. Match expected results as presented in CHPRC-03486, POSTAL Software Management Plan Section 13.3.3.9 and Attachment 9: Test Log for POSTAL-ITC-1 template.

16. Test Performed By: Neil Powers

17. Test Results: (●) Satisfactory, Accepted for Use ( ) Unsatisfactory

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CHPRC SOFTWARE INSTALLATION AND CHECKOUT FORM (continued)

1. Software Name: POSTAL Software Version No.: 3.0

18. Disposition (include HISI update):

Installation added to HISI registry. -WE Nichols

Prepared By:

19.	Software Owner (Signature)	William E Nichols (Print)	7 MAR 2018 (Date)

20. Test Personnel:

Sign	N. Powers (Print)	7 Mar 2018 (Date)
Sign	Print	Date
Sign	Print	Date

Approved By:

21. Software SME (Signature)	N/A (CHPRC-3486) (Print)	Date