APPENDIX O
GROUNDWATER TRANSPORT ANALYSIS

This appendix presents groundwater transport analysis as it relates to groundwater transport model development and results.

O.1 INTRODUCTION

The groundwater transport analysis for the *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)* focuses on groundwater quality and its relationship to long-term human health impacts. Groundwater quality is affected when discharges from facilities reach groundwater beneath the facilities. Contaminants from these discharges can be transported through the unconfined aquifer beneath the facilities and may enter the Columbia River. This appendix presents groundwater transport analysis as it relates to groundwater transport model development and groundwater transport model results. These results include a comparison of the projected water quality to a benchmark value derived from relevant regulatory standards, including the Clean Water Act, Safe Drinking Water Act, and Washington State regulations, as means of assessing long-term human health impacts.

O.1.1 Purpose

The purpose of groundwater transport analysis is to project the concentrations of contaminants released under each *TC & WM EIS* alternative from Hanford Site (Hanford) source locations through the unconfined aquifer to potential receptor locations (i.e., lines of analysis that include facility boundaries, barriers, the Core Zone Boundary, and the Columbia River) and to compare those results to relevant regulatory standards as means of assessing the long-term human health impacts. To achieve this purpose, the contaminant transport model links information from the groundwater flow field (which describes the directions and rates of groundwater flow; see Appendix L) and information from the vadose-zone transport model (which describes the rate of introduction of contaminants into the unconfined aquifer, see Appendix N). Output from the contaminant transport model includes concentrations of contaminants as a function of time at specified lines of analyses and maps of spatial distributions of contaminants at selected times.

O.1.2 Scope and Methodology

This section describes the scope of this appendix and the methodology used for the groundwater transport analysis conducted for this *TC & WM EIS*. Section O.2 summarizes the aspects of the particle-tracking method used to implement the contaminant transport model that are unique to this *TC & WM EIS* (citations are provided for general aspects of the method that are not unique to this *TC & WM EIS*). Groundwater transport modeling results for the Tank Closure, Fast Flux Test Facility (FFTF) Decommissioning, and Waste Management alternatives are contained in Sections O.3, O.4, and O.5, respectively. Section O.6 contains results that illustrate the effects of uncertainties in the input data on calculated results.

For each of the *TC & WM EIS* alternatives, data packages were developed to identify source locations within the Hanford study area and associated contaminant discharges to groundwater. Overall, this process resulted in approximately 1,700 individual groundwater contaminant transport runs. The inputs for the groundwater contaminant transport runs were based on outputs from vadose zone flow and transport runs that were calculated using the STOMP [Subsurface Transport Over Multiple Phases] computer modeling code (Nichols et al. 1997; White and Oostrom 1996, 1997). The STOMP code is discussed in Appendix N. Contaminants were excluded from groundwater transport runs if their STOMP results produced zero flux or peak fluxes that were less than 10×10^{-8} curies for radionuclide

contaminants or 10×10^{-8} grams for chemical contaminants. Peak fluxes smaller than these values resulted in maximum contaminant concentrations that were 2 orders of magnitude lower than benchmark values.

The particle-tracking code (see Section O.2) and the MODFLOW [modular three-dimensional finite-difference groundwater flow model] Base Case flow field (see Appendix L) were used to calculate a fully three-dimensional transient analysis of groundwater transport over a period of 10,000 years for each source location. The radionuclide and chemical contaminants included in this analysis are listed in Table O–1.

Table O–1. Contaminants Selected for Groundwater Transport Analysis

Americium-241	Benzene
Carbon-14	Boron and compounds
Cesium-137	Cadmium
Gadolinium-152	Carbon tetrachloride
Hydrogen-3 (tritium)	Chromium
Iodine-129	Dichloromethane
Potassium-40	Fluoride
Neptunium-237	Hydrazine/hydrazine sulfate
Plutonium-239 (includes plutonium-239 and -240)	Lead
Strontium-90	Manganese
Technetium-99	Mercury
Thorium-232	Molybdenum
Uranium-238 (includes uranium-233, -234, -235, and -238)	Nickel (soluble salts)
Zirconium-93	Nitrate
1,2-Dichloroethane	Polychlorinated biphenyls
1,4-Dioxane	Silver
1-Butanol	Strontium (stable)
Trichlorophenol	Trichloroethylene
Acetonitrile	Uranium total
Arsenic, inorganic	Vinyl chloride

Note: Groundwater transport analyses were also performed using consistent methodology for the long-term cumulative site and Black Rock Reservoir discharges. The long-term cumulative site results are included in Appendix U, while the Black Rock Reservoir results are included in Appendix V.

O.1.2.1 Source Locations

The source locations for the *TC & WM EIS* Tank Closure, FFTF Decommissioning, and Waste Management alternatives include contaminant discharges from the following:

- Cribs and trenches (ditches) closely associated with the tank farms (the B, BX, BY, T, TX, and TY cribs and trenches [ditches])
- 18 tanks farms (the A, AN, AP, AW, AX, AY, AZ, B, BX, BY, C, S, SX, SY, T, TX, TY, and U tank farms)
- FFTF

- Low-level radioactive waste burial ground (LLBG) 218-W-5 trenches 31 and 34 (Waste Management Alternative 1)

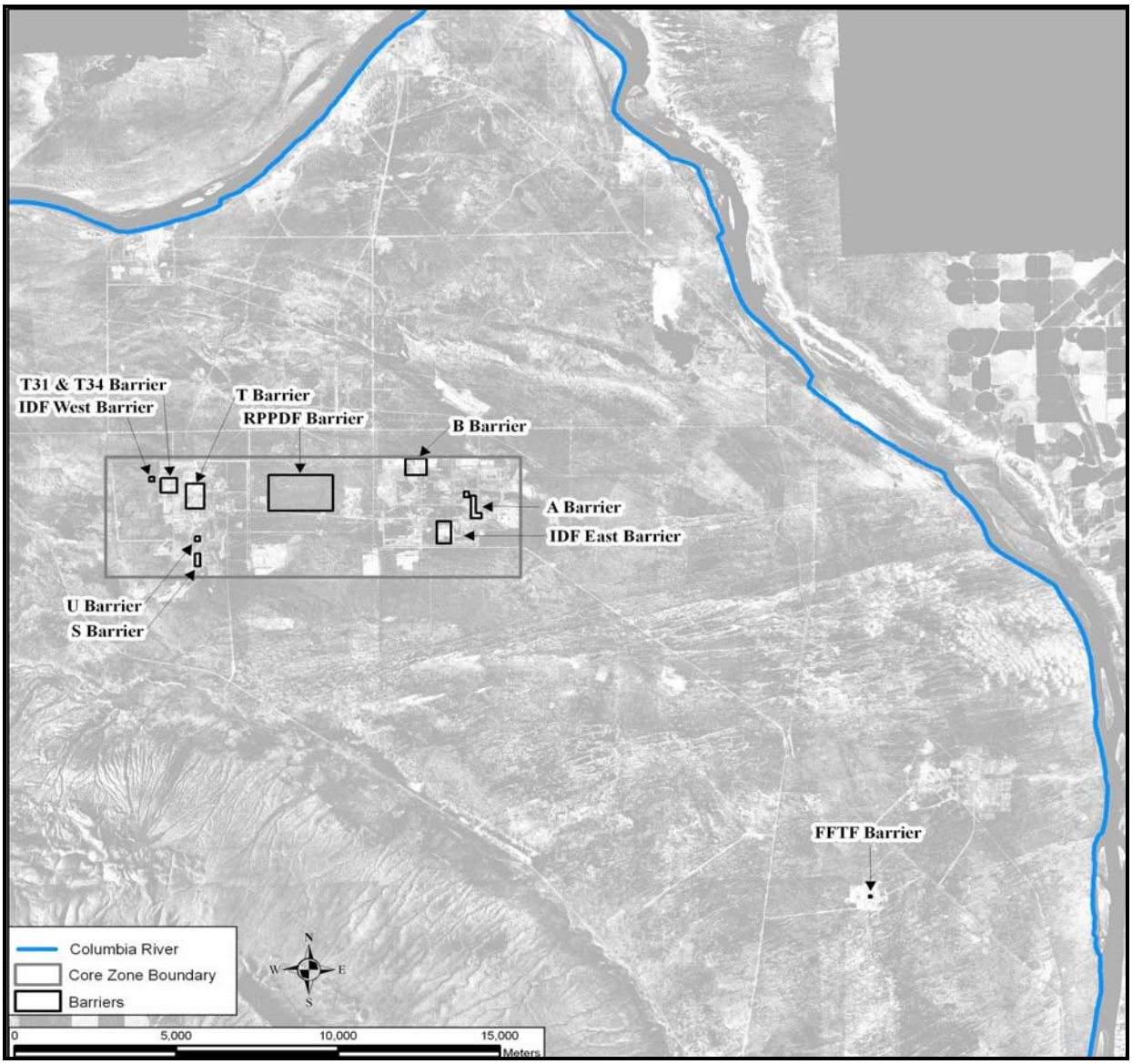
- Numerous waste forms, including immobilized low-activity waste (ILAW) glass, bulk vitrification glass, cast stone, steam reforming waste, Effluent Treatment Facility-generated secondary waste, other secondary waste, and offsite waste, discharged from an Integrated Disposal Facility (IDF) (Waste Management Alternatives 2 and 3)

- Waste from tank farm closure operations (e.g., from the River Protection Project Disposal Facility [RPPDF])

The locations of these facilities and areas were taken from the Hanford Site Atlas (BHI 2001).

O.1.2.2 Contaminant Reporting–Lines of Analysis

For the *TC & WM EIS* groundwater transport analyses, maximum concentrations were reported as a function of time along lines of analysis representing locations of interest within the Hanford study area. Near-field (i.e., close to the source location) lines of analysis include barrier boundaries (i.e., the edges of infiltration barriers constructed over disposal areas that are within 100 meters of facility fence lines). The near-field lines of analysis include the A, B, S, T, and U Barriers constructed over the tank farms and the closely associated cribs and trenches (ditches); the FFTF barrier; the 200-East Area IDF (IDF-East) and 200-West Area IDF (IDF-West) barriers; the LLBG 218-W-5 trench 31 and 34 barrier; and the RPPDF barrier. The midfield line of analysis is the Core Zone Boundary (see Chapter 2, Section 2.9.1.1). The far-field line of analysis is the Columbia River nearshore. The simulated contaminant concentrations along each line of analysis were evaluated for each time step and the highest concentration was tabulated. The locations of the lines of analysis are shown in Figure O–1.



Key: FFTF=Fast Flux Test Facility; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility; T31 & T34=trenches 31 and 34.

Figure O–1. Hanford Site Map Showing Locations of Lines of Analysis

O.1.3 Technical Guidance

In accordance with the *Technical Guidance Document for "Tank Closure Environmental Impact Statement" Vadose Zone and Groundwater Revised Analyses* (DOE 2005), two flow fields were developed. The Base Case flow field represented a condition in which long-term flow direction would be predominantly eastward; the Alternate Case, predominantly northward. The development of these flow fields is discussed in Appendix L. The results of the groundwater transport analysis presented in this appendix were calculated using the Base Case flow field. The results from the Alternate Case flow field were compared to those from the Base Case flow field as part of a sensitivity analysis for both the operational and postoperational time periods. The data from these sensitivity analyses are presented in Section O.6.

O.2 PARTICLE-TRACKING METHODOLOGY AND PARAMETER ESTIMATION

This section summarizes those aspects of the particle-tracking method used to implement the contaminant transport model that are unique to this *TC & WM EIS* (citations are provided for general aspects of the method that are not unique to this *TC & WM EIS*). The particle-tracking method models contaminant transport in the saturated zone that is under the influence of the groundwater flow field (advection), hydrodynamic dispersion, retardation, and radioactive decay. Development, validation, and applications of the particle-tracking method to evaluate contaminant transport are described in numerous open-literature publications (e.g., Ahlstrom et al. 1977; Prickett, Naymik, and Lonnquist 1981; Kinzelbach 1986: 298-315; Uffink 1983; LaBolle, Quastel, and Fogg 1998). This method is explicitly mass-conserving, has no numeric convergence issues, and is suitable for use in advection-dominated situations.

The following additions to the general particle-tracking methodology were developed for this *TC & WM EIS*:

- An interface with the vadose-zone contaminant transport model (STOMP)
- An evaluation of contaminant concentrations along lines of analysis
- A Gelhar description of the scale-dependence of dispersivity (Gelhar 1986)

These modifications are discussed in Sections O.2.1 through O.2.3. Section O.2.4 discusses the parameters that were used to model contaminant transport in the unconfined aquifer.

O.2.1 Interface with STOMP

The vadose-zone transport model (STOMP; see Appendix N) provides the contaminant flux to the particle-tracking model. Thus, each particle-tracking simulation must be preceded by a vadose zone simulation. An interface was developed to transfer the contaminant flux from the STOMP simulations to the particle-tracking model. Each STOMP simulation models a specific source that contains three release areas (see Appendix N). These areas are rectangular in shape and are numbered from 1 to 3, as shown in Figure O–2. In particular, area 1 is entirely contained within area 2, which in turn is completely contained within area 3. The collection of areas can then be rotated by an angle, θ, about the southwest corner, with θ measured in the positive clockwise direction.

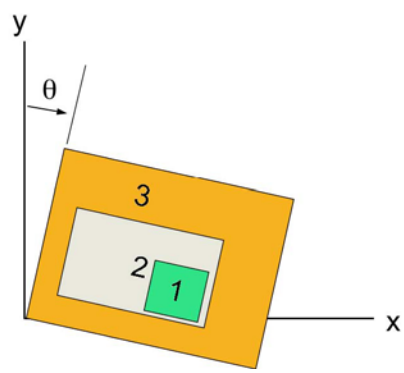


Figure O–2. Configuration of Release Areas for a Given Source

The flux through each release area as a function of time is calculated by STOMP. This time series of fluxes are read by the particle-tracking code, which describes the release of contaminants into the aquifer.

O.2.2 Reporting Concentration Along Lines of Analysis

After each time step, a grid of concentration values is calculated across the simulation domain using standard particle-tracking methodology (e.g., Kinzelbach 1986). The geographic definition of each line of analysis (i.e., the locations of the points along the line of analysis) is used to search the associated concentration grid elements to find the maximum concentration. In general, the location of the peak concentration along a line of analysis changes from time step to time step because the contaminant spatial distribution varies with time.

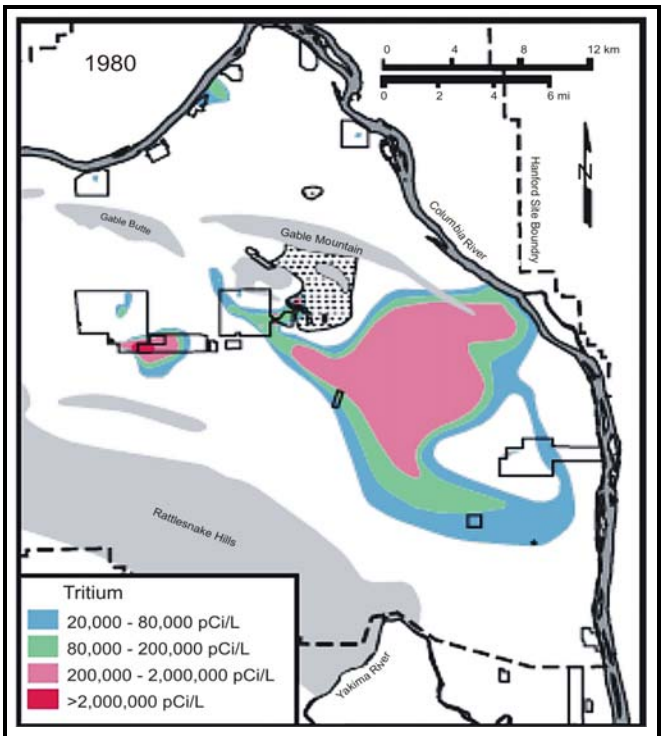
O.2.3 Scale-Dependent Dispersivity

Dispersivity is a measure of the degree of spreading of a contaminant plume. In the standard implementation of the particle-tracking method, the dispersivity is a constant and does not depend on distance from the source (scale). This *TC & WM EIS* uses a regional-scale model, which was considered important to describe the scale dependence of dispersivity. The Gelhar method (Gelhar 1986) was implemented in the particle-tracking model. The dispersivity increases linearly with distance from the source location up to a specified threshold. At distances greater than this threshold, the dispersivity remains constant at its maximum value.

O.2.4 Calibration Tests

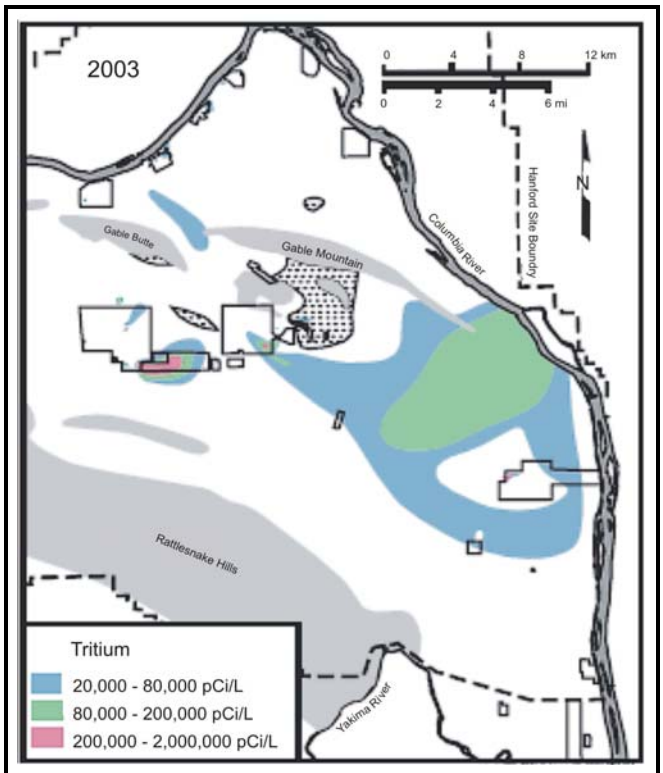
The particle-tracking model requires several parameters that describe physical properties of the unconfined aquifer. To obtain these parameters, a series of calibration tests were performed by varying the aquifer properties, initial injection depth, and well screen depth; calculating contaminant spatial distributions for two regional-scale contaminant plumes (the Plutonium-Uranium Extraction [PUREX] waste site and Reduction-Oxidation [REDOX] waste site hydrogen-3 [tritium] plumes, so called because of proximity for the respective facilities but composed of other waste discharge sources also); and adjusting the parameters to obtain a qualitative fit to observed tritium concentrations. Resulting tritium plume maps were generated for the years 1980, 1990, and 2005. These maps were visually compared to associated tritium plume maps provided in *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Hartman, Morasch, and Webber 2004).

Figures O–3 and O–4 are qualitative interpretations of the spatial distribution of tritium plumes in 1980 and 2003. The PUREX waste site plume is larger than the REDOX waste site plume, and its source location is in the southwest portion of 200-East Area. The REDOX waste site plume (to the west of the PUREX waste site plume) extends from the southern part of the 200-West Area through the center of the Central Plateau. Note that, by 1980, tritium concentrations greater than 20,000 picocuries per liter had reached the Columbia River and the 400 Area (FFTF). Peak concentrations in both the PUREX and REDOX waste site plumes are in excess of 2 million picocuries per liter. The PUREX waste site plume is approximately five times larger than the REDOX waste site plume, reflecting the higher hydraulic conductivity of the aquifer materials east of the Central Plateau (see Appendix L). By 2003 (Figure O-4), radioactive decay had attenuated peak concentrations in both plumes; however, the areas in excess of 20,000 picocuries per liter are approximately the same as in 1980. These are the principal features of the plumes against which the calibration test results were compared.



Source: Hartman, Morasch, and Webber 2004.

Figure O–3. Sitewide Hydrogen-3 (Tritium) Plumes, Calendar Year 1980



Source: Hartman, Morasch, and Webber 2004.

Figure O–4. Sitewide Hydrogen-3 (Tritium) Plumes, Calendar Year 2003

O.2.4.1 Sensitivity to Dispersivity Parameters

Longitudinal dispersivities of 100, 500, and 1,000 meters were examined to determine the effects on PUREX and REDOX waste site tritium plume concentrations. Each parameter set explored as part of these calibration tests is included in Table O–2 and Table O–3. The best overall fit with the groundwater monitoring data was based on tritium concentrations values reported at the Core Zone and Columbia River. As a result of these calibration tests, the values from Runs P10 and R10 were selected as the best fit parameter set. This selection was based on visual comparison of the tritium plume maps generated from these runs (Figures O–5 through O–10) to associated tritium plume maps provided in *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Figures O–3 and O–4) (Hartman, Morasch, and Webber 2004).

O.2.4.2 Sensitivity to Well Screen Depth for Calculating Concentration

Well screen depths of 10 and 40 meters were examined to determine the effects on PUREX and REDOX waste site tritium plume concentrations. Each parameter set explored as part of these calibration tests is included in Table O–2 and Table O–3. The best overall fit with the groundwater monitoring data was based on tritium concentrations values reported at the Core Zone and Columbia River. As a result of these calibration tests, the values from Runs P10 and R10 were selected as the best fit parameter set. This selection was based on visual comparison of the tritium plume maps generated from these runs (Figures O–5 through O–10) to associated tritium plume maps shown from *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Figures O–3 and O–4) (Hartman, Morasch, and Webber 2004).

O.2.4.3 Sensitivity to Initial Particle Injection Depth

Particle injection depths of 1, 5, 10, and 15 meters were examined to determine the effects on PUREX and REDOX waste site tritium plume concentrations. Each parameter set explored as part of these calibration tests is included in Tables O–2 and O–3. [The values presented in red represent parameters for each calibration run.] The best overall fit with the groundwater monitoring data was based on tritium concentrations values reported at the Core Zone and Columbia River. As a result of these calibration tests, the values from Runs P10 and R10 were selected as the best fit parameter set. This selection was based on the visual comparison of the tritium plume maps generated from these runs (Figures O–5 through O–10) to associated tritium plume maps provided in *Hanford Site Groundwater Monitoring for Fiscal Year 2003* (Figures O–3 and O–4) (Hartman, Morasch, and Webber 2004).

Table O–2. Calibration Test Matrix for Plutonium-Uranium Extraction (PUREX) Plant Sites

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P1)	**100**	**1,000**	**0.1**	**0.01**	**0.001**	**1**	**40**
216-A-4	100	1,000	0.1	0.01	0.001	1	40
216-A-5	100	1,000	0.1	0.01	0.001	1	40
216-A-6	100	1,000	0.1	0.01	0.001	1	40
216-A-8	100	1,000	0.1	0.01	0.001	1	40
216-A-10	100	1,000	0.1	0.01	0.001	1	40
216-A-21	100	1,000	0.1	0.01	0.001	1	40
216-A-24	100	1,000	0.1	0.01	0.001	1	40
216-A-27	100	1,000	0.1	0.01	0.001	1	40
216-A-30	100	1,000	0.1	0.01	0.001	1	40
216-A-36-B	100	1,000	0.1	0.01	0.001	1	40
216-A-37-1	100	1,000	0.1	0.01	0.001	1	40
216-A-37-2	100	1,000	0.1	0.01	0.001	1	40
216-A-45	100	1,000	0.1	0.01	0.001	1	40
Run (P2)	**100**	**1,000**	**0.1**	**0.1**	**0.001**	**1**	**40**
216-A-4	100	1,000	0.1	0.1	0.001	1	40
216-A-5	100	1,000	0.1	0.1	0.001	1	40
216-A-6	100	1,000	0.1	0.1	0.001	1	40
216-A-8	100	1,000	0.1	0.1	0.001	1	40
216-A-10	100	1,000	0.1	0.1	0.001	1	40
216-A-21	100	1,000	0.1	0.1	0.001	1	40
216-A-24	100	1,000	0.1	0.1	0.001	1	40
216-A-27	100	1,000	0.1	0.1	0.001	1	40
216-A-30	100	1,000	0.1	0.1	0.001	1	40
216-A-36-B	100	1,000	0.1	0.1	0.001	1	40
216-A-37-1	100	1,000	0.1	0.1	0.001	1	40
216-A-37-2	100	1,000	0.1	0.1	0.001	1	40
216-A-45	100	1,000	0.1	0.1	0.001	1	40

Table O–2. Calibration Test Matrix for Plutonium-Uranium Extraction (PUREX) Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P3)	**100**	**1,000**	**0.1**	**0.1**	**0.1**	**1**	**40**
216-A-4	100	1,000	0.1	0.1	0.1	1	40
216-A-5	100	1,000	0.1	0.1	0.1	1	40
216-A-6	100	1,000	0.1	0.1	0.1	1	40
216-A-8	100	1,000	0.1	0.1	0.1	1	40
216-A-10	100	1,000	0.1	0.1	0.1	1	40
216-A-21	100	1,000	0.1	0.1	0.1	1	40
216-A-24	100	1,000	0.1	0.1	0.1	1	40
216-A-27	100	1,000	0.1	0.1	0.1	1	40
216-A-30	100	1,000	0.1	0.1	0.1	1	40
216-A-36-B	100	1,000	0.1	0.1	0.1	1	40
216-A-37-1	100	1,000	0.1	0.1	0.1	1	40
216-A-37-2	100	1,000	0.1	0.1	0.1	1	40
216-A-45	100	1,000	0.1	0.1	0.1	1	40
Run (P4)	**100**	**1,000**	**0.1**	**0.01**	**0.002**	**1**	**40**
216-A-4	100	1,000	0.1	0.01	0.002	1	40
216-A-5	100	1,000	0.1	0.01	0.002	1	40
216-A-6	100	1,000	0.1	0.01	0.002	1	40
216-A-8	100	1,000	0.1	0.01	0.002	1	40
216-A-10	100	1,000	0.1	0.01	0.002	1	40
216-A-21	100	1,000	0.1	0.01	0.002	1	40
216-A-24	100	1,000	0.1	0.01	0.002	1	40
216-A-27	100	1,000	0.1	0.01	0.002	1	40
216-A-30	100	1,000	0.1	0.01	0.002	1	40
216-A-36-B	100	1,000	0.1	0.01	0.002	1	40
216-A-37-1	100	1,000	0.1	0.01	0.002	1	40
216-A-37-2	100	1,000	0.1	0.01	0.002	1	40
216-A-45	100	1,000	0.1	0.01	0.002	1	40

Table O–2. Calibration Test Matrix for Plutonium-Uranium Extraction (PUREX) Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P5)	**100**	**1,000**	**0.1**	**0.01**	**0.005**	**1**	**40**
216-A-4	100	1,000	0.1	0.01	0.005	1	40
216-A-5	100	1,000	0.1	0.01	0.005	1	40
216-A-6	100	1,000	0.1	0.01	0.005	1	40
216-A-8	100	1,000	0.1	0.01	0.005	1	40
216-A-10	100	1,000	0.1	0.01	0.005	1	40
216-A-21	100	1,000	0.1	0.01	0.005	1	40
216-A-24	100	1,000	0.1	0.01	0.005	1	40
216-A-27	100	1,000	0.1	0.01	0.005	1	40
216-A-30	100	1,000	0.1	0.01	0.005	1	40
216-A-36-B	100	1,000	0.1	0.01	0.005	1	40
216-A-37-1	100	1,000	0.1	0.01	0.005	1	40
216-A-37-2	100	1,000	0.1	0.01	0.005	1	40
216-A-45	100	1,000	0.1	0.01	0.005	1	40
Run (P6)	**100**	**1,000**	**0.1**	**0.02**	**0.005**	**1**	**40**
216-A-4	100	1,000	0.1	0.02	0.005	1	40
216-A-5	100	1,000	0.1	0.02	0.005	1	40
216-A-6	100	1,000	0.1	0.02	0.005	1	40
216-A-8	100	1,000	0.1	0.02	0.005	1	40
216-A-10	100	1,000	0.1	0.02	0.005	1	40
216-A-21	100	1,000	0.1	0.02	0.005	1	40
216-A-24	100	1,000	0.1	0.02	0.005	1	40
216-A-27	100	1,000	0.1	0.02	0.005	1	40
216-A-30	100	1,000	0.1	0.02	0.005	1	40
216-A-36-B	100	1,000	0.1	0.02	0.005	1	40
216-A-37-1	100	1,000	0.1	0.02	0.005	1	40
216-A-37-2	100	1,000	0.1	0.02	0.005	1	40
216-A-45	100	1,000	0.1	0.02	0.005	1	40

Table O–2. Calibration Test Matrix for Plutonium-Uranium Extraction (PUREX) Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P7)	**100**	**1,000**	**0.1**	**0.05**	**0.005**	**1**	**40**
216-A-4	100	1,000	0.1	0.05	0.005	1	40
216-A-5	100	1,000	0.1	0.05	0.005	1	40
216-A-6	100	1,000	0.1	0.05	0.005	1	40
216-A-8	100	1,000	0.1	0.05	0.005	1	40
216-A-10	100	1,000	0.1	0.05	0.005	1	40
216-A-21	100	1,000	0.1	0.05	0.005	1	40
216-A-24	100	1,000	0.1	0.05	0.005	1	40
216-A-27	100	1,000	0.1	0.05	0.005	1	40
216-A-30	100	1,000	0.1	0.05	0.005	1	40
216-A-36-B	100	1,000	0.1	0.05	0.005	1	40
216-A-37-1	100	1,000	0.1	0.05	0.005	1	40
216-A-37-2	100	1,000	0.1	0.05	0.005	1	40
216-A-45	100	1,000	0.1	0.05	0.005	1	40
Run (P8) Runs 1-6							
P8 Run 1	**100**	**1,000**	**0.1**	**0.1**	**0.001**	**1**	**40**
216-A-8	100	1,000	0.1	0.1	0.001	1	40
P8 Run 2	**100**	**1,000**	**0.1**	**0.1**	**0.01**	**1**	**40**
216-A-8	100	1,000	0.1	0.1	0.01	1	40
P8 Run 3	**100**	**1,000**	**0.1**	**0.01**	**0.002**	**1**	**40**
216-A-8	100	1,000	0.1	0.01	0.002	1	40
P8 Run 4	**100**	**1,000**	**0.1**	**0.1**	**0.002**	**1**	**40**
216-A-8	100	1,000	0.1	0.1	0.002	1	40
P8 Run 5	**100**	**1,000**	**0.1**	**0.01**	**0.005**	**1**	**40**
216-A-8	100	1,000	0.1	0.01	0.005	1	40
P8 Run 6	**100**	**1,000**	**0.1**	**0.1**	**0.005**	**1**	**40**
216-A-8	100	1,000	0.1	0.1	0.005	1	40

Table O–2. Calibration Test Matrix for Plutonium-Uranium Extraction (PUREX) Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P9)	**500**	**5,000**	**0.1**	**0.1**	**0.005**	**1**	**40**
216-A-4	500	5,000	0.1	0.1	0.005	1	40
216-A-5	500	5,000	0.1	0.1	0.005	1	40
216-A-6	500	5,000	0.1	0.1	0.005	1	40
216-A-8	500	5,000	0.1	0.1	0.005	1	40
216-A-10	500	5,000	0.1	0.1	0.005	1	40
216-A-21	500	5,000	0.1	0.1	0.005	1	40
216-A-24	500	5,000	0.1	0.1	0.005	1	40
216-A-27	500	5,000	0.1	0.1	0.005	1	40
216-A-30	500	5,000	0.1	0.1	0.005	1	40
216-A-36-B	500	5,000	0.1	0.1	0.005	1	40
216-A-37-1	500	5,000	0.1	0.1	0.005	1	40
216-A-37-2	500	5,000	0.1	0.1	0.005	1	40
216-A-45	500	5,000	0.1	0.1	0.005	1	40
Run (P10)	**500**	**5,000**	**0.1**	**0.1**	**0**	**1**	**40**
216-A-4	500	5,000	0.1	0.1	0	1	40
216-A-5	500	5,000	0.1	0.1	0	1	40
216-A-6	500	5,000	0.1	0.1	0	1	40
216-A-8	500	5,000	0.1	0.1	0	1	40
216-A-10	500	5,000	0.1	0.1	0	1	40
216-A-21	500	5,000	0.1	0.1	0	1	40
216-A-24	500	5,000	0.1	0.1	0	1	40
216-A-27	500	5,000	0.1	0.1	0	1	40
216-A-30	500	5,000	0.1	0.1	0	1	40
216-A-36-B	500	5,000	0.1	0.1	0	1	40
216-A-37-1	500	5,000	0.1	0.1	0	1	40
216-A-37-2	500	5,000	0.1	0.1	0	1	40
216-A-45	500	5,000	0.1	0.1	0	1	40

Table O–2. Calibration Test Matrix for Plutonium-Uranium Extraction (PUREX) Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P11)	**500**	**5,000**	**0.1**	**0.1**	**0.001**	**1**	**40**
216-A-4	500	5,000	0.1	0.1	0.001	1	40
216-A-5	500	5,000	0.1	0.1	0.001	1	40
216-A-6	500	5,000	0.1	0.1	0.001	1	40
216-A-8	500	5,000	0.1	0.1	0.001	1	40
216-A-10	500	5,000	0.1	0.1	0.001	1	40
216-A-21	500	5,000	0.1	0.1	0.001	1	40
216-A-24	500	5,000	0.1	0.1	0.001	1	40
216-A-27	500	5,000	0.1	0.1	0.001	1	40
216-A-30	500	5,000	0.1	0.1	0.001	1	40
216-A-36-B	500	5,000	0.1	0.1	0.001	1	40
216-A-37-1	500	5,000	0.1	0.1	0.001	1	40
216-A-37-2	500	5,000	0.1	0.1	0.001	1	40
216-A-45	500	5,000	0.1	0.1	0.001	1	40
Run (P12)	**500**	**5,000**	**0.1**	**0.1**	**0**	**10**	**40**
216-A-4	500	5,000	0.1	0.1	0	10	40
216-A-5	500	5,000	0.1	0.1	0	10	40
216-A-6	500	5,000	0.1	0.1	0	10	40
216-A-8	500	5,000	0.1	0.1	0	10	40
216-A-10	500	5,000	0.1	0.1	0	10	40
216-A-21	500	5,000	0.1	0.1	0	10	40
216-A-24	500	5,000	0.1	0.1	0	10	40
216-A-27	500	5,000	0.1	0.1	0	10	40
216-A-30	500	5,000	0.1	0.1	0	10	40
216-A-36-B	500	5,000	0.1	0.1	0	10	40
216-A-37-1	500	5,000	0.1	0.1	0	10	40
216-A-37-2	500	5,000	0.1	0.1	0	10	40
216-A-45	500	5,000	0.1	0.1	0	10	40

Table O–2. Calibration Test Matrix for Plutonium-Uranium Extraction (PUREX) Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P13)	**500**	**5,000**	**0.1**	**0.1**	**0**	**15**	**40**
216-A-4	500	5,000	0.1	0.1	0	15	40
216-A-5	500	5,000	0.1	0.1	0	15	40
216-A-6	500	5,000	0.1	0.1	0	15	40
216-A-8	500	5,000	0.1	0.1	0	15	40
216-A-10	500	5,000	0.1	0.1	0	15	40
216-A-21	500	5,000	0.1	0.1	0	15	40
216-A-24	500	5,000	0.1	0.1	0	15	40
216-A-27	500	5,000	0.1	0.1	0	15	40
216-A-30	500	5,000	0.1	0.1	0	15	40
216-A-36-B	500	5,000	0.1	0.1	0	15	40
216-A-37-1	500	5,000	0.1	0.1	0	15	40
216-A-37-2	500	5,000	0.1	0.1	0	15	40
216-A-45	500	5,000	0.1	0.1	0	15	40
Run (P14)	**1,000**	**10,000**	**0.1**	**0.1**	**0**	**1**	**40**
216-A-4	1,000	10,000	0.1	0.1	0	1	40
216-A-5	1,000	10,000	0.1	0.1	0	1	40
216-A-6	1,000	10,000	0.1	0.1	0	1	40
216-A-8	1,000	10,000	0.1	0.1	0	1	40
216-A-10	1,000	10,000	0.1	0.1	0	1	40
216-A-21	1,000	10,000	0.1	0.1	0	1	40
216-A-24	1,000	10,000	0.1	0.1	0	1	40
216-A-27	1,000	10,000	0.1	0.1	0	1	40
216-A-30	1,000	10,000	0.1	0.1	0	1	40
216-A-36-B	1,000	10,000	0.1	0.1	0	1	40
216-A-37-1	1,000	10,000	0.1	0.1	0	1	40
216-A-37-2	1,000	10,000	0.1	0.1	0	1	40
216-A-45	1,000	10,000	0.1	0.1	0	1	40

Table O–2. Calibration Test Matrix for Plutonium-Uranium Extraction (PUREX) Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P15)	**100**	**1,000**	**0.1**	**0.1**	**0.01**	**1**	**40**
216-A-4	100	1,000	0.1	0.1	0.01	1	40
216-A-5	100	1,000	0.1	0.1	0.01	1	40
216-A-6	100	1,000	0.1	0.1	0.01	1	40
216-A-8	100	1,000	0.1	0.1	0.01	1	40
216-A-10	100	1,000	0.1	0.1	0.01	1	40
216-A-21	100	1,000	0.1	0.1	0.01	1	40
216-A-24	100	1,000	0.1	0.1	0.01	1	40
216-A-27	100	1,000	0.1	0.1	0.01	1	40
216-A-30	100	1,000	0.1	0.1	0.01	1	40
216-A-36-B	100	1,000	0.1	0.1	0.01	1	40
216-A-37-1	100	1,000	0.1	0.1	0.01	1	40
216-A-37-2	100	1,000	0.1	0.1	0.01	1	40
216-A-45	100	1,000	0.1	0.1	0.01	1	40
Run (P16)	**100**	**1,000**	**0.1**	**0.1**	**0.002**	**1**	**40**
216-A-4	100	1,000	0.1	0.1	0.002	1	40
216-A-5	100	1,000	0.1	0.1	0.002	1	40
216-A-6	100	1,000	0.1	0.1	0.002	1	40
216-A-8	100	1,000	0.1	0.1	0.002	1	40
216-A-10	100	1,000	0.1	0.1	0.002	1	40
216-A-21	100	1,000	0.1	0.1	0.002	1	40
216-A-24	100	1,000	0.1	0.1	0.002	1	40
216-A-27	100	1,000	0.1	0.1	0.002	1	40
216-A-30	100	1,000	0.1	0.1	0.002	1	40
216-A-36-B	100	1,000	0.1	0.1	0.002	1	40
216-A-37-1	100	1,000	0.1	0.1	0.002	1	40
216-A-37-2	100	1,000	0.1	0.1	0.002	1	40
216-A-45	100	1,000	0.1	0.1	0.002	1	40

Table O–2. Calibration Test Matrix for Plutonium-Uranium Extraction (PUREX) Plant Sites *(continued)*

PUREX Plant Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (P17)	**100**	**1,000**	**0.1**	**0.1**	**0.005**	**1**	**40**
216-A-4	100	1,000	0.1	0.1	0.005	1	40
216-A-5	100	1,000	0.1	0.1	0.005	1	40
216-A-6	100	1,000	0.1	0.1	0.005	1	40
216-A-8	100	1,000	0.1	0.1	0.005	1	40
216-A-10	100	1,000	0.1	0.1	0.005	1	40
216-A-21	100	1,000	0.1	0.1	0.005	1	40
216-A-24	100	1,000	0.1	0.1	0.005	1	40
216-A-27	100	1,000	0.1	0.1	0.005	1	40
216-A-30	100	1,000	0.1	0.1	0.005	1	40
216-A-36-B	100	1,000	0.1	0.1	0.005	1	40
216-A-37-1	100	1,000	0.1	0.1	0.005	1	40
216-A-37-2	100	1,000	0.1	0.1	0.005	1	40
216-A-45	100	1,000	0.1	0.1	0.005	1	40
Run (P18)	**500**	**5,000**	**0.1**	**0.1**	**0**	**5**	**40**
216-A-4	500	5,000	0.1	0.1	0	5	40
216-A-5	500	5,000	0.1	0.1	0	5	40
216-A-6	500	5,000	0.1	0.1	0	5	40
216-A-8	500	5,000	0.1	0.1	0	5	40
216-A-10	500	5,000	0.1	0.1	0	5	40
216-A-21	500	5,000	0.1	0.1	0	5	40
216-A-24	500	5,000	0.1	0.1	0	5	40
216-A-27	500	5,000	0.1	0.1	0	5	40
216-A-30	500	5,000	0.1	0.1	0	5	40
216-A-36-B	500	5,000	0.1	0.1	0	5	40
216-A-37-1	500	5,000	0.1	0.1	0	5	40
216-A-37-2	500	5,000	0.1	0.1	0	5	40
216-A-45	500	5,000	0.1	0.1	0	5	40

Note: The values presented in red represent parameters modified for each calibration run. To convert meters to feet, multiply by 3.281.

Table O–3. Calibration Test Matrix for Reduction-Oxidation (REDOX) Facility Sites

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (R1)	**100**	**1,000**	**0.1**	**0.01**	**0.001**	**1**	**40**
216-S-1 & -2	100	1,000	0.1	0.01	0.001	1	40
216-S-7	100	1,000	0.1	0.01	0.001	1	40
216-S-9	100	1,000	0.1	0.01	0.001	1	40
216-S-13	100	1,000	0.1	0.01	0.001	1	40
216-S-20	100	1,000	0.1	0.01	0.001	1	40
216-S-21	100	1,000	0.1	0.01	0.001	1	40
216-S-25	100	1,000	0.1	0.01	0.001	1	40
216-S-26	100	1,000	0.1	0.01	0.001	1	40
216-U-8	100	1,000	0.1	0.01	0.001	1	40
216-U-12	100	1,000	0.1	0.01	0.001	1	40
Run (R2)	**100**	**1,000**	**0.1**	**0.1**	**0.001**	**1**	**40**
216-S-1 & -2	100	1,000	0.1	0.1	0.001	1	40
216-S-7	100	1,000	0.1	0.1	0.001	1	40
216-S-9	100	1,000	0.1	0.1	0.001	1	40
216-S-13	100	1,000	0.1	0.1	0.001	1	40
216-S-20	100	1,000	0.1	0.1	0.001	1	40
216-S-21	100	1,000	0.1	0.1	0.001	1	40
216-S-25	100	1,000	0.1	0.1	0.001	1	40
216-S-26	100	1,000	0.1	0.1	0.001	1	40
216-U-8	100	1,000	0.1	0.1	0.001	1	40
216-U-12	100	1,000	0.1	0.1	0.001	1	40
Run (R3)	**100**	**1,000**	**0.1**	**0.1**	**0.1**	**1**	**40**
216-S-1 & -2	100	1,000	0.1	0.1	0.1	1	40
216-S-7	100	1,000	0.1	0.1	0.1	1	40
216-S-9	100	1,000	0.1	0.1	0.1	1	40
216-S-13	100	1,000	0.1	0.1	0.1	1	40
216-S-20	100	1,000	0.1	0.1	0.1	1	40
216-S-21	100	1,000	0.1	0.1	0.1	1	40
216-S-25	100	1,000	0.1	0.1	0.1	1	40

Table O–3. Calibration Test Matrix for Reduction-Oxidation (REDOX) Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
216-S-26	100	1,000	0.1	0.1	0.1	1	40
216-U-8	100	1,000	0.1	0.1	0.1	1	40
216-U-12	100	1,000	0.1	0.1	0.1	1	40
Run (R4)	**100**	**1,000**	**0.1**	**0.01**	**0.002**	**1**	**40**
216-S-1 & -2	100	1,000	0.1	0.01	0.002	1	40
216-S-7	100	1,000	0.1	0.01	0.002	1	40
216-S-9	100	1,000	0.1	0.01	0.002	1	40
216-S-13	100	1,000	0.1	0.01	0.002	1	40
216-S-20	100	1,000	0.1	0.01	0.002	1	40
216-S-21	100	1,000	0.1	0.01	0.002	1	40
216-S-25	100	1,000	0.1	0.01	0.002	1	40
216-S-26	100	1,000	0.1	0.01	0.002	1	40
216-U-8	100	1,000	0.1	0.01	0.002	1	40
216-U-12	100	1,000	0.1	0.01	0.002	1	40
Run (R5)	**100**	**1,000**	**0.1**	**0.01**	**0.005**	**1**	**40**
216-S-1 & -2	100	1,000	0.1	0.01	0.005	1	40
216-S-7	100	1,000	0.1	0.01	0.005	1	40
216-S-9	100	1,000	0.1	0.01	0.005	1	40
216-S-13	100	1,000	0.1	0.01	0.005	1	40
216-S-20	100	1,000	0.1	0.01	0.005	1	40
216-S-21	100	1,000	0.1	0.01	0.005	1	40
216-S-25	100	1,000	0.1	0.01	0.005	1	40
216-S-26	100	1,000	0.1	0.01	0.005	1	40
216-U-8	100	1,000	0.1	0.01	0.005	1	40
216-U-12	100	1,000	0.1	0.01	0.005	1	40
Run (R6)	**100**	**1,000**	**0.1**	**0.02**	**0.005**	**1**	**40**
216-S-1 & -2	100	1,000	0.1	0.02	0.005	1	40
216-S-7	100	1,000	0.1	0.02	0.005	1	40
216-S-9	100	1,000	0.1	0.02	0.005	1	40
216-S-13	100	1,000	0.1	0.02	0.005	1	40

Table O–3. Calibration Test Matrix for Reduction-Oxidation (REDOX) Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
216-S-20	100	1,000	0.1	0.02	0.005	1	40
216-S-21	100	1,000	0.1	0.02	0.005	1	40
216-S-25	100	1,000	0.1	0.02	0.005	1	40
216-S-26	100	1,000	0.1	0.02	0.005	1	40
216-U-8	100	1,000	0.1	0.02	0.005	1	40
216-U-12	100	1,000	0.1	0.02	0.005	1	40
Run (R7)	**100**	**1,000**	**0.1**	**0.05**	**0.005**	**1**	**40**
216-S-1 & -2	100	1,000	0.1	0.05	0.005	1	40
216-S-7	100	1,000	0.1	0.05	0.005	1	40
216-S-9	100	1,000	0.1	0.05	0.005	1	40
216-S-13	100	1,000	0.1	0.05	0.005	1	40
216-S-20	100	1,000	0.1	0.05	0.005	1	40
216-S-21	100	1,000	0.1	0.05	0.005	1	40
216-S-25	100	1,000	0.1	0.05	0.005	1	40
216-S-26	100	1,000	0.1	0.05	0.005	1	40
216-U-8	100	1,000	0.1	0.05	0.005	1	40
216-U-12	100	1,000	0.1	0.05	0.005	1	40
Run (R8) Runs 1-6							
R8 Run 1	**100**	**1,000**	**0.1**	**0.1**	**0.001**	**1**	**40**
216-S-20	100	1,000	0.1	0.1	0.001	1	40
R8 Run 2	**100**	**1,000**	**0.1**	**0.1**	**0.01**	**1**	**40**
216-S-20	100	1,000	0.1	0.1	0.01	1	40
R8 Run 3	**100**	**1,000**	**0.1**	**0.01**	**0.002**	**1**	**40**
216-S-20	100	1,000	0.1	0.01	0.002	1	40
R8 Run 4	**100**	**1,000**	**0.1**	**0.1**	**0.002**	**1**	**40**
216-S-20	100	1,000	0.1	0.1	0.002	1	40
R8 Run 5	**100**	**1,000**	**0.1**	**0.01**	**0.005**	**1**	**40**
216-S-20	100	1,000	0.1	0.01	0.005	1	40
R8 Run 6	**100**	**1,000**	**0.1**	**0.1**	**0.005**	**1**	**40**
216-S-20	100	1,000	0.1	0.1	0.005	1	40

Table O–3. Calibration Test Matrix for Reduction-Oxidation (REDOX) Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
Run (R9)	**500**	**5,000**	**0.1**	**0.1**	**0.005**	**1**	**40**
216-S-1 & -2	500	5,000	0.1	0.1	0.005	1	40
216-S-7	500	5,000	0.1	0.1	0.005	1	40
216-S-9	500	5,000	0.1	0.1	0.005	1	40
216-S-13	500	5,000	0.1	0.1	0.005	1	40
216-S-20	500	5,000	0.1	0.1	0.005	1	40
216-S-21	500	5,000	0.1	0.1	0.005	1	40
216-S-25	500	5,000	0.1	0.1	0.005	1	40
216-S-26	500	5,000	0.1	0.1	0.005	1	40
216-U-8	500	5,000	0.1	0.1	0.005	1	40
216-U-12	500	5,000	0.1	0.1	0.005	1	40
Run (R10)	**500**	**5,000**	**0.1**	**0.1**	**0**	**1**	**40**
216-S-1 & -2	500	5,000	0.1	0.1	0	1	40
216-S-7	500	5,000	0.1	0.1	0	1	40
216-S-9	500	5,000	0.1	0.1	0	1	40
216-S-13	500	5,000	0.1	0.1	0	1	40
216-S-20	500	5,000	0.1	0.1	0	1	40
216-S-21	500	5,000	0.1	0.1	0	1	40
216-S-25	500	5,000	0.1	0.1	0	1	40
216-S-26	500	5,000	0.1	0.1	0	1	40
216-U-8	500	5,000	0.1	0.1	0	1	40
216-U-12	500	5,000	0.1	0.1	0	1	40
Run (R11)	**500**	**5,000**	**0.1**	**0.1**	**0.001**	**1**	**40**
216-S-1 & -2	500	5,000	0.1	0.1	0.001	1	40
216-S-7	500	5,000	0.1	0.1	0.001	1	40
216-S-9	500	5,000	0.1	0.1	0.001	1	40
216-S-13	500	5,000	0.1	0.1	0.001	1	40
216-S-20	500	5,000	0.1	0.1	0.001	1	40
216-S-21	500	5,000	0.1	0.1	0.001	1	40
216-S-25	500	5,000	0.1	0.1	0.001	1	40

Table O–3. Calibration Test Matrix for Reduction-Oxidation (REDOX) Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
216-S-26	500	5,000	0.1	0.1	0.001	1	40
216-U-8	500	5,000	0.1	0.1	0.001	1	40
216-U-12	500	5,000	0.1	0.1	0.001	1	40
Run (R12)	**500**	**5,000**	**0.1**	**0.1**	**0**	**10**	**40**
216-S-1 & -2	500	5,000	0.1	0.1	0	10	40
216-S-7	500	5,000	0.1	0.1	0	10	40
216-S-9	500	5,000	0.1	0.1	0	10	40
216-S-13	500	5,000	0.1	0.1	0	10	40
216-S-20	500	5,000	0.1	0.1	0	10	40
216-S-21	500	5,000	0.1	0.1	0	10	40
216-S-25	500	5,000	0.1	0.1	0	10	40
216-S-26	500	5,000	0.1	0.1	0	10	40
216-U-8	500	5,000	0.1	0.1	0	10	40
216-U-12	500	5,000	0.1	0.1	0	10	40
Run (R13)	**500**	**5,000**	**0.1**	**0.1**	**0**	**15**	**40**
216-S-1 & -2	500	5,000	0.1	0.1	0	15	40
216-S-7	500	5,000	0.1	0.1	0	15	40
216-S-9	500	5,000	0.1	0.1	0	15	40
216-S-13	500	5,000	0.1	0.1	0	15	40
216-S-20	500	5,000	0.1	0.1	0	15	40
216-S-21	500	5,000	0.1	0.1	0	15	40
216-S-25	500	5,000	0.1	0.1	0	15	40
216-S-26	500	5,000	0.1	0.1	0	15	40
216-U-8	500	5,000	0.1	0.1	0	15	40
216-U-12	500	5,000	0.1	0.1	0	15	40
Run (R14)	**1,000**	**10,000**	**0.1**	**0.1**	**0**	**1**	**40**
216-S-1 & -2	1,000	10,000	0.1	0.1	0	1	40
216-S-7	1,000	10,000	0.1	0.1	0	1	40
216-S-9	1,000	10,000	0.1	0.1	0	1	40
216-S-13	1,000	10,000	0.1	0.1	0	1	40

Table O–3. Calibration Test Matrix for Reduction-Oxidation (REDOX) Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
216-S-20	1,000	10,000	0.1	0.1	0	1	40
216-S-21	1,000	10,000	0.1	0.1	0	1	40
216-S-25	1,000	10,000	0.1	0.1	0	1	40
216-S-26	1,000	10,000	0.1	0.1	0	1	40
216-U-8	1,000	10,000	0.1	0.1	0	1	40
216-U-12	1,000	10,000	0.1	0.1	0	1	40
Run (R15)	**100**	**1,000**	**0.1**	**0.1**	**0.01**	**1**	**40**
216-S-1 & -2	100	1,000	0.1	0.1	0.01	1	40
216-S-7	100	1,000	0.1	0.1	0.01	1	40
216-S-9	100	1,000	0.1	0.1	0.01	1	40
216-S-13	100	1,000	0.1	0.1	0.01	1	40
216-S-20	100	1,000	0.1	0.1	0.01	1	40
216-S-21	100	1,000	0.1	0.1	0.01	1	40
216-S-25	100	1,000	0.1	0.1	0.01	1	40
216-S-26	100	1,000	0.1	0.1	0.01	1	40
216-U-8	100	1,000	0.1	0.1	0.01	1	40
216-U-12	100	1,000	0.1	0.1	0.01	1	40
Run (R16)	**100**	**1,000**	**0.1**	**0.1**	**0.002**	**1**	**40**
216-S-1 & -2	100	1,000	0.1	0.1	0.002	1	40
216-S-7	100	1,000	0.1	0.1	0.002	1	40
216-S-9	100	1,000	0.1	0.1	0.002	1	40
216-S-13	100	1,000	0.1	0.1	0.002	1	40
216-S-20	100	1,000	0.1	0.1	0.002	1	40
216-S-21	100	1,000	0.1	0.1	0.002	1	40
216-S-25	100	1,000	0.1	0.1	0.002	1	40
216-S-26	100	1,000	0.1	0.1	0.002	1	40
216-U-8	100	1,000	0.1	0.1	0.002	1	40
216-U-12	100	1,000	0.1	0.1	0.002	1	40
Run (R17)	**100**	**1,000**	**0.1**	**0.1**	**0.005**	**1**	**40**
216-S-1 & -2	100	1,000	0.1	0.1	0.005	1	40

Table O–3. Calibration Test Matrix for Reduction-Oxidation (REDOX) Facility Sites *(continued)*

REDOX Facility Site Name	Maximum Longitudinal Dispersivity (meters)	Dispersivity Threshold (meters)	Longitudinal Dispersivity Scaling Factor (unitless)	Ratio of Transverse to Longitudinal Dispersivity (unitless)	Ratio of Vertical to Transverse Dispersivity (unitless)	Initial Injection Depth (meters)	Well Screen Depth for Calculating Concentration (meters)
216-S-7	100	1,000	0.1	0.1	0.005	1	40
216-S-9	100	1,000	0.1	0.1	0.005	1	40
216-S-13	100	1,000	0.1	0.1	0.005	1	40
216-S-20	100	1,000	0.1	0.1	0.005	1	40
216-S-21	100	1,000	0.1	0.1	0.005	1	40
216-S-25	100	1,000	0.1	0.1	0.005	1	40
216-S-26	100	1,000	0.1	0.1	0.005	1	40
216-U-8	100	1,000	0.1	0.1	0.005	1	40
216-U-12	100	1,000	0.1	0.1	0.005	1	40
Run (R18)	**500**	**5,000**	**0.1**	**0.1**	**0**	**5**	**40**
216-S-1 & -2	500	5,000	0.1	0.1	0	5	40
216-S-7	500	5,000	0.1	0.1	0	5	40
216-S-9	500	5,000	0.1	0.1	0	5	40
216-S-13	500	5,000	0.1	0.1	0	5	40
216-S-20	500	5,000	0.1	0.1	0	5	40
216-S-21	500	5,000	0.1	0.1	0	5	40
216-S-25	500	5,000	0.1	0.1	0	5	40
216-S-26	500	5,000	0.1	0.1	0	5	40
216-U-8	500	5,000	0.1	0.1	0	5	40
216-U-12	500	5,000	0.1	0.1	0	5	40

Note: The values presented in red represent parameters modified for each calibration run. To convert meters to feet, multiply by 3.281.

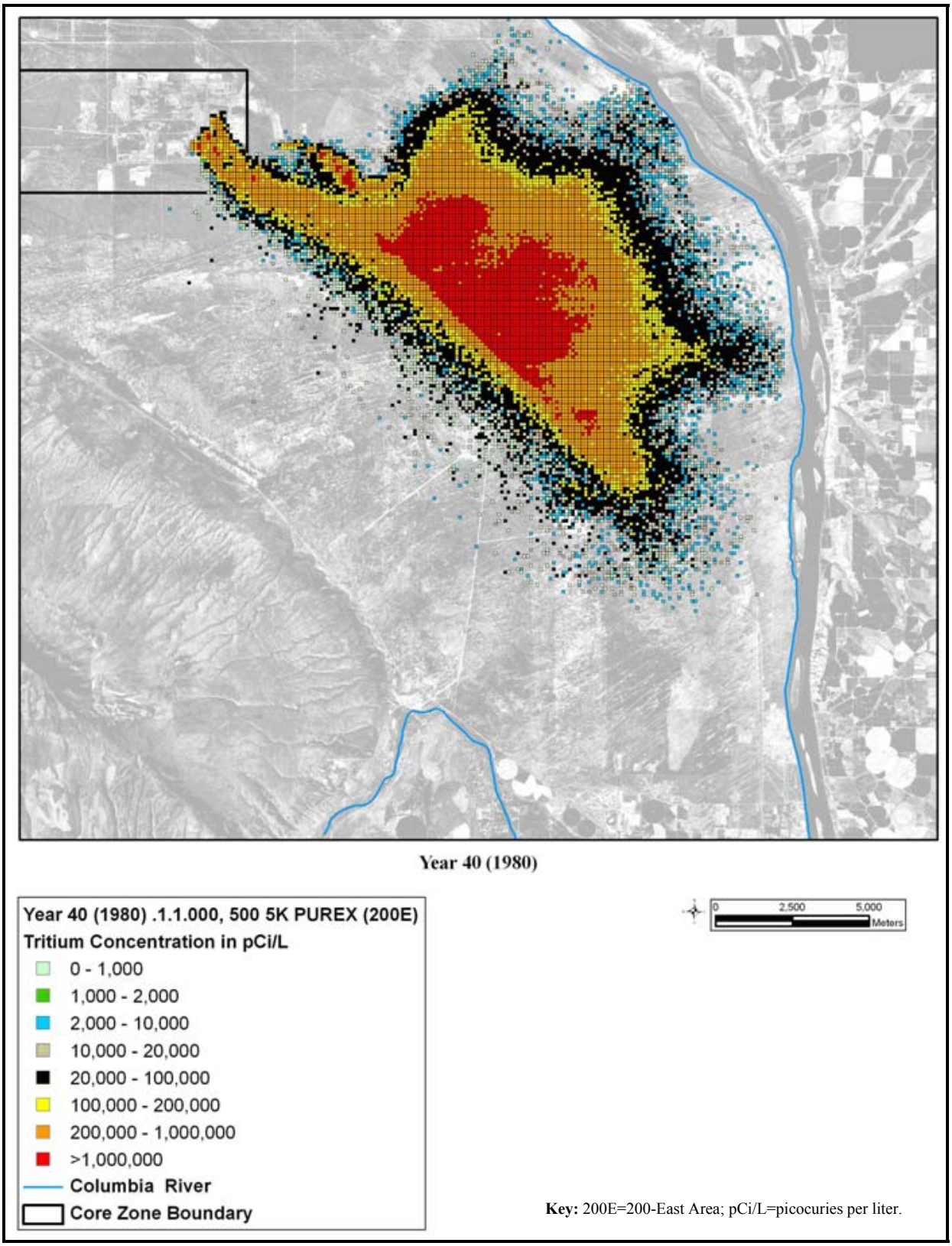


Figure O–5. Plutonium-Uranium Extraction (PUREX) Waste Site Hydrogen-3 (Tritium) Plume for Run P10, Calendar Year 1980

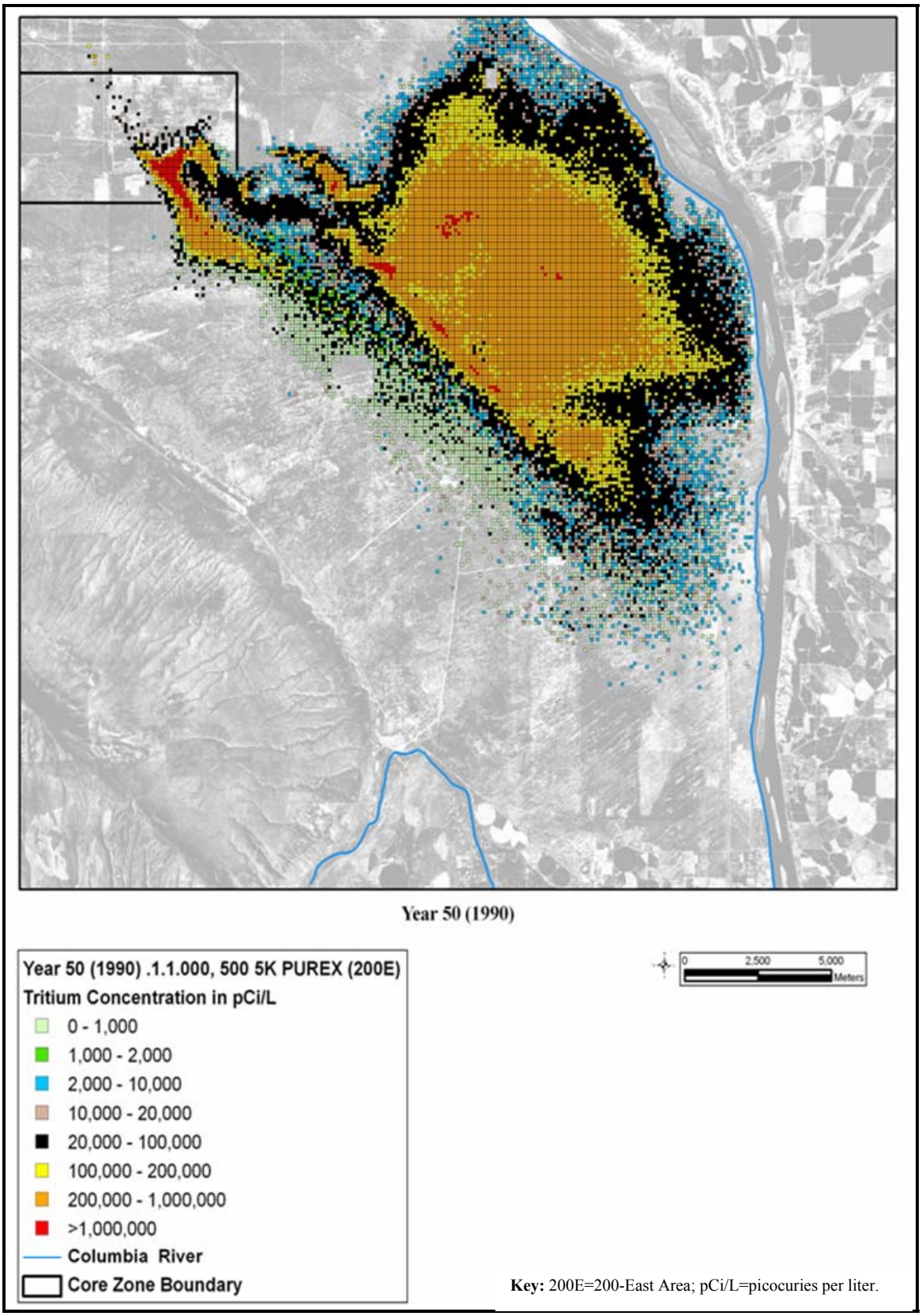


Figure O–6. Plutonium-Uranium Extraction (PUREX) Waste Site Hydrogen-3 (Tritium) Plume for Run P10, Calendar Year 1990

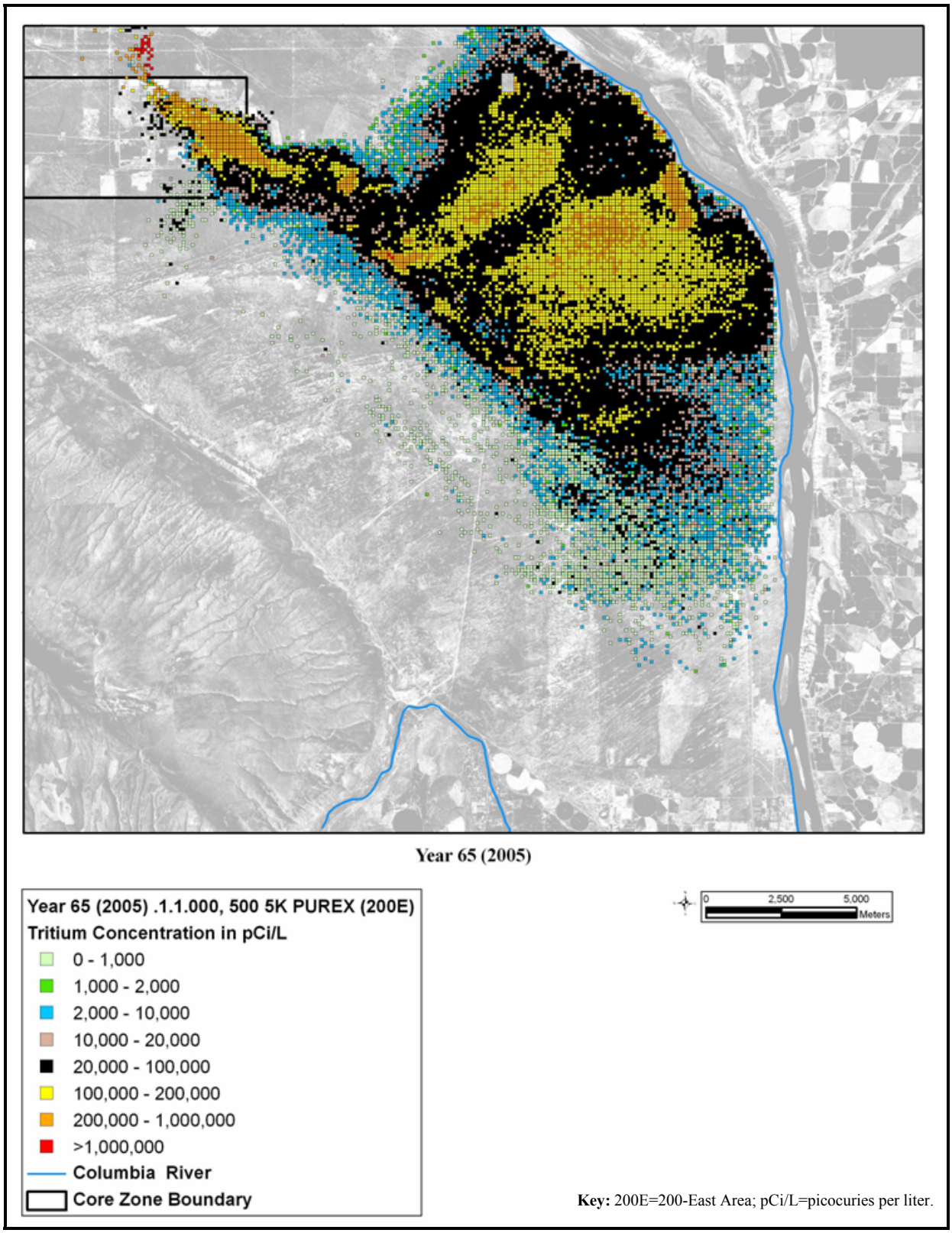
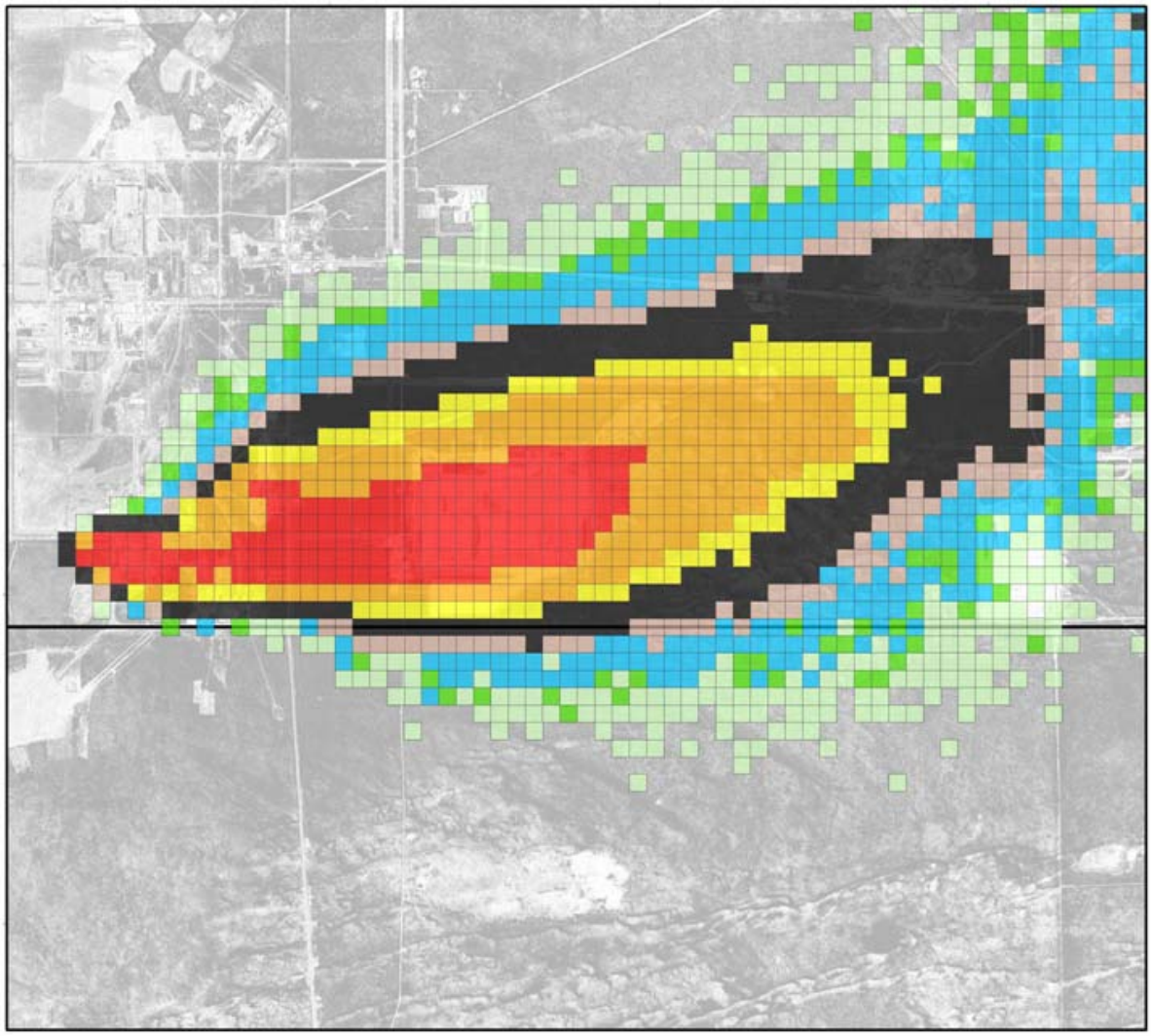
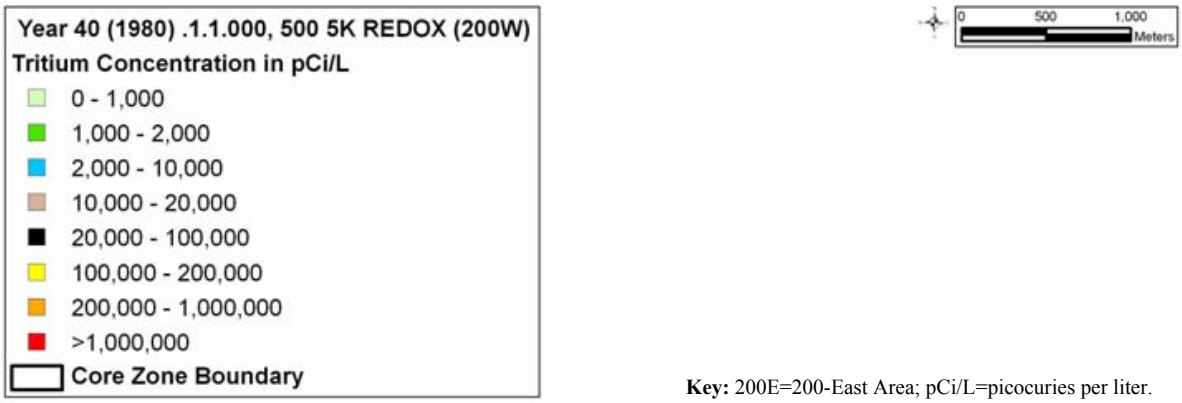


Figure O–7. Plutonium-Uranium Extraction (PUREX) Waste Site Hydrogen-3 (Tritium) Plume for Run P10, Calendar Year 2005

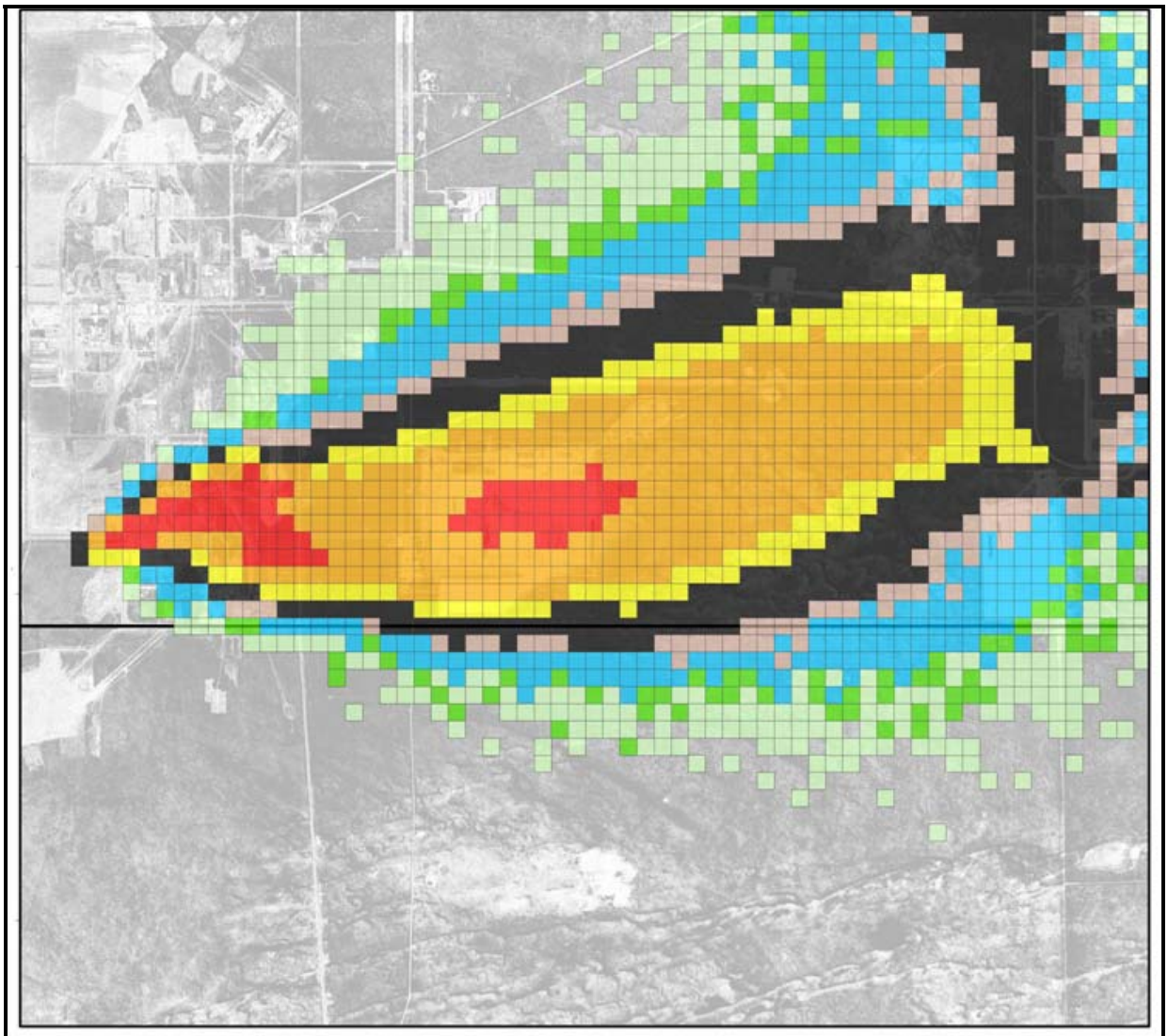


Year 40 (1980)

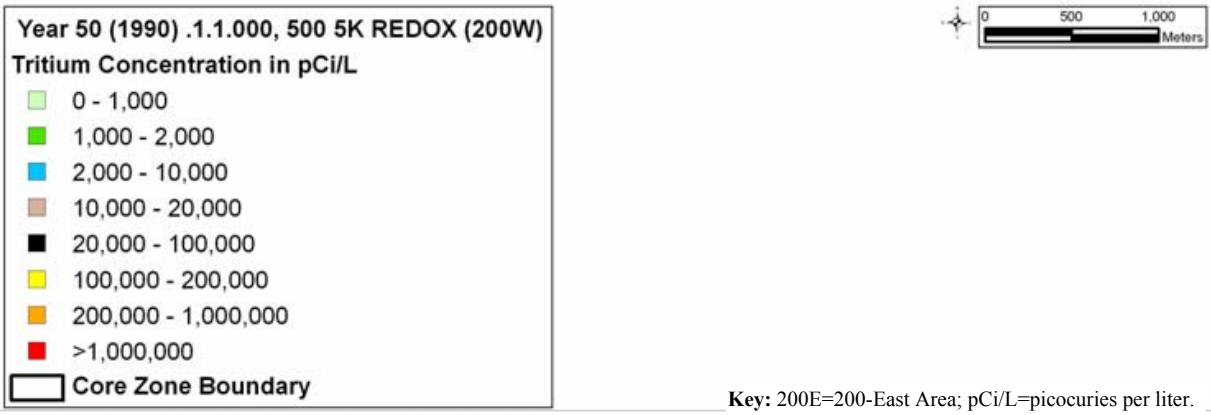


Key: 200E=200-East Area; pCi/L=picocuries per liter.

Figure O–8. Reduction-Oxidation (REDOX) Waste Site Hydrogen-3 (Tritium) Plume for Run R10, Calendar Year 1980



Year 50 (1990)



Key: 200E=200-East Area; pCi/L=picocuries per liter.

Figure O–9. Reduction-Oxidation (REDOX) Waste Site Hydrogen-3 (Tritium) Plume for Run R10, Calendar Year 1990

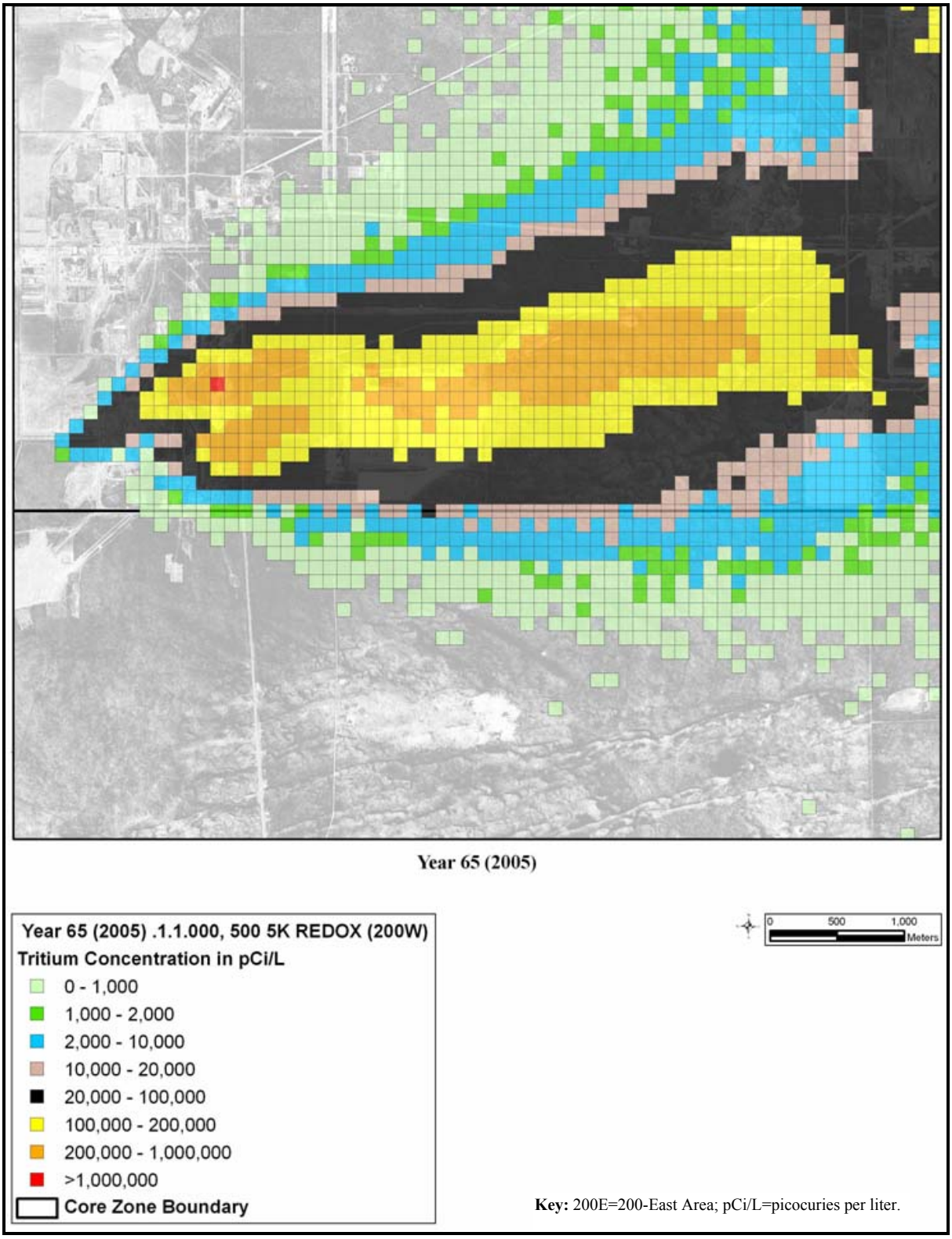


Figure O–10. Reduction-Oxidation (REDOX) Waste Site Hydrogen-3 (Tritium) Plume for Run R10, Calendar Year 2005

Comparison of the results from the selected parameter set against the observed contaminant distribution suggests the following:

- Modeled contaminant velocities from the 200-East Area are greater than from the 200-West Area, in agreement with the hydraulic conductivity distribution.

- The overall shape and area of the modeled plumes are similar to the observed field distribution, particularly for the PUREX waste site plume. The modeled REDOX waste site plume is larger and extends more northerly than the actual plume (note that the effects of the pump-and-treat remediation system installed in the 200-West Area are not reflected in the *TC & WM EIS* groundwater flow and transport calculations).

- Modeled peak concentration values are similar to field measurements in 1980 for the both the PUREX and REDOX waste site plumes. The modeled PUREX waste site plume attenuates slightly less than the field measurements indicate by 2003, while the REDOX waste site plume attenuates slightly more than the field measurements indicate.

These results suggest that the *TC & WM EIS* integrated inventory, release, vadose-zone, and groundwater models compare within a close order of magnitude with field observations for the two regional-scale contaminant plumes.

O.3 GROUNDWATER TRANSPORT RESULTS FOR THE TANK CLOSURE ALTERNATIVES

Groundwater transport results for the *TC & WM EIS* alternatives were reported in picocuries per liter for radionuclides and micrograms per liter for chemicals. To facilitate evaluation of these results, benchmark concentrations for the constituents of potential concern (COPCs) were developed based on regulatory standards and guidance. The health-based benchmark concentrations for radionuclides and chemical (inorganic and organic) constituents are presented in Tables O–4 and O–5, respectively. These benchmark concentrations apply to the Tank Closure alternatives analysis (this section), the FFTF Decommissioning alternatives analysis (see Section O.4), and the Waste Management alternatives analysis (see Section O.5).

Table O–4. Benchmark Concentrations for Radionuclides

Radionuclide	Benchmark Concentration (picocuries per liter)	Reference
Hydrogen-3 (tritium)	20,000	EPA 2002
Carbon-14	2,000	EPA 2002
Potassium-40	280	DOE Order 5400.5
Strontium-90	8	EPA 2002
Zirconium-93	2,000	EPA 2002
Technetium-99	900	EPA 2002
Iodine-129	1	EPA 2002
Cesium-137	200	EPA 2002
Gadolinium-152	15	EPA 2009a
Thorium-232	15	EPA 2009a
Uranium-238[a]	15	EPA 2009a
Neptunium-237	15	EPA 2009a
Plutonium-239[b]	15	EPA 2009a
Americium-241	15	EPA 2009a

[a] Includes uranium-233, -234, -235, and -238.
[b] Includes plutonium-239 and -240.

Table O–5. Benchmark Concentrations for Chemical Constituents

Constituent		Benchmark Concentration (micrograms per liter)	Reference
Arsenic	As	10	EPA 2009a
Boron and compounds	B	7,000	EPA 2006
Cadmium	Cd	5	EPA 2009a
Chromium	Cr	100	EPA 2009a
Fluoride	F	4,000	EPA 2009a
Lead	Pb	15	EPA 2009a
Manganese	Mn	1,600	EPA 2006
Mercury	Hg	2	EPA 2009a
Molybdenum	Mo	200	EPA 2006
Nickel (soluble salts)	Ni	700	EPA 2006
Nitrate[a]	NO_3	45,000	EPA 2009a
Silver	Ag	200	EPA 2006
Strontium (stable)	Sr	20,000	EPA 2006
Uranium (total)	Utot	30	EPA 2009a
Acetonitrile	CH_3CN	100	EPA 2009b
Benzene	C_6H_6	5	EPA 2009a
1-Butanol	C_4H_9OH	3,600	EPA 2009b
Carbon tetrachloride	CCl_4	5	EPA 2009a
1,2-Dichloroethane	1,2-DCA	5	EPA 2009a
Dichloromethane	CH_2C_{12}	5	EPA 2009a
1,4-Dioxane	1,4-Dioxane	6.1	EPA 2009b
Hydrazine	H_4N_2	0.022	EPA 2009b
Polychlorinated biphenyls	PCB	0.5	EPA 2009a
Trichloroethylene	TCE	5	EPA 2009a
2,4,6-Trichlorophenol	2,4,6-TCP	10	EPA 2006
Vinyl chloride	C_2H_3Cl	2	EPA 2009a

[a] The U.S. Environmental Protection Agency's published maximum contaminant level for nitrate is 10 milligrams per liter as nitrogen. The tabulated value includes conversion to compare as weight of nitrate.

Tables O–6 through O–32 summarize the maximum concentration and corresponding calendar year (shown in parentheses) of occurrence for each contaminant in the unconfined aquifer. These concentrations and times are reported at the Columbia River for each of the 13 Tank Closure alternatives (presented as 9 alternatives because Alternatives 2B, 3A, 3B, 3C, and 6C have been combined).

Tables O–6, O–9, O–12, O–15, O–18, O–21, O–24, O–27, and O–30 include the maximum concentrations and times as reported at the Core Zone Boundary, applicable barrier, and Columbia River related to cribs and trenches (ditches) after year 1940.

Tables O–7, O–10, O–13, O–16, O–19, O–22, O–25, O–28, and O–31 include the maximum concentrations and times as reported at the Core Zone Boundary, applicable barrier, and Columbia River for past leaks after year 1940.

Tables O–8, O–11, O–14, O–17, O–20, O–23, O–26, O–29, and O–32 include maximum concentrations and times as reported at the Core Zone Boundary, applicable barrier, and Columbia River for a combination of past leaks, cribs and trenches (ditches), and other tank farm sources after year 2050.

The benchmark concentration for each contaminant is provided in the right-hand column for comparison purposes.

The COPCs for the Tank Closure alternatives include tritium; carbon-14; strontium-90; technetium-99; iodine-129; cesium-137; uranium-238 (reported as uranium isotopes); neptunium-237; plutonium-239; 1-butanol; 2,4,6-trichlorophenol; acetonitrile; benzene; chromium; lead; mercury; nitrate; polychlorinated biphenyls (PCBs); and total uranium. Zero values were reported when COPC concentrations were below minimum thresholds based on a percentage of the benchmark concentration. If the concentration value for a COPC was zero at all lines of analysis, the COPC was not reported for brevity.

O.3.1 Tank Closure Alternative 1

Under Tank Closure Alternative 1, the tank farms would be maintained in the current condition indefinitely; however, for analysis purposes, the tank farms were assumed to fail after an institutional control period of 100 years. At this time, the salt cake in the single-shell tanks was assumed to be available for leaching into the vadose zone, and the liquid contents of the double-shell tanks were assumed to be discharged directly to the vadose zone.

Groundwater transport results (anticipated maximum contaminant concentrations) for this alternative related to cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment) are summarized in Tables O–6 through O–8.

Table O–6. Tank Closure Alternative 1 Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Hydrogen-3 (tritium)	2,855,631	12,350,337	2,855,631	1,723	20,000
	(1956)	(1975)	(1956)	(1998)	
Technetium-99	143,880	435	143,880	79	900
	(1956)	(1966)	(1956)	(2457)	
Iodine-129	187.8	3.5	187.8	0.1	1
	(1956)	(1966)	(1956)	(2768)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	34	14	10	0	15
	(11,757)	(11,707)	(11,714)	(11,370)	
Chemicals in micrograms per liter					
Chromium	50,531	9,007	28,686	33	100
	(1955)	(1961)	(1956)	(2408)	
Nitrate	17,182,820	2,099,621	13,364,821	9,999	45,000
	(1955)	(1961)	(1956)	(2417)	
Total uranium	11	4	8	0	30
	(11,790)	(11,755)	(10,719)	(10,356)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–7. Tank Closure Alternative 1 Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	3,653	198	463	5,628	61	511	1	20,000
	(1999)	(2018)	(2013)	(2005)	(2011)	(2008)	(2050)	
Technetium-99	12,347	9,107	3,984	23,125	153	5,471	146	900
	(1999)	(2052)	(2022)	(2029)	(2065)	(2310)	(2211)	
Iodine-129	23.3	16.5	7.7	45.1	0.3	9.9	0.3	1
	(1999)	(2045)	(2030)	(2027)	(2048)	(2327)	(2252)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	0	45	3	22	8	74	1	15
	(11,774)	(11,793)	(10,108)	(11,726)	(11,759)	(11,837)	(11,573)	
Chemicals in micrograms per liter								
Chromium	59	103	419	539	13	449	4	100
	(1999)	(2051)	(2030)	(2025)	(2020)	(2271)	(2137)	
Nitrate	4,272	18,235	11,747	40,118	689	14,997	259	45,000
	(1999)	(2040)	(2024)	(2021)	(2048)	(2271)	(2708)	
Total uranium	0	67	4	10	11	92	1	30
	(11,828)	(11,772)	(9820)	(11,799)	(11,573)	(11,570)	(11,382)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–8. Tank Closure Alternative 1 Maximum COPC Concentrations Related to Past Leaks, Cribs and Trenches (Ditches), and Other Sources After Calendar Year 2050

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	4,186	2,686	2,458	5,570	12	3,793	180	20,000
	(2112)	(2052)	(2117)	(2052)	(2051)	(2102)	(2054)	
Technetium-99	70,050	175,426	38,734	14,980	14,824	349,996	5,231	900
	(2114)	(3837)	(3238)	(2051)	(3536)	(3837)	(4032)	
Iodine-129	71.2	397.6	67.0	71.1	29.2	682.2	13.0	1
	(2114)	(3801)	(3312)	(3756)	(3536)	(3801)	(4411)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	23	490	259	102	40	1,066	6	15
	(11,789)	(11,749)	(11,730)	(11,820)	(11,758)	(11,683)	(11,918)	
Chemicals in micrograms per liter								
Chromium	284	5,053	1,651	911	308	12,190	165	100
	(2114)	(3628)	(3172)	(2050)	(3587)	(3524)	(4019)	
Nitrate	69,566	1,743,875	107,499	200,810	34,949	1,126,141	23,484	45,000
	(2119)	(2087)	(3138)	(2088)	(3654)	(2059)	(3911)	
Total uranium	5	695	281	96	51	1,220	8	30
	(11,769)	(11,762)	(11,762)	(11,836)	(11,739)	(11,648)	(11,591)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.2 Tank Closure Alternative 2A

Under Tank Closure Alternative 2A, tank waste would be retrieved to a volume corresponding to 99 percent retrieval, but the residual material in tanks would not be stabilized. After an institutional control period of 100 years, salt cake in the tanks was assumed to be available for dissolution in infiltrating water.

Groundwater transport results for this alternative as related to cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment) are summarized in Tables O–9 through O–11.

Table O–9. Tank Closure Alternative 2A Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Hydrogen-3 (tritium)	2,955,633	12,264,698	2,955,633	1,383	20,000
	(1956)	(1975)	(1956)	(1998)	
Technetium-99	148,565	437	148,565	67	900
	(1956)	(1966)	(1956)	(2645)	
Iodine-129	194.6	3.5	194.6	0.1	1
	(1956)	(1966)	(1956)	(2536)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	38	15	12	0	15
	(11,754)	(11,776)	(11,809)	(113,02)	
Chemicals in micrograms per liter					
Chromium	45,892	9,116	27,172	29	100
	(1955)	(1961)	(1956)	(2603)	
Nitrate	18,103,786	2,115,355	13,492,655	8,743	45,000
	(1955)	(1961)	(1956)	(2400)	
Total uranium	12	5	8	0	30
	(11,608)	(11,782)	(11,752)	(11,663)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–10. Tank Closure Alternative 2A Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	3,531	198	479	5,564	60	449	1	20,000
	(1999)	(2019)	(2011)	(2009)	(2009)	(2009)	(2023)	
Technetium-99	11,891	9,473	3,942	22,779	153	5,031	143	900
	(1999)	(2052)	(2028)	(2026)	(2064)	(2275)	(2406)	
Iodine-129	23.2	16.8	7.6	44.7	0.3	9.1	0.2	1
	(1999)	(2058)	(2029)	(2026)	(2036)	(2269)	(2227)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	0	95	3	26	10	110	1	15
	(11,770)	(11,814)	(8018)	(11,365)	(11,763)	(11,837)	(11,336)	

Table O–10. Tank Closure Alternative 2A Maximum COPC Concentrations Related to Past Leaks *(continued)*

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Chemicals in micrograms per liter								
Chromium	59	96	407	529	14	497	4	100
	(1999)	(2052)	(2026)	(2026)	(2028)	(2277)	(2500)	
Nitrate	4,127	18,874	11,889	39,689	689	14,373	276	45,000
	(1999)	(2039)	(2023)	(2027)	(2029)	(2249)	(2338)	
Total uranium	0	163	4	12	14	164	1	30
	(11,819)	(11,836)	(8011)	(11,709)	(11,082)	(11,624)	(11,809)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–11. Tank Closure Alternative 2A Maximum COPC Concentrations Related to Past Leaks, Cribs and Trenches (Ditches), and Other Sources After Calendar Year 2050

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	35	5,034	51	5,215	13	5,633	135	20,000
	(2052)	(2051)	(2050)	(2061)	(2050)	(2051)	(2050)	
Technetium-99	1,586	31,656	2,821	15,036	546	27,833	204	900
	(2055)	(2076)	(2050)	(2051)	(2096)	(2076)	(3464)	
Iodine-129	3.2	50.0	4.8	30.3	1.1	43.0	0.4	1
	(2057)	(2072)	(2050)	(2051)	(2089)	(2072)	(3355)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	3	142	7	42	11	148	1	15
	(11,707)	(11,814)	(11,714)	(11,799)	(11,763)	(11,828)	(11,783)	
Chemicals in micrograms per liter								
Acetonitrile	1	0	0	0	0	1	0	100
	(3341)	(1940)	(3417)	(1940)	(1940)	(3551)	(3617)	
Chromium	12	4,264	290	800	17	1,958	32	100
	(2070)	(2085)	(2050)	(2050)	(2086)	(2066)	(2603)	
Nitrate	11,617	1,639,900	9,956	167,605	5,796	1,099,667	9,102	45,000
	(2068)	(2081)	(2073)	(2086)	(2083)	(2059)	(2400)	
Total uranium	1	190	8	20	15	196	1	30
	(11,805)	(11,836)	(9863)	(11,709)	(10,978)	(11,624)	(11,809)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.3 Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C

Activities under Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C would be similar to those under Tank Closure Alternative 2A, except that residual material in tanks would be stabilized in place. Soil would be removed down to 4.6 meters (15 feet) at the BX and SX tank farms and replaced with clean soils from onsite sources. The tank farms and six sets of adjacent cribs and trenches (ditches) would be covered with an engineered modified Resource Conservation and Recovery Act (RCRA) Subtitle C barrier.

Groundwater transport results for these alternatives as related to cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment) are summarized in Tables O–12 through O–14.

Table O–12. Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, and 6C ─ Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Hydrogen-3 (tritium)	2,823,299	12,499,824	2,823,299	1,279	20,000
	(1956)	(1974)	(1956)	(1994)	
Technetium-99	144,196	441	144,196	89	900
	(1956)	(1966)	(1956)	(2025)	
Iodine-129	187.0	3.6	187.0	0.1	1
	(1956)	(1966)	(1956)	(2579)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	34	13	10	0	15
	(11,742)	(11,780)	(11,758)	(11,844)	
Chemicals in micrograms per liter					
Chromium	50,842	9,325	28,041	31	100
	(1955)	(1961)	(1956)	(2695)	
Nitrate	17,418,627	2,112,423	12,890,767	8,272	45,000
	(1955)	(1961)	(1956)	(2450)	
Total uranium	10	4	7	0	30
	(11,678)	(11,755)	(11,678)	(11,508)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–13. Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, and 6C – Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	3,634	198	466	5,516	62	542	1	20,000
	(1999)	(2018)	(2013)	(2004)	(2011)	(2008)	(2048)	
Technetium-99	11,600	8,416	4,096	22,631	144	4,859	140	900
	(1999)	(2050)	(2026)	(2029)	(2050)	(2034)	(2480)	
Iodine-129	23.6	16.8	7.7	45.1	0.3	9.1	0.3	1
	(1999)	(2052)	(2026)	(2028)	(2052)	(2040)	(2184)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	0	20	3	14	8	54	1	15
	(11,766)	(11,823)	(9474)	(11,792)	(11,441)	(11,527)	(11,147)	
Chemicals in micrograms per liter								
Chromium	61	96	413	528	14	403	4	100
	(1999)	(2047)	(2030)	(2027)	(2028)	(2258)	(2190)	
Nitrate	4,173	17,926	12,098	41,069	709	12,917	258	45,000
	(1999)	(2048)	(2030)	(2028)	(2030)	(2215)	(2789)	
Total uranium	0	29	4	6	12	81	1	30
	(11,806)	(11,792)	(10,052)	(11,800)	(11,599)	(11,689)	(11,146)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–14. Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, and 6C ─ Maximum COPC Concentrations Related to Past Leaks, Cribs and Trenches (Ditches), and Other Sources After Calendar Year 2050

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	28	5,078	52	7,272	13	6,079	178	20,000
	(2051)	(2054)	(2050)	(2055)	(2050)	(2054)	(2050)	
Technetium-99	1,449	29,966	2,661	15,221	284	25,890	205	900
	(2058)	(2050)	(2050)	(2050)	(3499)	(2050)	(2480)	
Iodine-129	2.6	39.9	5.0	29.6	0.4	33.6	0.4	1
	(2053)	(2057)	(2050)	(2050)	(3708)	(2057)	(2876)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	1	55	6	27	8	73	1	15
	(11,755)	(11,739)	(11,765)	(11,780)	(11,441)	(11,691)	(11,871)	
Chemicals in micrograms per liter								
Acetonitrile	1	0	0	0	0	1	0	100
	(3701)	(1940)	(3566)	(1940)	(1940)	(3829)	(4021)	
Chromium	9	3,229	271	768	10	1,667	34	100
	(2057)	(2055)	(2050)	(2050)	(2050)	(2050)	(2695)	
Nitrate	5,650	1,542,362	8,954	132,754	1,379	1,010,240	8,576	45,000
	(2057)	(2050)	(2050)	(2054)	(2068)	(2050)	(2450)	
Total uranium	0	46	8	11	12	103	1	30
	(11,795)	(11,792)	(11,602)	(11,840)	(11,599)	(11,683)	(11,146)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.4 Tank Closure Alternative 4

Under Tank Closure Alternative 4, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval. Except for the BX and SX tank farms, residual material in tanks would be stabilized in place and the tank farms and adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier. The BX and SX tank farms would undergo clean closure by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column.

Groundwater transport results for this alternative as related to cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment) are summarized in Tables O–15 through O–17.

Table O–15. Tank Closure Alternative 4 Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Hydrogen-3 (tritium)	2,823,299	12,499,824	2,823,299	1,279	20,000
	(1956)	(1974)	(1956)	(1994)	
Technetium-99	144,196	441	144,196	89	900
	(1956)	(1966)	(1956)	(2025)	
Iodine-129	187.0	3.6	187.0	0.1	1
	(1956)	(1966)	(1956)	(2579)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	34	13	10	0	15
	(11,742)	(11,780)	(11,758)	(11,844)	
Chemicals in micrograms per liter					
Chromium	50,842	9,325	28,041	31	100
	(1955)	(1961)	(1956)	(2695)	
Nitrate	17,418,627	2,112,423	12,890,767	8,272	45,000
	(1955)	(1961)	(1956)	(2450)	
Total uranium	10	4	7	0	30
	(11,678)	(11,755)	(11,678)	(11,508)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–16. Tank Closure Alternative 4 Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	3,634	196	469	5,516	62	535	1	20,000
	(1999)	(2018)	(2008)	(2004)	(2011)	(2008)	(2048)	
Technetium-99	11,600	7,657	3,837	22,631	144	4,951	133	900
	(1999)	(2044)	(2022)	(2029)	(2050)	(2034)	(2480)	
Iodine-129	23.6	15.3	7.7	45.1	0.3	9.1	0.3	1
	(1999)	(2041)	(2026)	(2028)	(2052)	(2024)	(2184)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	0	2	0	14	8	38	1	15
	(11,766)	(11,760)	(11,785)	(11,792)	(11,441)	(10,975)	(11,147)	
Chemicals in micrograms per liter								
Chromium	61	6	397	528	14	255	3	100
	(1999)	(2043)	(2030)	(2027)	(2028)	(2197)	(2382)	
Nitrate	4,173	17,479	11,964	41,069	709	10,858	257	45,000
	(1999)	(2038)	(2030)	(2028)	(2030)	(2028)	(2789)	
Total uranium	0	3	0	6	12	56	1	30
	(11,806)	(11,814)	(11,758)	(11,800)	(11,599)	(11,690)	(11,577)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–17. Tank Closure Alternative 4 Maximum COPC Concentrations Related to Past Leaks, Cribs and Trenches (Ditches), and Other Sources After Calendar Year 2050

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	28	5,063	4	7,272	13	6,062	178	20,000
	(2051)	(2054)	(2062)	(2055)	(2050)	(2054)	(2050)	
Technetium-99	1,457	28,163	214	15,249	180	24,055	191	900
	(2058)	(2050)	(2060)	(2050)	(2060)	(2050)	(2480)	
Iodine-129	2.7	37.6	0.4	29.6	0.3	31.2	0.3	1
	(2053)	(2057)	(2052)	(2050)	(2052)	(2057)	(2181)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	0	36	1	26	8	48	1	15
	(11,814)	(11,742)	(11,795)	(11,780)	(11,441)	(11,529)	(11,891)	
Chemicals in micrograms per liter								
Chromium	9	3,217	36	768	10	1,647	34	100
	(2057)	(2055)	(2057)	(2050)	(2050)	(2050)	(2695)	
Nitrate	5,531	1,537,421	1,403	132,582	1,233	1,005,408	8,490	45,000
	(2056)	(2050)	(2059)	(2054)	(2067)	(2050)	(2450)	
Total uranium	0	14	1	11	12	63	1	30
	(11,819)	(11,678)	(11,828)	(11,840)	(11,599)	(11,690)	(11,577)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.5 Tank Closure Alternative 5

Under Tank Closure Alternative 5, tank waste would be retrieved to a volume corresponding to 90 percent retrieval. Residual material in tanks would be stabilized in place, and the tank farms and adjacent cribs and trenches (ditches) would be covered with a Hanford barrier.

Groundwater transport results for this alternative as related to cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment) are summarized in Tables O–18 through O–20.

Table O–18. Tank Closure Alternative 5 Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Hydrogen-3 (tritium)	2,823,299	12,499,824	2,823,299	1,279	20,000
	(1956)	(1974)	(1956)	(1994)	
Technetium-99	144,196	441	144,196	89	900
	(1956)	(1966)	(1956)	(2025)	
Iodine-129	187.0	3.6	187.0	0.1	1
	(1956)	(1966)	(1956)	(2579)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	34	13	10	0	15
	(11,742)	(11,780)	(11,758)	(11,844)	
Chemicals in micrograms per liter					
Chromium	50,842	9,325	28,041	31	100
	(1955)	(1961)	(1956)	(2695)	
Nitrate	17,418,627	2,112,423	12,890,767	8,272	45,000
	(1955)	(1961)	(1956)	(2450)	
Total uranium	10	4	7	0	30
	(11,678)	(11,755)	(11,678)	(11,508)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–19. Tank Closure Alternative 5 Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	3,634	198	466	5,516	62	542	1	20,000
	(1999)	(2018)	(2013)	(2004)	(2011)	(2008)	(2048)	
Technetium-99	12,353	2,128	4,053	23,597	146	5,071	121	900
	(1999)	(2027)	(2030)	(2027)	(2048)	(2247)	(2153)	
Iodine-129	23.2	16.4	7.6	22.7	0.3	9.3	0.3	1
	(1999)	(2047)	(2030)	(2041)	(2041)	(2032)	(2132)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	0	15	3	12	8	57	1	15
	(11,825)	(11,799)	(10,284)	(11,854)	(11,750)	(11,704)	(11,594)	
Chemicals in micrograms per liter								
Chromium	62	97	421	527	14	452	5	100
	(1999)	(2051)	(2026)	(2026)	(2025)	(2244)	(2503)	
Nitrate	4,171	19,053	11,682	40,309	690	12,798	283	45,000
	(1999)	(2050)	(2022)	(2026)	(2033)	(2281)	(2474)	
Total uranium	0	22	4	5	12	77	1	30
	(11,813)	(11,807)	(9966)	(11,854)	(11,051)	(11,835)	(11,936)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–20. Tank Closure Alternative 5 Maximum COPC Concentrations Related to Past Leaks, Cribs and Trenches (Ditches), and Other Sources After Calendar Year 2050

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	28	5,072	52	7,272	13	6,072	178	20,000
	(2051)	(2054)	(2050)	(2055)	(2050)	(2054)	(2050)	
Technetium-99	3,037	22,529	3,336	15,319	1,776	35,748	724	900
	(4338)	(2050)	(3931)	(2050)	(4022)	(4326)	(5017)	
Iodine-129	2.8	41.6	4.9	18.9	0.8	33.7	0.5	1
	(2059)	(2057)	(2050)	(2051)	(4694)	(2057)	(7030)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	1	67	15	25	9	102	1	15
	(11,845)	(11,739)	(11,727)	(11,780)	(11,750)	(11,735)	(11,594)	
Chemicals in micrograms per liter								
Acetonitrile	8	0	2	0	0	12	1	100
	(4221)	(1940)	(4208)	(1940)	(1940)	(4510)	(4297)	
Chromium	29	3,205	289	782	36	1,728	35	100
	(4094)	(2055)	(2050)	(2050)	(3847)	(3891)	(2695)	
Nitrate	6,509	1,543,074	13,211	132,603	4,507	1,010,081	8,748	45,000
	(4099)	(2050)	(3586)	(2054)	(3794)	(2050)	(2450)	
Total uranium	0	83	33	15	15	204	1	30
	(11,795)	(11,798)	(11,473)	(11,815)	(11,821)	(11,805)	(11,935)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.6 Tank Closure Alternative 6A, Base Case

Under Tank Closure Alternative 6A, Base Case, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval. All tanks farms would be clean-closed by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. The adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier.

Groundwater transport results for this alternative as related to cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment) are summarized in Tables O–21 through O–23.

Table O–21. Tank Closure Alternative 6A, Base Case, Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Hydrogen-3 (tritium)	2,823,299	12,499,824	2,823,299	1,279	20,000
	(1956)	(1974)	(1956)	(1994)	
Technetium-99	144,196	441	144,196	89	900
	(1956)	(1966)	(1956)	(2025)	
Iodine-129	187.0	3.6	187.0	0.1	1
	(1956)	(1966)	(1956)	(2579)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	34	13	10	0	15
	(11,742)	(11,780)	(11,758)	(11,844)	
Chemicals in micrograms per liter					
Chromium	50,842	9,325	28,041	31	100
	(1955)	(1961)	(1956)	(2695)	
Nitrate	17,418,627	2,112,423	12,890,767	8,272	45,000
	(1955)	(1961)	(1956)	(2450)	
Total uranium	10	4	7	0	30
	(11,678)	(11,755)	(11,678)	(11,508)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–22. Tank Closure Alternative 6A, Base Case, Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	3,577	194	467	5,570	61	451	1	20,000
	(1999)	(2018)	(2011)	(2004)	(2011)	(2007)	(2044)	
Technetium-99	11,954	8,332	3,963	22,765	150	4,916	147	900
	(1999)	(2049)	(2027)	(2026)	(2064)	(2292)	(2502)	
Iodine-129	23.3	16.9	8.0	43.7	0.3	10.1	0.3	1
	(1999)	(2050)	(2027)	(2028)	(2040)	(2252)	(2308)	
Chemicals in micrograms per liter								
Chromium	61	93	397	533	13	401	4	100
	(1999)	(2048)	(2026)	(2026)	(2024)	(2251)	(2413)	
Nitrate	4,335	18,149	11,732	40,194	684	14,256	291	45,000
	(1999)	(2046)	(2030)	(2023)	(2026)	(2234)	(2669)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–23. Tank Closure Alternative 6A, Base Case, Maximum COPC Concentrations Related to Past Leaks, Cribs and Trenches (Ditches), and Other Sources After Calendar Year 2050

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	26	4,995	51	7,311	13	5,996	178	20,000
	(2052)	(2054)	(2050)	(2055)	(2052)	(2054)	(2050)	
Technetium-99	1,352	29,050	2,679	15,197	150	24,661	169	900
	(2056)	(2050)	(2050)	(2051)	(2064)	(2050)	(2515)	
Iodine-129	2.7	40.9	5.1	30.9	0.3	31.3	0.3	1
	(2053)	(2057)	(2050)	(2050)	(2070)	(2057)	(2579)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	0	34	0	13	0	10	0	15
	(1940)	(11,742)	(2166)	(11,780)	(1940)	(11,758)	(11,844)	
Chemicals in micrograms per liter								
Chromium	8	3,175	289	761	10	1,660	33	100
	(2050)	(2050)	(2050)	(2050)	(2050)	(2050)	(2695)	
Nitrate	475	1,540,345	8,547	132,510	667	1,008,775	8,409	45,000
	(2051)	(2050)	(2050)	(2054)	(2054)	(2050)	(2450)	
Total uranium	0	10	0	4	0	7	0	30
	(2160)	(11,678)	(2166)	(11,755)	(2167)	(11,678)	(11,508)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.7 Tank Closure Alternative 6A, Option Case

Under Tank Closure Alternative 6A, Option Case, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval. All tanks farms would be clean-closed by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. In addition, the adjacent cribs and trenches (ditches) would be clean-closed.

Groundwater transport results for this alternative related to cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment) are summarized in Tables O–24 through O–26.

Table O–24. Tank Closure Alternative 6A, Option Case, Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Hydrogen-3 (tritium)	2,835,466	12,350,299	2,835,466	1,267	20,000
	(1956)	(1975)	(1956)	(2016)	
Technetium-99	144,526	423	144,526	67	900
	(1956)	(1966)	(1956)	(2477)	
Iodine-129	188.4	3.5	188.4	0.1	1
	(1956)	(1966)	(1956)	(1967)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	1	2	1	0	15
	(1981)	(1980)	(1981)	(4077)	
Chemicals in micrograms per liter					
Chromium	50,965	8,860	28,382	26	100
	(1955)	(1961)	(1956)	(2256)	
Nitrate	17,327,249	2,097,467	13,367,907	7,772	45,000
	(1955)	(1961)	(1956)	(2460)	
Total uranium	1	3	1	0	30
	(1981)	(1980)	(1981)	(4581)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–25. Tank Closure Alternative 6A, Option Case, Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	3,577	194	467	5,570	61	451	1	20,000
	(1999)	(2018)	(2011)	(2004)	(2011)	(2007)	(2044)	
Technetium-99	11,954	8,332	3,963	22,765	150	4,916	147	900
	(1999)	(2049)	(2027)	(2026)	(2064)	(2292)	(2502)	
Iodine-129	23.3	16.9	8.0	43.7	0.3	10.1	0.3	1
	(1999)	(2050)	(2027)	(2028)	(2040)	(2252)	(2308)	
Chemicals in micrograms per liter								
Chromium	61	93	397	533	13	401	4	100
	(1999)	(2048)	(2026)	(2026)	(2024)	(2251)	(2413)	
Nitrate	4,335	18,149	11,732	40,194	684	14,256	291	45,000
	(1999)	(2046)	(2030)	(2023)	(2026)	(2234)	(2669)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–26. Tank Closure Alternative 6A, Option Case, Maximum COPC Concentrations Related to Past Leaks, Cribs and Trenches (Ditches), and Other Sources After Calendar Year 2050

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	26	5,135	51	5,191	13	6,991	170	20,000
	(2052)	(2050)	(2050)	(2050)	(2052)	(2050)	(2057)	
Technetium-99	1,352	25,018	2,679	15,197	150	20,975	181	900
	(2056)	(2055)	(2050)	(2051)	(2064)	(2056)	(2502)	
Iodine-129	2.7	44.7	5.1	30.9	0.3	35.2	0.3	1
	(2053)	(2057)	(2050)	(2050)	(2070)	(2057)	(2308)	
Chemicals in micrograms per liter								
Chromium	8	3,787	289	772	10	1,663	29	100
	(2050)	(2088)	(2050)	(2051)	(2050)	(2051)	(2256)	
Nitrate	475	1,665,075	8,547	153,923	667	1,184,388	7,933	45,000
	(2051)	(2056)	(2050)	(2102)	(2054)	(2056)	(2460)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.3.8 Tank Closure Alternative 6B, Base and Option Cases

The Tank Closure Alternative 6B, Base and Option Cases, resemble the Tank Closure Alternative 6A, Base and Option Cases, except that waste retrieval and processing would proceed at a faster rate and closure would occur at an earlier date. All tank farms would be clean-closed. Under the Base Case, the adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier. Under the Option Case, the adjacent cribs and trenches (ditches) would be clean-closed.

Groundwater transport results for the Tank Closure Alternative 6B, Base and Option Cases, related to cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment) are summarized in Tables O–27 through O–32.

Table O–27. Tank Closure Alternative 6B, Base Case, Maximum COPC Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Hydrogen-3 (tritium)	2,823,299	12,499,824	2,823,299	1,279	20,000
	(1956)	(1974)	(1956)	(1994)	
Technetium-99	144,196	441	144,196	89	900
	(1956)	(1966)	(1956)	(2025)	
Iodine-129	187.0	3.6	187.0	0.1	1
	(1956)	(1966)	(1956)	(2579)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	34	13	10	0	15
	(11,742)	(11,780)	(11,758)	(11,844)	

Table O–27. Tank Closure Alternative 6B, Base Case, Maximum COPC Concentrations Related to Cribs and Trenches (Ditches) *(continued)*

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Chemicals in micrograms per liter					
Chromium	50,842	9,325	28,041	31	100
	(1955)	(1961)	(1956)	(2695)	
Nitrate	17,418,627	2,112,423	12,890,767	8,272	45,000
	(1955)	(1961)	(1956)	(2450)	
Total uranium	10	4	7	0	30
	(11,678)	(11,755)	(11,678)	(11,508)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–28. Tank Closure Alternative 6B, Base Case, Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	3,609	198	478	5,476	64	458	1	20,000
	(1999)	(2018)	(2013)	(2012)	(2011)	(2011)	(2054)	
Technetium-99	12,380	8,553	3,897	23,468	142	4,593	142	900
	(1999)	(2050)	(2030)	(2026)	(2049)	(2034)	(2133)	
Iodine-129	23.9	17.3	7.6	44.8	0.3	9.0	0.3	1
	(1999)	(2051)	(2030)	(2027)	(2054)	(2038)	(2319)	
Chemicals in micrograms per liter								
Chromium	63	91	407	532	14	417	4	100
	(1999)	(2049)	(2029)	(2027)	(2026)	(2224)	(2152)	
Nitrate	4,193	17,879	11,766	39,627	683	13,264	237	45,000
	(1999)	(2048)	(2028)	(2020)	(2040)	(2253)	(2204)	

Note: Corresponding calendar years shown are in parentheses.
Key: COPC=constituent of potential concern.

Table O–29. Tank Closure Alternative 6B, Base Case, Maximum COPC Concentrations Related to Past Leaks, Cribs and Trenches (Ditches), and Other Sources After Calendar Year 2050

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Hydrogen-3 (tritium)	30	5,006	46	7,299	20,000
	(2051)	(2054)	(2050)	(2055)	
Technetium-99	1,386	29,281	2,562	15,519	900
	(2050)	(2050)	(2050)	(2051)	
Iodine-129	2.7	39.4	4.8	29.4	1
	(2050)	(2057)	(2050)	(2050)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	0	34	0	13	15
	(1940)	(11,742)	(1940)	(11,780)	
Chemicals in micrograms per liter					
Chromium	7	3,177	283	771	100
	(2050)	(2055)	(2050)	(2050)	
Nitrate	511	1,540,147	8,652	132,564	45,000
	(2059)	(2050)	(2050)	(2051)	
Total uranium	0	10	0	4	30
	(1940)	(11,678)	(1940)	(11,755)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–30. Tank Closure Alternative 6B, Option Case, Maximum Contaminant Concentrations Related to Cribs and Trenches (Ditches)

Contaminant	B Barrier	T Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Hydrogen-3 (tritium)	2,843,651	12,440,075	2,843,651	1,607	20,000
	(1956)	(1974)	(1956)	(1997)	
Technetium-99	143,823	430	143,823	60	900
	(1956)	(1966)	(1956)	(2461)	
Iodine-129	187.3	3.5	187.3	0.1	1
	(1956)	(1966)	(1956)	(2030)	
Uranium isotopes (includes uranium-233, -234, -235, -238)	1	1	1	0	15
	(1981)	(1980)	(1981)	(3268)	
Chemicals in micrograms per liter					
Chromium	51,235	9,139	28,338	26	100
	(1955)	(1961)	(1956)	(2166)	
Nitrate	17,805,762	2,135,491	13,709,300	7,075	45,000
	(1955)	(1961)	(1956)	(2056)	
Total uranium	1	3	1	0	30
	(1981)	(1980)	(1981)	(3972)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–31. Tank Closure Alternative 6B, Option Case, Maximum COPC Concentrations Related to Past Leaks

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	3,609	198	478	5,476	64	458	1	20,000
	(1999)	(2018)	(2013)	(2012)	(2011)	(2011)	(2054)	
Technetium-99	12,380	8,553	3,897	23,468	142	4,593	142	900
	(1999)	(2050)	(2030)	(2026)	(2049)	(2034)	(2133)	
Iodine-129	23.9	17.3	7.6	44.8	0.3	9.0	0.3	1
	(1999)	(2051)	(2030)	(2027)	(2054)	(2038)	(2319)	
Chemicals in micrograms per liter								
Chromium	63	91	407	532	14	417	4	100
	(1999)	(2049)	(2029)	(2027)	(2026)	(2224)	(2152)	
Nitrate	4,193	17,879	11,766	39,627	683	13,264	237	45,000
	(1999)	(2048)	(2028)	(2020)	(2040)	(2253)	(2204)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

Table O–32. Tank Closure Alternative 6B, Option Case, Maximum COPC Concentrations Related to Past Leaks, Cribs and Trenches (Ditches), and Other Sources After Calendar Year 2050

Contaminant	A Barrier	B Barrier	S Barrier	T Barrier	U Barrier	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter								
Hydrogen-3 (tritium)	30	4,867	46	6,681	13	5,189	172	20,000
	(2051)	(2073)	(2050)	(2067)	(2052)	(2073)	(2088)	
Technetium-99	1,386	27,036	2,562	15,521	140	22,693	162	900
	(2050)	(2058)	(2050)	(2051)	(2060)	(2058)	(2304)	
Iodine-129	2.7	38.3	4.8	29.4	0.3	29.5	0.3	1
	(2050)	(2051)	(2050)	(2050)	(2054)	(2052)	(2319)	
Chemicals in micrograms per liter								
Chromium	7	3,769	283	778	9	1,762	28	100
	(2050)	(2087)	(2050)	(2050)	(2050)	(2061)	(2166)	
Nitrate	511	1,691,829	8,652	153,825	624	1,227,849	7,107	45,000
	(2059)	(2053)	(2050)	(2084)	(2057)	(2053)	(2056)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.4 GROUNDWATER TRANSPORT RESULTS FOR THE FFTF DECOMMISSIONING ALTERNATIVE

Tables O–33 and O–34 summarize the maximum concentration and corresponding calendar year (shown in parentheses) of occurrence for each contaminant in the unconfined aquifer as a result of FFTF Decommissioning Alternatives 1 and 2 (under FFTF Decommissioning Alternative 3, all contaminated materials would be removed, resulting in no impacts on groundwater or human health). The concentrations and years of occurrence shown in Tables O–33 and O–34 are reported at the Columbia River, Core Zone Boundary, and the FFTF barrier for each of these two FFTF Decommissioning alternatives. As expected, the concentration values at the Core Zone were zero due to its distance from

FFTF. The benchmark concentration for each contaminant is provided in the right-hand column for comparison purposes.

The COPCs for the FFTF Decommissioning alternatives include tritium, carbon-14, potassium-40; strontium-90; zirconium-93; technetium-99; iodine-129; cesium-137; gadolinium-152; thorium-232; uranium-238 (reported as uranium isotopes); neptunium-237; plutonium-239; americium-241; 1,2-dichloroethane; 1,4-dioxane; 1-butanol; 2,4,6-trichlorophenol; acetonitrile; arsenic; benzene; boron; cadmium; carbon tetrachloride; chromium; dichloromethane; fluoride; hydrazine; lead; manganese; mercury; molybdenum; nickel; nitrate; PCBs; silver; strontium; total uranium; trichloroethylene; and vinyl chloride. Zero values were reported when COPC concentrations were below minimum thresholds based on a percentage of the benchmark concentration. If the concentration value for a COPC was zero at all lines of analysis, the COPC was not reported for brevity.

O.4.1 FFTF Decommissioning Alternative 1

Under FFTF Decommissioning Alternative 1, only those actions consistent with previous U.S. Department of Energy (DOE) National Environmental Policy Act actions would be completed. Final decommissioning of FFTF would not occur. For analysis purposes, the remaining waste would be available for release to the environment after an institutional control period of 100 years.

Groundwater transport results for this alternative are summarized in Table O–33.

Table O–33. FFTF Decommissioning Alternative 1 Maximum COPC Concentrations

Contaminant	FFTF Barrier	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter			
Carbon-14	16	0	2,000
	(11,889)	(11,811)	
Technetium-99	416	12	900
	(2425)	(2702)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; FFTF=Fast Flux Test Facility.

O.4.2 FFTF Decommissioning Alternative 2

Under FFTF Decommissioning Alternative 2, all aboveground structures and minimal below-grade structures, equipment, and materials would be removed. An RCRA-compliant barrier would be constructed over the Reactor Containment Building and any other remaining below-grade structures (including the reactor vessel).

Groundwater transport results for this alternative are summarized in Table O–34.

Table O–34. FFTF Decommissioning Alternative 2 Maximum COPC Concentrations

Contaminant	FFTF Barrier	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter			
Carbon-14	15	0	2,000
	(11,898)	(11,741)	
Technetium-99	407	12	900
	(2819)	(2965)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; FFTF=Fast Flux Test Facility.

O.4.3 FFTF Decommissioning Alternative 3

Under FFTF Decommissioning Alternative 3, all aboveground structures, and all contaminated below-grade structures, equipment, and materials would be removed, resulting in zero impacts on groundwater and human health.

O.5 GROUNDWATER TRANSPORT RESULTS FOR THE WASTE MANAGEMENT ALTERNATIVES INCLUDING DISPOSAL GROUPS

Tables O–35 through O–59 summarize the maximum concentration and corresponding calendar year (shown in parentheses) of occurrence for each contaminant in the unconfined aquifer. These concentrations and times shown in the tables are reported at the Columbia River, Core Zone Boundary and applicable barrier(s) for each of the Waste Management alternatives including the disposal groups. The benchmark concentration for each contaminant is provided in the right-hand column for comparison purposes.

The COPCs for the Waste Management alternatives include tritium; carbon-14; potassium-40; strontium-90; zirconium-93; technetium-99; iodine-129; cesium-137; gadolinium-152; thorium-232; uranium-238 (reported as uranium isotopes); neptunium-237; plutonium-239; americium-241; 1,2-dichloroethane, 1,4-dioxane, 1-butanol; 2,4,6-trichlorophenol; acetonitrile; arsenic; benzene; boron; cadmium; carbon tetrachloride; chromium; dichloromethane; fluoride; hydrazine; lead; manganese; mercury; molybdenum; nickel; nitrate; PCBs; silver; strontium; total uranium; trichloroethylene; and vinyl chloride. Zero values were reported when COPC concentrations were below minimum thresholds based on a percentage of the benchmark concentration. If the concentration value for a COPC was zero at all lines of analysis, the COPC was not reported for brevity.

O.5.1 Waste Management Alternative 1

Under Waste Management Alternative 1, only those wastes currently generated on site at Hanford from non–Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) actions would continue to be disposed of in LLBG 218-W-5 trenches 31 and 34. Although the short-term impacts do not address the impacts associated with closure activities for this site, for long-term impacts analysis purposes, it was assumed that these trenches would be closed using an RCRA-compliant barrier consistent with the closure plans for these burial grounds. As a result, the non-CERCLA waste disposed of in these trenches from 2008 to 2035 would become available for release to the environment.

Groundwater transport results for this alternative are summarized in Table O–35.

Table O–35. Waste Management Alternative 1 Maximum COPC Concentrations

Contaminant	Trenches 31 and 34 Barrier	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	22	N/A	4	1	900
	(3499)		(3474)	(3974)	
Chemicals in micrograms per liter					
Chromium	3	N/A	1	0	100
	(3526)		(3615)	(4353)	
Fluoride	4	N/A	1	0	4,000
	(3545)		(3661)	(4592)	
Nitrate	47	N/A	9	2	45,000
	(3534)		(3600)	(4417)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern.

O.5.2 Waste Management Alternative 2

Under Waste Management Alternative 2, waste from tank treatment operations, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites would be disposed of in IDF-East. Waste from tank farm cleanup activities would be disposed of in the RPPDF. As a result, the waste disposed of in these two facilities would become available for release to the environment. Because different waste types would result from the Tank Closure action alternatives, three disposal groups were considered to account for the different IDF-East sizes and operational periods. In addition, within these three disposal groups, subgroups were identified to allow consideration of the different waste types resulting from the Tank Closure alternatives. Groundwater transport results of these subgroups under this alternative are discussed in the following sections.

O.5.2.1 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A

Disposal Group 1, Subgroup 1-A, addresses the waste resulting from Tank Closure Alternative 2B, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 2B.

Groundwater transport results for this alternative are summarized in Table O–36.

Table O–36. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Maximum COPC Concentrations

Contaminant	IDF-East	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	2,041	33	1,178	675	900
	(9004)	(3825)	(9155)	(9451)	
Iodine-129	18.7	0.1	8.5	7.0	1
	(8739)	(3772)	(8858)	(8700)	
Chemicals in micrograms per liter					
Chromium	4	2	2	1	100
	(8511)	(3856)	(3889)	(8898)	
Fluoride	0	0	1	0	4,000
	(8035)	(1940)	(7258)	(8913)	
Nitrate	14,245	149	5,630	2,444	45,000
	(8522)	(3811)	(9653)	(8827)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.2 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B

Disposal Group 1, Subgroup 1-B, addresses the waste resulting from Tank Closure Alternative 3A, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Bulk vitrification glass
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3A.

Groundwater transport results for this alternative are summarized in Table O–37.

Table O–37. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Maximum COPC Concentrations

Contaminant	IDF-East	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	2,878	33	1,253	815	900
	(8486)	(3825)	(7998)	(8273)	
Iodine-129	18.4	0.1	8.4	7.0	1
	(8195)	(3772)	(8858)	(8700)	
Chemicals in micrograms per liter					
Chromium	2	2	2	0	100
	(8278)	(3856)	(3889)	(4826)	
Fluoride	0	0	1	0	4,000
	(8035)	(1940)	(7258)	(8913)	
Nitrate	14,384	149	5,859	3,681	45,000
	(7821)	(3811)	(8905)	(8144)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.3 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C

Disposal Group 1, Subgroup 1-C, addresses the waste resulting from Tank Closure Alternative 3B, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Cast stone
- Tank closure secondary waste
- FFTF decommissioning secondary waste

- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3B.

Groundwater transport results for this alternative are summarized in Table O–38.

Table O–38. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Maximum COPC Concentrations

Contaminant	IDF-East	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	5,659	33	8,156	1,686	900
	(9048)	(3825)	(9163)	(8927)	
Iodine-129	18.2	0.1	8.4	7.0	1
	(8491)	(3772)	(8858)	(8700)	
Chemicals in micrograms per liter					
Acetonitrile	25	0	9	7	100
	(8281)	(1940)	(8313)	(8973)	
Chromium	437	2	265	116	100
	(8940)	(3856)	(8760)	(9311)	
Fluoride	0	0	1	0	4,000
	(8035)	(1940)	(7258)	(8913)	
Nitrate	50,237	149	21,194	14,132	45,000
	(8665)	(3811)	(8290)	(9453)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.4 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D

Disposal Group 1, Subgroup 1-D, addresses the waste resulting from Tank Closure Alternative 3C, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Steam reforming waste
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3C.

Groundwater transport results for this alternative are summarized in Table O–39.

Table O–39. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Maximum COPC Concentrations

Contaminant	IDF-East	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	30,126	33	24,782	7,608	900
	(9032)	(3825)	(9067)	(8274)	
Iodine-129	24.0	0.1	15.5	8.2	1
	(8195)	(3772)	(8082)	(8699)	
Chemicals in micrograms per liter					
Acetonitrile	436	2	174	116	100
	(9071)	(3856)	(8397)	(9878)	
Chromium	0	0	1	0	100
	(8035)	(1940)	(7258)	(8913)	
Fluoride	14,514	149	4,971	3,318	4,000
	(7859)	(3811)	(7269)	(7744)	
Nitrate	436	2	174	116	45,000
	(9071)	(3856)	(8397)	(9878)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.5 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E

Disposal Group 1, Subgroup 1-E, addresses the waste resulting from Tank Closure Alternative 4, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Bulk vitrification glass
- Cast stone
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 4.

Groundwater transport results for this alternative are summarized in Table O–40.

Table O–40. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Maximum COPC Concentrations

Contaminant	IDF-East	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	6,494	103	3,094	2,030	900
	(9035)	(3822)	(9499)	(8117)	
Iodine-129	18.4	0.2	8.4	7.0	1
	(8491)	(3940)	(8858)	(8699)	
Chemicals in micrograms per liter					
Acetonitrile	16	0	5	4	100
	(7959)	(1940)	(7381)	(6849)	
Chromium	224	6	96	64	100
	(9069)	(3804)	(8643)	(8079)	
Fluoride	0	0	1	0	4,000
	(8035)	(1940)	(7258)	(8913)	
Nitrate	28,997	229	13,920	6,384	45,000
	(9330)	(4042)	(8994)	(8673)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.6 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F

Disposal Group 1, Subgroup 1-F, addresses the waste resulting from Tank Closure Alternative 5, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Bulk vitrification glass
- Cast stone
- Sulfate grout
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The RPPDF would not be constructed or operated under Tank Closure Alternative 5 because tank closure cleanup activities would not be conducted.

Groundwater transport results for this alternative are summarized in Table O–41.

Table O–41. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Maximum COPC Concentrations

Contaminant	IDF-East	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	3,513	N/A	1,497	891	900
	(8276)		(9155)	(8090)	
Iodine-129	18.4	N/A	8.4	7.0	1
	(8195)		(8858)	(8699)	
Chemicals in micrograms per liter					
Acetonitrile	5	N/A	2	1	100
	(8475)		(9519)	(8575)	
Chromium	335	N/A	148	110	100
	(8735)		(8764)	(8819)	
Fluoride	0	N/A	1	0	4,000
	(8035)		(7258)	(8913)	
Nitrate	21,393	N/A	7,417	4,560	45,000
	(8448)		(8887)	(8787)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.7 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G

Disposal Group 1, Subgroup 1-G, addresses the waste resulting from Tank Closure Alternative 6C, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6C.

Groundwater transport results for this alternative are summarized in Table O–42.

Table O–42. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Maximum COPC Concentrations

Contaminant	IDF-East	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	2,185	33	1,152	674	900
	(9004)	(3825)	(9155)	(9451)	
Iodine-129	18.7	0.1	8.5	7.0	1
	(8739)	(3772)	(8858)	(8699)	
Chemicals in micrograms per liter					
Chromium	4	2	2	1	100
	(8618)	(3856)	(3889)	(8528)	
Fluoride	0	0	1	0	4,000
	(8035)	(1940)	(7258)	(8913)	
Nitrate	14,245	149	5,630	2,444	45,000
	(8522)	(3811)	(9653)	(8827)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.8 Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A

Disposal Group 2, Subgroup 2-A, addresses the waste resulting from Tank Closure Alternative 2A, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The RPPDF would not be constructed or operated under Tank Closure Alternative 2A because tank closure cleanup activities would not be conducted.

Groundwater transport results for this alternative are summarized in Table O–43.

Table O–43. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Maximum COPC Concentrations

Contaminant	IDF-East	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	2,824	N/A	1,145	671	900
	(8580)		(8365)	(8478)	
Iodine-129	23.8	N/A	9.7	5.6	1
	(9058)		(9178)	(9652)	
Chemicals in micrograms per liter					
Chromium	3	N/A	2	1	100
	(9308)		(8982)	(8354)	
Nitrate	15,512	N/A	5,695	4,068	45,000
	(8055)		(7905)	(8056)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.9 Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base and Option Cases

Disposal Group 2, Subgroup 2-B, addresses the waste resulting from Tank Closure Alternative 6B, Base and Option Cases, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- Preprocessing Facility (PPF) glass
- PPF melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6B, Base and Option Cases.

Groundwater transport results for this alternative are summarized in Tables O–44 and O–45.

Table O–44. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Maximum COPC Concentrations

Contaminant	IDF-East	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	2,894	283	1,138	703	900
	(8580)	(3889)	(8365)	(8477)	
Iodine-129	24.1	0.5	9.6	5.6	1
	(9058)	(4089)	(9188)	(9652)	
Chemicals in micrograms per liter					
Chromium	3	6	11	2	100
	(8281)	(3868)	(11,232)	(5035)	
Nitrate	16,645	353	5,751	3,313	45,000
	(8162)	(3996)	(8245)	(7837)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

Table O–45. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Maximum COPC Concentrations

Contaminant	IDF-East	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	2,894	340	1,351	717	900
	(8580)	(4213)	(4466)	(8477)	
Iodine-129	24.1	0.6	9.6	5.7	1
	(9058)	(4176)	(9188)	(9652)	
Chemicals in micrograms per liter					
Chromium	3	33	97	17	100
	(8281)	(4118)	(10,533)	(5522)	
Nitrate	16,645	9,073	28,374	5,696	45,000
	(8162)	(3962)	(9305)	(4618)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.2.10 Waste Management Alternative 2, Disposal Group 3, Base and Option Cases

Disposal Group 3 addresses the waste resulting from Tank Closure Alternative 6A, Base and Option Cases, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6A, Base and Option Cases.

Groundwater transport results for this alternative are summarized in Tables O–46 and O–47.

Table O–46. Waste Management Alternative 2, Disposal Group 3, Base Case, Maximum COPC Concentrations

Contaminant	IDF-East	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	3,039	303	1,180	848	900
	(8646)	(3987)	(8173)	(9284)	
Iodine-129	22.3	0.5	11.2	5.6	1
	(8850)	(4073)	(11,300)	(8985)	
Chemicals in micrograms per liter					
Chromium	3	6	11	3	100
	(8561)	(4109)	(6384)	(4877)	
Nitrate	16,640	404	6,550	3,312	45,000
	(7367)	(4001)	(6859)	(7741)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

Table O–47. Waste Management Alternative 2, Disposal Group 3, Option Case, Maximum COPC Concentrations

Contaminant	IDF-East	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter					
Technetium-99	3,039	386	1,180	861	900
	(8646)	(4013)	(8173)	(9284)	
Iodine-129	22.3	0.6	11.2	5.7	1
	(8850)	(4172)	(11,300)	(8985)	
Chemicals in micrograms per liter					
Chromium	3	36	125	20	100
	(8561)	(3878)	(6610)	(6701)	
Nitrate	16,640	10,251	30,238	5,616	45,000
	(7367)	(4544)	(4627)	(6522)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility.

O.5.3 Waste Management Alternative 3

Under Waste Management Alternative 3, the waste from tank treatment operations would be disposed of in IDF-East, and waste from onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites would be disposed of in IDF-West. Waste from tank farm cleanup operations would be disposed of in the RPPDF. As a result, the waste disposed of in these three facilities would become available for release to the environment. Because of the different waste types that result from the Tank Closure action alternatives, three disposal groups were considered to account for the different IDF-East sizes and operational time periods. In addition, within these three disposal groups, subgroups were identified to allow consideration of the different waste types resulting from the Tank Closure alternatives.

Groundwater transport results of these subgroups under this alternative are discussed in the following section.

O.5.3.1 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A

Disposal Group 1, Subgroup 1-A, addresses the waste resulting from Tank Closure Alternative 2B, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 2B.

Groundwater transport results for this alternative are summarized in Table O–48.

Table O–48. Waste Management-Alternative 3, Disposal Group 1, Subgroup 1-A, Maximum COPC Concentrations

Contaminant	IDF-East	IDF-West	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter						
Technetium-99	471	20,209	33	7,555	1,129	900
	(8991)	(3713)	(3825)	(3690)	(4528)	
Iodine-129	1.4	172.6	0.1	60.3	8.3	1
	(11,243)	(3797)	(3772)	(3853)	(4729)	
Chemicals in micrograms per liter						
Chromium	4	2	2	3	1	100
	(8511)	(3696)	(3856)	(3628)	(8879)	
Fluoride	0	1	0	1	0	100
	(1940)	(3684)	(1940)	(3907)	(4555)	
Nitrate	14,243	17	149	5,630	2,443	45,000
	(8522)	(3703)	(3811)	(9653)	(8043)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.2 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B

Disposal Group 1, Subgroup 1-B, addresses the waste resulting from Tank Closure Alternative 3A, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Bulk vitrification glass
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3A.

Groundwater transport results for this alternative are summarized in Table O–49.

Table O–49. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Maximum COPC Concentrations

Contaminant	IDF-East	IDF-West	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter						
Technetium-99	1,604	20,209	33	7,555	1,129	900
	(8486)	(3713)	(3825)	(3690)	(4528)	
Iodine-129	1.7	172.6	0.1	60.3	8.3	1
	(11,284)	(3797)	(3772)	(3853)	(4729)	
Chemicals in micrograms per liter						
Chromium	2	2	2	3	0	100
	(8278)	(3696)	(3856)	(3628)	(4812)	
Fluoride	0	1	0	1	0	4,000
	(1940)	(3684)	(1940)	(3907)	(4555)	
Nitrate	14,381	17	149	5,858	3,680	45,000
	(7821)	(3703)	(3811)	(8905)	(8144)	

Note: Corresponding calendar years are shown in parentheses.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.3 Waste Management Alternative 3 Disposal Group 1, Subgroup 1-C

Disposal Group 1, Subgroup 1-C, addresses the waste resulting from Tank Closure Alternative 3B, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters

- Cast stone
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3B.

Groundwater transport results for this alternative are summarized in Table O–50.

Table O–50. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Maximum COPC Concentrations

Contaminant	IDF-East	IDF-West	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter						
Technetium-99	5,022	20,209	33	7,838	1,689	900
	(9048)	(3713)	(3825)	(9163)	(8939)	
Iodine-129	0.7	172.6	0.1	60.3	8.3	1
	(10,915)	(3797)	(3772)	(3853)	(4729)	
Chemicals in micrograms per liter						
Acetonitrile	25	0	0	9	7	100
	(8281)	(1940)	(1940)	(8313)	(8973)	
Chromium	436	2	2	265	116	100
	(8940)	(3696)	(3856)	(8760)	(9311)	
Fluoride	0	1	0	1	0	4,000
	(1940)	(3684)	(1940)	(3907)	(4555)	
Nitrate	50,234	17	149	21,193	14,132	45,000
	(8665)	(3703)	(3811)	(8290)	(9453)	

Note: Corresponding calendar years are shown in parentheses.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.4 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D

Disposal Group 1, Subgroup 1-D, addresses the waste resulting from Tank Closure Alternative 3C, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Steam reforming waste
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 3C.

Groundwater transport results for this alternative are summarized in Table O–51.

Table O–51. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Maximum COPC Concentrations

Contaminant	IDF-East	IDF-West	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter						
Technetium-99	29,171	20,209	33	24,626	7,451	900
	(9032)	(3713)	(3825)	(9067)	(9206)	
Iodine-129	10.7	172.6	0.1	60.3	8.3	1
	(8514)	(3797)	(3772)	(3853)	(4729)	
Chemicals in micrograms per liter						
Chromium	436	2	2	174	116	100
	(9071)	(3696)	(3856)	(8397)	(9878)	
Fluoride	0	1	0	1	0	4,000
	(1940)	(3684)	(1940)	(3907)	(4555)	
Nitrate	14,512	17	149	4,971	3,318	45,000
	(7859)	(3703)	(3811)	(7269)	(7528)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.5 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E

Disposal Group 1, Subgroup 1-E, addresses the waste resulting from Tank Closure Alternative 4, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Bulk vitrification glass
- Cast stone
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 4.

Groundwater transport results for this alternative are summarized in Table O–52.

Table O–52. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Maximum COPC Concentrations

Contaminant	IDF-East	IDF-West	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter						
Technetium-99	5,638	20,209	103	7,596	2,031	900
	(9826)	(3713)	(3822)	(3690)	(8117)	
Iodine-129	1.1	172.6	0.2	60.4	8.3	1
	(11,228)	(3797)	(3940)	(3853)	(4728)	
Chemicals in micrograms per liter						
Chromium	223	2	6	96	64	100
	(9069)	(3696)	(3804)	(8643)	(8079)	
Fluoride	0	1	0	1	0	4,000
	(1940)	(3684)	(1940)	(3907)	(4555)	
Nitrate	28,995	17	229	13,919	6,384	45,000
	(9330)	(3703)	(4042)	(8994)	(8673)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.6 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F

Disposal Group 1, Subgroup 1-F, addresses the waste resulting from Tank Closure Alternative 5, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Bulk vitrification glass
- Cast stone
- Sulfate grout
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The RPPDF would not be constructed or operated under Tank Closure Alternative 5 because tank closure cleanup activities would not be conducted.

Groundwater transport results for this alternative are summarized in Table O–53.

Table O–53. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Maximum COPC Concentrations

Contaminant	IDF-East	IDF-West	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter						
Technetium-99	2,388	20,209	N/A	7,537	1,125	900
	(9701)	(3713)		(3690)	(4528)	
Iodine-129	1.2	172.6	N/A	60.3	8.3	1
	(11,711)	(3797)		(3853)	(4729)	
Chemicals in micrograms per liter						
Acetonitrile	5	0	N/A	2	1	100
	(8475)	(1940)		(9519)	(8575)	
Chromium	335	2	N/A	148	110	100
	(8735)	(3696)		(8764)	(8819)	
Fluoride	0	1	N/A	1	0	4,000
	(1940)	(3684)		(3907)	(4555)	
Nitrate	21,390	17	N/A	7,417	4,559	45,000
	(8448)	(3703)		(8887)	(8787)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.7 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G

Disposal Group 1, Subgroup 1-G, addresses the waste resulting from Tank Closure Alternative 6C, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6C.

Groundwater transport results for this alternative are summarized in Table O–54.

Table O–54. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Maximum COPC Concentrations

Contaminant	IDF-East	IDF-West	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter						
Technetium-99	414	20,209	33	7,555	1,129	900
	(10,032)	(3713)	(3825)	(3690)	(4528)	
Iodine-129	1.4	172.6	0.1	60.3	8.3	1
	(11,243)	(3797)	(3772)	(3853)	(4729)	
Chemicals in micrograms per liter						
Chromium	4	2	2	3	1	100
	(8618)	(3696)	(3856)	(3628)	(8204)	
Fluoride	0	1	0	1	0	4,000
	(1940)	(3684)	(1940)	(3907)	(4555)	
Nitrate	14,243	17	149	5,630	2,443	45,000
	(8522)	(3703)	(3811)	(9653)	(8043)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.8 Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A

Disposal Group 2, Subgroup 2-A, addresses the waste resulting from Tank Closure Alternative 2A, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- ILAW glass
- ILAW melters
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The RPPDF would not be constructed or operated under Tank Closure Alternative 2A because tank closure cleanup activities would not be conducted.

Groundwater transport results for this alternative are summarized in Table O–55.

Table O–55. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Maximum COPC Concentrations

Contaminant	IDF-East	IDF-West	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter						
Technetium-99	334	20,209	N/A	7,537	1,125	900
	(9823)	(3713)		(3690)	(4528)	
Iodine-129	1.7	172.6	N/A	60.3	8.3	1
	(10,498)	(3797)		(3853)	(4729)	
Chemicals in micrograms per liter						
Chromium	3	2	N/A	2	1	100
	(9308)	(3696)		(8982)	(8353)	
Fluoride	0	1	N/A	1	0	4,000
	(1940)	(3684)		(3907)	(4555)	
Nitrate	15,510	17	N/A	5,695	4,067	45,000
	(7977)	(3703)		(7905)	(8056)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.9 Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base and Option Cases

Disposal Group 2, Subgroup 2-B, addresses the waste resulting from Tank Closure Alternative 6B, Base and Option Cases, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6B, Base and Option Cases.

Groundwater transport results for this alternative are summarized in Tables O–56 and O–57.

Table O–56. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Maximum COPC Concentrations

Contaminant	IDF-East	IDF-West	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter						
Technetium-99	347	20,209	283	7,747	1,179	900
	(10,643)	(3713)	(3889)	(3690)	(3884)	
Iodine-129	1.6	172.6	0.5	60.7	8.4	1
	(11,363)	(3797)	(4089)	(3853)	(4392)	
Chemicals in micrograms per liter						
Chromium	3	2	6	12	2	100
	(8281)	(3696)	(3868)	(4042)	(4714)	
Fluoride	0	1	0	1	0	4,000
	(1940)	(3684)	(1940)	(3907)	(4555)	
Nitrate	16,643	17	353	5,751	3,313	45,000
	(8162)	(3703)	(3996)	(8245)	(7831)	

Note: Corresponding calendar years are shown in parentheses.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

Table O–57. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Option Case, Maximum COPC Concentrations

Contaminant	IDF-East	IDF-West	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter						
Technetium-99	347	20,209	340	7,586	1,188	900
	(10,643)	(3713)	(4213)	(3690)	(4191)	
Iodine-129	1.6	172.6	0.6	60.8	8.4	1
	(11,363)	(3797)	(4176)	(3853)	(4392)	
Chemicals in micrograms per liter						
Chromium	3	2	33	97	17	100
	(8281)	(3696)	(4118)	(10,533)	(5522)	
Fluoride	0	1	0	1	0	4,000
	(1940)	(3684)	(1940)	(3907)	(4555)	
Nitrate	16,643	17	9,073	28,373	5,697	45,000
	(8162)	(3703)	(3962)	(9305)	(4618)	

Note: Corresponding calendar years are shown in parentheses.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.5.3.10 Waste Management Alternative 3, Disposal Group 3, Subgroup 3-A, Base and Option Cases

Disposal Group 3 addresses the waste resulting from Tank Closure Alternative 6A, Base and Option Cases, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms for IDF-East include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste

Waste forms for IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the RPPDF include those resulting from tank closure cleanup activities under Tank Closure Alternative 6A, Base and Option Cases.

Groundwater transport results for this alternative are summarized in Tables O–58 and O–59.

Table O–58. Waste Management Alternative 3, Disposal Group 3, Base Case, Maximum COPC Concentrations

Contaminant	IDF-East	IDF-West	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter						
Technetium-99	389	20,209	303	7,765	1,181	900
	(9324)	(3713)	(3987)	(3690)	(4186)	
Iodine-129	1.6	172.6	0.5	60.7	8.4	1
	(11,096)	(3797)	(4073)	(3853)	(4392)	
Chemicals in micrograms per liter						
Chromium	3	2	6	12	3	100
	(8037)	(3696)	(4109)	(4035)	(4877)	
Fluoride	0	1	0	1	0	4,000
	(1940)	(3684)	(1940)	(3907)	(4555)	
Nitrate	16,640	17	404	6,550	3,312	45,000
	(7367)	(3703)	(4001)	(6859)	(7717)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

Table O–59. Waste Management Alternative 3, Disposal Group 3, Option Case, Maximum COPC Concentrations

Contaminant	IDF-East	IDF-West	River Protection Project Disposal Facility	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclides in picocuries per liter						
Technetium-99	389	20,209	386	7,935	1,219	900
	(9324)	(3713)	(4013)	(3690)	(4066)	
Iodine-129	1.6	172.6	0.6	60.9	8.4	1
	(11,096)	(3797)	(4172)	(3853)	(4728)	
Chemicals in micrograms per liter						
Chromium	3	2	36	125	20	100
	(8037)	(3696)	(3878)	(6610)	(6701)	
Fluoride	0	1	0	1	0	4,000
	(1940)	(3684)	(1940)	(3907)	(4555)	
Nitrate	16,640	17	10,251	30,238	5,616	45,000
	(7367)	(3703)	(4544)	(4627)	(6522)	

Note: Corresponding calendar years are shown in parentheses.
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

O.6 SENSITIVITY ANALYSIS

The calibrated parameter set for the Base Case flow and transport models provide plume simulations that agree with regional-scale field distributions to a close order of magnitude (see Section O.2.4). In this section, the sensitivity of the results to uncertainties in key parameters is discussed. The focus is on the sensitivity to the Base and Alternate Case flow fields, distribution coefficient for iodine-129, length of analysis period, and contaminant inventory and release.

O.6.1 Comparison of Base Case and Alternate Case Flow Fields During Hanford Operational Period

Two groundwater flow fields were developed for this *TC & WM EIS* (see Appendix L). These flow fields reflect uncertainty in the top of basalt surface in the Gable Mountain–Gable Butte area, and consequent variation in predominant flow direction from the Central Plateau. The groundwater flow analysis suggested that, within the uncertainty of the top of the basalt surface, flow fields could be developed that (1) compare equally well to field measurements during the operational period (1944–2006) and (2) simulate different groundwater flow pathways in the post-Hanford period. In this section, the Base and Alternate Case flow fields are used to illustrate the sensitivity of contaminant transport results.

O.6.1.1 Past Leaks from Tank Farms, Discharges to Cribs and Trenches (Ditches)

Particle-tracking analyses were performed to compare the results of the Base and Alternate Case flow fields during Hanford's operational period (1944–2006). Contaminant transport of chromium, nitrate, iodine-129, and technetium-99 due to past leaks from tank farms and discharges to cribs and trenches (ditches) were selected as the basis for this comparison. Figures O–11 through O–18 show the spatial distribution of each contaminant for the Base and Alternate Case flow fields near the end of the operational period (year 2005). These results suggest that regional-scale contaminant plumes (i.e., areas of groundwater contaminated above benchmark values) from *TC & WM EIS* alternative analysis sources are similar for the Base and Alternate Case flow models.

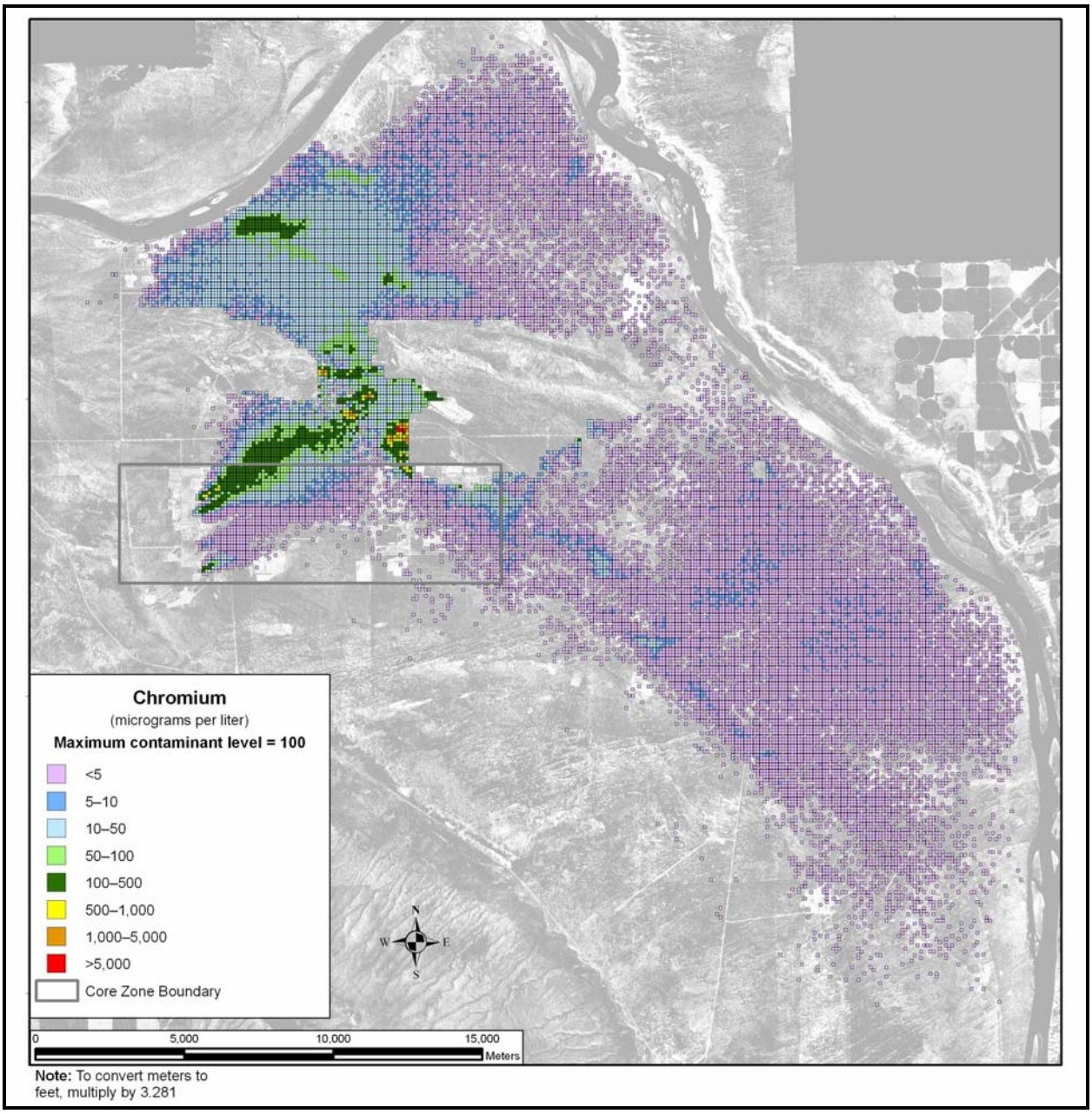


Figure O–11. Base Case Operational Period Chromium Plume Map, Calendar Year 2005

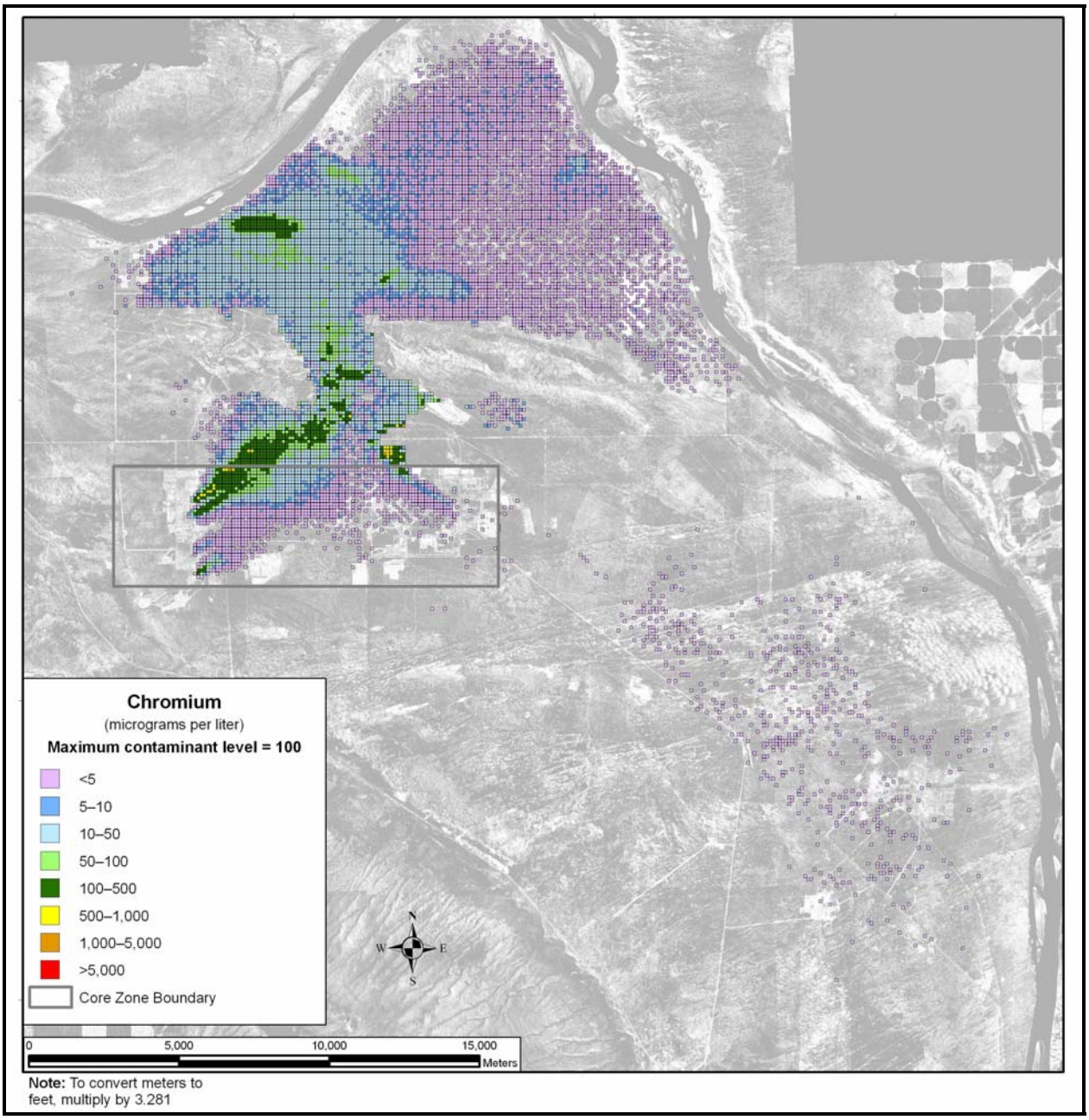


Figure O–12. Alternate Case Operational Period Chromium Plume Map, Calendar Year 2005

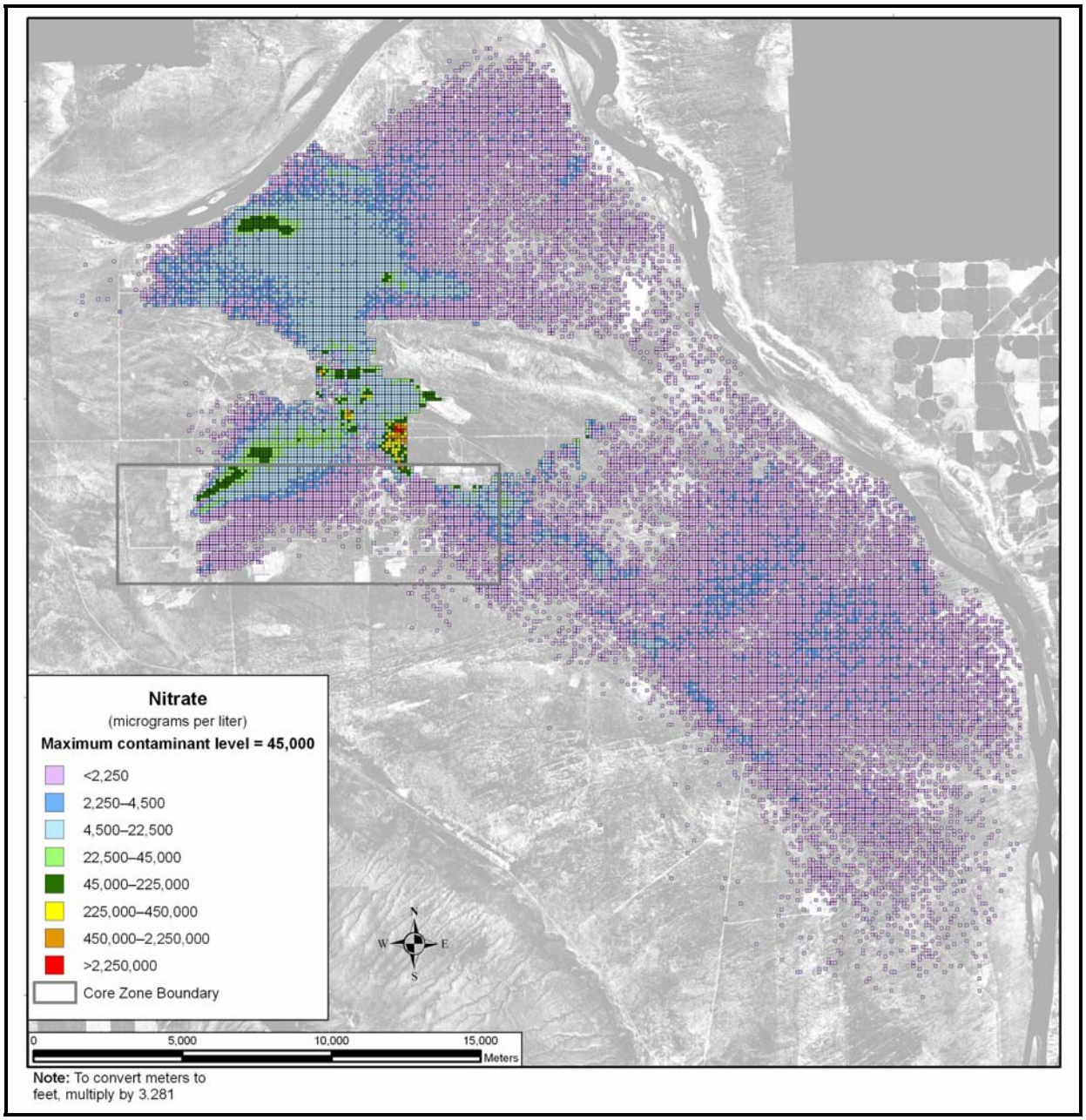


Figure O–13. Base Case Operational Period Nitrate Plume Map, Calendar Year 2005

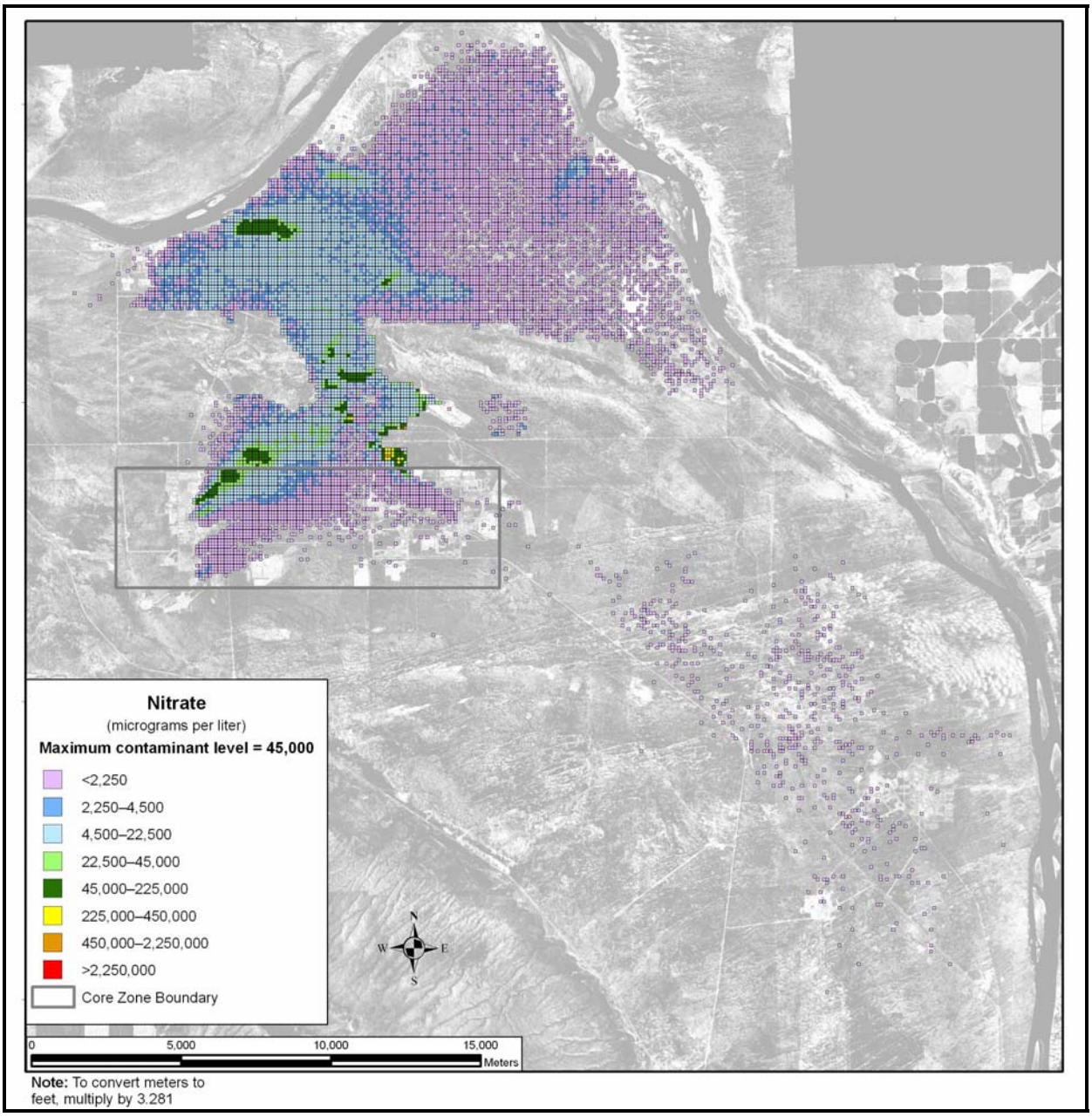


Figure O–14. Alternate Case Operational Period Nitrate Plume Map, Calendar Year 2005

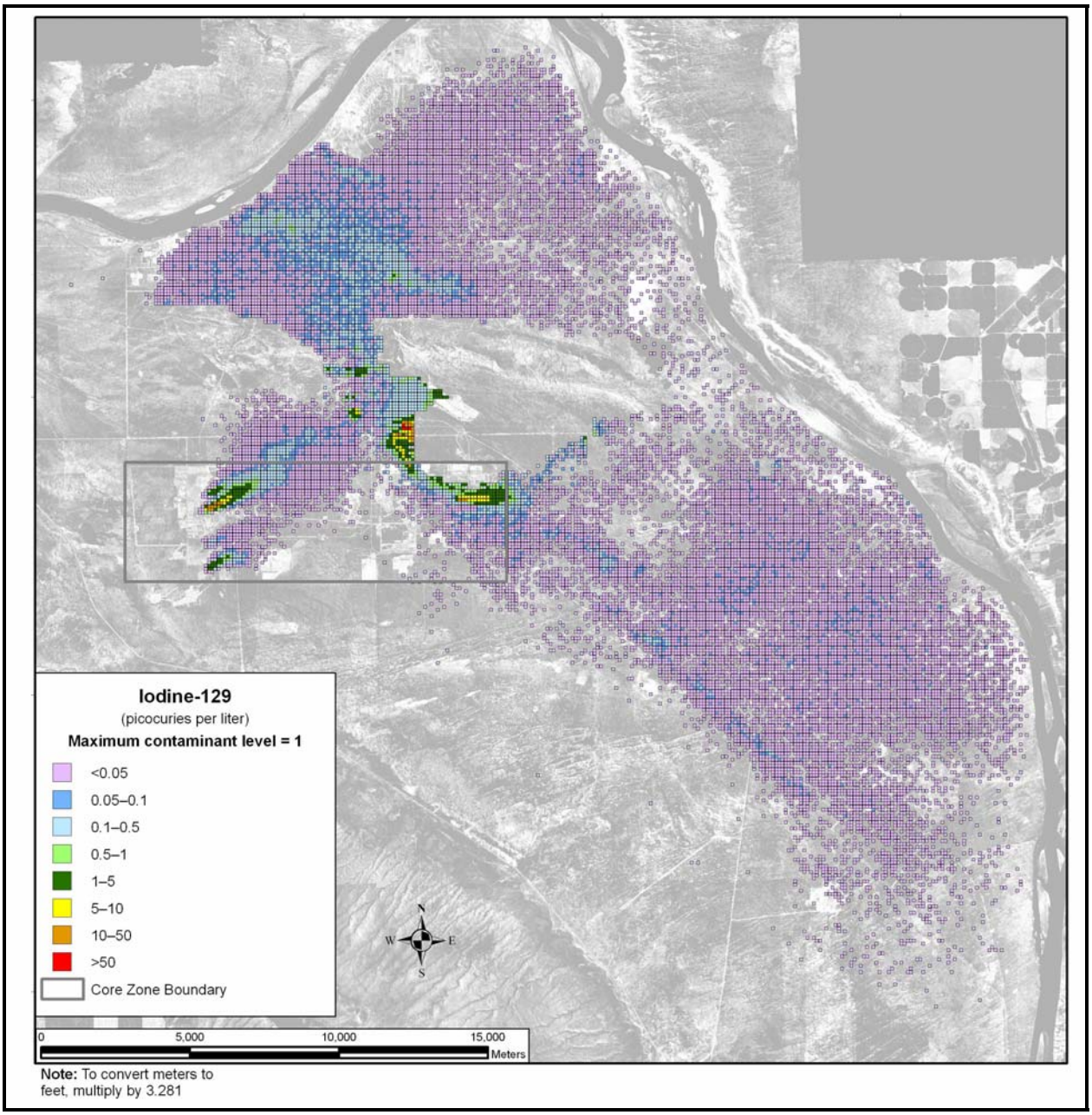


Figure O–15. Base Case Operational Period Iodine-129 Plume Map, Calendar Year 2005

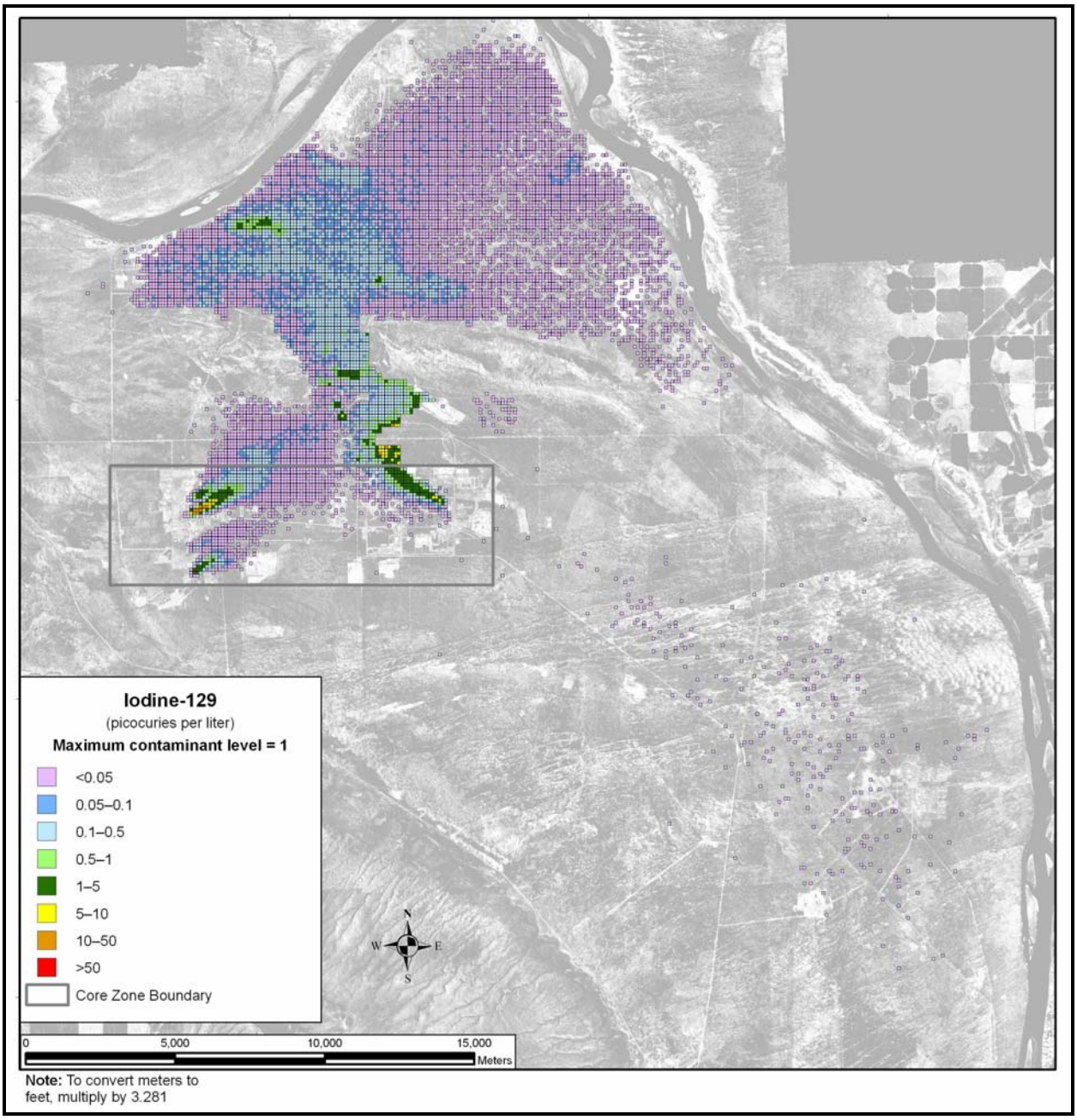


Figure O–16. Alternate Case Operational Period Iodine-129 Plume Map, Calendar Year 2005

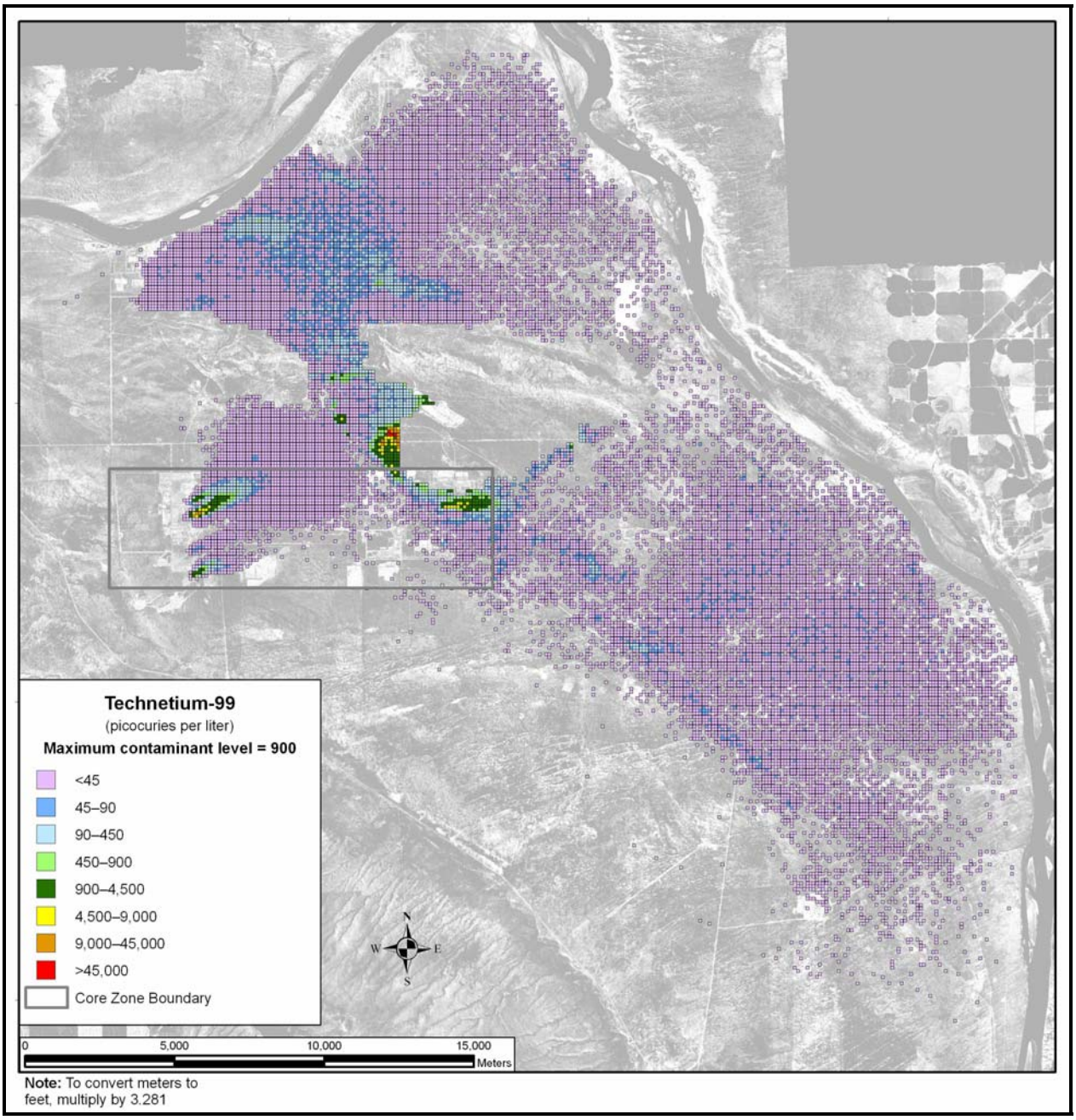


Figure O–17. Base Case Operational Period Technetium-99 Plume Map, Calendar Year 2005

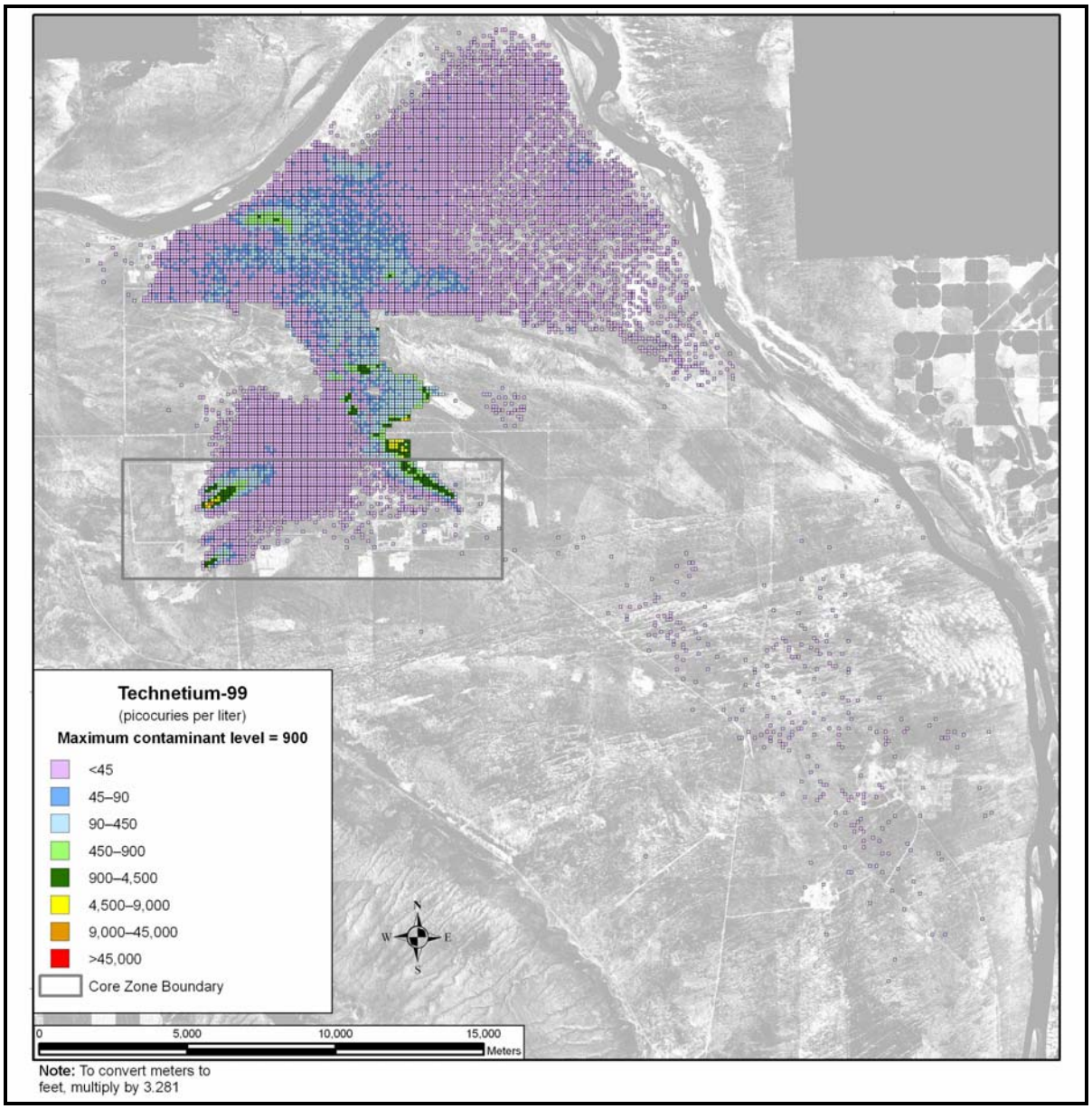


Figure O–18. Alternate Case Operational Period Technetium-99 Plume Map, Calendar Year 2005

O.6.1.2 PUREX Waste Site Hydrogen-3 (Tritium) Plume

Particle-tracking analyses were performed to compare the results of the Base and Alternate Case flow fields during Hanford's operational period (1944–2006). This comparison included the PUREX waste sites that make up the 200-East Area tritium plume, including 216-A-10, 216-A-21, 216-A-24, 216-A-27, 216-A-30, 216-A-36B, 216-A-37-1, 216-A-37-2, 216-A-4, 216-A-45, 216-A-5, 216-A-6, and 216-A-8. Figures O–19 and O–20 respectively show the spatial distribution of the PUREX waste site tritium plume for the Base and Alternate Case flow fields near the end of the operational period (year 2005). These results suggest that regional-scale contaminant plumes (i.e., areas of groundwater contaminated above benchmark values) from *TC & WM EIS* cumulative analysis sources in the 200-East Area are somewhat different for the Base and Alternate Case flow fields. The Base Case flow field simulates a tritium plume with peak concentrations and spatial distribution in qualitatively better agreement with field measurements.

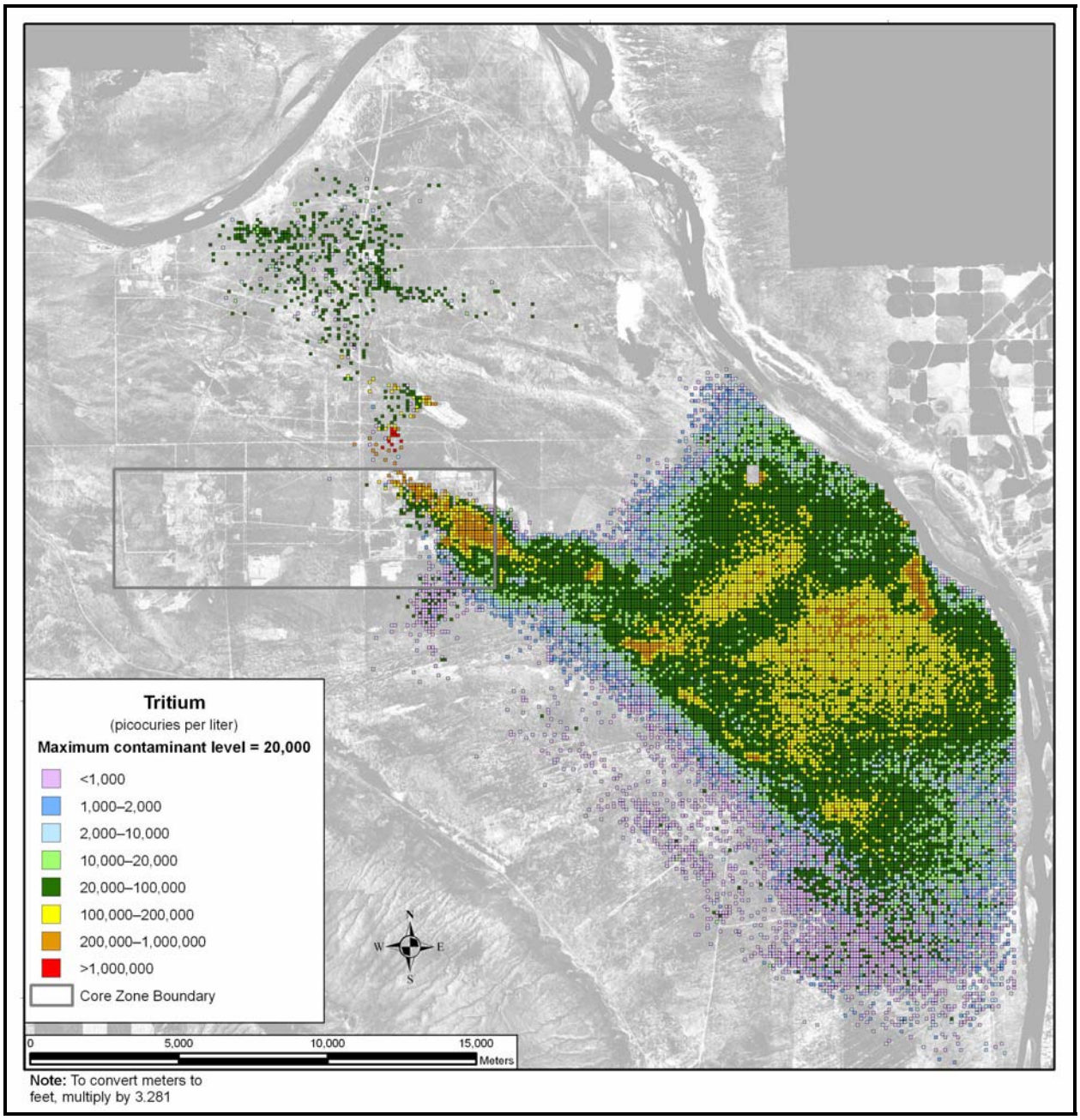


Figure O–19. Base Case Operational Period Plutonium-Uranium Extraction (PUREX) Waste Site Hydrogen-3 (Tritium) Plume Map, Calendar Year 2005

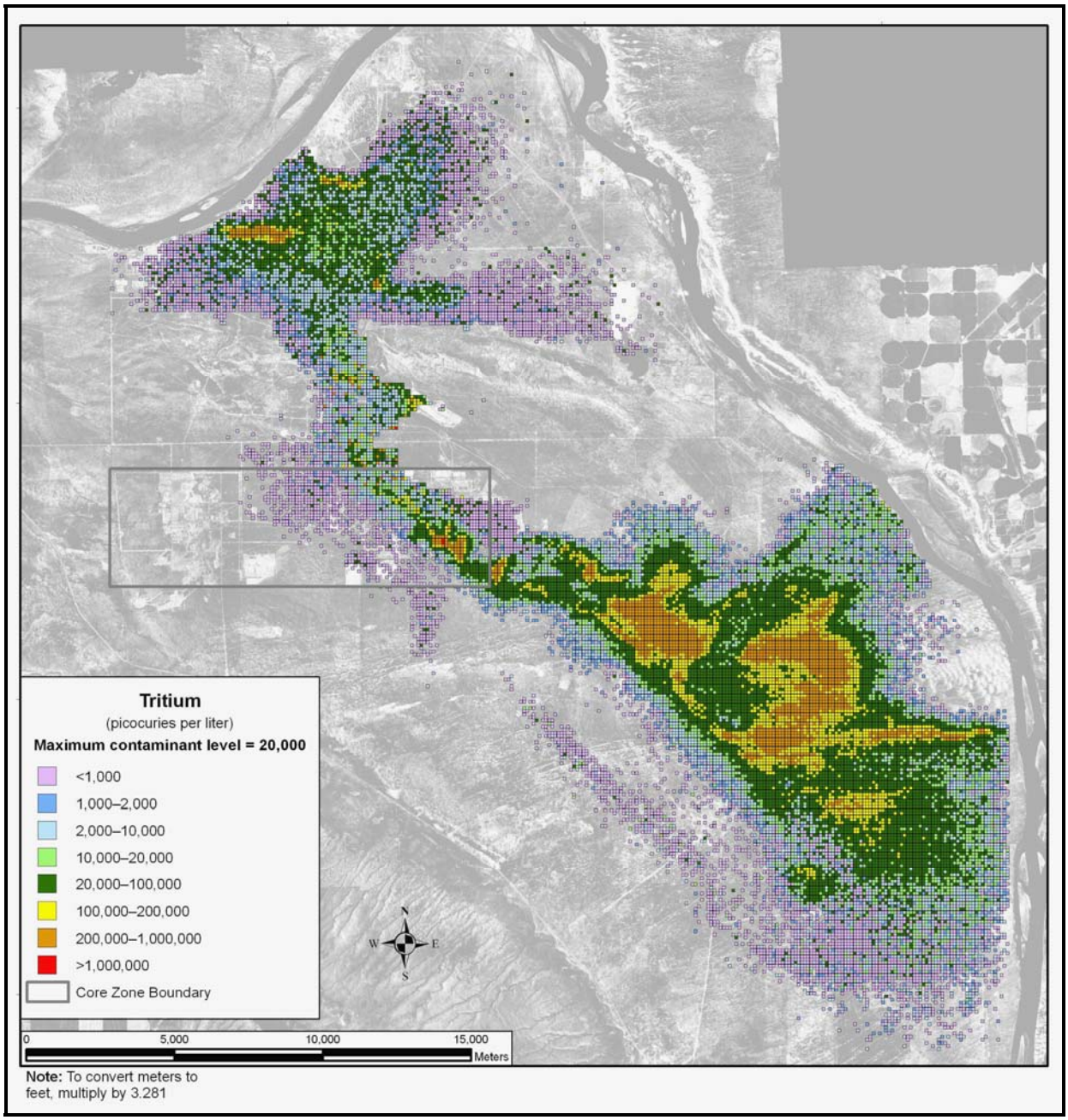


Figure O–20. Alternate Case Operational Period Plutonium-Uranium Extraction (PUREX) Waste Site Hydrogen-3 (Tritium) Plume Map, Calendar Year 2005

O.6.1.3 REDOX Waste Site Hydrogen-3 (Tritium) Plume

Particle-tracking analyses were performed to compare the results of the Base and Alternate Case flow fields during Hanford's operational period (1944–2006). This comparison included the REDOX waste site sites that make up the 200-West Area tritium plume, including 216-S1 and 2, 216-S-13, 216-S-20, 216-S-25, 216-S-26, 216-S-7, 216-S-9, 216-S-21, 216-U-12, and 216-U-8. Figures O–21 and O–22 respectively show the spatial distribution of the REDOX waste site tritium plume for the Base and Alternate Case flow fields near the end of the operational period (year 2005). These results suggest that regional-scale contaminant plumes (i.e., areas of groundwater contaminated above benchmark values) from *TC & WM EIS* cumulative analysis sources in the 200-West Area are similar for the Base and Alternate Case flow fields.

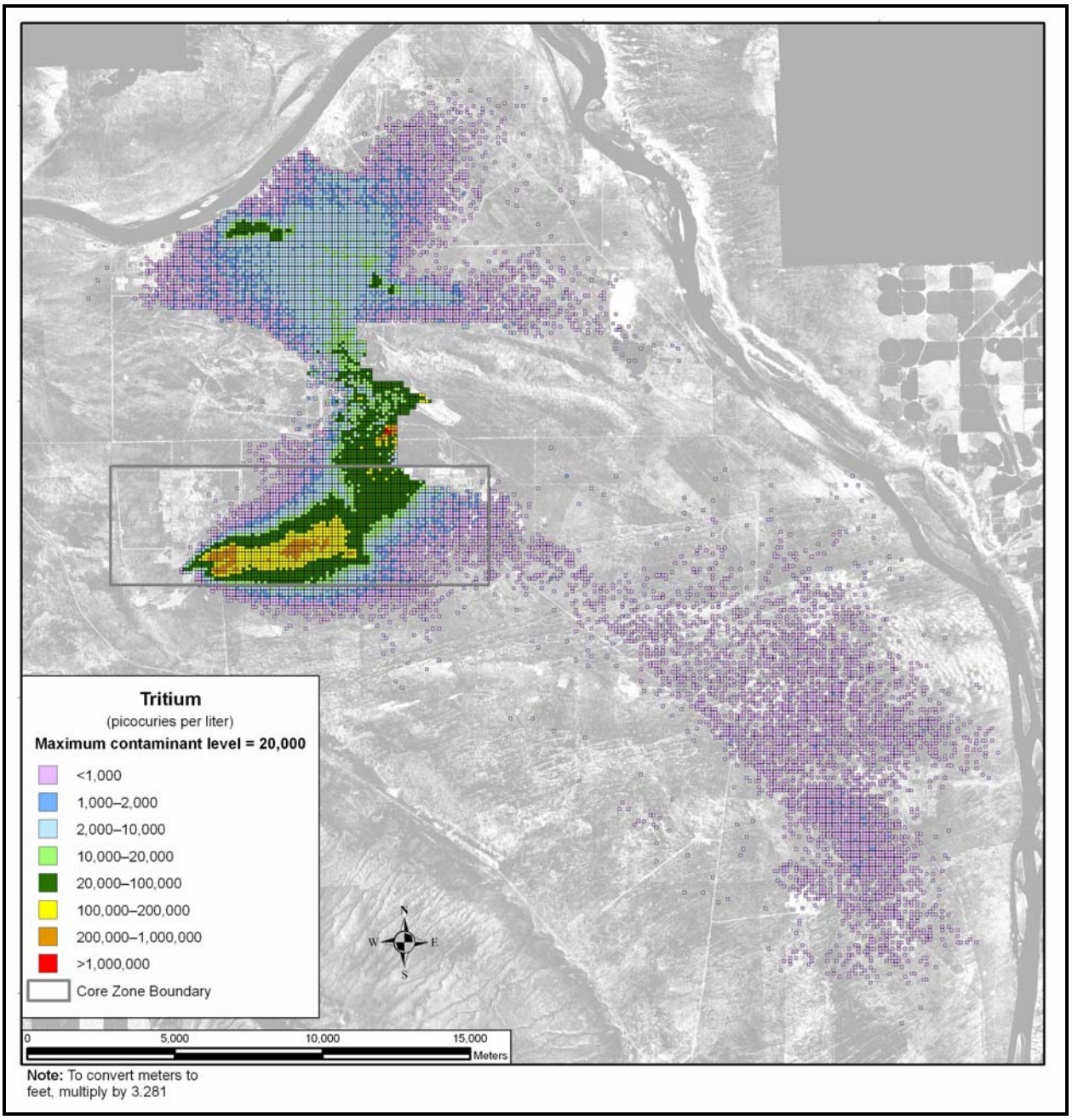


Figure O–21. Base Case Operational Period Reduction-Oxidation (REDOX) Waste Site Hydrogen-3 (Tritium) Plume Map, Calendar Year 2005

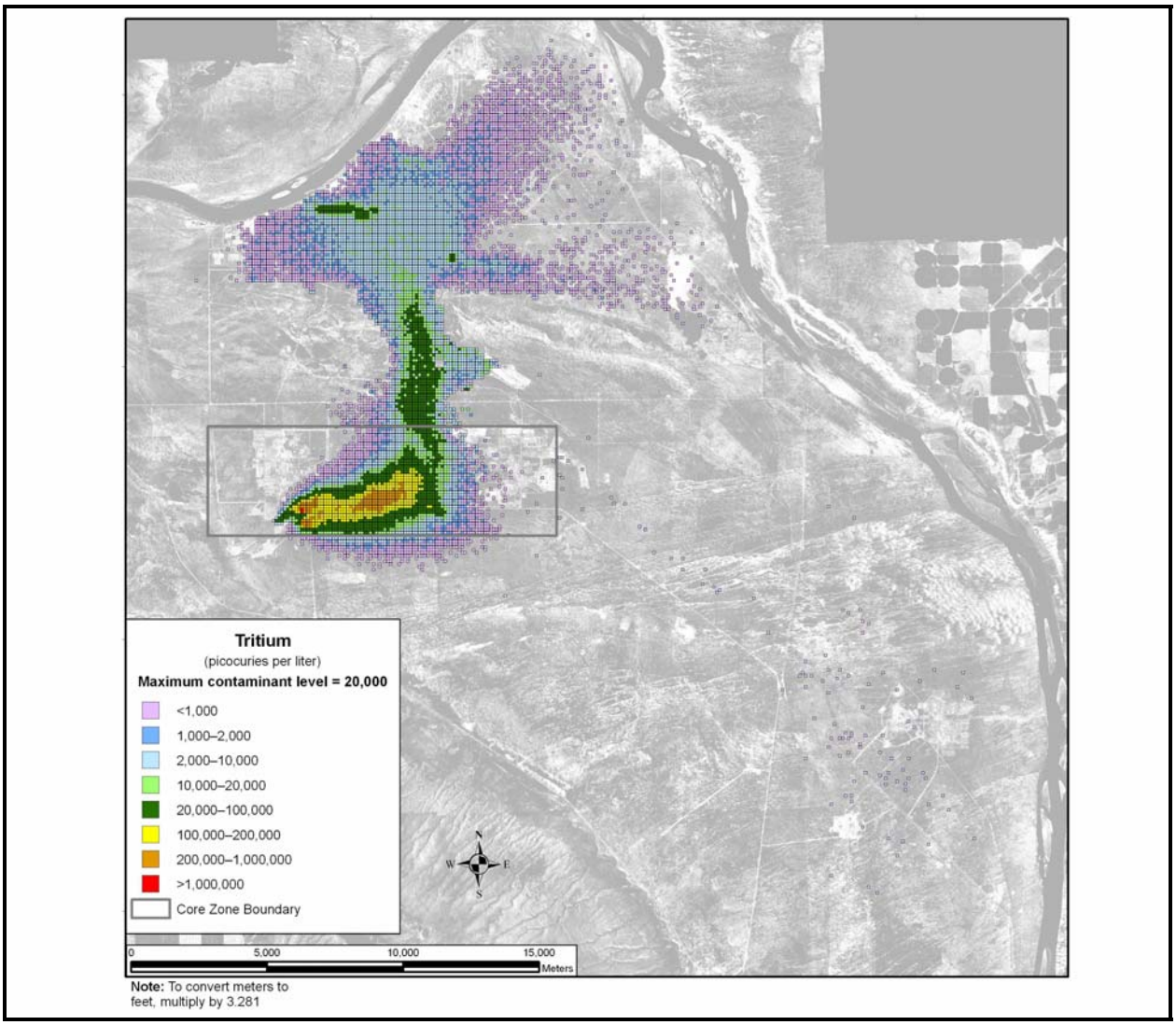


Figure O–22. Alternate Case Operational Period Reduction-Oxidation (REDOX) Waste Site Hydrogen-3 (Tritium) Plume Map, Calendar Year 2005

O.6.2 Comparison of Base Case and Alternate Case Flow Fields During Hanford Postoperational Period

The Base Case flow field was also compared to the Alternate Case flow field for the post-operational period. Particle-tracking analyses were performed to compare the concentration results for technetium-99 at the Columbia River for the Base and Alternate Case flow fields over a 500-year period (1940–2440). This comparison was based on the release of 1 curie of technetium-99 from each of the 10 source areas that are included in this *TC & WM EIS* alternatives analysis (the A, B, S, T, and U tank farms; LLBG 218-W-5 trenches 31 and 34; IDF-East; IDF-West; FFTF; and RPPDF). The releases were assumed to occur within a single year (2100). The peak concentrations of technetium-99 at the Columbia River for both the Base and Alternate Case flow fields are shown in Table O–60 for each source area. Note that, in general, the Alternate Case flow field predicts maximum concentrations at the Columbia River that are 50 to 100 percent greater than the Base Case. This suggests that, in general, the Alternate Case flow field, with greater postoperational flows through Gable Gap, attenuates contaminant mass in the far field to a smaller extent than the Base Case flow field. Figures O–23 through O–32 compares concentration versus time for technetium-99 at the Columbia River for both the Base and Alternate Cases

for each source area during these simulations. The comparison of the Base and Alternate Case flow fields for contaminant transport suggests that the two flow fields yield mostly similar results during the operational period (with the Base Case in somewhat better agreement with field observations), but differ during the postoperational period by up to a factor of 3. Overall, both flow fields predict peak concentrations and spatial distributions within a close order of magnitude of each other and with field data.

Table O–60. Barrier Analysis Results for Hanford Site Postoperational Time Period

Technetium-99 Peak Concentration at the Columbia River in picocuries per liter		
Barrier	**Base Case**	**Alternate Case**
A	6.44×10^{-1}	1.19
	(2206)	(2273–2313)
B	1.09	1.34
	(2207)	(2281)
Fast Flux Test Facility	9.05×10^{-2}	9.06×10^{-2}
	(2171–2436)	(2401–2402)
200-East Area Integrated Disposal Facility	3.89	1.02
	(2149)	(2250–2265)
200-West Area Integrated Disposal Facility	1.20	1.36
	(2201–2203)	(2160)
River Protection Project Disposal Facility	1.02	1.91
	(2191–2192)	(2109)
S	5.94×10^{-1}	9.98×10^{-1}
	(2373)	(2161)
Low-level radioactive waste burial ground 218-W-5 trenches 31 and 34	1.30	1.09
	(2238)	(2166)
T	1.02	1.45
	(2211)	(2144)
U	7.52×10^{-1}	8.20×10^{-1}
	(2242)	(2261)

Note: Corresponding calendar years are shown in parentheses.

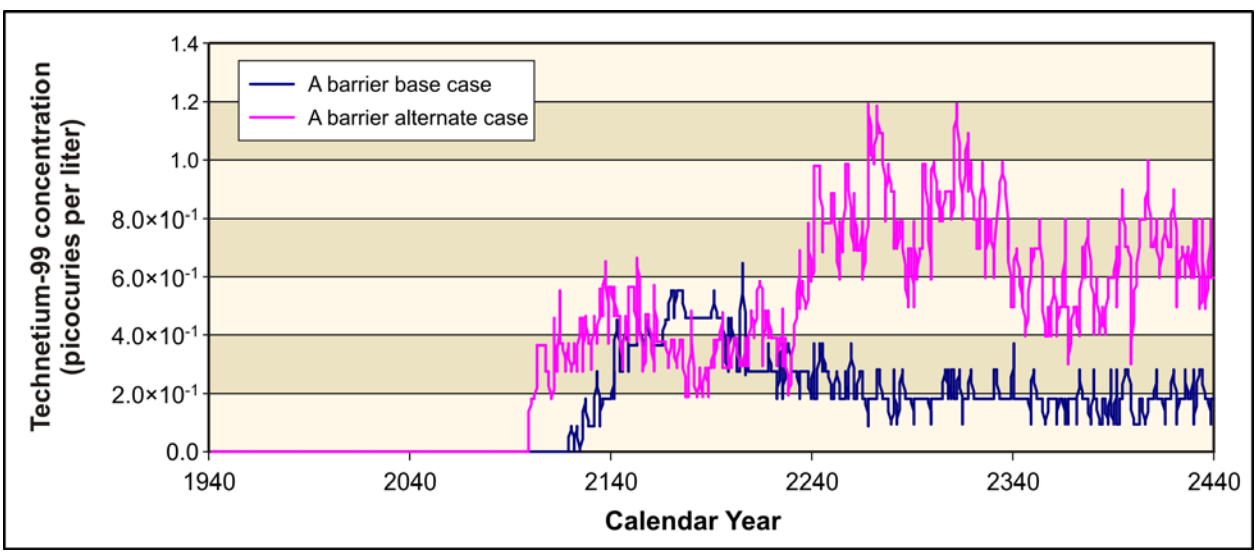


Figure O–23. A Barrier, Hanford Site Postoperational Period

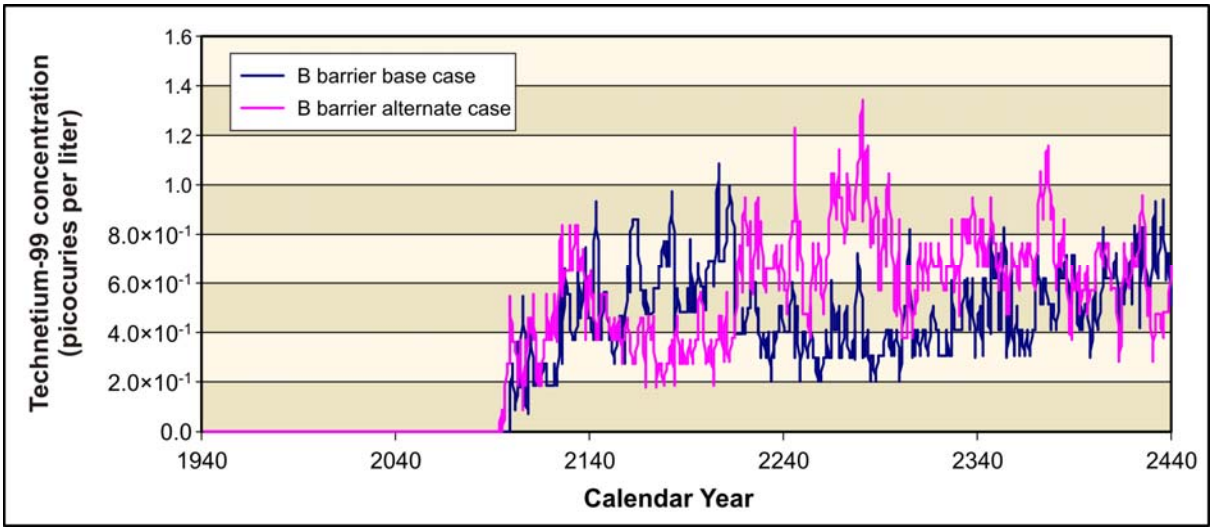


Figure O–24. B Barrier, Hanford Site Postoperational Period

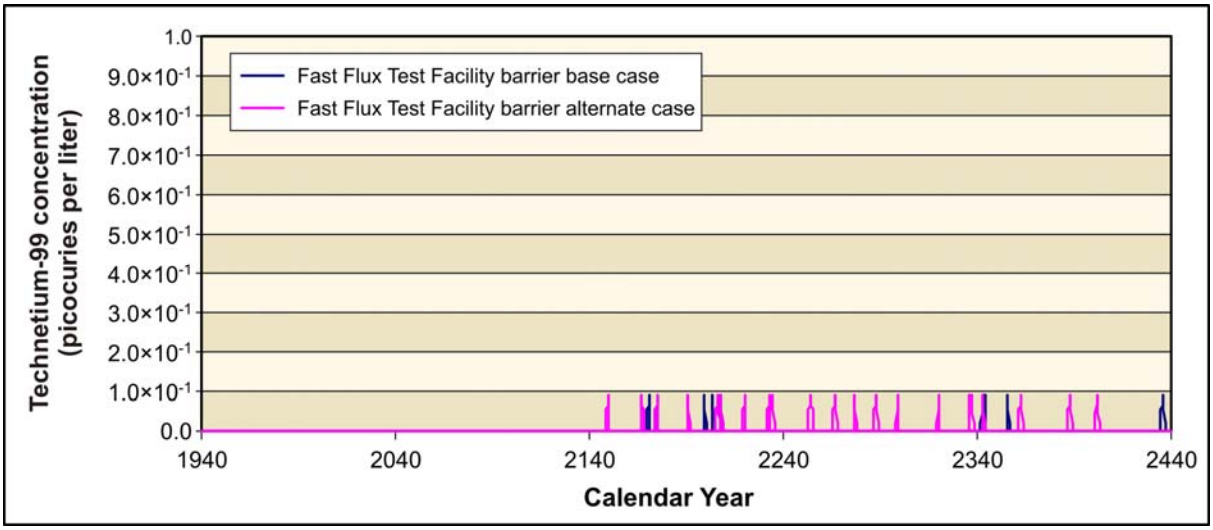


Figure O–25. Fast Flux Test Facility Barrier, Hanford Site Postoperational Period

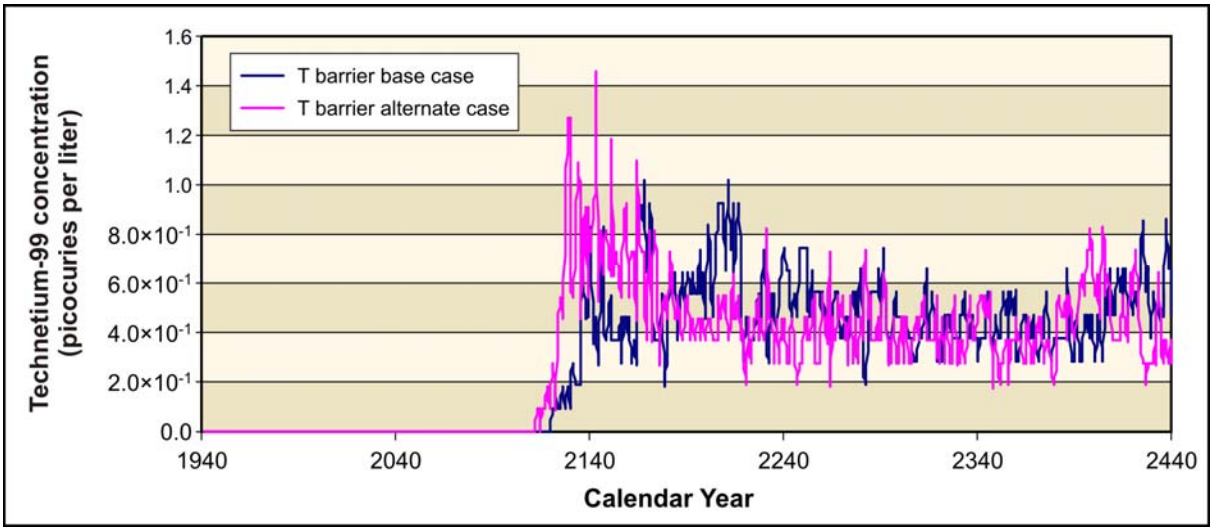


Figure O–26. T Barrier, Hanford Site Postoperational Period

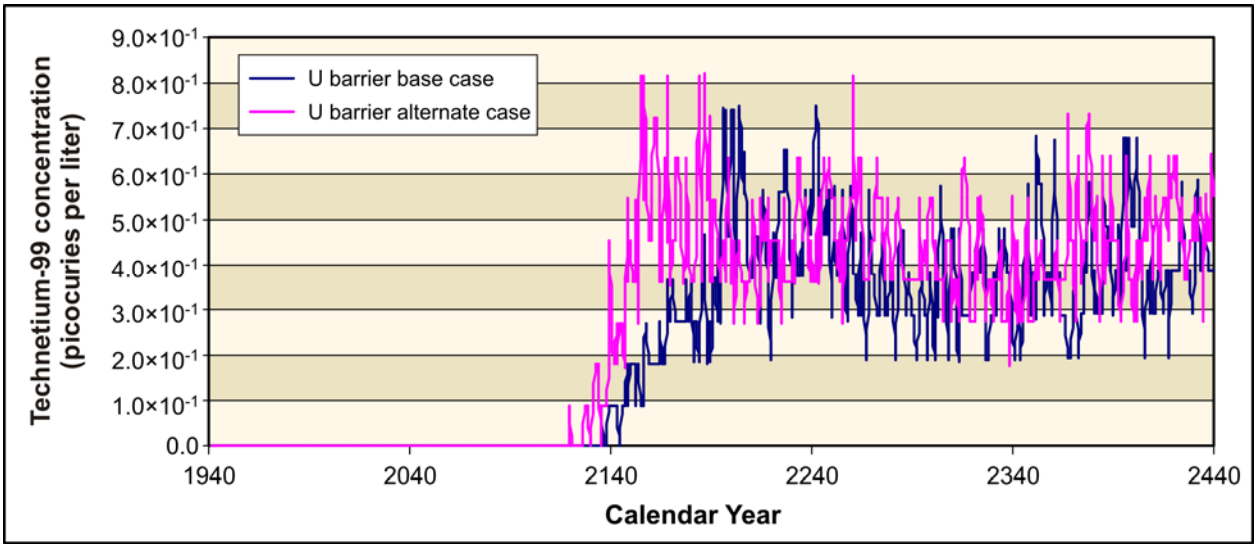


Figure O–27. U Barrier, Hanford Site Postoperational Period

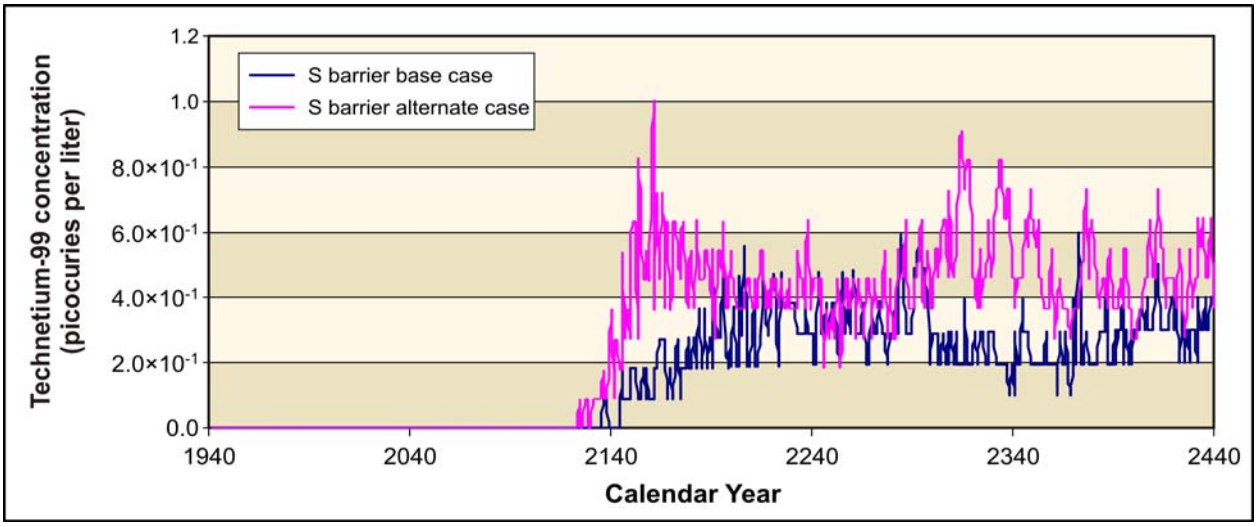


Figure O–28. S Barrier, Hanford Site Postoperational Period

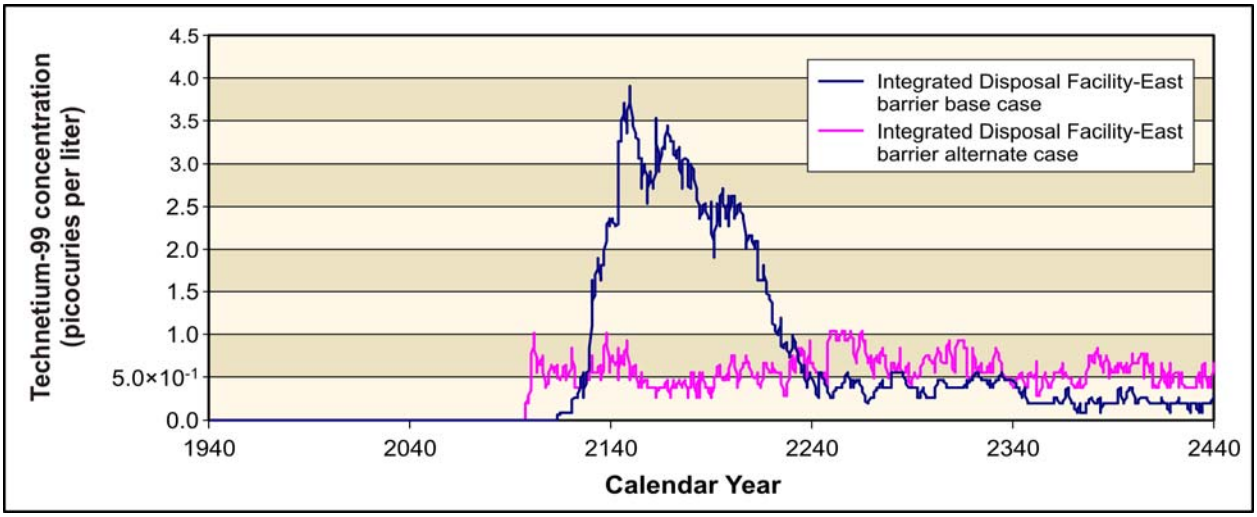


Figure O–29. 200-East Area Integrated Disposal Facility Barrier, Hanford Site Postoperational Period

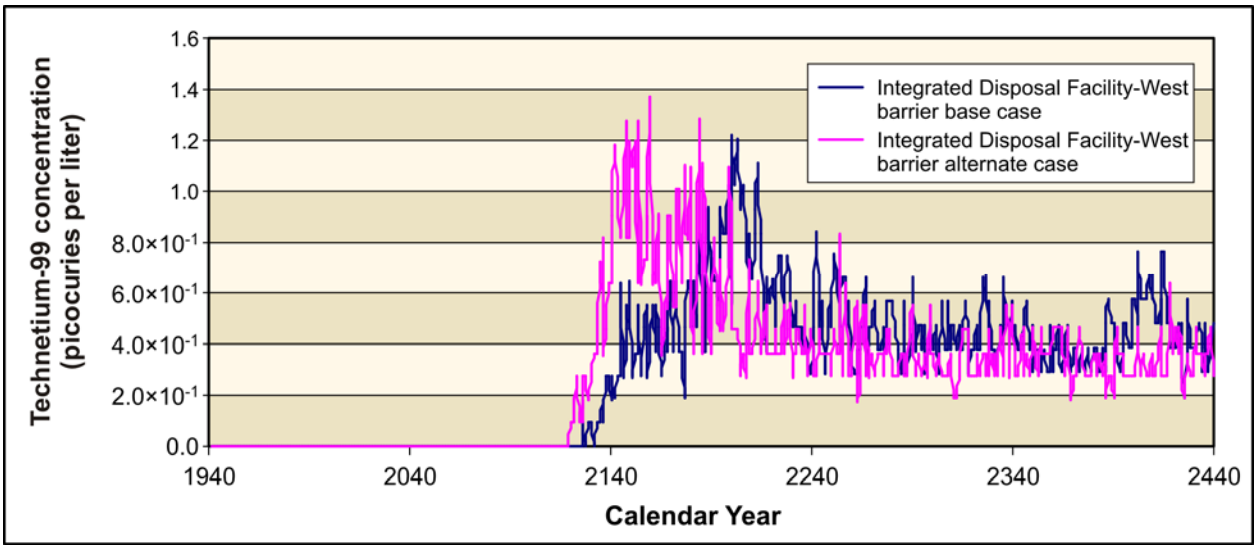


Figure O–30. 200-West Area Integrated Disposal Facility Barrier, Hanford Site Postoperational Period

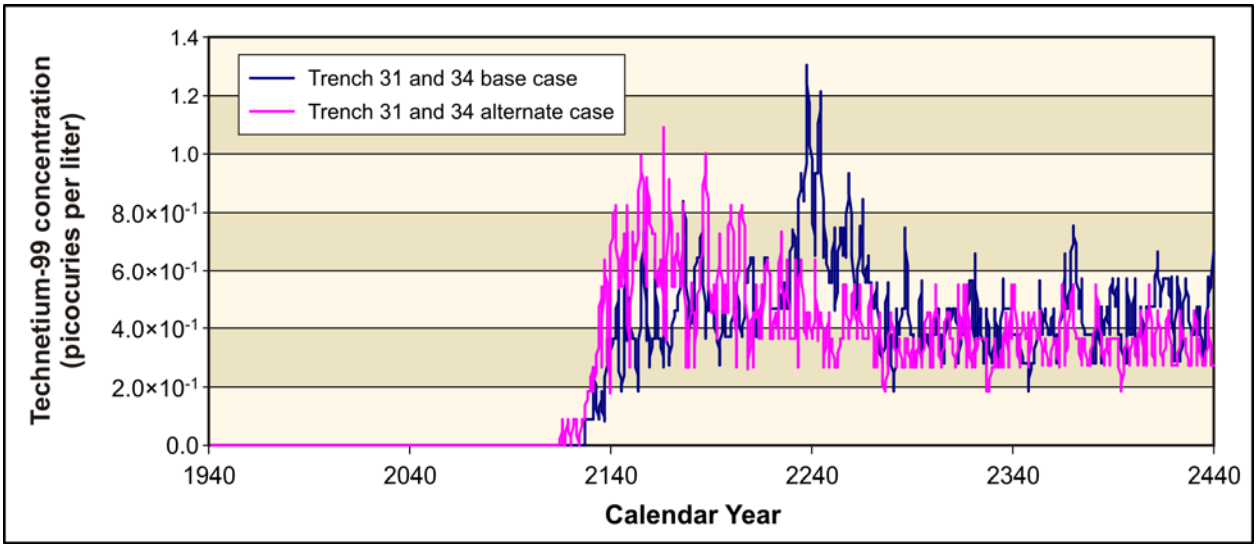


Figure O–31. Low-Level Radioactive Waste Burial Ground Trenches 31 and 34 Barrier, Hanford Site Postoperational Period

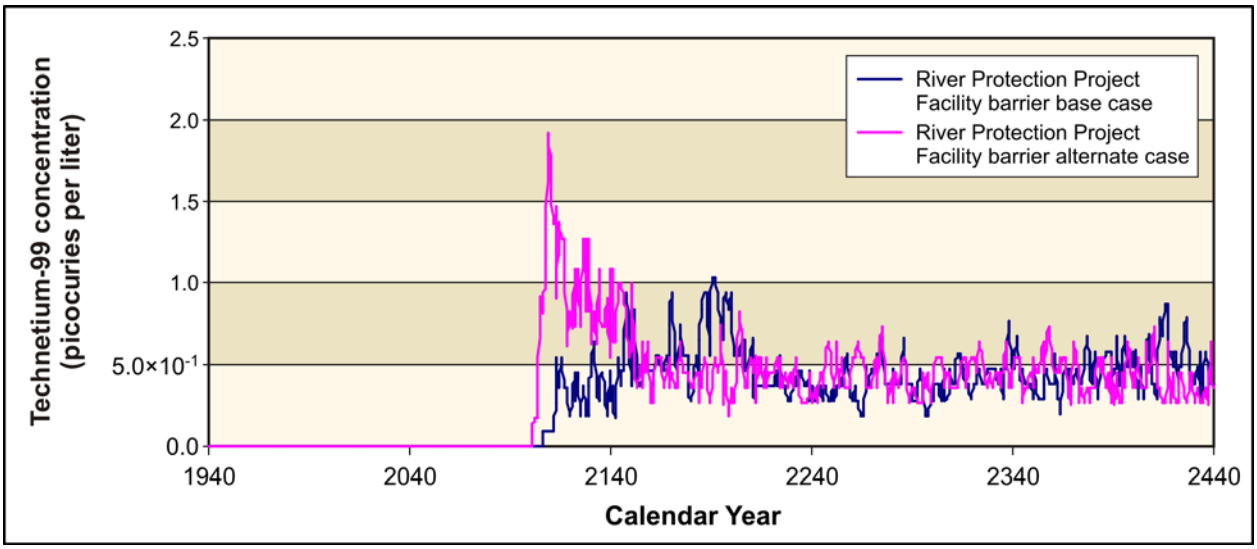


Figure O–32. River Protection Project Disposal Facility Barrier, Hanford Site Postoperational Period

O.6.3 Iodine-129 Distribution Coefficient Sensitivity Analysis

The purpose of the groundwater transport analysis was to project contaminant concentrations in the aquifer from the initial release locations to points of assessment such as the Core Zone Boundary and the Columbia River. Contaminants moving through an aquifer system are affected by a variety of physical and chemical processes. One of these processes includes retardation, which was modeled using the standard distribution coefficient (K_d) approach.

The purpose of this analysis was to demonstrate the sensitivity of contaminant transport relative to changes in the distribution coefficient. The distribution coefficients for iodine-129 were specified in the *Technical Guidance Document for "Tank Closure Environmental Impact Statement" Vadose Zone and Groundwater Revised Analyses* (DOE 2005) as 0 milliliters per gram (Base Case) and 0.2 milliliters per gram (sensitivity case). These values resulted in retardation factors (R) of approximately 1 and 3 for the bulk density (2.6 grams per cubic centimeter) and porosity (0.25) assumed for the unconfined aquifer.

Table O–61 compares the groundwater transport results for each condition (R = 1 and R = 3), showing the peak concentration of iodine-129 and the year of occurrence at the Columbia River and Core Zone Boundary.

Table O–61. Iodine-129 Distribution Coefficient Sensitivity Results

Area	Columbia River in picocuries per liter		Core Zone in picocuries per liter	
	R = 1	R = 3	R = 1	R = 3
BY Cribs	1.97×10^{-1}	1.87×10^{-1}	1.87×10^{2}	6.86×10^{2}
	(2015)	(4071)	(1957)	(1957)
TY Cribs	1.58×10^{-2}	1.75×10^{-2}	1.50×10^{-1}	2.49×10^{-1}
	(3344)	(3900–3905)	(2002)	(2035)

Note: The health-based benchmark for iodine-129 is 1 picocurie per liter (EPA 2002). Corresponding calendar years are shown in parentheses.

Key: R=retardation factor.

For the BY Cribs, the results showed a near-field (Core Zone) increase in the peak concentration of iodine-129 by a factor of 3.5 when the retardation factor was higher (3 versus 1). In both cases, the peak concentrations of iodine-129 occurred at the same time (1957). This was during the operational period, when flow field changes in velocity and direction occurred due to changes in the anthropogenic recharge (see Appendix L). By comparison, the peak concentrations of iodine-129 in the far field (Columbia River) were very similar, with the exception that the peak concentrations occurred much later for the higher retardation factor (3 versus 1).

For the TY Cribs, the results showed a significantly later arrival time for the peak concentrations in the near field (Core Zone) when the retardation factor was higher (3 versus 1). Additionally, the peak concentrations of iodine-129 were higher by a factor of 1.5 when the retardation factor was higher.

By comparison, the peak concentrations of iodine-129 in the far field (Columbia River) were very similar, with the exception that the peak concentrations occurred much later for the higher retardation factor (3 versus 1). These arrival times may be comparatively insignificant because both times were greater than 1,000 years beyond the start of the simulation.

Overall, the iodine-129 K_d sensitivity analysis showed a greater impact with respect to peak concentrations and arrival times for sources located near the Core Zone and the Columbia River than for sources located a greater distance away. Plume maps showing the results of the spatial distribution of iodine-129 for each condition (R = 1 and R = 3) at the BY Cribs and TY Cribs at years 2005, 3500, and 7010 are provided in Figures O–33 through O–44.

These results suggest that changes in transport velocity induced by different retardation factors interact with changes in flow field direction to produce short-term differences in peak concentrations in the near-field. The iodine-129 retardation factor of 1 is in slightly better agreement with the field observations from the BY Cribs; however the iodine-129 retardation factor of 3 is in better agreement with field observations from the TY Cribs in 2005. Overall, the results are in a close order of magnitude agreement for the range of retardation factors investigated.

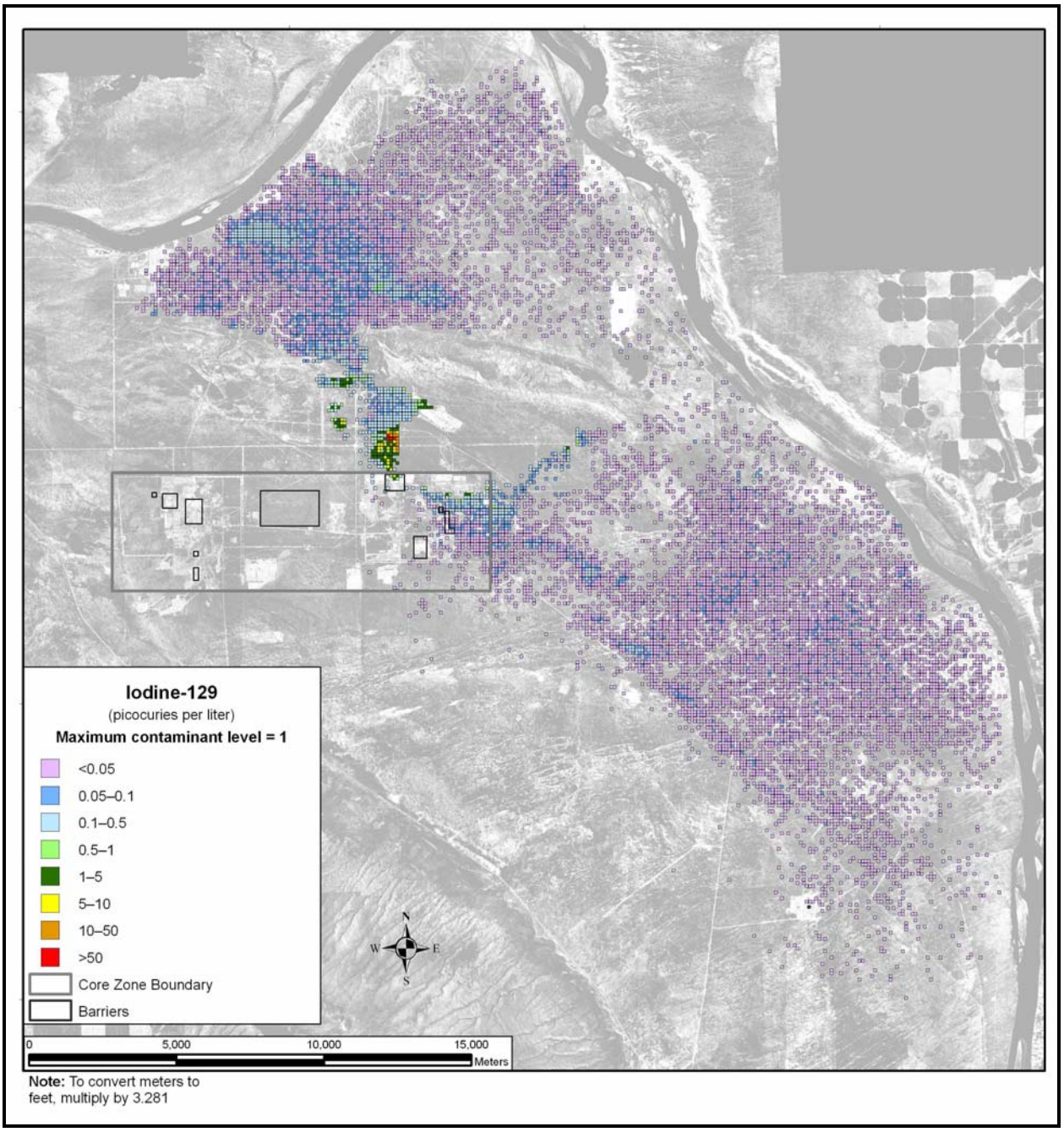


Figure O–33. Spatial Distribution of Groundwater Iodine-129 Concentration at BY Cribs, Calendar Year 2005 – Retardation Factor of One

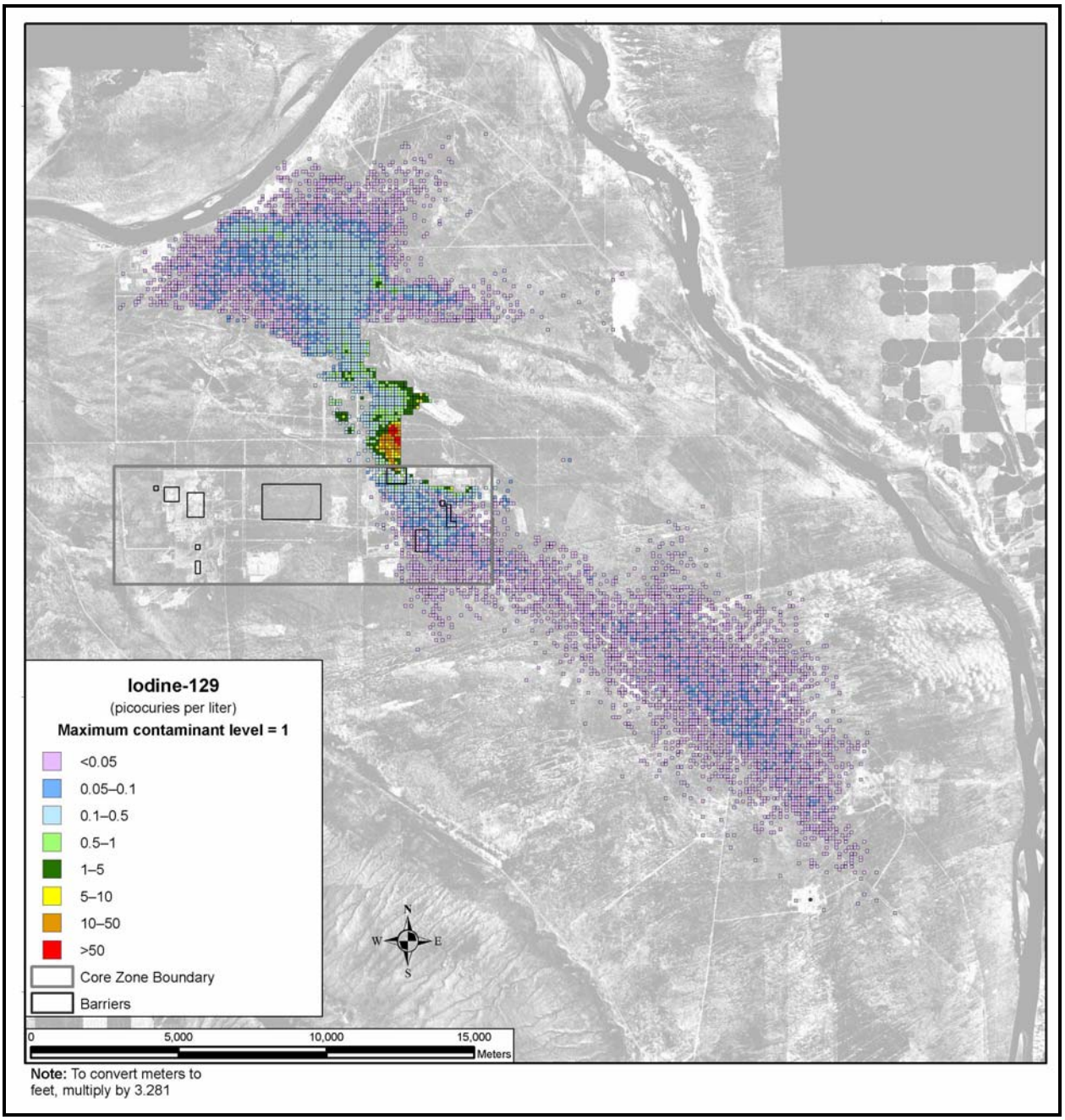


Figure O–34. Spatial Distribution of Groundwater Iodine-129 Concentration at BY Cribs, Calendar Year 2005 – Retardation Factor of Three

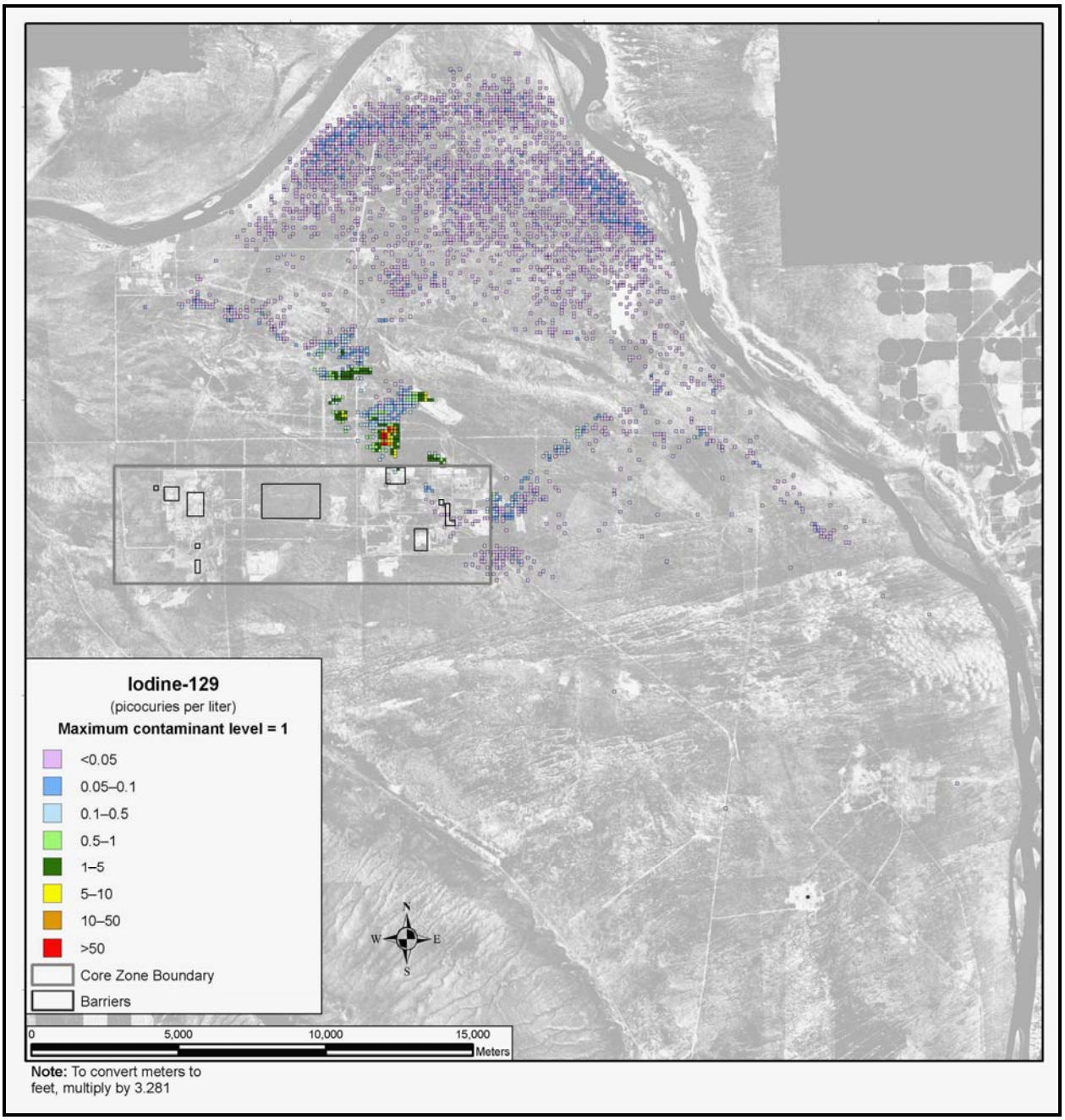


Figure O–35. Spatial Distribution of Groundwater Iodine-129 Concentration at BY Cribs, Calendar Year 3500 – Retardation Factor of One

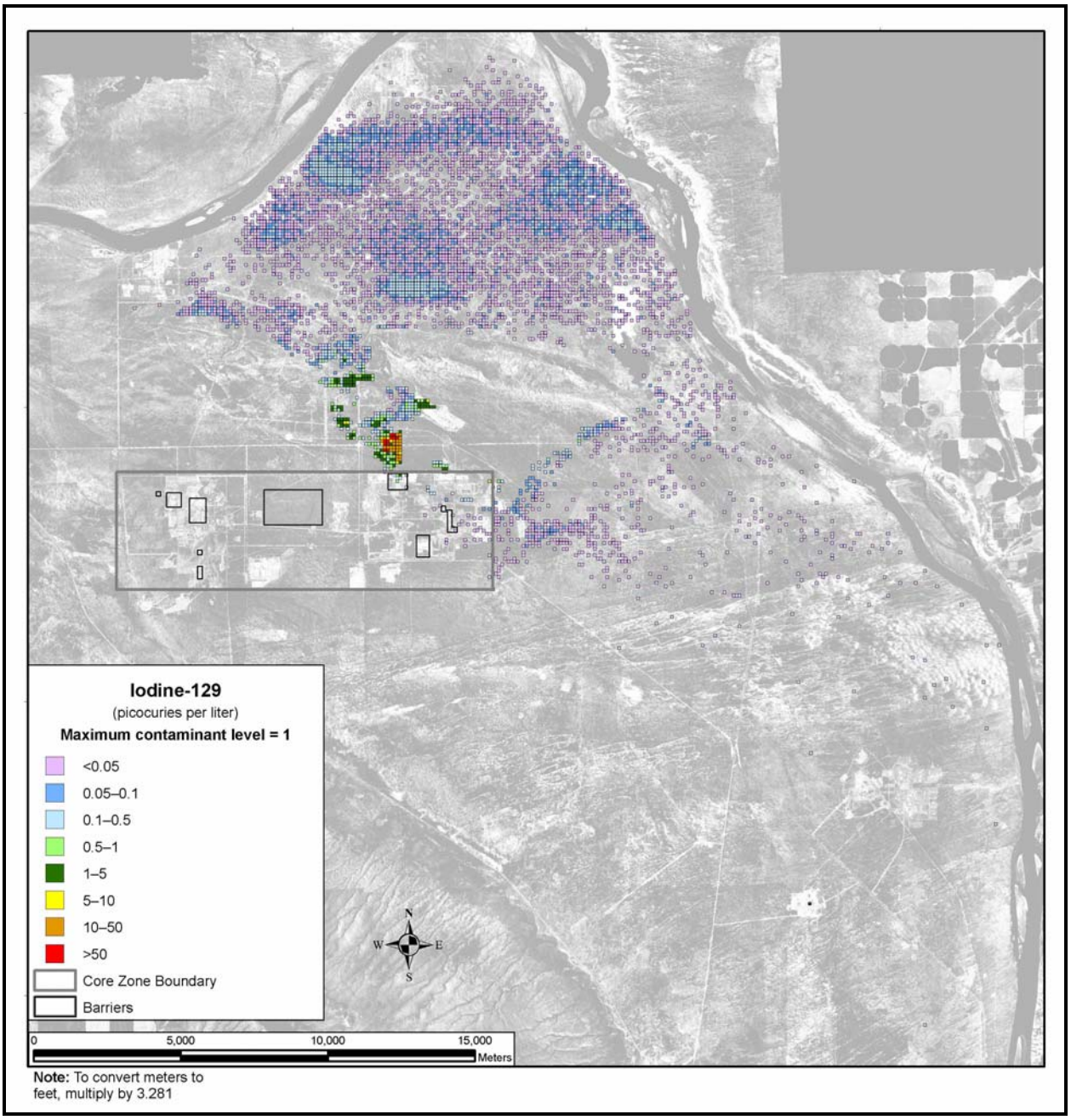


Figure O–36. Spatial Distribution of Groundwater Iodine-129 Concentration at BY Cribs, Calendar Year 3500 – Retardation Factor of Three

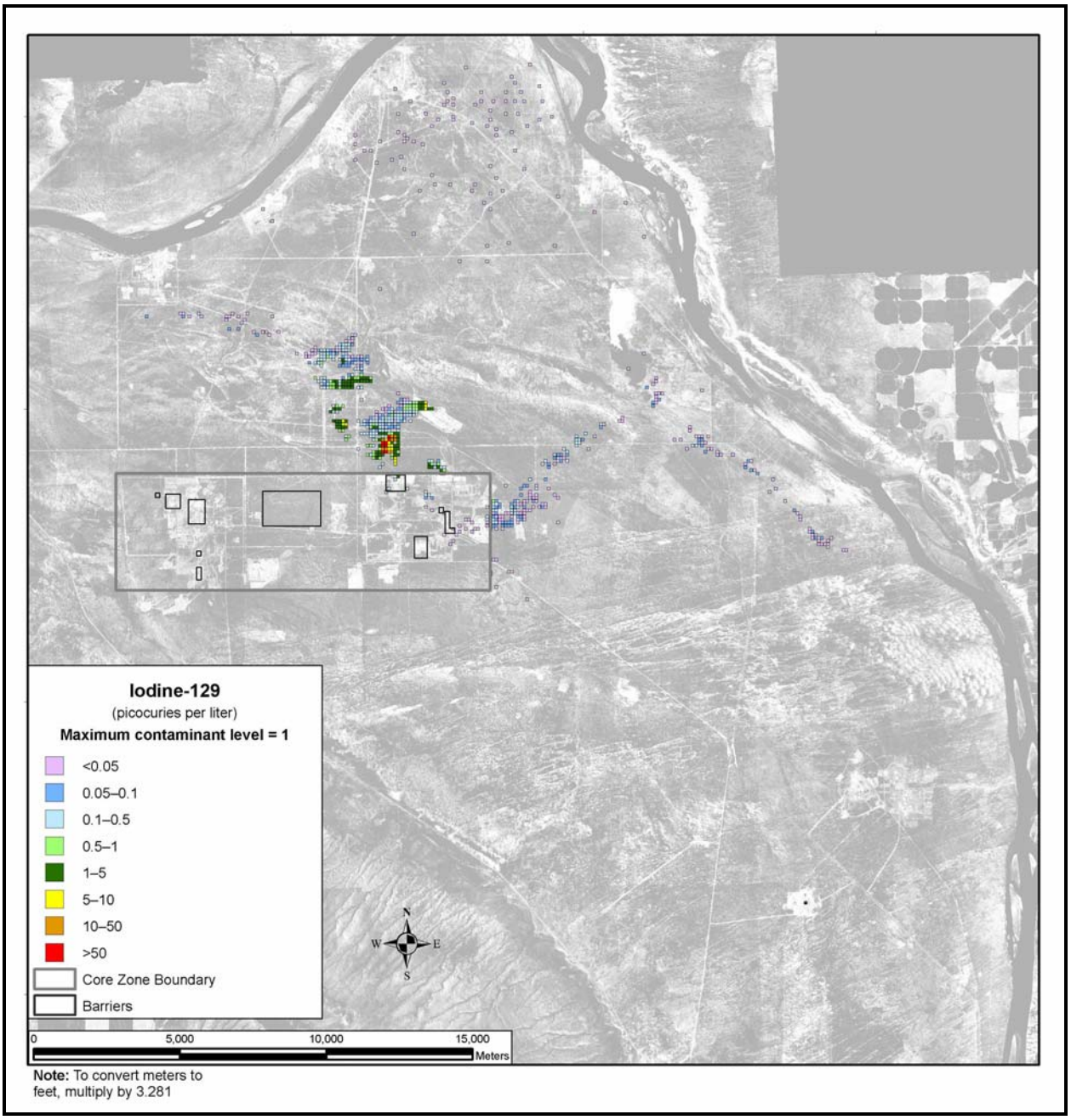


Figure O–37. Spatial Distribution of Groundwater Iodine-129 Concentration at BY Cribs, Calendar Year 7010 – Retardation Factor of One

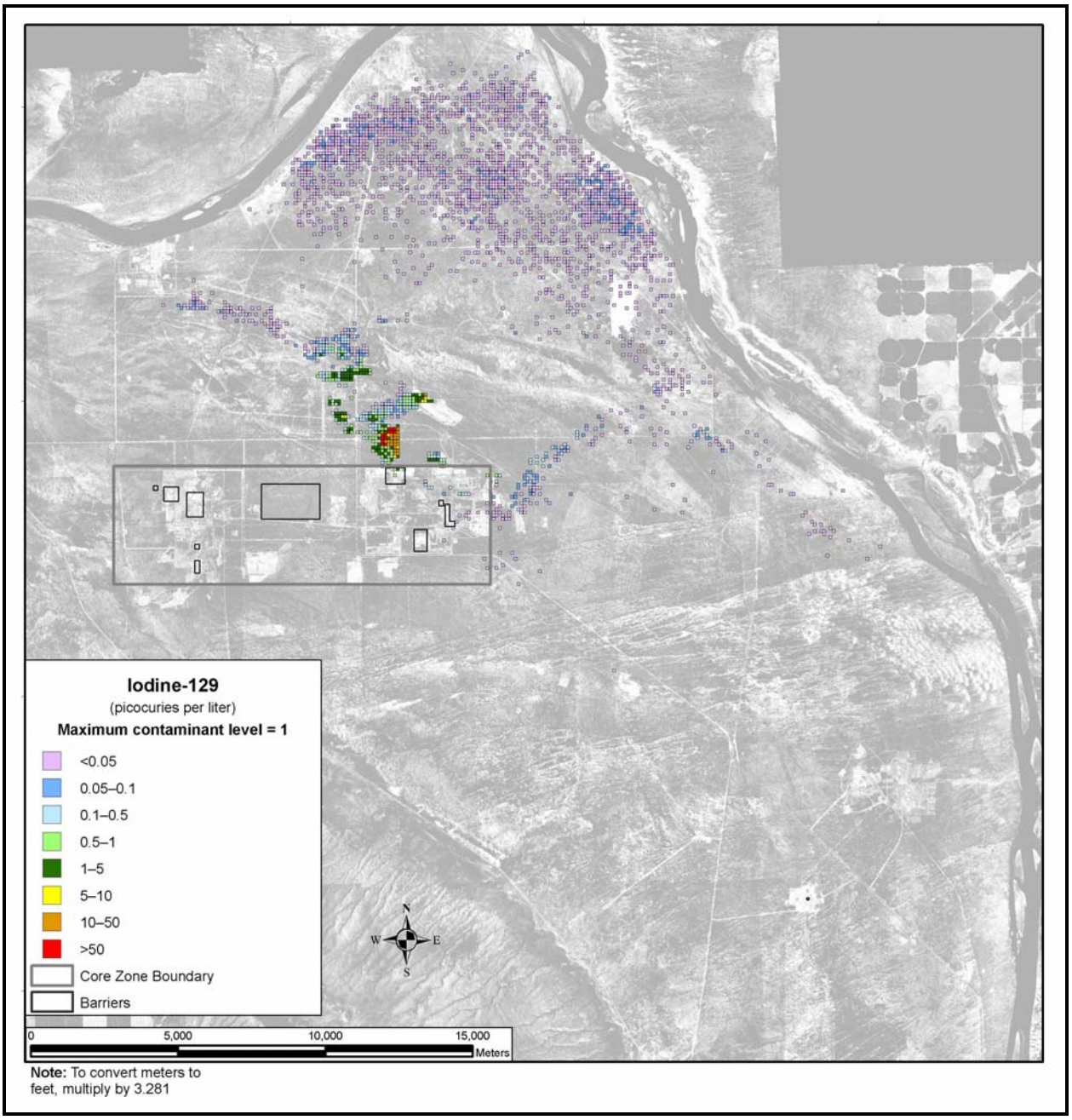


Figure O–38. Spatial Distribution of Groundwater Iodine-129 Concentration at BY Cribs, Calendar Year 7010 – Retardation Factor of Three

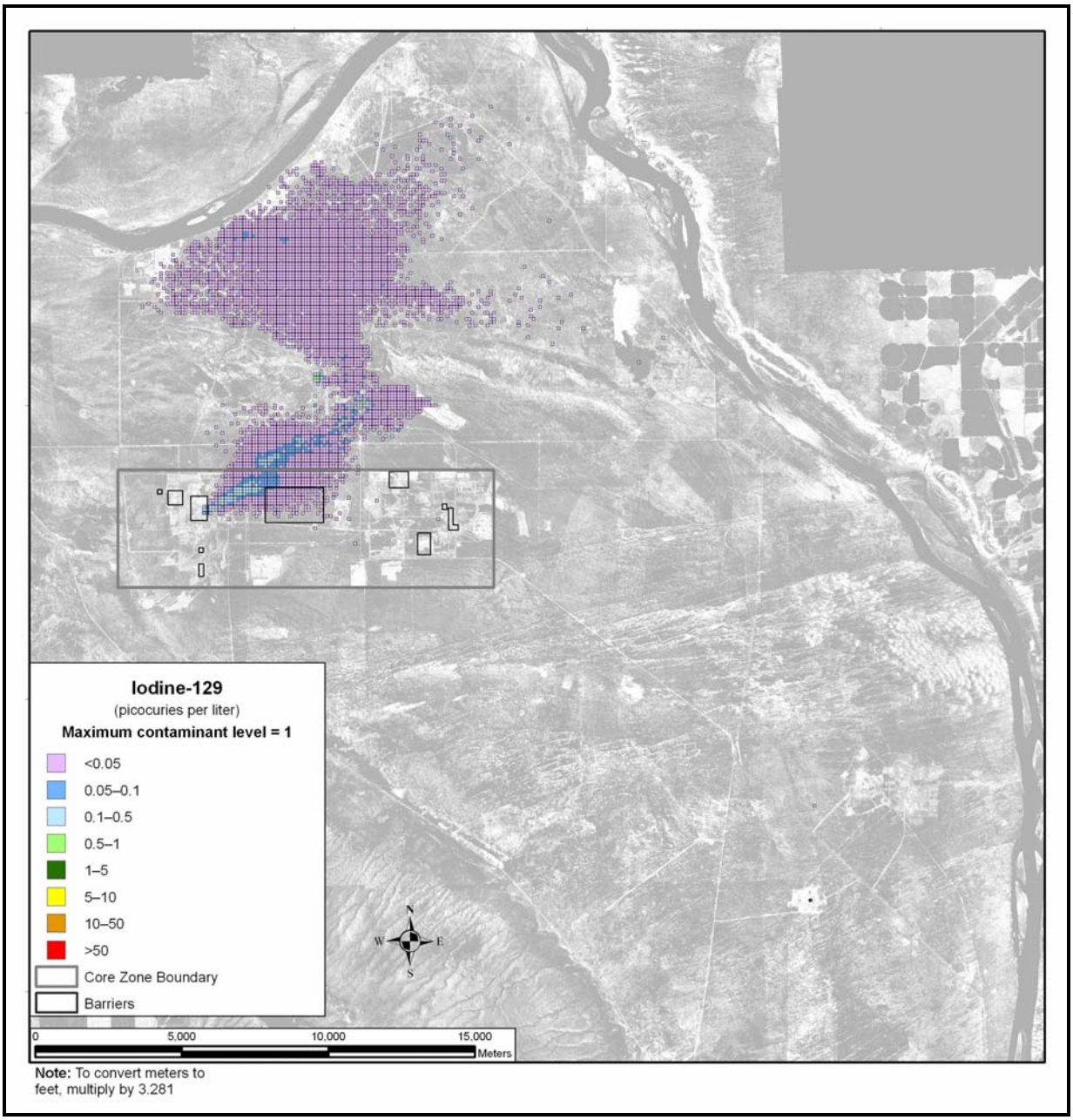


Figure O–39. Spatial Distribution of Groundwater Iodine-129 Concentration at TY Cribs, Calendar Year 2005 – Retardation Factor of One

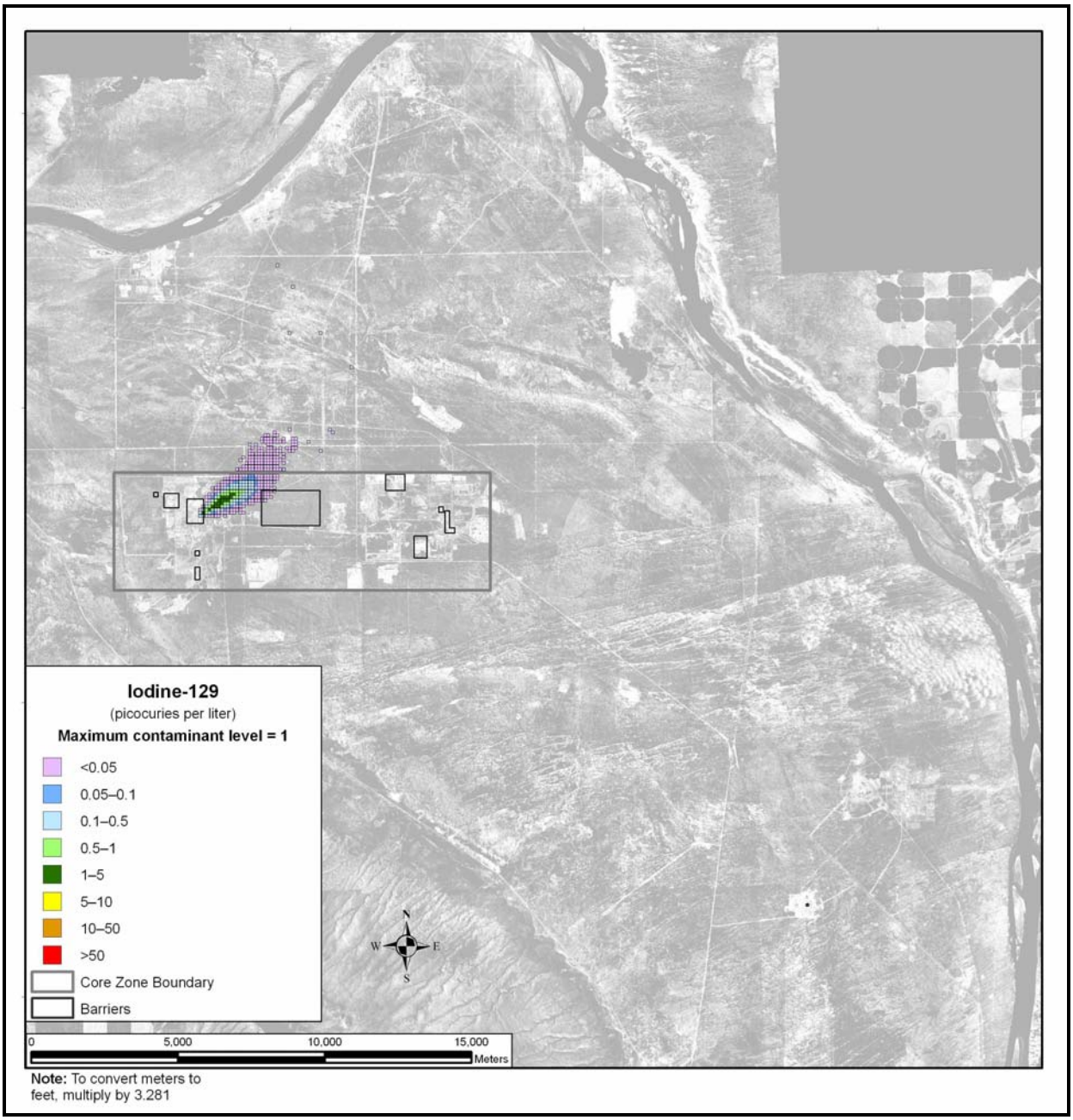


Figure O–40. Spatial Distribution of Groundwater Iodine-129 Concentration at TY Cribs, Calendar Year 2005 – Retardation Factor of Three

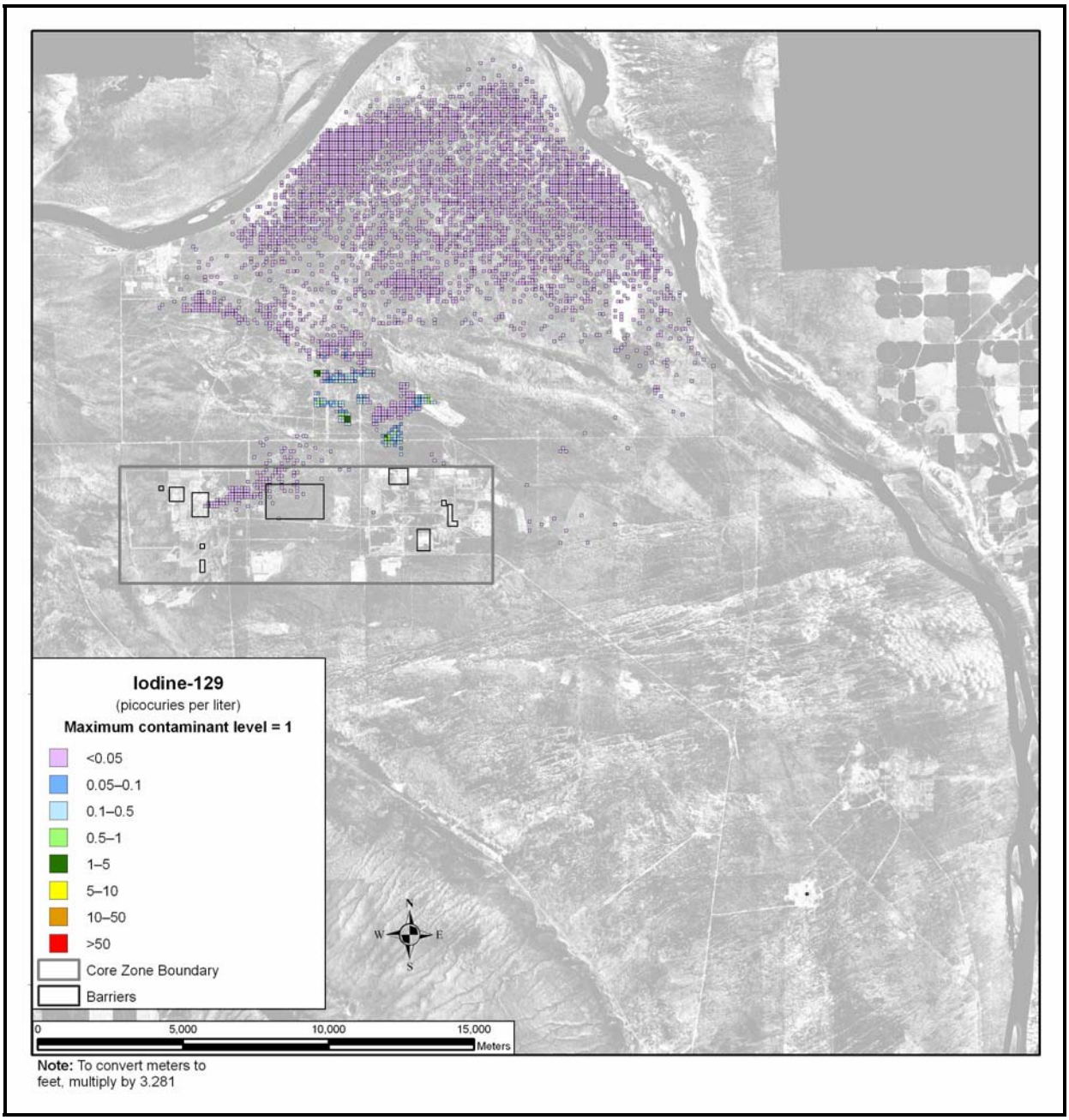


Figure O–41. Spatial Distribution of Groundwater Iodine-129 Concentration at TY Cribs, Calendar Year 3500 – Retardation Factor of One

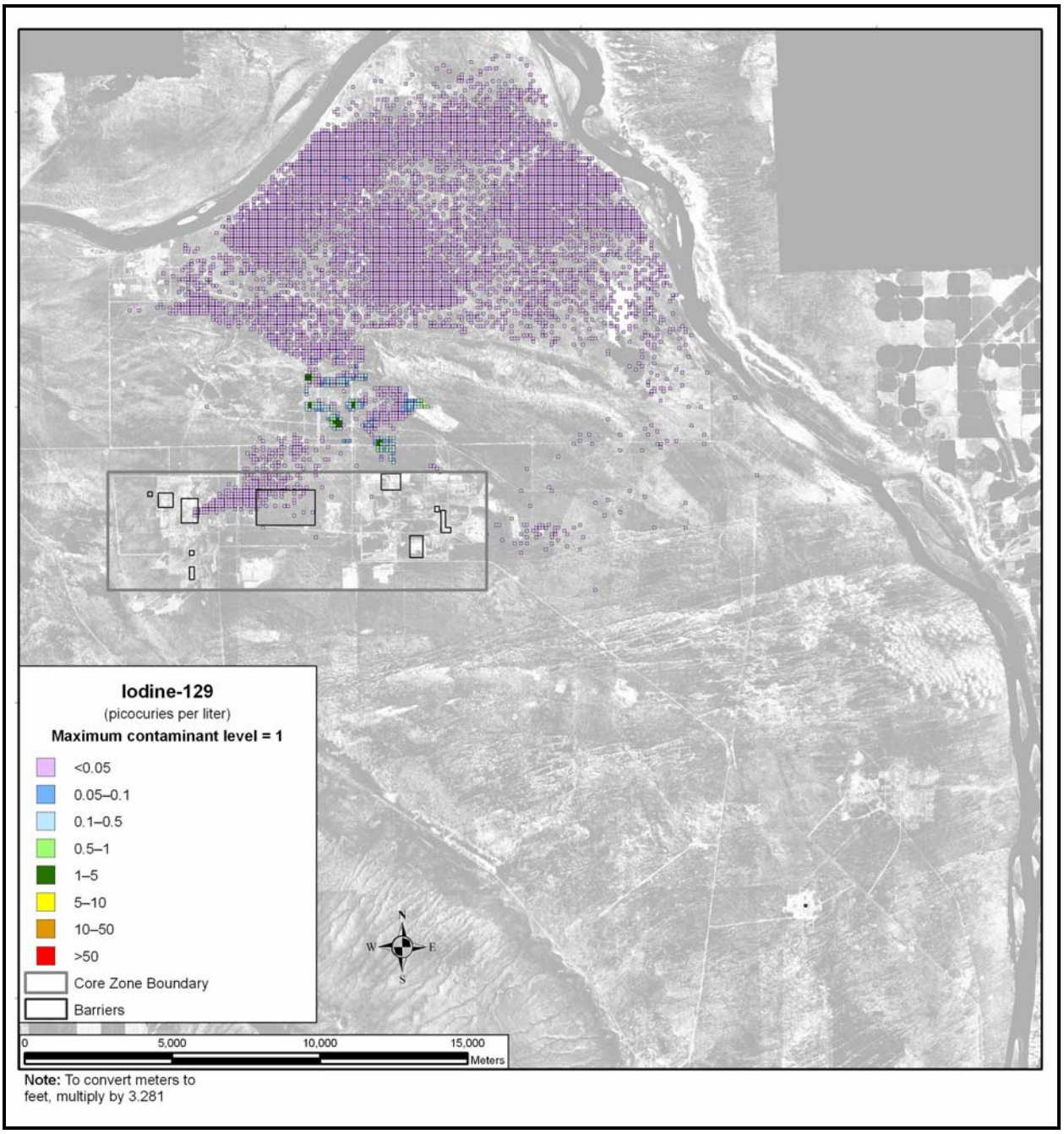


Figure O–42. Spatial Distribution of Groundwater Iodine-129 Concentration at TY Cribs, Calendar Year 3500 – Retardation Factor of Three

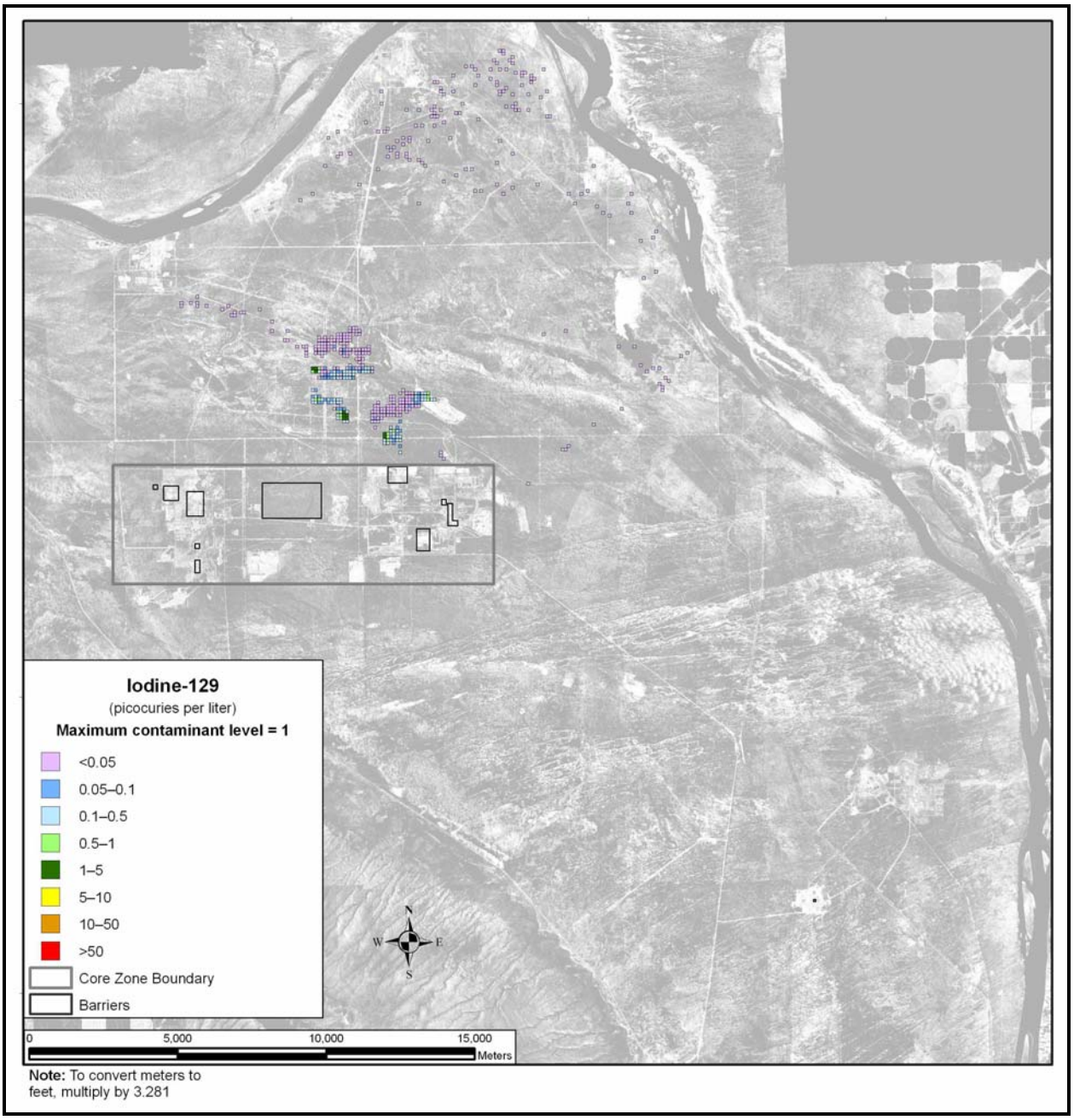


Figure O–43. Spatial Distribution of Groundwater Iodine-129 Concentration at TY Cribs, Calendar Year 7010 – Retardation Factor of One

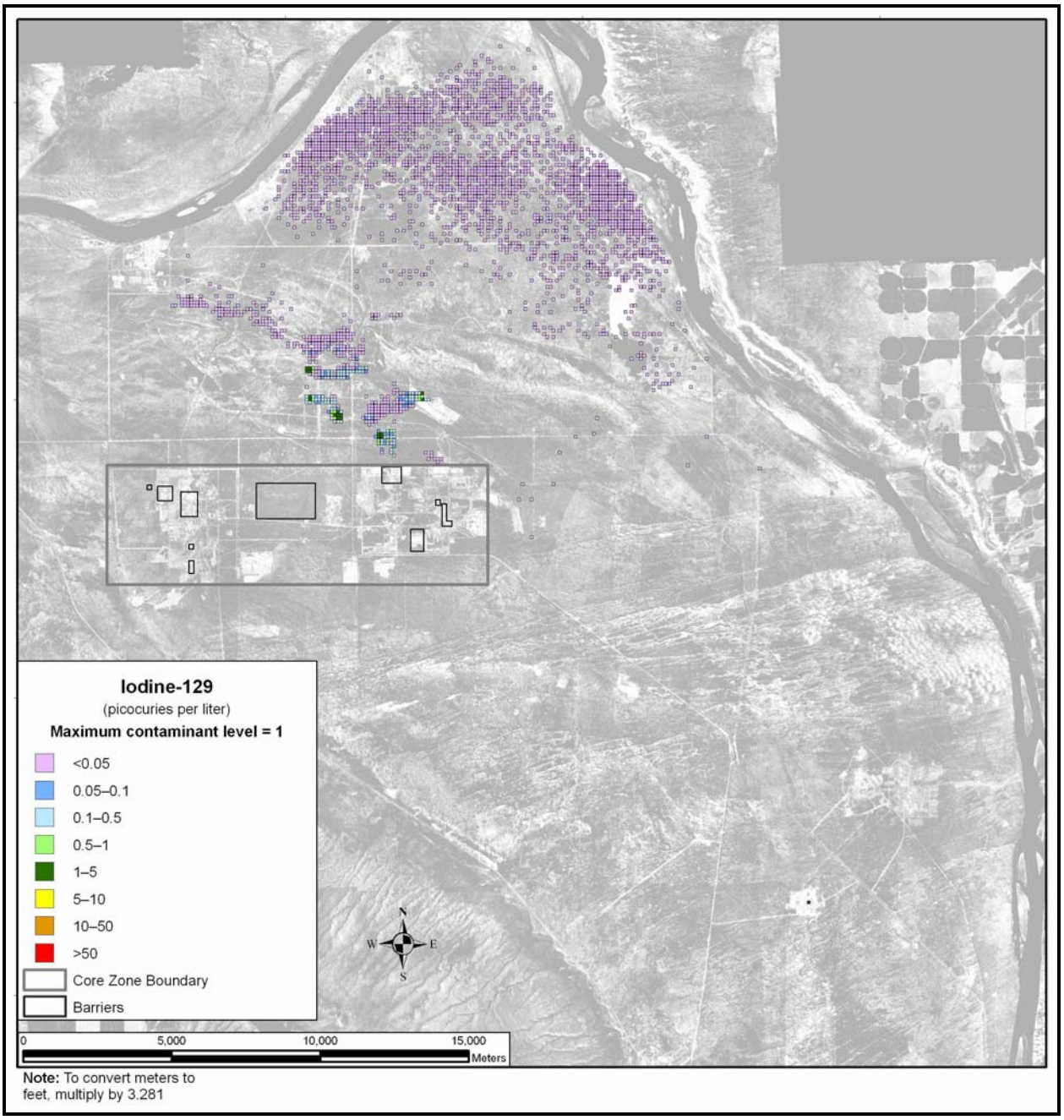


Figure O–44. Spatial Distribution of Groundwater Iodine-129 Concentration at TY Cribs, Calendar Year 7010 – Retardation Factor of Three

O.6.4 Long-Term Analysis of Uranium-238

Many of the results from standard groundwater transport runs showed increases in uranium-238 concentrations at the end of the analysis period. It is uncertain whether peak concentrations of uranium-238 were captured during this standard analysis period of 10,000 years. Therefore, it was necessary to increase the analysis period to 30,000 years to observe whether peak concentrations of uranium-238 occurred beyond the standard analysis period. The particle-tracking code calculated uranium-238 concentrations using a retardation factor of 7.24 (K_d = 0.6) and a half-life of 4.47×10^9 years.

Uranium-238 from the SX tank farm was selected for this test case. First, the vadose zone (STOMP) analysis was modified to run for 30,000 years. The results of the standard and modified STOMP analysis were as follows:

Standard (10,000 years)

Flux in = 2.97×10^{1} curies
Flux out = 1.05×10^{1} curies
Accumulated solute = 1.93×10^{1} curies
Decay (percent) = 4.04×10^{-5}

Modified (30,000 years)

Flux in = 2.97×10^{1} curies
Flux out = 2.81×10^{1} curies
Accumulated solute = 1.65 curies
Decay (percent) = 5.69×10^{-5}

Groundwater transport analysis was performed using the results from the modified STOMP analysis. The results of the standard and modified groundwater transport runs were as follows:

Standard (10,000 years)

Release to groundwater = 1.02×10^{1} curies
Release to Columbia River = 2.83×10 curies

Modified (30,000 years)

Release to groundwater = 2.8×10^{1} curies
Release to Columbia River = 2.50×10^{1} curies

The maximum concentrations and years of occurrence for uranium-238 for both conditions (10,000 years and 30,000 years) are shown in Figures O–45 and O–46 and Table O–62.

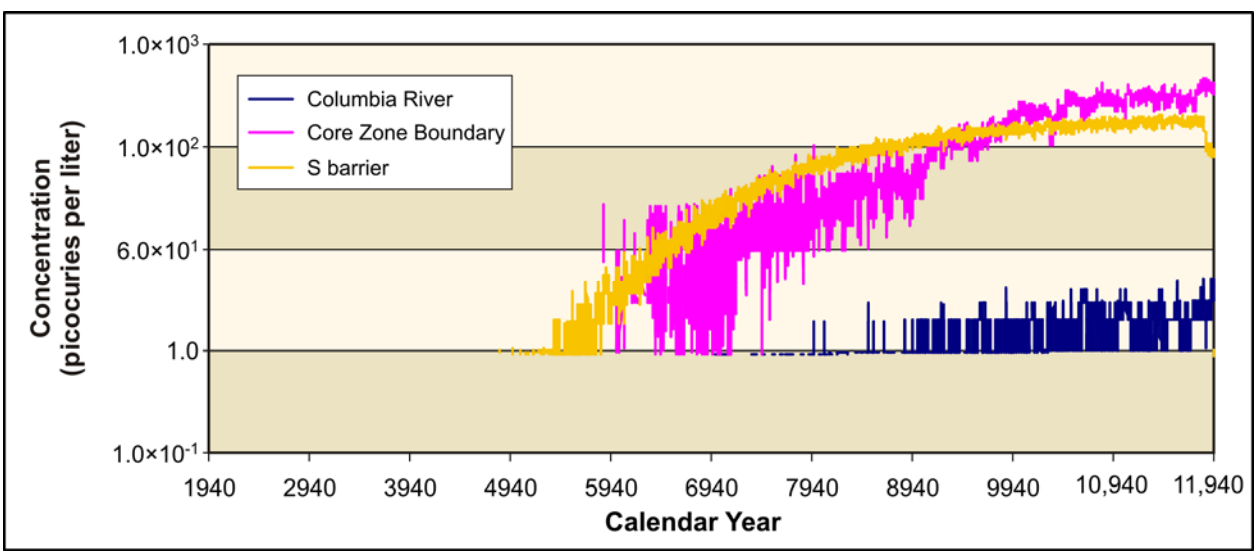


Figure O–45. Concentration of Uranium-238 for Standard 10,000-Year Period

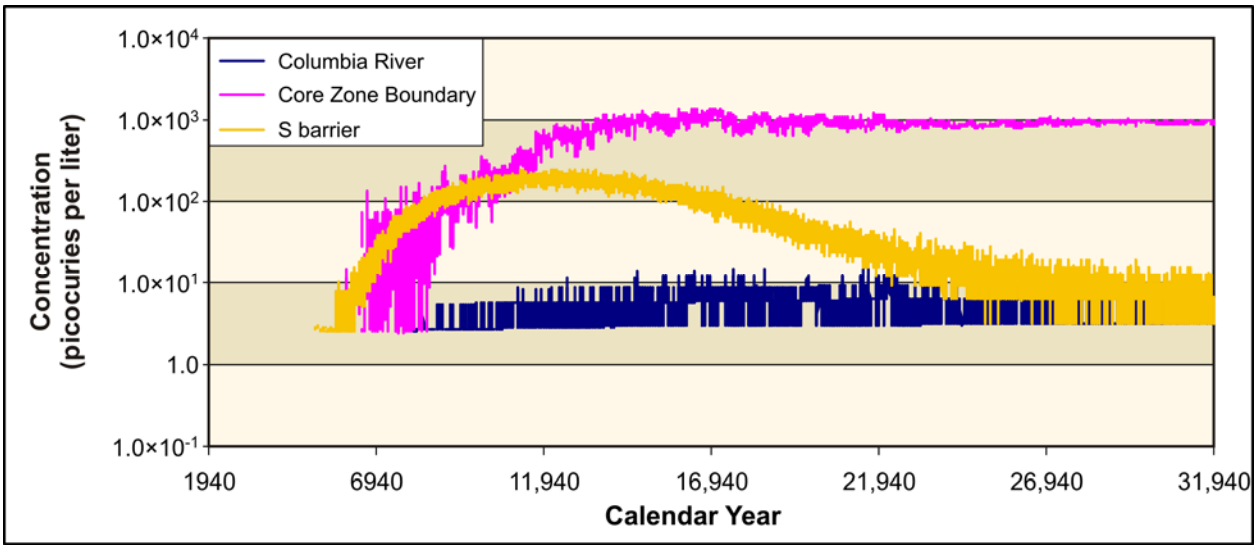


Figure O–46. Concentration of Uranium-238 for Modified 30,000-Year Period

Table O–62. Summary of Maximum Uranium-238 Concentrations (10,000- Versus 30,000-Year Periods)

Maximum Concentration of U-238 in picocuries per liter				
Run Duration (years)	**Uranium-238 Release to Groundwater in Curies**	**S Barrier**	**Core Zone**	**Columbia River**
10,000	1.02×10^{1}	2.12×10^{2} (11,399–11,743)	4.82×10^{2} (11,869)	5.05 (11,934)
30,000	2.80×10^{1}	2.40×10^{2} (12,114–13,118)	1.36×10^{3} (16,880–17,040)	1.52×10^{1} (22,162–22,238)

Note: The health-based benchmark for uranium-238 (includes uranium-233, -234, -235 and -238) is 15 picocuries per liter (EPA 2009a).

By comparison, the groundwater transport behavior of uranium-238 was different when reported over a 30,000-year period versus the standard 10,000-year period. The first notable difference was the much higher release of uranium-238 to groundwater from the vadose zone (three times).

The near-field (S Barrier) results for both time periods showed very similar peak concentration values and slightly slower arrival times. The far-field results (Core Zone and Columbia River) for the 30,000-year period showed peak concentration values that were consistently higher by an order of magnitude. Additionally, the results for the 30,000-year period showed much later peak arrival times (1,000 to 10,000 years).

O.6.5 Sensitivity to Contaminant Inventory Variations

One of the biggest uncertainties in the alternative impact groundwater analyses is the time history of contaminant flux entering the aquifer from a particular source. This flux history is uncertain because of uncertainties in inventories, release mechanisms, and infiltration histories (see Appendices M and N). Expectations are that uncertainties in the rate of release from a source will result in consequent variations in the predictions of concentrations in the far field (at the Columbia River nearshore). This sensitivity analysis reflects how those uncertainties were propagated through the model.

The purpose of this analysis was to demonstrate the sensitivity of contaminant transport results due to uncertainties in the flux discharged to the unconfined aquifer. Flux files (produced from STOMP output, see Appendix N) for technetium-99 were selected from the BY and TY Crib areas from the Base Case alternatives impact analysis. To reflect uncertainties in inventory, 100 variants of the Base Case were generated. For each variant, the flux history predicted by STOMP was multiplied by a uniformly distributed random number ranging from 0.5 to 1.5. This roughly reflects a 50 percent uncertainty in inventory. The randomly generated scaling factors are shown in Table O–63.

Each realization was run for 500 years (1940–2440) using the Base Case flow field.

Figures O–47 through O–49 show the resulting technetium-99 concentrations for all BY Crib realizations at the Columbia River, Core Zone Boundary, and B Barrier.

Figures O–50 through O–52 show the resulting technetium-99 concentrations for all TY Crib realizations at the Columbia River, Core Zone Boundary, and T Barrier.

These results suggest that variations of source strength on the order of 50 percent would result in large variations in the near field (at the barriers surrounding the sources). This effect would be greater at the B Barrier (with resulting variations in concentration of over an order of magnitude) than at the T Barrier (with resulting variations in concentration of about 50 percent). For both the T and B Barriers, the concentration variations would diminish with distance from the source. The results further suggest that uncertainties in source strength would translate roughly linearly into variations in concentrations at the Columbia River.

Evaluations of the differences among the alternatives were performed by comparing the groundwater concentrations for combinations of sources at the barriers, the Core Zone Boundary, and the Columbia River. These evaluations were developed from information containing uncertainties in source strength that were roughly on the order of about 50 percent. The model propagated these uncertainties into uncertainties in concentration predictions that were roughly less than or equal to an order of magnitude. The uncertainties in concentration prediction are expected to be greater for sources in the 200-East Area than in the 200-West Area because of greater temporal and spatial variations in the flow field.

The data demonstrated that, for the range of scaling factors applied to each flux input (0.559–1.631), the fluctuation in flux out at the barriers, Core Zone Boundary, and Columbia River would lead to variations in concentration predictions ranging from 50 to 100 percent over the 500-year span.

Table O–63. Randomly Generated Scaling Factors Used to Demonstrate Sensitivity to Flux Uncertainty

Realization	Scaling Factor Applied	Realization	Scaling Factor Applied	Realization	Scaling Factor Applied	Realization	Scaling Factor Applied
1	0.796	26	0.887	51	1.063	76	0.985
2	0.794	27	0.819	52	1.056	77	0.917
3	1.000	28*	0.559	53	1.089	78	0.982
4	1.008	29	1.411	54	1.117	79	1.386
5	1.587	30	0.947	55	1.054	80	0.977
6	1.369	31	1.147	56	0.881	81*	1.631
7	0.890	32	0.821	57	1.158	82	0.594
8	0.952	33	0.721	58	1.164	83	0.986
9	1.158	34	1.018	59	1.182	84	0.714
10	1.017	35	0.932	60	1.021	85	0.56
11	1.044	36	1.263	61	0.904	86	1.067
12	1.059	37	0.666	62	0.606	87	1.087
13	1.002	38	0.843	63	1.318	88	0.875
14	1.295	39	0.65	64	0.801	89	1.12
15	1.507	40	1.288	65	0.731	90	0.876
16	1.231	41	0.926	66	0.934	91	1.181
17	1.103	42	0.932	67	1.252	92	1.018
18	1.392	43	0.913	68	0.84	93	1.279
19	1.337	44	1.147	69	0.889	94	1.234
20	1.251	45	0.897	70	0.563	95	1.21
21	1.128	46	1.088	71	0.679	96	0.957
22	0.831	47	0.893	72	1.353	97	0.836
23	1.135	48	0.983	73	0.725	98	0.621
24	0.819	49	0.891	74	0.8	99	0.842
25	1.143	50	1.102	75	1.067	100	0.911

Note: These cases represent the highest and lowest scaling factors applied.

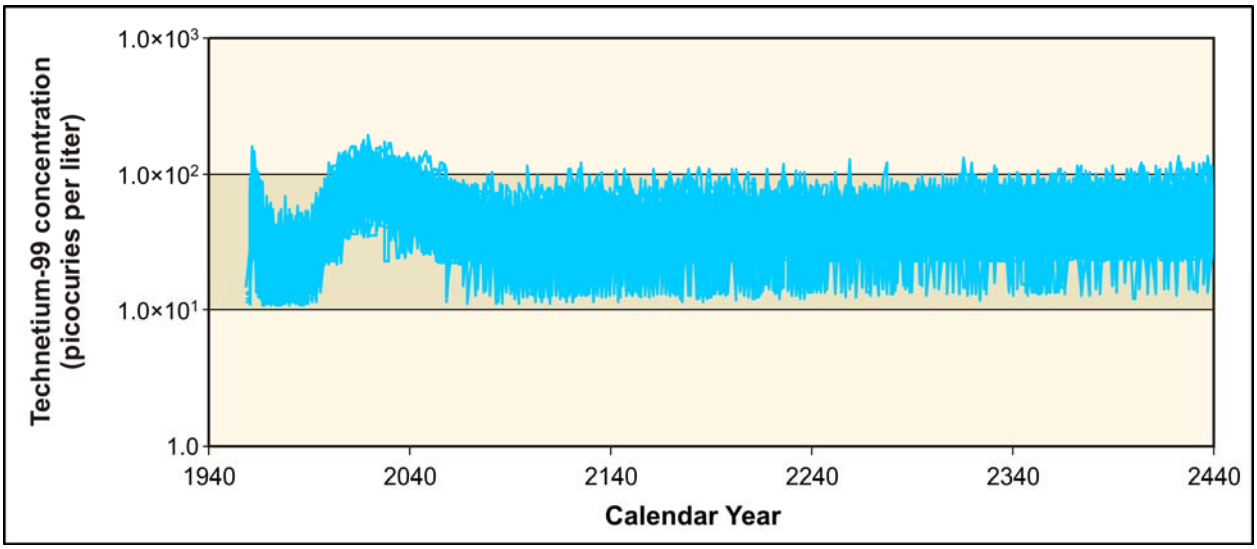


Figure O–47. Realizations for BY Cribs at the Columbia River

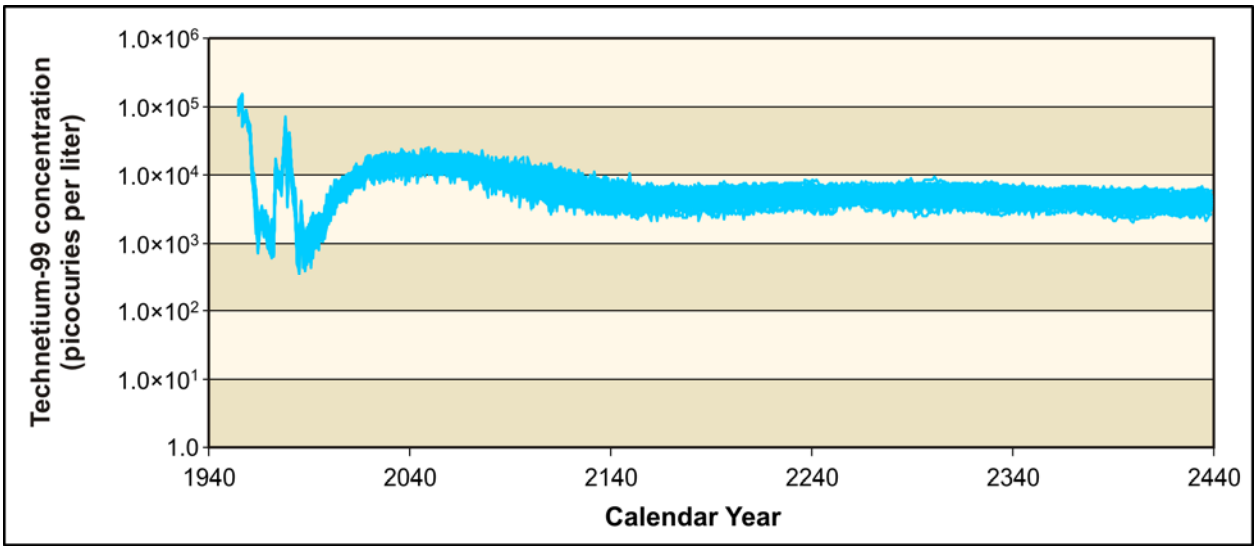


Figure O–48. Realizations for BY Cribs at the Core Zone Boundary

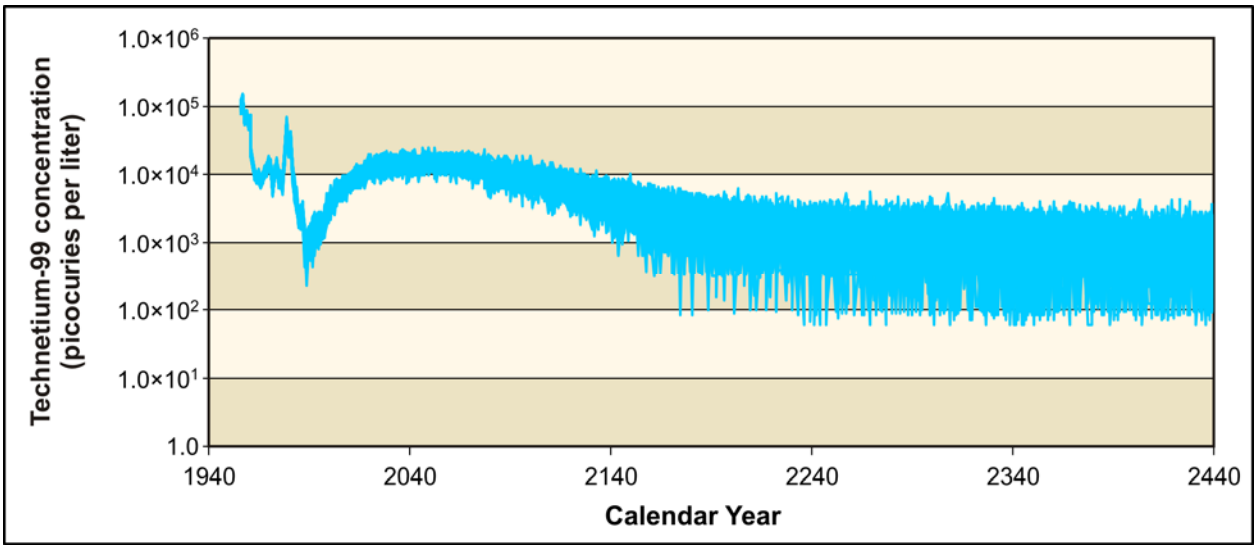


Figure O–49. Realizations for BY Cribs at the B Barrier

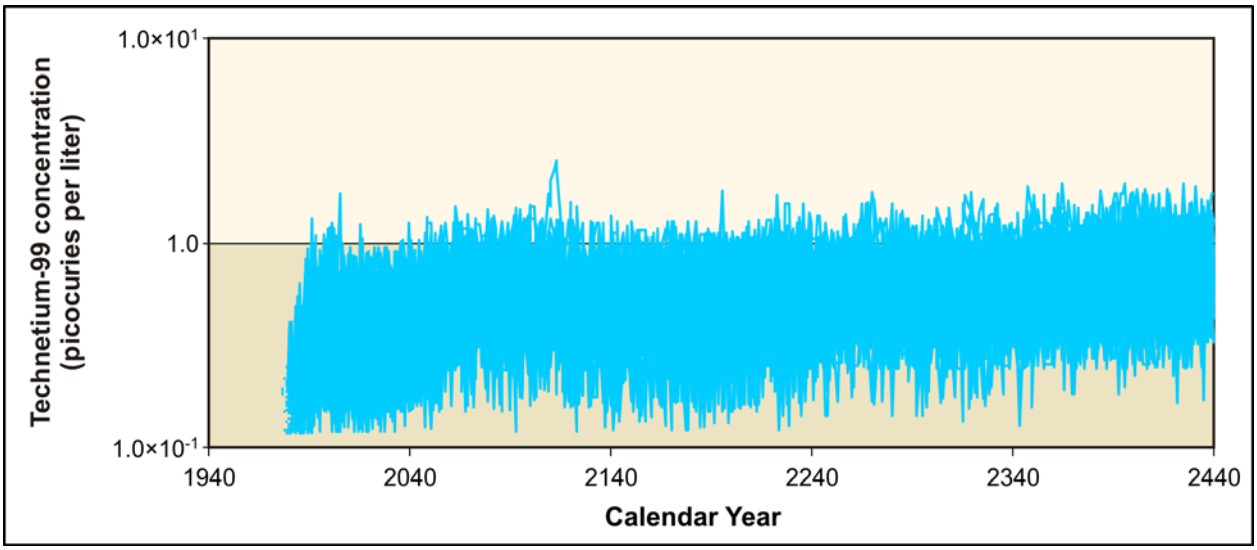


Figure O–50. Realizations for TY Cribs at the Columbia River

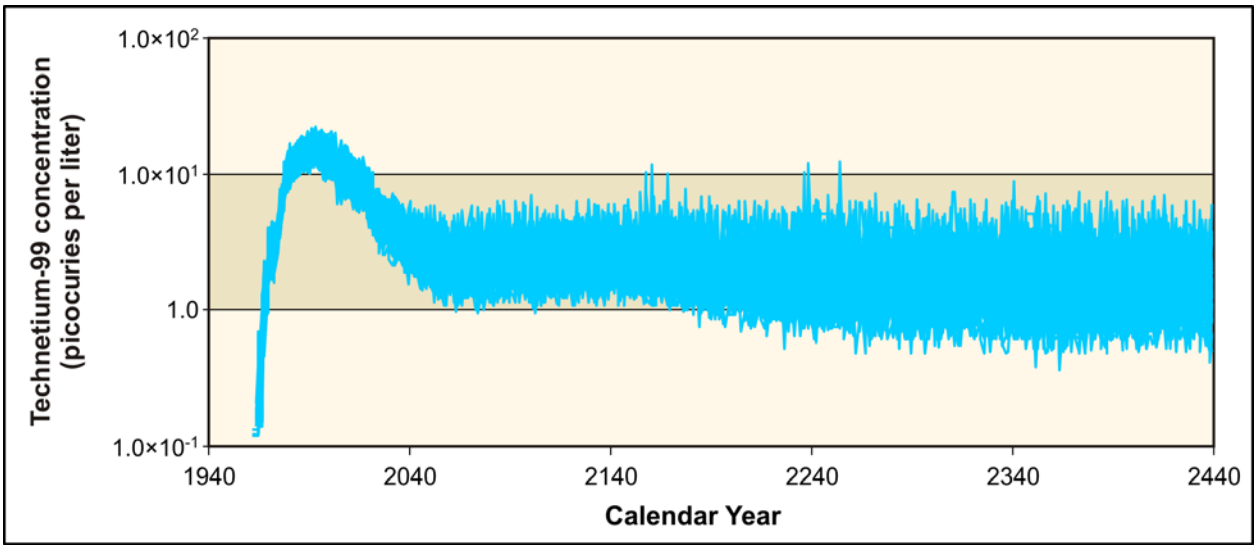


Figure O–51. Realizations for TY Cribs at the Core Zone Boundary

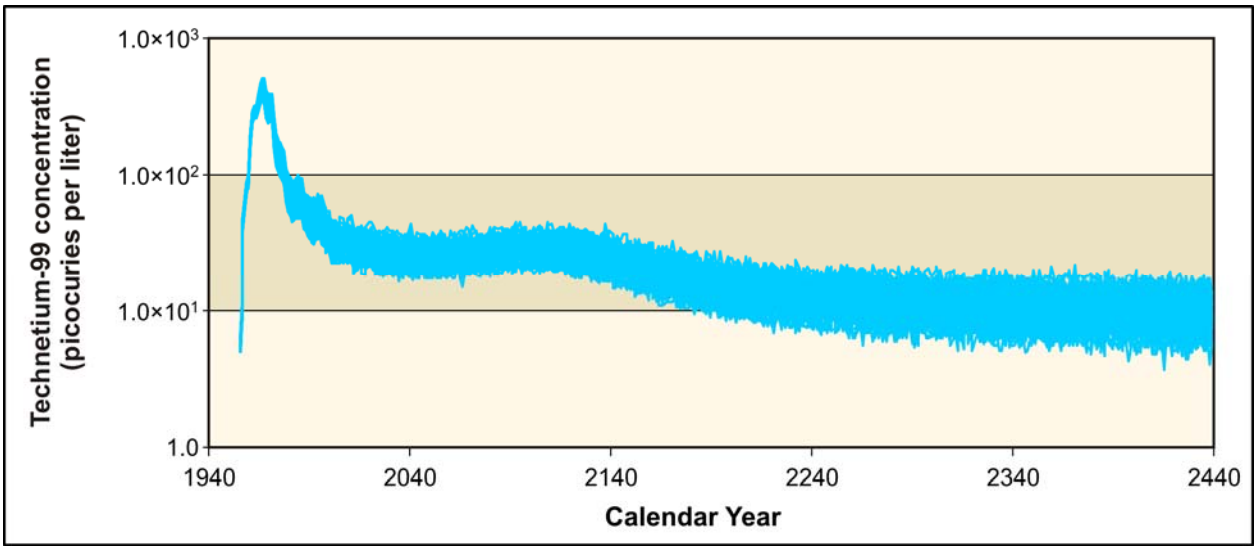


Figure O–52. Realizations for TY Cribs at the T Barrier

O.7 SUMMARY

A three-dimensional contaminant transport model was developed to support the *TC & WM EIS* analyses of alternatives and cumulative impacts. The transport model used a particle-tracking algorithm to predict the temporal and spatial distribution of groundwater contaminants from sources across Hanford. The flow field for the contaminant transport model was obtained from MODFLOW calculations using methods described in Appendix L. The source terms for each of the alternative and cumulative impact sources were obtained from STOMP using the methods described in Appendix N. The particle-tracking code used this information, in conjunction with standard equations for groundwater transport, to model the effects of advection, dispersion, retardation, and radioactive decay as contaminants migrate from their source areas to the Columbia River.

The model is mildly sensitive to concentration measurement parameters and dispersivity assumptions. These parameters were calibrated against several well-known plumes at Hanford. Independent testing showed that the model could produce results that compared reasonably well to measured concentrations in groundwater from sources significant to the *TC & WM EIS* alternatives and cumulative impacts analysis.

For the purposes of this *TC & WM EIS*, an accurate estimate of the uncertainty in the model was an important objective. Accordingly, an effort was made to estimate the propagation of uncertainties in the source data through the model. The model is sensitive to the flow field; as suggested by the results discussed in Appendix L, both the Base and Alternate Case flow fields yielded similar results during the operational period (1944 through 2006). However, the Alternate Case flow field, with significantly higher flow through Gable Gap, generally predicted less attenuation and greater concentrations at the Columbia River nearshore. The model is also sensitive to the source term flux history. Uncertainties of 50 percent in the source flux can lead to variations in concentration predictions ranging from 50 to 100 percent.

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