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Revision 5

Modeling of RI/FS Design Alternatives for 100-HR-3

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

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

CH2MHILL
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1. Purpose

The purpose of this environmental calculation brief (ECF) is to present the results of groundwater flow and contaminant transport modeling for the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) Remedial Investigation (RI) and Feasibility Study (FS) undertaken for the 100-HR-3 portion of the Hanford Site that will support final remedy selection and provide the basis for a final Record of Decision (ROD) for 100-HR-3. The modeling effort focused on the evaluation of remedy alternatives to prevent the migration of contaminants of concern (COC) toward the Columbia River and lower COC concentrations in the aquifer below target values.

The model was used as the basis for the evaluation of four alternative remedy designs:

(a) Alternative 1 – No Action (as required by the National Contingency Plan): operation of DX/HX remedial process optimization (RPO) pump-and-treat (P&T) until December 2012. No further remedial actions after December 2012. COC plume migration and discharge to the river under ambient aquifer conditions for a period of 75 years.

(b) Alternative 2 – Removal, Treatment and Disposal (RTD) and Grouting for Waste Site and P&T with Biological Treatment for Groundwater: operation of DX/HX RPO P&T until December 2012. Expanded P&T with implementation of in-situ treatment (bioremediation – in HX only) until aquifer cleanup is achieved.

(c) Alternative 3 – RTD and Grouting of Waste Site and Increased Capacity Groundwater P&T for Groundwater: operation of DX/HX RPO P&T until December 2012. Expanded P&T with additional system capacity until aquifer cleanup is achieved.

(d) Alternative 4 – RTD for Waste Sites and P&T for Groundwater: operation of DX/HX RPO P&T until December 2012. Expanded P&T without additional system capacity until aquifer cleanup is achieved.

2. Methodology

2.1 Overview of the 100 Area Groundwater Model

A groundwater flow and contaminant transport model has been developed for remedy design evaluation purposes in the 100 Areas. Groundwater flow and advective-reactive contaminant transport simulations, together with advective particle tracking analyses, were performed for each conceptual remedy design to determine the feasibility of each design and - if feasible - corresponding pumping rates to evaluate whether the resulting hydraulic conditions would prevent the migration of COC above the target levels to the Columbia River and would reduce COC concentrations in the aquifer below target levels.

The model development and calibration is documented in a comprehensive modeling report (*Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model*, SGW-46279, Rev. 2). The groundwater flow model is constructed using the U.S. Geological Survey (USGS) modular groundwater flow model MODFLOW (*A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model* [McDonald and Harbaugh 1988]; *User Documentation for MODFLOW 96, An Update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model* [Harbaugh and McDonald 1996]; *MODFLOW-2000, The U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process* [Harbaugh et al. 2000]; *MODFLOW-2005, The U.S. Geological Survey Modular Ground-Water Model – The Ground-Water Flow Process* [Harbaugh 2005]). Particle tracking was performed using the USGS program MODPATH (*User's Guide for MODPATH/MODPATH-PLOT, Version 3: A Particle Tracking Post-*

Processing Package for MODFLOW, the U.S. Geological Survey Finite-Difference Ground-Water Flow Model [Pollock 1994]). MT3DMS (1998 to present) was used to simulate the contaminant plume migration (*MT3DMS, A Modular Three-Dimensional Multi-Species Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems; Documentation and User's Guide* [Zheng and Wang 1999]; *MT3DMS V5.3 Supplemental User's Guide* [Zheng 2010]).

Predictive simulations were based on transient-state (i.e., time-varying) conditions in the aquifer that reflect water-level changes due to river-stage variation. The modeling timeframe corresponds to a 77-year period in which the first two years (2011 through 2012) are evaluated with current pump-and-treat systems operating, followed by a 75-year simulation period (2013 through 2087) without pump-and-treat operations; this represents the "no further action" condition. To allow for a balance between efficient model computer run time and resolution of river stage effects on the model predictions in the most critical early part of the simulation timeframe when the plumes are most spatially expansive and most sensitive to river stage changes, for the first 27 years (2011 through 2037, when higher temporal resolution is needed), the simulations are discretized into twelve monthly stress periods, reflecting the seasonally varying river stage, that are repeated in the same sequence. These stress periods correspond to monthly average river stages, each representing the average river stage for the particular calendar month over the period 2006-2010 (excluding 2007 values, when the river-stage variation pattern was inconsistent with the other years). Exclusion of 2007 data was a decision made in model development based on review of monthly-average river stage plots for each river gauge for 2006 to 2010. In this review, it was observed that inclusion of the 2007 data, which displayed a notably different hydrograph from the other years, would have resulted in average high-river stage conditions appearing earlier in the year compared to the pattern shown in 2006, 2008, 2009, or 2010. A decision was made to base future predictions on average conditions for these four years that exhibited a comparable pattern. It is assumed that these conditions are representative of the typical conditions in the field and that future conditions will not vary significantly from these conditions. For the remaining 50 years (2038 through 2087, when less temporal resolution is required because the contamination mass remaining is not as near to the river and is consequently less sensitive to the river stage variation pattern), a single transient stress period is used with the river stage elevation remaining constant reflecting annual average conditions, corresponding to 2006-2010 average elevations for the month of January (which was the month selected as most approximating the annual average of monthly average river stages).

The migration of hexavalent chrome (Cr(VI)) in response to current and projected extraction and injection well operations in the 100-HR-3 Area was simulated. In addition to Cr(VI), transport simulations were performed to evaluate corresponding migration patterns as a result of the current and projected extraction and injection well operations for two other COCs: Strontium-90 and Nitrate. Transport simulations were based on the transient flow fields calculated by the groundwater flow model using the stress periods described above and a mapped initial distribution for each COC in groundwater. A dual-domain formulation representing plume migration in a dual-porosity continuum with mass transfer between mobile and immobile domains was considerd for Cr(VI) and Strontium-90. Nitrate was simulated assuming single-domain formulation.

Bioremediation of Cr(VI) was also simulated assuming of injection of a suitable substrate at selected injection wells. Radioactive decay was considered for Strontium-90.

Nitrate and Strontium-90 passing through the Ion Exchange (IX) Treatment System are not removed under the current treatment process. They are therefore recirculated in the aquifer via injection at the injection wells connected to each treatment plant.Nitrate and Strontium-90 concentrations injected back into the aquifer are equal to the blended influent concentration at the treatment plant.

2.2 Predictive Hydraulic Containment Calculations

A systematic approach was developed and applied to estimate hydraulic containment in 2012 using the groundwater model. An estimate of the approximate extent of hydraulic capture was calculated using the transient model based on an approach similar to that described in *The Capture Efficiency Map: The Capture Zone Under Time-Varying Flow* (Festger and Walter, 2002) and *Sources of Water to Wells for Transient Cyclic Systems* (Reilly and Pollock, 1996), focusing on the evaluation of the temporal variation in capture due to changing flow patterns and hydraulic gradients:

- Releasing particles near the end of each of the twelve monthly stress periods and simulating their migration using a very low effective porosity, ensuring that particle travel times are essentially instantaneous.
- Recording the instantaneous fate of each particle during each stress period.
- Calculating a capture zone for each stress period based on the "snapshot" of aquifer conditions at the time of the particle release, in this case producing twelve instantaneous "snapshots" of the extent of capture.
- Constructing a simulated capture frequency map (SCFM) by counting the number of times a particle originating from a location was captured by a well, and dividing this count by the total number of releases (i.e., twelve).

2.3 Predictive Modeling Process

For each alternative design, a systematic process was followed to develop model input files, to perform the model simulation, and post-process the model results to evaluate system performance. This procedure is described by the following steps:

1. Well locations for injection and extraction wells were proposed, discussed and selected.
2. Injection and extraction rates were proposed, discussed and assigned to each well.
3. An input file for the MODFLOW Multi-Node Well (MNW2) Package (Konikow et al., 2009) was constructed to describe the spatial and temporal configuration of the well operations.
4. The flow model was executed to simulate transient hydraulic head distributions, together with accessory outputs including model-wide and cell-by-cell flow budgets.
5. Input files for subsequent particle tracking analyses were constructed, including particle starting locations encompassing an area equivalent to the footprint of the corresponding COC plume.
6. MODPATH was executed to simulate the conservative, advective transport of groundwater and dissolved contaminants, and the results were post-processed to identify particles that - given sufficient time - would (a) ultimately migrate to the river or would (b) ultimately be captured by the extraction wells.
7. A map of hydraulic capture frequency (i.e., SCFM) was constructed, using the method described above.
8. Input files for the advective-dispersive-reactive contaminant transport model were constructed for each COC, including the initial distribution, COC-specific transport parameters such as decay rate, and the time-varying mass loading of any injected substrate at each bio-injection, where applicable.

9. MT3DMS was executed to simulate the advective-dispersive-reactive transport of each COC, and the results were post-processed.
10. Post-processing of the MT3DMS simulations was completed, comprising:
    a. Maps of the simulated distribution of each COC at varying intervals.
    b. Graphs for each COC depicting concentration statistics at the river shoreline and within the aquifer; plume mass/volume in the aquifer; blended influent concentrations at the treatment plant; and affected shoreline length.
    c. Tabulated estimated cleanup times based on the calculated maximum concentration for each COC and the corresponding applicable standard.

3. Modeling Assumptions and Inputs

3.1 Model Structure

The groundwater flow model grid encompasses all 100-Area Operable Units (OU). The model finite-difference grid is constructed so that the north and northeast boundaries of the flow model are parallel to, and abut, the Columbia River. The model extends southward, toward Gable Butte and Gable Mountain. The grid spacing is relatively coarse (about 100 m) throughout much of the domain, but it is refined (15 m) in the area of each 100 Area OU to support remedy evaluations.

Groundwater flow is simulated as three-dimensional (3D) using four layers. These layers represent the Hanford formation (always present in Layer 1, across the model domain) and the Ringold Formation unit E (typically represented by Layers 2 through 4, except east of 100-D where all model layers represent the Hanford formation). Throughout much of the western half of the modeled area (including 100-K and 100-D), the water table lies within the Ringold Formation unit E sands, whereas toward the east and north of the modeled area (including 100-H and 100-F), the water table lies within the Hanford formation sands and gravels. In the vicinity of 100-B/C the water table fluctuates between the two formations.

The base of the model is assumed to be the top of the Ringold Upper Mud (RUM) where present and the top of the basalt where the RUM is absent, which typically occurs in the southern portions of the model approaching Gable Butte. The geologic characterization compiled as part of the Model Data Packages (SGW-40781 Rev. 0, *100-HR-3 Remedial Process Optimization Modeling Data Package*; SGW-41213 Rev. 0, *100-KR-4 Remedial Process Optimization Modeling Data Package*; SGW-44022 Rev. 0, *Geohydrologic Data Package in Support of 100-BC-5 Modeling*; SGW-47040 Rev. 0, *Geohydrologic Data Package in Support of 100-FR-3 Modeling*) depicts a reasonably abrupt lateral transition from areas where the water table lies dominantly within the Ringold Unit E in the west and south of the model domain to areas where the water table lies dominantly within the Hanford formation sands and gravels in the east and north of the model domain, that occurs between the 100-D and 100-H areas.

The principal aquifer property specified in the flow model is the spatially varying hydraulic conductivity of the saturated aquifer materials. The hydraulic conductivity distribution in the model was developed based on the information included in the Model Data Packages and a pilot-point parameterization technique (Doherty, 2003) that was implemented in the model calibration process. Estimates of hydraulic conductivity compiled as part of the Model Data Packages were tabulated and assigned to their corresponding aquifer unit. The mean values for the aquifer hydraulic conductivity that resulted from the model calibration process are:

- 19 m/day for Ringold Unit E in the 100-HR-3 Area region of the aquifer.
- 63 m/day for the Hanford formation.

Areal recharge from precipitation was specified based on information included in the Groundwater Data Package for Hanford Assessments (*Groundwater Data Package for Hanford Assessments*, PNNL-14753). An electronic version of the recharge package developed and presented in PNNL-14753 was obtained; the data were spatially distributed to the model grid cells; and this initial distribution was subsequently adjusted during model calibration. Based on the results of the model calibration, the recharge value was set equal to 12 mm/yr throughout the model domain.

Initial effective porosity and specific yield values for the aquifer were identified from published sources: these were revised during the model calibration and set equal to 18% and 10%, respectively. Both values are within the range of values documented in previous investigations for Hanford (*Development of a Three-Dimensional Ground-Water Model of the Hanford Site Unconfined Aquifer System*, PNNL-10886). As a result of the approach taken to the model calibration, the relatively low value of specific yield (versus the higher value of effective porosity) principally reflects periodic but incomplete draining and rewetting of aquifer materials near the shoreline in response to oscillatory river stage changes. Finally, riverbed conductance values were also determined during calibration, separately for the stretches of the Columbia River within each Area.

The groundwater flow model was calibrated to data included in the Model Data Packages for each OU, through a combined manual (i.e., trial-and-error) and automated process. Model calibration was facilitated by the use of PEST (Doherty, 2010) and post-processing programs that calculate simulated water-level responses to stresses. The model was calibrated to data obtained from January 2006 to June 2009, and was then validated using data obtained from July 2009 to December 2010. Calibration focused on the transient response of water levels to changing stresses and how these compare to values measured at wells at each OU; in addition, maps of water-level contours calculated by the model were compared to contours included in published reports to ensure that the simulated hydraulic gradient magnitude and direction is in agreement with prior independent interpretations.

The potential to apply historical concentration data, particularly tritium, to support inverse calibration of the groundwater model was considered. The available data were judged inadequate to this purpose, because only trailing edge behavior was available. Hence, these data are of limited value to calibrate a numerical flow and transport model.

Further details about all parameter values used in the model are provided in the comprehensive modeling report (*Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model*, SGW-46279, Rev. 2).

3.2 Contaminant Transport Processes

The migration of Cr(VI) in response to current and projected extraction and injection well operations in the 100-HR-3 Area was simulated to support remedy design evaluation. In addition to Cr(VI), transport simulations were performed for two other COCs (Strontium-90 and Nitrate), to evaluate corresponding migration patterns as a result of the current and projected extraction and injection well operations. Transport simulations were based on transient flow fields calculated by the groundwater flow model and a mapped initial distribution of each COC in groundwater. A dual-domain formulation representing plume migration in a dual-porosity continuum with mass transfer between mobile and immobile domains was considerd for Cr(VI) and Strontium-90. Nitrate was simulated assuming a single-domain, single-porosity

formulation and no sorption/reaction. Bioremediation of Cr(VI) was also simulated assuming injection of a suitable substrate at selected injection wells. Radioactive decay was considered for Strontium-90.

Nitrate and Strontium-90 passing through the Ion Exchange (IX) Treatment System are not removed under the current treatment process. They are therefore recirculated in the aquifer via injection at the injection wells connected to each treatment plant.Nitrate and Strontium-90 concentrations injected back into the aquifer at each injection well are equal to the blended influent concentration at the treatment plant.

A brief description of these processes is provided below. All transport parameters used in the model simulations are summarized in Table 3-1.

3.2.1 Dual domain

Although often assumed to be conservative, recent studies by PNNL (Geochemical Characterization of Chromate Contamination in the 100 Area Vadose Zone at the Hanford Site, PNNL-17674) suggest that Cr(VI) within soils of the 100 Areas exhibits migration characteristics that may be more complex than can be represented using simple advection. According to these tests, although the majority of the mass is highly mobile and migrates principally by advection, Cr(VI) mass can be held in heterogeneous parts of the aquifer that possess a low hydraulic conductivity. This relatively less mobile Cr(VI) constitutes a longer-term source of chromium to the mobile domain that is facilitated by mass transfer between the two domains. Based on these observations, the migration of Cr(VI) can be reasonably described by a dual-domain (or dual-porosity) approach that divides the aquifer into two domains: mobile and immobile. Advective-dispersive transport occurs predominantly in the mobile domain while mass transfer occurs between the mobile and immobile domains.

MT3DMS supports the use of a dual-domain formulation to simulate the transport of a contaminant in groundwater. To do so, the following parameters must be defined for the dual domain formulation: the fraction of mobile and immobile domains; the mass transfer coefficient between the mobile and immobile domains; and when considering sorption or related retardation processes, distribution coefficients that describe sorption within the mobile and immobile domains. For the 100 Area transport model, it was assumed that for Cr(VI) some sorption occurs within the immobile domain, and that no sorption occurs within the mobile domain. Sorption occurs both in the mobile and immobile domain for Strontium-90. No sorption was assumed for Nitrate, which was simulated using a single-domain, single-porosity formulation.

Further details on the development of the dual-domain parameters can be found in the comprehensive modeling report (*Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model*, SGW-46279, Rev. 2).

3.2.2 Bio-remediation

The groundwater flow and transport model was also used to make predictive simulations of the impact of injection of water amended with a suitable substrate for remediation of Cr(VI). Simulations consider the transport and interaction of two species - the first species being Cr(VI), and the second species being the injected substrate. The substrate injection is simulated as an injection concentration that enters the groundwater system through an injection well using the Source Sink Mixing (SSM) package of MT3DMS. An instantaneous reaction is simulated, with a specified stoichiometry – i.e., a specified ratio of the substrate that is required to reduce/consume/transform the COC such that under most conditions absent transport of the species either (a) the substrate completely and instantaneously reduces/consumes/transforms the contaminant in the model cell or (b) the substrate is entirely consumed and reduces/consumes/transforms the corresponding amount of contaminant. This reaction between the

two species assumes instantaneous and complete mixing within each model cell, and is represented explicitly in the model. The rate of the reaction - i.e. the amount of contaminant that is reduced/consumed/transformed by the injected substrate - is calculated directly based on the specific reaction stoichiometry for the two corresponding species.

The foregoing approach to simulating degradation can in theory be used to represent direct reduction (or oxidation) and/or bio-degradation/bio-transformation. The approach does not explicitly consider the growth of organisms in the case of bio-remediation: the reaction stoichiometry will in many cases be semi-empirical, based in part upon equations that describe the oxidation-reduction system including the target contaminant, but also considering field experience with similar remediation technologies.

For the purposes of the model simulations presented herein, ethanol (C_2H_6O) is assumed as a carbon source to reduce Cr(VI) to trivalent chromium, Cr(III). The stoichiometric equation that describes the chemical reaction that is involved in this reduction does not consider the fact that before the substrate reacts with the chromium, it is also consumed by two processes due to competitive demand for ethanol:

1. Bio-activity of the microbes that diminishes the substrate concentration; and,
2. Competitive reaction with other compounds present in the system.

Since neither bioactivity of microbes nor the reaction of the substrate with secondary compounds is explicitly simulated in the transport model, the MT3DMS reactive transport simulator developed for use with the transport model enables a first-order decay term to be applied to the substrate that can approximate the consumption of the substrate over time due to these two processes. Typically, the half-life of this first-order decay term will be empirically based, derived from field observations of pilot scale studies and other field-scale applications. In the case of Cr(VI) reduction to Cr(III) though injection of ethanol, a first-order decay rate for the substrate is provided that assumes that the substrate has a half-life of 20 days as a result of competing demands. In this context, “half-life” refers to the surrogate representation of the consumption of the substrate by a variety of processes that are collectively represented as a first-order decay process.

Further details on the modeling of the bio-remediation processes can be found in the comprehensive modeling report (*Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model*, SGW-46279, Rev. 2).

3.2.3 Radioactive Decay

Radioactive decay was simulated for Strontium-90. A half-life value of 28.8 years was used in the model applying to both the dissolved and sorbed phases.

3.2.4 Treatment System Recirculation

The groundwater flow and transport model was also configured to simulate the circulation of extracted COCs (i.e. Strontium-90 and Nitrate) within the P&T system while Cr(VI) is actively treated. During this process, those secondary contaminants are recovered at the extraction wells, pass untreated through the treatment system, and are returned to the groundwater domain via injection wells. Blending of the extracted water occurs within the above-ground treatment system so that the effluent concentration is generally lower (more dilute) than the highest influent concentration measured at the wellhead. This movement of contaminants through a P&T system is simulated using the Contaminant Treatment System (CTS) package implemented in MT3DMS (Bedekar et al, 2011).

Table 3-1. Parameter Values for the MT3DMS Transport Simulations.

Parameter		Chromium		Nitrate	Strontium	
		Mobile Domain	Immobile Domain	Single Domain	Mobile Domain	Immobile Domain
COC	Porosity	0.18	0.045	0.225	0.18	0.045
	Bulk density (g/cc)	1.72		1.72	1.72	
	Kd (cc/g)	0.0[1]	0.3	-	7.0[2]	39.0[2]
	Decay in water (1/day)	0.0		-	6.59E-05	
	Decay on soil (1/day)	0.0		-	6.59E-05	
	Radioactive Decay (years)[3]	-		-	28.8	
	Mass transfer rate (1/day)	0.01		-	0.01	
Substrate	Kd (cc/g)	0.0	0.0	-	-	
	Decay in water (1/day)	3.4657E-02		-	-	
	Decay on soil (1/day)	0.0		-	-	
	Mass transfer rate (1/day)	0.0		-	-	

[1] PNNL-18564, Table 6.9, Sandy Gravel sediment type

[2] Based on a value of 12 cc/g (PNNL-18564, Table 6.9, Sandy Gravel sediment type) and distributed in the mobile and immobile domains based on the approximate ratio of the corresponding porosities

[3] Decay values in water/soil correspond to the half-life represented by the radioactive decay

3.3 Initial Distribution of COCs

The development of the initial distribution of each COc in groundwater within the 100-HR-3 OU was based on the following stepwise procedure:

1. Concentration contours from the plume depiction presented in the *Hanford Site Groundwater Monitoring Report for 2011* (DOE/RL-2011-118, Rev.0, Section 2.5) were imported in ArcGIS (Mitchell, 1999); densified to increase the number of vertices per contour to 5-meter spaced vertices; and digitized to generate point values for each contour.

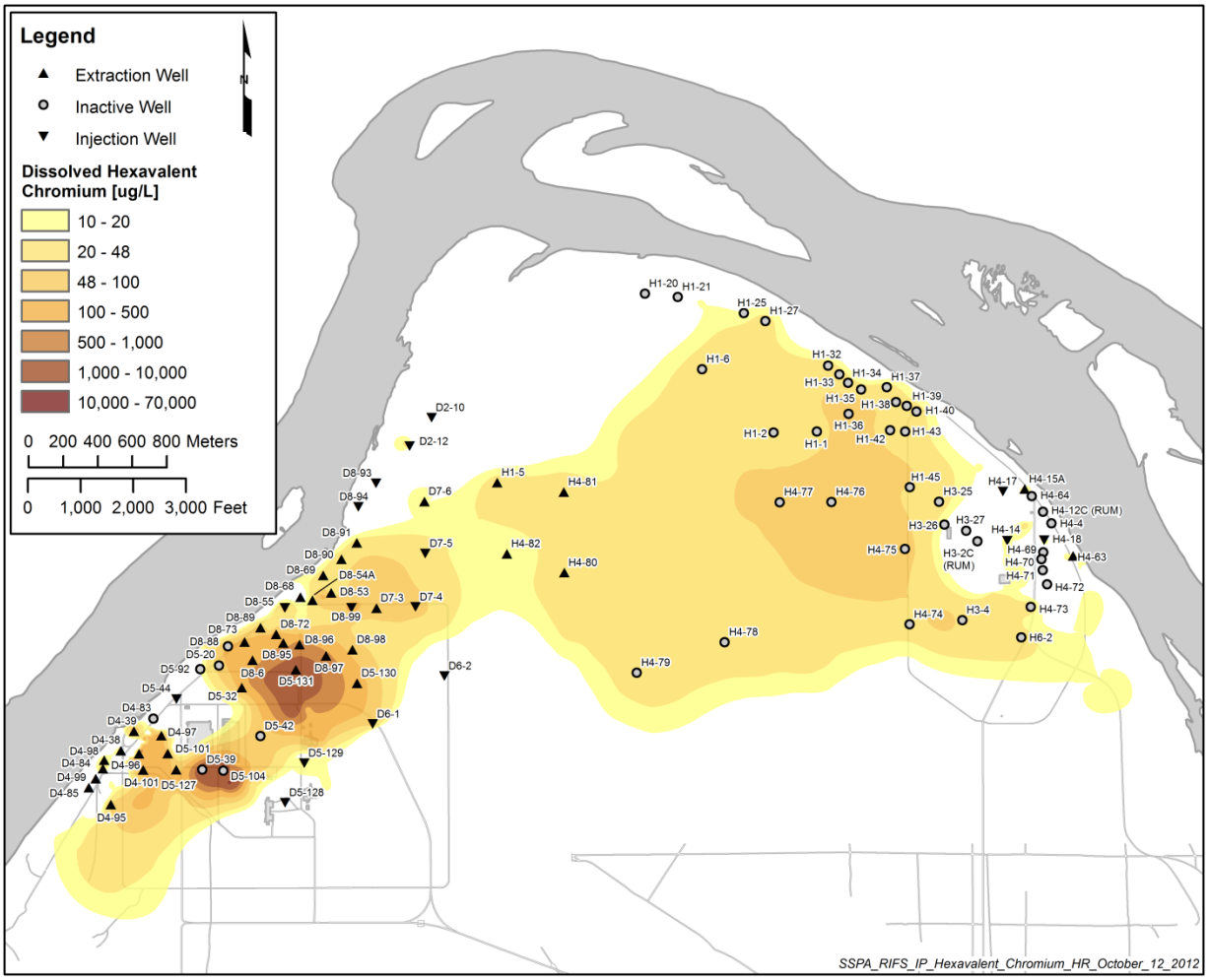
2. The concentration dataset used for the development of the plume depictions for the 2011 Monitoring Report was combined with the point values developed in (1).

3. The combined dataset from (2) was imported in Surfer (Golden Software, 2012) and interpolated using the Natural Neighbor interpolation method on a 5m-by-5m grid.

Initial concentrations in the mobile and immobile domains were assumed to be the same for Cr(VI) and Strontium-90. Figures 3-1 through 3-3 show the initial distribution of Cr(VI), Strontium-90 and Nitrate, respectively.

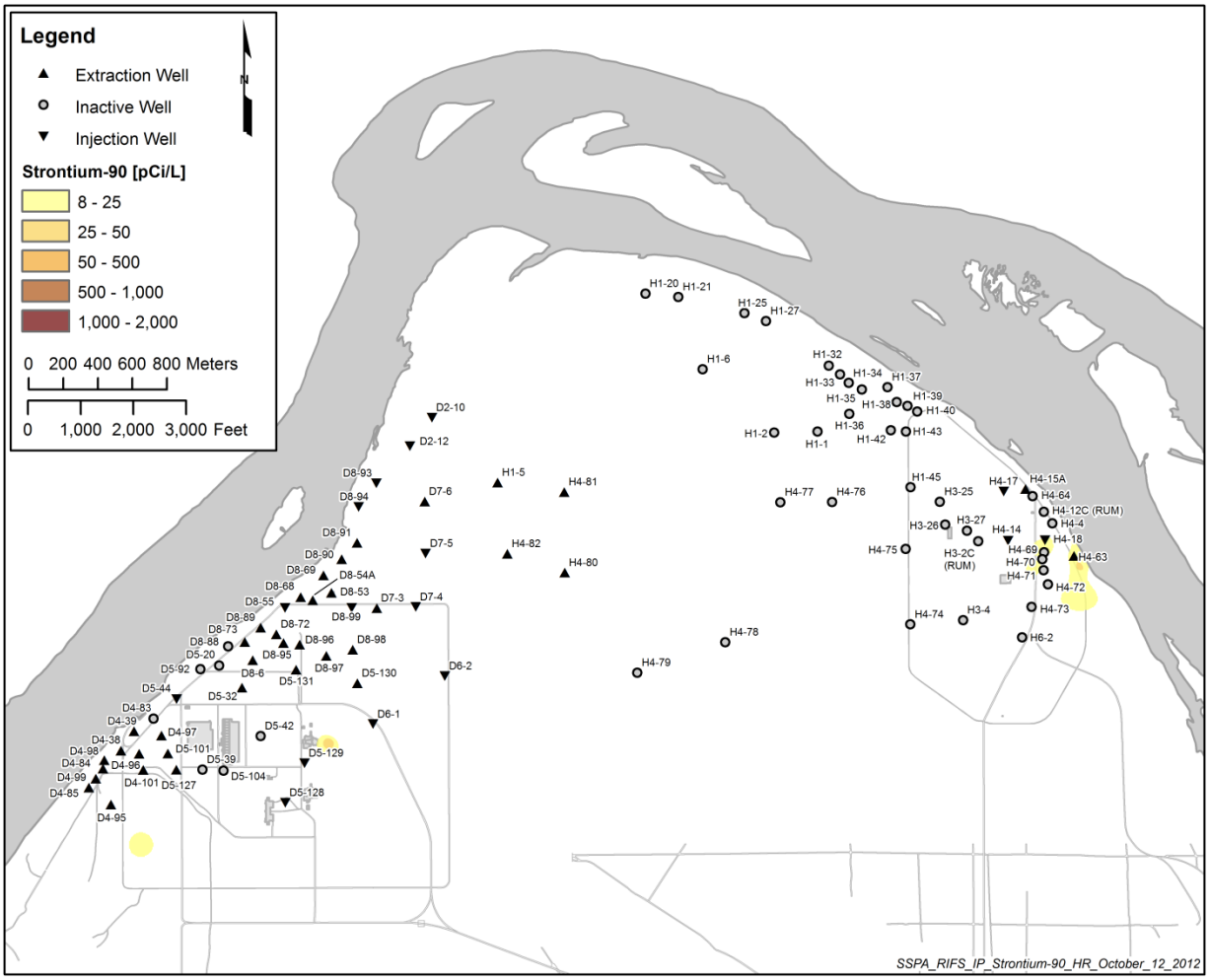
The initial condition shown in Figure 3-3 for nitrate depicts two elevated nitrate concentration areas (plumes) near wells H4-75 and H1-27. These plumes were reported in the source used for development of this initial nitrate condition (DOE/RL-2011-118, Rev.0, Section 2.5), but these plume depictions were

subsequently investigated and determined to be based on erroneous data; a revised depiction of current nitrate conditions is provided in Figure 4-90 of the RI/FS (DOE/RL-2011-118, Rev.0). Modeling was not repeated for nitrate to correct for these non-existent nitrate plumes because predictive simulations did not indicate these would lead to a need for action.



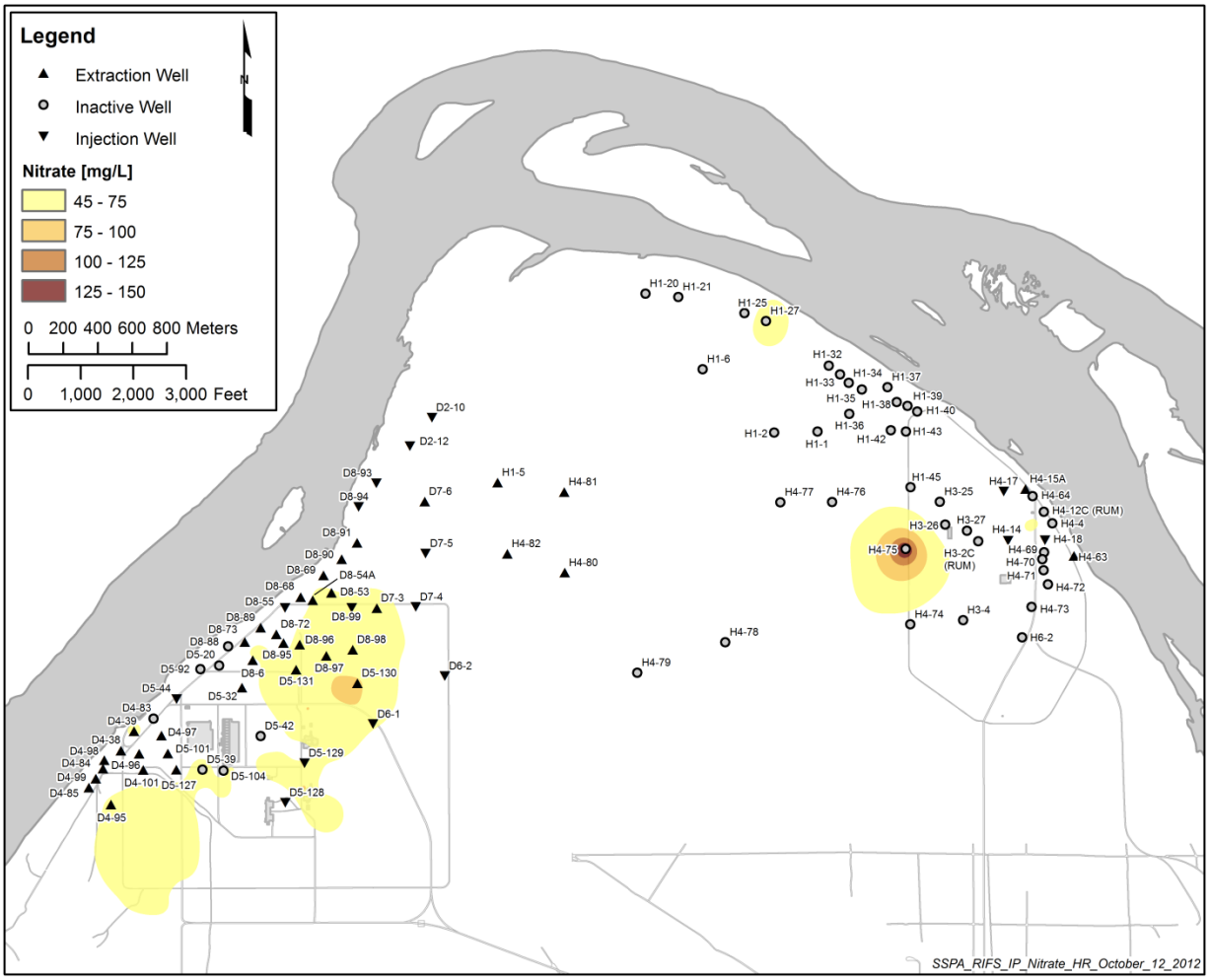
Note: Depicts initial condition of the Cr(VI) contaminant plume in the groundwater transport model representing conditions at start of January 1, 2011.

Figure 3-1. Initial Cr(VI) Distribution in 100-HR-3.



Note: Depicts initial condition of the strontium-90 contaminant plume in the groundwater transport model representing conditions at start of January 1, 2011.

Figure 3-2. Initial Strontium-90 Distribution in 100-HR-3.



Note: Depicts initial condition of the nitrate contaminant plume in the groundwater transport model representing conditions at start of January 1, 2011.

Note: The elevated nitrate concentration areas evident near wells H4-75 and H1-27 were reported in the source used for development of this initial nitrate condition, but these plume depictions were subsequently investigated and determined to be based on erroneous data; a revised depiction of current nitrate conditions is provided in Figure 4-90 of the RI/FS (DOE/RL-2011-118, Rev.0, Section 2.5). Modeling was not repeated for nitrate to correct for these non-existent nitrate plumes because predictive simulations did not indicate these would lead to a need for action.

Figure 3-3. Initial Nitrate Distribution in 100-HR-3.

3.4 Wells

Flow and transport model simulations were performed for four alternative remedy designs. The basis of all designs is the currently operational interim action P&T system in 100-HR-3. Alternative 1 considers only wells of the interim P&T while Alternatives 2, 3 and 4 comprise additional extraction and injection wells. Alternatives 1, 3, and 4 consider only conventional P&T operations. Alternative 2 includes in-situ treatment in the form of injection of a suitable substrate at selected wells.

In all cases, extraction wells screened in the RUM (i.e. 199-H3-2C and 199-H4-12C) were not included in the simulations as their screened interval is below the model bottom layer, as described in Section 3.1.

However, screening-level calculations performed in support of the 100-HR-3 RI/FS to evaluate time-dependent zones of contribution and contaminant recovery under various pumping scenarios from wells screened in the upper portion on the RUM are presented in the *Evaluation of Potential Hydraulic Capture and Plume Recovery from the Ringold Upper Mud (RUM) in the 100-HR-3 Operable Unit (OU)* (ECF-100HR3-12-0025, Rev.1)

Detailed descriptions of each alternative well configuration are presented in the following subsections.

3.4.1 Alternative 1: No Action

Alternative 1 comprises extraction and injection wells as part of RPO P&T system currently operating in 100-HR-3. The P&T system currently includes two ion exchange (IX) treatment systems, DX and HX, for a total treatment capacity of 1,400 gpm. P&T well configuration reflects current system operations as reported interms of extracted/injected volumes at each well during the period January 2011 through July 2012. It was assumed that May 2012 pumping rates, corresponding to the highest total extraction/injection in DX and HX collectively, will apply for the remainder of CY2012. This configuration is common to all alternatives as proposed system configuration modifications were implemented after that period.

After December 2012, the system is assumed to be shut down and plume migration patterns for all COCs are simulated assuming ambient aquifer conditions for a 75-year period.

Figure 3-4 shows the extraction and injection well configuration for this alternative design. Detailed account of the pumping rates for all wells is included in Table 3-2.

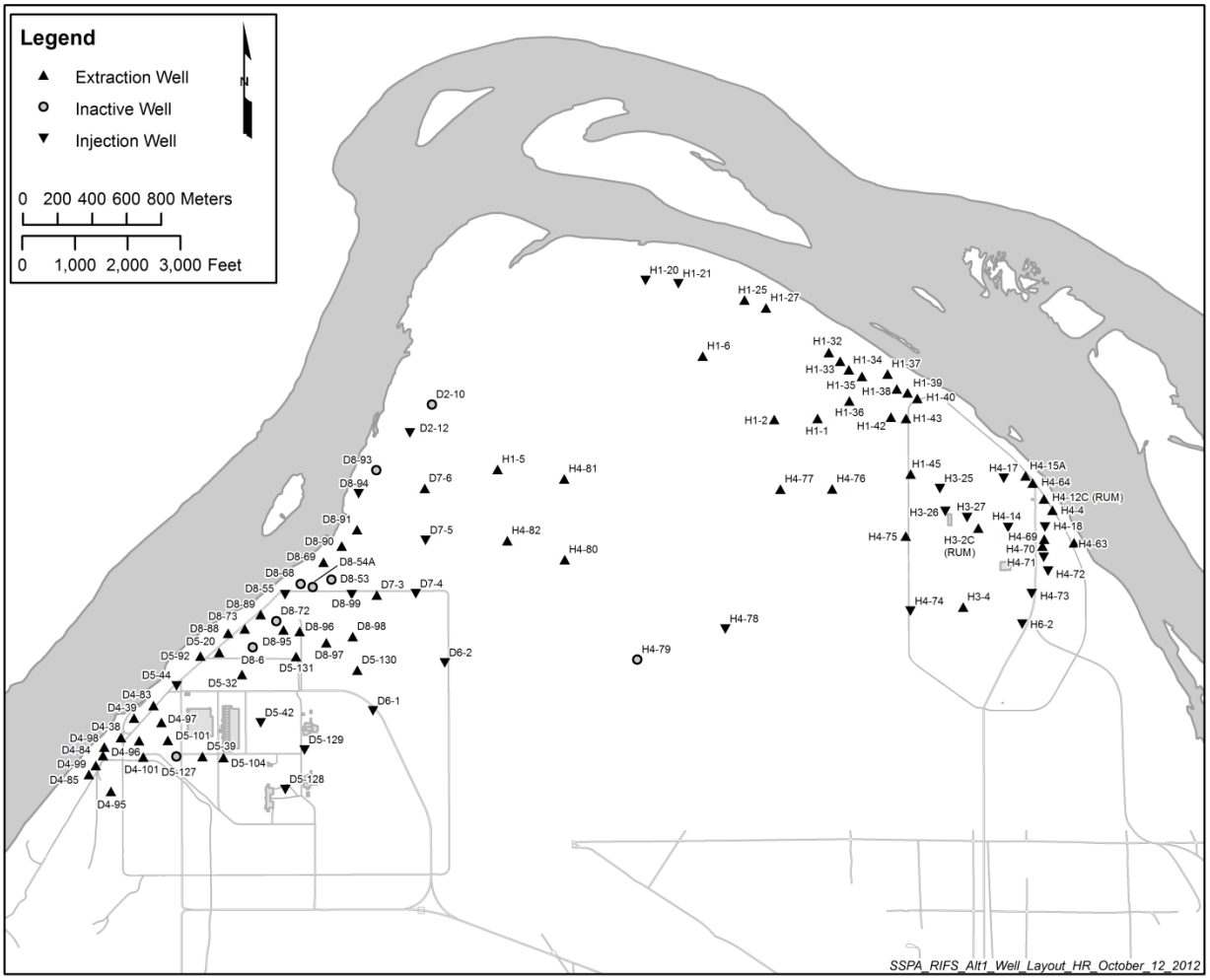


Figure 3-4. Extraction/Injection Well Configuration – Alternative 1.

Table 3-2. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 1

Well Name	Easting	Northing	Syestem	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
199-D5-104	573265.48	151422.43	DX	-	-	-	-	-	-	(17.1)[1,2]	(21.5)	(20.5)	(20.5)	(24.1)	(25.0)	(25.0)	(22.0)	(25.0)	(24.2)	(25.0)	(23.9)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)
199-D5-20	573239.97	152030.15	DX	-	-	-	-	-	-	(8.2)	(8.3)	(3.9)	(3.9)	(0.0)	-	-	-	(0.0)	(7.6)	(9.5)	(9.1)	(9.8)	(9.5)	(9.5)	(9.5)	(9.5)	(9.5)
199-D5-32	573372.04	151903.39	DX	(15.4)	(17.8)	(18.8)	(17.2)	(16.0)	(15.5)	(15.8)	(14.9)	(17.0)	(17.0)	(18.1)	(18.4)	(17.5)	(15.7)	(18.0)	(17.6)	(19.0)	(17.6)	(16.9)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)
199-D5-39	573142.86	151428.43	DX	-	-	-	-	-	-	(20.2)	(24.3)	(22.9)	(22.9)	(24.5)	(24.9)	(24.4)	(21.7)	(24.9)	(23.8)	(25.0)	(23.0)	(24.8)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)
199-D5-42	573479.77	151622.67	DX	-	-	-	-	-	-	31.5	33.2	28.0	28.0	22.7	23.7	23.0	17.0	24.4	25.9	25.3	22.6	24.6	25.3	25.3	25.3	25.3	25.3
199-D5-44	572993.58	151835.74	DX	86.5	87.1	66.1	40.7	34.2	33.7	43.9	46.6	45.3	45.3	44.5	46.9	45.7	35.3	39.9	34.2	26.7	25.7	26.4	26.7	26.7	26.7	26.7	26.7
199-D5-92	573131.93	152009.82	DX	-	-	-	-	-	-	(21.2)	(23.5)	(17.0)	(17.0)	(15.6)	(18.0)	(18.5)	(21.2)	(29.0)	(29.7)	(33.0)	(30.3)	(29.8)	(33.0)	(33.0)	(33.0)	(33.0)	(33.0)
199-D4-95	572613.00	151227.00	DX	(13.0)	(12.5)	(12.6)	(12.1)	(10.2)	(10.9)	(9.0)	(10.0)	(12.2)	(12.2)	(12.5)	(13.0)	(13.0)	(11.4)	(13.0)	(12.6)	(13.0)	(11.4)	(11.5)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)
199-D4-96	572777.00	151520.00	DX	(13.1)	(12.7)	(12.6)	(13.3)	(10.5)	(13.8)	(15.0)	(15.0)	(15.1)	(15.1)	(13.0)	(10.7)	(7.8)	(4.7)	(5.9)	(2.7)	(7.0)	(7.0)	(8.0)	(7.0)	(7.0)	(7.0)	(7.0)	(7.0)
199-D4-97	572906.53	151624.87	DX	(12.8)	(12.2)	(12.2)	(12.1)	(10.2)	(10.9)	(10.3)	(10.0)	(11.4)	(11.4)	(12.5)	(13.0)	(13.0)	(11.4)	(12.2)	(11.6)	(12.0)	(11.5)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)
199-D4-98	572575.59	151483.28	DX	(13.0)	(12.4)	(12.7)	(11.9)	(10.2)	(10.7)	(11.5)	(10.0)	(11.0)	(11.0)	(11.6)	(12.5)	(13.0)	(11.1)	(13.0)	(12.6)	(13.0)	(12.4)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)
199-D4-99	572526.48	151376.63	DX	(19.5)	(16.3)	(15.4)	(13.7)	(11.0)	(15.8)	(16.5)	(15.0)	(15.6)	(15.6)	(11.1)	(16.5)	(18.0)	(15.4)	(18.9)	(18.4)	(19.0)	(18.0)	(17.2)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)
199-D2-10	574470.70	153465.17	DX	2.7	2.5	0.4	0.4	0.8	-	-	-	0.1	0.1	0.6	0.1	0.1	5.1	1.1	0.6	-	-	-	-	-	-	-	-
199-D2-12	574343.40	153300.80	DX	8.8	10.4	4.0	2.1	1.2	-	-	-	0.4	0.4	5.5	3.3	2.4	3.4	5.7	2.8	0.0	-	-	0.0	0.0	0.0	0.0	0.0
199-D8-6	573434.69	152060.82	DX	(14.7)	(14.3)	(13.7)	(10.9)	-	-	-	-	-	-	-	-	-	-	-	-	-	(2.0)	(6.9)	-	-	-	-	-
199-D8-89	573479.46	152250.40	DX	(11.5)	(11.2)	(14.0)	(13.9)	(12.4)	(13.5)	(18.4)	(19.1)	(13.3)	(13.3)	(12.1)	(11.1)	(10.6)	(9.6)	(11.1)	(11.1)	(12.1)	(11.6)	(12.4)	(12.1)	(12.1)	(12.1)	(12.1)	(12.1)
199-D8-90	573948.74	152646.20	DX	(19.5)	(18.8)	(19.3)	(13.6)	(11.5)	(14.2)	(18.5)	(17.9)	(16.1)	(16.1)	(12.5)	(19.4)	(18.4)	(10.6)	(18.7)	(18.4)	(17.2)	(17.6)	(17.6)	(17.2)	(17.2)	(17.2)	(17.2)	(17.2)
199-D8-91	574037.21	152741.29	DX	(19.6)	(19.0)	(20.1)	(14.0)	(11.5)	(14.8)	(22.5)	(23.3)	(16.7)	(16.7)	(17.0)	(20.5)	(19.0)	(10.7)	(16.8)	(17.3)	(18.9)	(17.7)	(17.6)	(18.9)	(18.9)	(18.9)	(18.9)	(18.9)
199-D8-93	574148.99	153085.76	DX	13.4	14.6	14.8	8.5	2.1	-	-	-	-	-	0.2	(0.0)	(0.0)	(0.0)	(0.0)	-	-	-	-	-	-	-	-	-
199-D8-94	574047.13	152949.35	DX	5.9	1.4	2.8	1.9	0.9	-	-	-	-	-	-	2.9	7.4	5.1	8.8	3.9	0.0	-	-	0.0	0.0	0.0	0.0	0.0
199-D8-53	573889.86	152452.26	DX	(17.0)	(15.6)	(15.1)	(14.4)	(1.0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
199-D8-54A	573781.17	152408.03	DX	(18.6)	(19.9)	(19.7)	(17.3)	(1.0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
199-D8-68	573711.67	152427.10	DX	(52.0)	(50.8)	(53.8)	(49.9)	(3.3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
199-D8-72	573570.48	152211.77	DX	(3.7)	(8.4)	(7.4)	(7.2)	(0.7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
199-D4-101	572800.10	151425.94	DX	(2.5)	(4.3)	(2.2)	(0.0)	(0.0)	(0.0)	-	(0.0)	(0.0)	(0.0)	-	-	-	-	(6.8)	(8.2)	(4.9)	-	(3.8)	(4.9)	(4.9)	(4.9)	(4.9)	(4.9)
199-D4-38	572671.32	151537.86	DX	(8.0)	(7.5)	(7.6)	(7.4)	(6.3)	(7.5)	(8.9)	(7.7)	(8.1)	(8.1)	(5.8)	-	-	-	(6.2)	(7.7)	(8.0)	(7.5)	(8.0)	(8.0)	(8.0)	(8.0)	(8.0)	(8.0)
199-D4-39	572747.45	151650.84	DX	(16.4)	(15.5)	(16.0)	(13.8)	(11.0)	(17.1)	(15.4)	(13.6)	(14.4)	(14.4)	(16.1)	(15.4)	(15.0)	(13.2)	(15.9)	(15.5)	(14.5)	(12.4)	(13.8)	(14.5)	(14.5)	(14.5)	(14.5)	(14.5)
199-D4-83	572859.43	151723.42	DX	-	-	-	(0.1)	-	-	-	-	-	-	-	-	-	-	-	-	(5.0)	(9.3)	(11.0)	(5.0)	(5.0)	(5.0)	(5.0)	(5.0)
199-D4-84	572568.04	151433.52	DX	(10.7)	(11.2)	(11.9)	(11.6)	(9.9)	(10.9)	(10.3)	(10.0)	(9.4)	(9.4)	(9.1)	(9.6)	(9.7)	(7.9)	(9.4)	(10.1)	(11.0)	(10.3)	(11.2)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)
199-D4-85	572486.16	151324.20	DX	(19.7)	(18.7)	(18.8)	(13.8)	(12.4)	(16.6)	(16.6)	(15.0)	(15.7)	(15.7)	(11.1)	(13.1)	(14.1)	(16.3)	(16.5)	(18.2)	(19.0)	(17.6)	(17.1)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)

Table 3-2. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 1

Well Name	Easting	Northing	Syestem	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
199-D5-101	572943.04	151521.52	DX	(23.0)	(21.0)	(21.3)	(15.1)	(11.0)	(20.2)	(22.2)	(22.7)	(17.9)	(17.9)	(26.1)	(26.3)	(26.0)	(22.9)	(26.9)	(26.1)	(27.0)	(25.9)	(25.1)	(27.0)	(27.0)	(27.0)	(27.0)	(27.0)
199-D5-127	572992.26	151428.31	DX	(17.8)	(17.6)	(14.3)	(13.0)	(11.0)	(13.2)	(13.8)	(10.9)	(8.5)	(8.5)	(3.9)	-	-	-	(0.0)	-	-	-	(4.7)	-	-	-	-	-
199-D5-128	573622.04	151237.06	DX	77.0	80.4	80.3	72.5	61.0	68.4	81.4	78.0	75.5	75.5	73.4	77.1	75.2	58.1	81.7	84.0	91.3	87.6	90.1	91.3	91.3	91.3	91.3	91.3
199-D5-129	573733.26	151465.18	DX	85.0	87.1	92.2	78.0	65.6	73.5	88.0	83.8	81.2	81.2	79.0	83.0	80.8	62.5	87.8	90.7	99.0	95.6	98.6	99.0	99.0	99.0	99.0	99.0
199-D5-130	574039.20	151928.51	DX	(14.5)	(13.8)	(15.0)	(13.1)	(13.3)	(12.0)	(13.2)	(14.6)	(14.8)	(14.8)	(15.5)	(15.8)	(14.7)	(10.5)	(12.0)	(11.6)	(12.0)	(11.1)	(8.8)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)
199-D5-131	573684.39	152006.75	DX	(17.2)	(15.8)	(15.5)	(13.3)	(12.4)	(13.4)	(13.7)	(14.6)	(15.1)	(15.1)	(17.9)	(18.2)	(17.9)	(15.7)	(18.0)	(17.4)	(17.5)	(16.7)	(17.2)	(17.5)	(17.5)	(17.5)	(17.5)	(17.5)
199-D6-1	574129.87	151691.71	DX	10.6	3.1	16.3	14.7	11.5	32.9	48.2	51.8	47.0	47.0	47.4	52.4	50.4	27.2	51.0	43.9	47.4	40.8	39.2	47.4	47.4	47.4	47.4	47.4
199-D6-2	574544.61	151970.20	DX	52.0	49.6	71.1	70.2	62.0	48.4	54.4	54.4	51.2	51.2	50.9	45.3	36.0	24.9	36.3	30.9	24.1	25.9	28.9	24.1	24.1	24.1	24.1	24.1
199-D7-3	574151.38	152363.41	DX	(18.4)	(19.0)	(18.0)	(14.3)	(11.5)	(14.4)	(16.7)	(14.7)	(17.6)	(17.6)	(19.7)	(20.2)	(18.4)	(10.6)	(15.9)	(16.1)	(17.0)	(16.1)	(17.2)	(17.0)	(17.0)	(17.0)	(17.0)	(17.0)
199-D7-4	574377.07	152369.64	DX	21.6	25.5	22.6	17.5	15.1	31.1	33.6	39.8	37.5	37.5	37.3	41.6	41.7	29.7	50.4	78.5	101.7	103.1	115.1	101.7	101.7	101.7	101.7	101.7
199-D7-5	574434.31	152678.72	DX	53.3	48.0	68.0	67.0	59.3	46.7	44.2	39.1	36.5	36.5	36.5	41.0	40.6	28.5	41.1	42.7	51.2	52.3	58.8	51.2	51.2	51.2	51.2	51.2
199-D7-6	574429.20	152980.43	DX	(16.7)	(16.3)	(16.4)	(12.9)	(11.5)	(14.2)	(14.9)	(12.3)	(14.7)	(14.7)	(12.0)	(14.6)	(14.1)	(3.8)	(15.7)	(15.6)	(17.4)	(17.0)	(17.5)	(17.4)	(17.4)	(17.4)	(17.4)	(17.4)
199-D8-55	573620.95	152364.35	DX	20.9	15.8	11.2	8.7	2.9	2.3	3.3	3.5	3.4	3.4	2.9	1.4	3.6	2.2	4.0	3.4	2.7	1.6	2.5	2.7	2.7	2.7	2.7	2.7
199-D8-69	573843.61	152552.20	DX	(18.8)	(19.0)	(19.4)	(14.3)	(12.4)	(14.9)	(18.8)	(18.1)	(17.0)	(17.0)	(18.1)	(19.2)	(17.9)	(10.7)	(20.6)	(20.1)	(20.9)	(19.6)	(20.2)	(20.9)	(20.9)	(20.9)	(20.9)	(20.9)
199-D8-73	573388.70	152167.38	DX	(3.2)	(3.2)	(3.8)	(3.8)	(3.3)	(3.1)	(3.7)	(3.6)	(3.0)	(3.0)	(2.8)	(3.1)	(2.9)	(1.1)	(0.1)	(4.6)	(5.4)	(5.1)	(5.4)	(5.4)	(5.4)	(5.4)	(5.4)	(5.4)
199-D8-88	573292.33	152141.26	DX	-	-	(0.4)	(0.6)	(0.0)	(3.3)	(2.8)	(1.9)	(2.2)	(2.2)	(2.3)	(3.6)	(3.8)	(3.7)	(4.8)	(6.0)	(6.3)	(6.2)	(7.7)	(6.3)	(6.3)	(6.3)	(6.3)	(6.3)
199-D8-95	573611.96	152160.61	DX	(16.4)	(16.3)	(16.9)	(13.8)	(12.4)	(14.0)	(15.9)	(14.6)	(14.4)	(14.4)	(17.7)	(15.7)	(17.1)	(10.7)	(17.8)	(17.7)	(17.9)	(17.0)	(17.6)	(17.9)	(17.9)	(17.9)	(17.9)	(17.9)
199-D8-96	573706.00	152152.24	DX	(21.8)	(22.1)	(22.5)	(15.2)	(12.8)	(14.6)	(16.4)	(14.6)	(18.3)	(18.3)	(23.2)	(23.7)	(23.9)	(20.9)	(23.9)	(23.2)	(24.0)	(22.3)	(21.0)	(24.0)	(24.0)	(24.0)	(24.0)	(24.0)
199-D8-97	573859.56	152087.42	DX	(17.5)	(17.2)	(19.5)	(14.8)	(12.4)	(16.3)	(19.1)	(19.4)	(18.9)	(18.9)	(21.2)	(21.1)	(19.1)	(11.5)	(17.8)	(17.5)	(18.9)	(17.7)	(17.6)	(18.9)	(18.9)	(18.9)	(18.9)	(18.9)
199-D8-98	574013.12	152123.02	DX	(17.4)	(16.8)	(18.1)	(14.0)	(10.7)	(14.5)	(16.8)	(14.6)	(16.5)	(16.5)	(19.7)	(13.3)	(12.3)	(12.4)	(18.9)	(18.4)	(18.5)	(17.1)	(17.5)	(18.5)	(18.5)	(18.5)	(18.5)	(18.5)
199-D8-99	574006.77	152364.37	DX	9.5	10.1	8.7	6.0	5.3	57.6	83.4	77.3	72.9	72.9	73.2	81.0	80.3	58.9	86.7	85.2	90.9	76.1	71.8	90.9	90.9	90.9	90.9	90.9
199-H1-5	574850.72	153090.30	DX	(19.0)	(19.0)	(19.3)	(13.6)	(11.5)	(16.2)	(18.8)	(19.4)	(14.4)	(14.4)	(10.8)	(14.6)	(14.1)	(3.8)	(15.7)	(15.6)	(17.4)	(17.0)	(17.5)	(17.4)	(17.4)	(17.4)	(17.4)	(17.4)
199-H4-80	575238.97	152568.16	DX	(14.6)	(14.1)	(15.4)	(13.9)	(12.4)	(13.5)	(16.5)	(14.7)	(15.0)	(15.0)	(12.9)	(16.6)	(16.0)	(3.8)	(15.7)	(15.6)	(17.4)	(17.0)	(17.6)	(17.4)	(17.4)	(17.4)	(17.4)	(17.4)
199-H4-81	575236.93	153035.36	DX	(14.7)	(14.5)	(15.2)	(13.5)	(12.4)	(12.4)	(15.5)	(14.6)	(14.8)	(14.8)	(13.4)	(15.8)	(15.7)	(4.1)	(15.0)	(15.1)	(16.4)	(16.1)	(16.9)	(16.4)	(16.4)	(16.4)	(16.4)	(16.4)
199-H4-82	574906.99	152677.72	DX	(0.2)	(10.1)	(12.7)	(10.3)	(7.7)	(15.6)	(19.0)	(19.5)	(15.5)	(15.5)	(11.1)	(17.4)	(16.9)	(3.8)	(17.6)	(17.5)	(18.4)	(17.9)	(17.8)	(18.4)	(18.4)	(18.4)	(18.4)	(18.4)
199-H4-14	577803.75	152752.36	HX	91.1	97.6	95.8	90.4	7.5	-	-	-	-	19.6	20.9	15.3	14.8	14.5	15.6	11.0	11.0	8.5	11.6	11.0	11.0	11.0	11.0	11.0
199-H4-15A	577906.00	153052.00	HX	(19.0)	(19.1)	(18.7)	(17.9)	(1.5)	-	-	-	-	(35.2)	(34.3)	(38.5)	(33.3)	(37.5)	(37.7)	(38.2)	(39.1)	(32.1)	(31.0)	(39.1)	(39.1)	(39.1)	(39.1)	(39.1)
199-H4-17	577779.18	153037.64	HX	52.2	51.3	53.9	49.1	11.5	-	-	-	-	8.5	10.8	11.6	9.6	10.3	9.2	7.1	5.8	5.4	6.7	5.8	5.8	5.8	5.8	5.8
199-H4-18	578018.29	152756.48	HX	40.4	50.3	46.5	42.8	3.5	-	-	-	-	22.2	13.7	12.8	12.2	12.1	13.2	11.7	11.4	9.5	7.3	11.4	11.4	11.4	11.4	11.4
199-H4-4	578060.86	152853.96	HX	-	(8.7)	(4.8)	(5.5)	(0.6)	-	-	-	-	(2.4)	(4.5)	(5.3)	(4.2)	(2.5)	(6.1)	(11.0)	(11.0)	(10.9)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)
199-H4-63	578185.83	152665.53	HX	(24.0)	(24.1)	(23.4)	(21.1)	(1.6)	-	-	-	-	(25.0)	(24.7)	(25.6)	(25.7)	(26.0)	(26.3)	(26.1)	(27.4)	(26.8)	(27.0)	(27.4)	(27.4)	(27.4)	(27.4)	(27.4)
199-H4-64	577946.11	153010.58	HX	-	-	-	-	-	-	-	-	-	(8.2)	(12.1)	(13.3)	(12.3)	(11.7)	(14.9)	(22.9)	(20.7)	(20.1)	(15.0)	(20.7)	(20.7)	(20.7)	(20.7)	(20.7)

Table 3-2. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 1

Well Name	Easting	Northing	Syestem	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
199-H3-2C	577632.07	152750.30	HX	-	-	-	-	-	-	-	-	-	(46.0)	(45.5)	(45.6)	(47.4)	(48.0)	(47.8)	(46.8)	(50.0)	(49.4)	(50.0)	(50.0)	(50.0)	(50.0)	(50.0)	(50.0)
199-H4-12C	578011.77	152919.81	HX	-	-	-	-	-	-	-	-	-	(27.2)	(26.5)	(29.4)	(29.4)	(29.7)	(29.2)	(28.8)	(30.0)	(29.6)	(30.0)	(30.0)	(30.0)	(30.0)	(30.0)	(30.0)
199-H3-4	577544.29	152293.21	HX	-	-	-	-	-	-	-	-	-	(84.6)	(102.9)	(125.0)	(124.2)	(125.0)	(123.9)	(108.8)	(113.4)	(95.6)	(99.4)	(113.4)	(113.4)	(113.4)	(113.4)	(113.4)
199-H1-1	576702.31	153384.49	HX	-	-	-	-	-	-	-	-	-	(28.7)	(29.2)	(30.0)	(29.9)	(29.4)	(30.1)	(26.1)	(29.5)	(26.7)	(19.9)	(29.5)	(29.5)	(29.5)	(29.5)	(29.5)
199-H1-2	576451.07	153378.26	HX	-	-	-	-	-	-	-	-	-	(3.1)	(2.6)	(2.4)	(2.1)	(1.9)	(1.9)	(2.2)	(4.6)	(6.1)	(6.9)	(4.6)	(4.6)	(4.6)	(4.6)	(4.6)
199-H1-20	575706.04	154183.61	HX	-	-	-	-	-	-	-	-	-	72.3	68.8	74.3	71.6	69.2	72.7	79.0	23.9	19.3	0.7	23.9	23.9	23.9	23.9	23.9
199-H1-21	575896.84	154163.80	HX	-	-	-	-	-	-	-	-	-	96.1	88.7	94.7	91.8	90.0	94.0	96.0	67.9	65.7	2.1	67.9	67.9	67.9	67.9	67.9
199-H1-25	576279.64	154069.97	HX	-	-	-	-	-	-	-	-	-	(17.5)	(24.5)	(28.9)	(28.6)	(26.6)	(28.4)	(28.7)	(29.1)	(26.3)	(16.1)	(29.1)	(29.1)	(29.1)	(29.1)	(29.1)
199-H1-27	576403.86	154024.21	HX	-	-	-	-	-	-	-	-	-	(11.2)	(18.0)	(22.1)	(21.5)	(18.7)	(23.8)	(28.7)	(29.6)	(26.4)	(19.0)	(29.6)	(29.6)	(29.6)	(29.6)	(29.6)
199-H1-32	576767.07	153766.00	HX	-	-	-	-	-	-	-	-	-	(1.3)	(1.7)	(1.5)	(1.4)	(0.3)	(1.7)	(9.5)	(18.5)	(19.7)	(19.0)	(18.5)	(18.5)	(18.5)	(18.5)	(18.5)
199-H1-33	576833.29	153716.23	HX	-	-	-	-	-	-	-	-	-	(4.8)	(7.6)	(11.5)	(6.6)	(0.2)	(6.2)	(22.8)	(27.8)	(25.3)	(19.9)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)
199-H1-34	576883.13	153667.06	HX	-	-	-	-	-	-	-	-	-	(11.2)	(13.9)	(14.4)	(13.3)	(11.0)	(15.1)	(25.3)	(27.4)	(27.6)	(27.8)	(27.4)	(27.4)	(27.4)	(27.4)	(27.4)
199-H1-35	576958.26	153628.14	HX	-	-	-	-	-	-	-	-	-	(23.6)	(25.3)	(28.5)	(27.4)	(23.1)	(25.0)	(26.3)	(22.0)	(26.5)	(26.8)	(22.0)	(22.0)	(22.0)	(22.0)	(22.0)
199-H1-36	576885.62	153486.51	HX	-	-	-	-	-	-	-	-	-	(8.1)	(7.1)	(6.9)	(6.3)	(5.3)	(4.7)	(7.7)	(9.0)	(8.9)	(8.9)	(9.0)	(9.0)	(9.0)	(9.0)	(9.0)
199-H1-37	577106.92	153641.63	HX	-	-	-	-	-	-	-	-	-	(7.8)	(10.7)	(12.8)	(7.7)	(3.0)	(10.1)	(27.5)	(27.8)	(27.6)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)
199-H1-38	577161.00	153555.01	HX	-	-	-	-	-	-	-	-	-	(6.1)	(4.3)	(4.0)	(3.4)	(4.3)	(6.3)	(13.5)	(24.4)	(24.5)	(24.9)	(24.4)	(24.4)	(24.4)	(24.4)	(24.4)
199-H1-39	577223.54	153533.40	HX	-	-	-	-	-	-	-	-	-	(1.9)	(1.8)	(1.1)	(1.0)	(0.6)	(2.3)	(32.9)	(41.1)	(37.6)	(29.8)	(41.1)	(41.1)	(41.1)	(41.1)	(41.1)
199-H1-40	577279.34	153500.19	HX	-	-	-	-	-	-	-	-	-	(3.7)	(3.1)	(3.5)	(2.6)	(2.5)	(4.1)	(10.4)	(22.4)	(29.2)	(19.9)	(22.4)	(22.4)	(22.4)	(22.4)	(22.4)
199-H1-42	577127.18	153391.65	HX	-	-	-	-	-	-	-	-	-	(27.2)	(27.6)	(29.0)	(27.6)	(28.9)	(27.9)	(27.9)	(29.0)	(28.0)	(27.8)	(29.0)	(29.0)	(29.0)	(29.0)	(29.0)
199-H1-43	577213.74	153384.28	HX	-	-	-	-	-	-	-	-	-	(28.7)	(28.5)	(19.9)	(21.8)	(24.6)	(29.0)	(28.3)	(29.6)	(29.6)	(29.8)	(29.6)	(29.6)	(29.6)	(29.6)	(29.6)
199-H1-45	577240.96	153062.41	HX	-	-	-	-	-	-	-	-	-	(25.8)	(25.6)	(26.5)	(26.7)	(27.0)	(26.9)	(26.7)	(9.3)	(4.1)	(27.0)	(9.3)	(9.3)	(9.3)	(9.3)	(9.3)
199-H1-6	576037.81	153745.74	HX	-	-	-	-	-	-	-	-	-	(2.2)	(1.5)	(0.4)	(0.1)	(1.0)	(2.2)	(2.8)	(6.3)	(8.5)	(11.7)	(6.3)	(6.3)	(6.3)	(6.3)	(6.3)
199-H3-25	577410.36	152978.49	HX	-	-	-	-	-	-	-	-	-	44.1	49.1	53.3	51.3	49.8	53.3	65.9	90.7	88.2	94.0	90.7	90.7	90.7	90.7	90.7
199-H3-26	577440.83	152846.50	HX	-	-	-	-	-	-	-	-	-	41.0	42.7	45.2	43.9	42.7	45.5	55.9	83.8	83.9	89.4	83.8	83.8	83.8	83.8	83.8
199-H3-27	577567.05	152811.14	HX	-	-	-	-	-	-	-	-	-	35.0	36.8	39.0	37.8	36.6	39.5	55.0	73.5	70.9	75.1	73.5	73.5	73.5	73.5	73.5
199-H4-69	578014.05	152686.66	HX	-	-	-	-	-	-	-	-	-	(26.0)	(24.8)	(27.6)	(27.2)	(21.3)	(24.4)	(27.7)	(28.0)	(27.7)	(28.0)	(28.0)	(28.0)	(28.0)	(28.0)	(28.0)
199-H4-70	578003.82	152646.45	HX	-	-	-	-	-	-	-	-	-	(22.8)	(22.7)	(23.6)	(23.7)	(24.0)	(23.9)	(23.4)	(21.0)	(22.3)	(23.0)	(21.0)	(21.0)	(21.0)	(21.0)	(21.0)
199-H4-71	578010.64	152581.53	HX	-	-	-	-	-	-	-	-	-	27.8	31.7	33.6	32.2	31.1	34.2	43.5	60.7	58.8	62.9	60.7	60.7	60.7	60.7	60.7
199-H4-72	578036.28	152500.14	HX	-	-	-	-	-	-	-	-	-	14.7	20.2	23.1	22.2	20.7	24.2	33.6	58.9	58.6	62.7	58.9	58.9	58.9	58.9	58.9
199-H4-73	577940.58	152369.98	HX	-	-	-	-	-	-	-	-	-	18.4	23.9	25.9	24.6	22.5	25.6	34.9	54.7	53.6	57.7	54.7	54.7	54.7	54.7	54.7
199-H4-74	577239.07	152268.83	HX	-	-	-	-	-	-	-	-	-	34.3	33.8	35.7	34.7	33.5	36.1	45.7	66.8	68.9	75.7	66.8	66.8	66.8	66.8	66.8

Table 3-2. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 1

Well Name	Easting	Northing	Syestem	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
199-H4-75	577212.36	152704.64	HX	-	-	-	-	-	-	-	-	-	(19.1)	(19.0)	(19.7)	(19.7)	(20.0)	(19.0)	(18.1)	(19.0)	(19.1)	(20.0)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)
199-H4-76	576787.32	152976.85	HX	-	-	-	-	-	-	-	-	-	(14.0)	(9.0)	(4.0)	(1.1)	-	-	(0.0)	(3.5)	(13.6)	(17.9)	(3.5)	(3.5)	(3.5)	(3.5)	(3.5)
199-H4-77	576487.79	152975.43	HX	-	-	-	-	-	-	-	-	-	(12.4)	(11.1)	(10.1)	(9.9)	(9.1)	(8.7)	(7.1)	(9.3)	(9.3)	(8.4)	(9.3)	(9.3)	(9.3)	(9.3)	(9.3)
199-H4-78	576168.23	152166.12	HX	-	-	-	-	-	-	-	-	-	50.7	54.6	58.2	55.8	52.2	56.2	71.8	101.2	96.1	122.2	101.2	101.2	101.2	101.2	101.2
199-H4-79	575659.13	151989.31	HX	-	-	-	-	-	-	-	-	-	38.8	58.4	69.3	65.8	62.0	70.1	67.2	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
199-H6-2	577886.50	152194.11	HX	-	-	-	-	-	-	-	-	-	15.1	18.1	20.3	19.2	17.7	20.5	29.9	49.9	52.3	56.2	49.9	49.9	49.9	49.9	49.9

[1] Pumping rates in gallons per minute (gpm)

[2] Values in parentheses indicate extraction

3.4.2 Alternative 2: RTD and Grouting for Waste Site and P&T with Biological Treatment for Groundwater

The RPO P&T system is expanded in Alternative 2 to include additional extraction and injection wells, thus encompassing a larger area to improve hydraulic containment and expedite plume recovery. In addition, in-situ treatment is considered in the form of bio-injection at selected wells in HX to further enhance the reduction of dissolved COC concentrations in the aquifer and improve cleanup times. Well locations were determined based on the COC plume distributions, although spatial restrictions due to cultural and other constraints were considered.

The reported operation of the DX and HX wells of the interim action P&T are considered for the initial two-year period (2011-2012) as described in Alternative 1. The expanded system is operational for the 75-year period after that, with bio-injection occurring at selected wells during that period. The system operation is assumed to be constant throughout the 75-year period to evaluate aquifer cleanup times for each COC under the proposed configuration.

The P&T system capacity is assumed to be reduced by 15% to account for scheduled/unforeseen shut-down periods and reduced pumping rates caused by seasonal changes in river levels. As a result, a total capacity of 510 gpm was assumed for DX and 680 gpm for HX. During periods of in-situ treatment implementation, bio-amended water injected at the designated injection wells is recovered at downgradient extraction wells but bypasses the IX treatment system, allowing for increased total system capacity. The total proposed capacity for the bio-remediation loop is 263 gpm.

Figure 3-5 shows the extraction and injection well configuration for Alternative 2, with proposed wells depicted using red symbols and bio-injection identified by the blue labels. Detailed account of the pumping rates for all wells is included in Table 3-3, with shaded cells indicating bioremediation well operation.

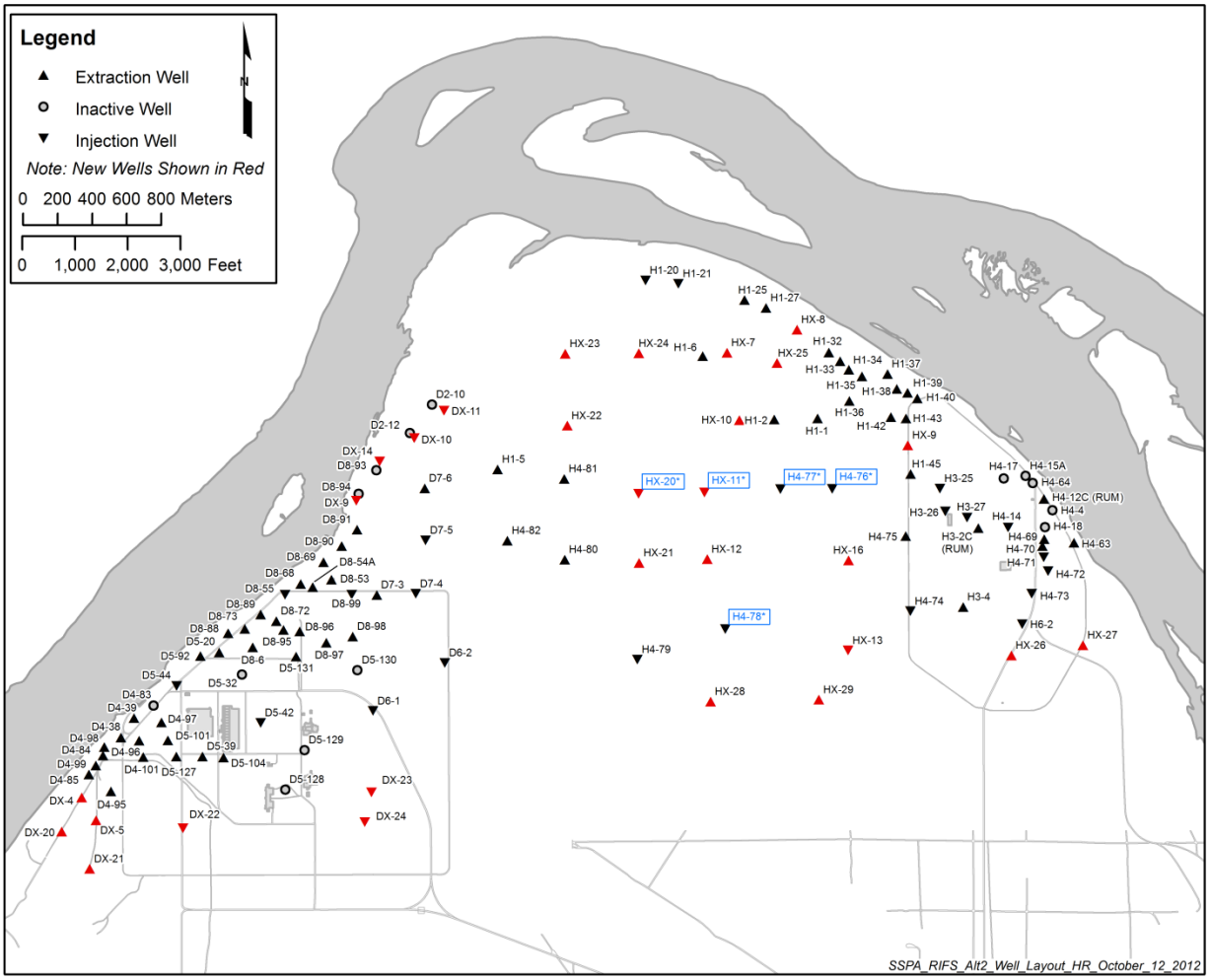


Figure 3-5. Extraction/Injection Well Configuration – Alternative 2.

Table 3-3. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 2

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
199-D5-104	573265.48	151422.43	DX	-	-	-	-	-	-	(17.1)[1,2]	(21.5)	(20.5)	(20.5)	(24.1)	(25.0)	(25.0)	(22.0)	(25.0)	(24.2)	(25.0)	(23.9)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)	(11.0)
199-D5-20	573239.97	152030.15	DX	-	-	-	-	-	-	(8.2)	(8.3)	(3.9)	(3.9)	(0.0)	-	-	-	(0.0)	(7.6)	(9.5)	(9.1)	(9.8)	(9.5)	(9.5)	(9.5)	(9.5)	(9.5)	(9.0)
199-D5-32	573372.04	151903.39	DX	(15.4)	(17.8)	(18.8)	(17.2)	(16.0)	(15.5)	(15.8)	(14.9)	(17.0)	(17.0)	(18.1)	(18.4)	(17.5)	(15.7)	(18.0)	(17.6)	(19.0)	(17.6)	(16.9)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)	-
199-D5-39	573142.86	151428.43	DX	-	-	-	-	-	-	(20.2)	(24.3)	(22.9)	(22.9)	(24.5)	(24.9)	(24.4)	(21.7)	(24.9)	(23.8)	(25.0)	(23.0)	(24.8)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)	(18.0)
199-D5-42	573479.77	151622.67	DX	-	-	-	-	-	-	31.5	33.2	28.0	28.0	22.7	23.7	23.0	17.0	24.4	25.9	25.3	22.6	24.6	25.3	25.3	25.3	25.3	25.3	20.0
199-D5-44	572993.58	151835.74	DX	86.5	87.1	66.1	40.7	34.2	33.7	43.9	46.6	45.3	45.3	44.5	46.9	45.7	35.3	39.9	34.2	26.7	25.7	26.4	26.7	26.7	26.7	26.7	26.7	20.0
199-D5-92	573131.93	152009.82	DX	-	-	-	-	-	-	(21.2)	(23.5)	(17.0)	(17.0)	(15.6)	(18.0)	(18.5)	(21.2)	(29.0)	(29.7)	(33.0)	(30.3)	(29.8)	(33.0)	(33.0)	(33.0)	(33.0)	(33.0)	(18.0)
199-D4-95	572613.00	151227.00	DX	(13.0)	(12.5)	(12.6)	(12.1)	(10.2)	(10.9)	(9.0)	(10.0)	(12.2)	(12.2)	(12.5)	(13.0)	(13.0)	(11.4)	(13.0)	(12.6)	(13.0)	(11.4)	(11.5)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)	(10.0)
199-D4-96	572777.00	151520.00	DX	(13.1)	(12.7)	(12.6)	(13.3)	(10.5)	(13.8)	(15.0)	(15.0)	(15.1)	(15.1)	(13.0)	(10.7)	(7.8)	(4.7)	(5.9)	(2.7)	(7.0)	(7.0)	(8.0)	(7.0)	(7.0)	(7.0)	(7.0)	(7.0)	(8.0)
199-D4-97	572906.53	151624.87	DX	(12.8)	(12.2)	(12.2)	(12.1)	(10.2)	(10.9)	(10.3)	(10.0)	(11.4)	(11.4)	(12.5)	(13.0)	(13.0)	(11.4)	(12.2)	(11.6)	(12.0)	(11.5)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)	(8.0)
199-D4-98	572575.59	151483.28	DX	(13.0)	(12.4)	(12.7)	(11.9)	(10.2)	(10.7)	(11.5)	(10.0)	(11.0)	(11.0)	(11.6)	(12.5)	(13.0)	(11.1)	(13.0)	(12.6)	(13.0)	(12.4)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)	(10.0)
199-D4-99	572526.48	151376.63	DX	(19.5)	(16.3)	(15.4)	(13.7)	(11.0)	(15.8)	(16.5)	(15.0)	(15.6)	(15.6)	(11.1)	(16.5)	(18.0)	(15.4)	(18.9)	(18.4)	(19.0)	(18.0)	(17.2)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)	(12.0)
199-D2-10	574470.70	153465.17	DX	2.7	2.5	0.4	0.4	0.8	-	-	-	0.1	0.1	0.6	0.1	0.1	5.1	1.1	0.6	-	-	-	-	-	-	-	-	-
199-D2-12	574343.40	153300.80	DX	8.8	10.4	4.0	2.1	1.2	-	-	-	0.4	0.4	5.5	3.3	2.4	3.4	5.7	2.8	0.0	-	-	0.0	0.0	0.0	0.0	0.0	-
199-D8-6	573434.69	152060.82	DX	(14.7)	(14.3)	(13.7)	(10.9)	-	-	-	-	-	-	-	-	-	-	-	-	-	(2.0)	(6.9)	-	-	-	-	-	(6.8)
199-D8-89	573479.46	152250.40	DX	(11.5)	(11.2)	(14.0)	(13.9)	(12.4)	(13.5)	(18.4)	(19.1)	(13.3)	(13.3)	(12.1)	(11.1)	(10.6)	(9.6)	(11.1)	(11.1)	(12.1)	(11.6)	(12.4)	(12.1)	(12.1)	(12.1)	(12.1)	(12.1)	(11.0)
199-D8-90	573948.74	152646.20	DX	(19.5)	(18.8)	(19.3)	(13.6)	(11.5)	(14.2)	(18.5)	(17.9)	(16.1)	(16.1)	(12.5)	(19.4)	(18.4)	(10.6)	(18.7)	(18.4)	(17.2)	(17.6)	(17.6)	(17.2)	(17.2)	(17.2)	(17.2)	(17.2)	(18.0)
199-D8-91	574037.21	152741.29	DX	(19.6)	(19.0)	(20.1)	(14.0)	(11.5)	(14.8)	(22.5)	(23.3)	(16.7)	(16.7)	(17.0)	(20.5)	(19.0)	(10.7)	(16.8)	(17.3)	(18.9)	(17.7)	(17.6)	(18.9)	(18.9)	(18.9)	(18.9)	(18.9)	(18.0)
199-D8-93	574148.99	153085.76	DX	13.4	14.6	14.8	8.5	2.1	-	-	-	-	-	0.2	(0.0)	(0.0)	(0.0)	(0.0)	-	-	-	-	-	-	-	-	-	-
199-D8-94	574047.13	152949.35	DX	5.9	1.4	2.8	1.9	0.9	-	-	-	-	-	-	2.9	7.4	5.1	8.8	3.9	0.0	-	-	0.0	0.0	0.0	0.0	0.0	-
DX-10	574369.00	153271.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25.0
DX-11	574540.00	153430.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.0
DX-14	574168.00	153136.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.0
DX-4	572444.00	151191.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(10.0)
DX-5	572527.00	151059.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(10.0)
DX-9	574034.00	152909.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40.0
DX-20	572329.00	150994.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(12.0)
DX-21	572491.00	150778.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(12.0)
DX-22	573030.00	151013.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60.0
DX-23	574121.00	151221.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40.0

Table 3-3. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 2

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
DX-24	574083.00	151049.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35.0
199-D8-53	573889.86	152452.26	DX	(17.0)	(15.6)	(15.1)	(14.4)	(1.0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(7.2)
199-D8-54A	573781.17	152408.03	DX	(18.6)	(19.9)	(19.7)	(17.3)	(1.0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(12.5)
199-D8-68	573711.67	152427.10	DX	(52.0)	(50.8)	(53.8)	(49.9)	(3.3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(11.5)
199-D8-72	573570.48	152211.77	DX	(3.7)	(8.4)	(7.4)	(7.2)	(0.7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(10.5)
199-D4-101	572800.10	151425.94	DX	(2.5)	(4.3)	(2.2)	(0.0)	(0.0)	(0.0)	-	(0.0)	(0.0)	(0.0)	-	-	-	-	(6.8)	(8.2)	(4.9)	-	(3.8)	(4.9)	(4.9)	(4.9)	(4.9)	(4.9)	(3.8)
199-D4-38	572671.32	151537.86	DX	(8.0)	(7.5)	(7.6)	(7.4)	(6.3)	(7.5)	(8.9)	(7.7)	(8.1)	(8.1)	(5.8)	-	-	-	(6.2)	(7.7)	(8.0)	(7.5)	(8.0)	(8.0)	(8.0)	(8.0)	(8.0)	(8.0)	(8.0)
199-D4-39	572747.45	151650.84	DX	(16.4)	(15.5)	(16.0)	(13.8)	(11.0)	(17.1)	(15.4)	(13.6)	(14.4)	(14.4)	(16.1)	(15.4)	(15.0)	(13.2)	(15.9)	(15.5)	(14.5)	(12.4)	(13.8)	(14.5)	(14.5)	(14.5)	(14.5)	(14.5)	(10.0)
199-D4-83	572859.43	151723.42	DX	-	-	-	(0.1)	-	-	-	-	-	-	-	-	-	-	-	-	(5.0)	(9.3)	(11.0)	(5.0)	(5.0)	(5.0)	(5.0)	(5.0)	-
199-D4-84	572568.04	151433.52	DX	(10.7)	(11.2)	(11.9)	(11.6)	(9.9)	(10.9)	(10.3)	(10.0)	(9.4)	(9.4)	(9.1)	(9.6)	(9.7)	(7.9)	(9.4)	(10.1)	(11.0)	(10.3)	(11.2)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)
199-D4-85	572486.16	151324.20	DX	(19.7)	(18.7)	(18.8)	(13.8)	(12.4)	(16.6)	(16.6)	(15.0)	(15.7)	(15.7)	(11.1)	(13.1)	(14.1)	(16.3)	(16.5)	(18.2)	(19.0)	(17.6)	(17.1)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)	(12.0)
199-D5-101	572943.04	151521.52	DX	(23.0)	(21.0)	(21.3)	(15.1)	(11.0)	(20.2)	(22.2)	(22.7)	(17.9)	(17.9)	(26.1)	(26.3)	(26.0)	(22.9)	(26.9)	(26.1)	(27.0)	(25.9)	(25.1)	(27.0)	(27.0)	(27.0)	(27.0)	(27.0)	(20.0)
199-D5-127	572992.26	151428.31	DX	(17.8)	(17.6)	(14.3)	(13.0)	(11.0)	(13.2)	(13.8)	(10.9)	(8.5)	(8.5)	(3.9)	-	-	-	(0.0)	-	-	-	(4.7)	-	-	-	-	-	(4.7)
199-D5-128	573622.04	151237.06	DX	77.0	80.4	80.3	72.5	61.0	68.4	81.4	78.0	75.5	75.5	73.4	77.1	75.2	58.1	81.7	84.0	91.3	87.6	90.1	91.3	91.3	91.3	91.3	91.3	-
199-D5-129	573733.26	151465.18	DX	85.0	87.1	92.2	78.0	65.6	73.5	88.0	83.8	81.2	81.2	79.0	83.0	80.8	62.5	87.8	90.7	99.0	95.6	98.6	99.0	99.0	99.0	99.0	99.0	-
199-D5-130	574039.20	151928.51	DX	(14.5)	(13.8)	(15.0)	(13.1)	(13.3)	(12.0)	(13.2)	(14.6)	(14.8)	(14.8)	(15.5)	(15.8)	(14.7)	(10.5)	(12.0)	(11.6)	(12.0)	(11.1)	(8.8)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)	-
199-D5-131	573684.39	152006.75	DX	(17.2)	(15.8)	(15.5)	(13.3)	(12.4)	(13.4)	(13.7)	(14.6)	(15.1)	(15.1)	(17.9)	(18.2)	(17.9)	(15.7)	(18.0)	(17.4)	(17.5)	(16.7)	(17.2)	(17.5)	(17.5)	(17.5)	(17.5)	(17.5)	(14.0)
199-D6-1	574129.87	151691.71	DX	10.6	3.1	16.3	14.7	11.5	32.9	48.2	51.8	47.0	47.0	47.4	52.4	50.4	27.2	51.0	43.9	47.4	40.8	39.2	47.4	47.4	47.4	47.4	47.4	35.0
199-D6-2	574544.61	151970.20	DX	52.0	49.6	71.1	70.2	62.0	48.4	54.4	54.4	51.2	51.2	50.9	45.3	36.0	24.9	36.3	30.9	24.1	25.9	28.9	24.1	24.1	24.1	24.1	24.1	25.0
199-D7-3	574151.38	152363.41	DX	(18.4)	(19.0)	(18.0)	(14.3)	(11.5)	(14.4)	(16.7)	(14.7)	(17.6)	(17.6)	(19.7)	(20.2)	(18.4)	(10.6)	(15.9)	(16.1)	(17.0)	(16.1)	(17.2)	(17.0)	(17.0)	(17.0)	(17.0)	(17.0)	(12.0)
199-D7-4	574377.07	152369.64	DX	21.6	25.5	22.6	17.5	15.1	31.1	33.6	39.8	37.5	37.5	37.3	41.6	41.7	29.7	50.4	78.5	101.7	103.1	115.1	101.7	101.7	101.7	101.7	101.7	55.0
199-D7-5	574434.31	152678.72	DX	53.3	48.0	68.0	67.0	59.3	46.7	44.2	39.1	36.5	36.5	36.5	41.0	40.6	28.5	41.1	42.7	51.2	52.3	58.8	51.2	51.2	51.2	51.2	51.2	40.0
199-D7-6	574429.20	152980.43	DX	(16.7)	(16.3)	(16.4)	(12.9)	(11.5)	(14.2)	(14.9)	(12.3)	(14.7)	(14.7)	(12.0)	(14.6)	(14.1)	(3.8)	(15.7)	(15.6)	(17.4)	(17.0)	(17.5)	(17.4)	(17.4)	(17.4)	(17.4)	(17.4)	(15.0)
199-D8-55	573620.95	152364.35	DX	20.9	15.8	11.2	8.7	2.9	2.3	3.3	3.5	3.4	3.4	2.9	1.4	3.6	2.2	4.0	3.4	2.7	1.6	2.5	2.7	2.7	2.7	2.7	2.7	2.5
199-D8-69	573843.61	152552.20	DX	(18.8)	(19.0)	(19.4)	(14.3)	(12.4)	(14.9)	(18.8)	(18.1)	(17.0)	(17.0)	(18.1)	(19.2)	(17.9)	(10.7)	(20.6)	(20.1)	(20.9)	(19.6)	(20.2)	(20.9)	(20.9)	(20.9)	(20.9)	(20.9)	(16.5)
199-D8-73	573388.70	152167.38	DX	(3.2)	(3.2)	(3.8)	(3.8)	(3.3)	(3.1)	(3.7)	(3.6)	(3.0)	(3.0)	(2.8)	(3.1)	(2.9)	(1.1)	(0.1)	(4.6)	(5.4)	(5.1)	(5.4)	(5.4)	(5.4)	(5.4)	(5.4)	(5.4)	(5.4)
199-D8-88	573292.33	152141.26	DX	-	-	(0.4)	(0.6)	(0.0)	(3.3)	(2.8)	(1.9)	(2.2)	(2.2)	(2.3)	(3.6)	(3.8)	(3.7)	(4.8)	(6.0)	(6.3)	(6.2)	(7.7)	(6.3)	(6.3)	(6.3)	(6.3)	(6.3)	(7.7)
199-D8-95	573611.96	152160.61	DX	(16.4)	(16.3)	(16.9)	(13.8)	(12.4)	(14.0)	(15.9)	(14.6)	(14.4)	(14.4)	(17.7)	(15.7)	(17.1)	(10.7)	(17.8)	(17.7)	(17.9)	(17.0)	(17.6)	(17.9)	(17.9)	(17.9)	(17.9)	(17.9)	(15.0)
199-D8-96	573706.00	152152.24	DX	(21.8)	(22.1)	(22.5)	(15.2)	(12.8)	(14.6)	(16.4)	(14.6)	(18.3)	(18.3)	(23.2)	(23.7)	(23.9)	(20.9)	(23.9)	(23.2)	(24.0)	(22.3)	(21.0)	(24.0)	(24.0)	(24.0)	(24.0)	(24.0)	(18.0)
199-D8-97	573859.56	152087.42	DX	(17.5)	(17.2)	(19.5)	(14.8)	(12.4)	(16.3)	(19.1)	(19.4)	(18.9)	(18.9)	(21.2)	(21.1)	(19.1)	(11.5)	(17.8)	(17.5)	(18.9)	(17.7)	(17.6)	(18.9)	(18.9)	(18.9)	(18.9)	(18.9)	(16.0)

Table 3-3. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 2

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
199-D8-98	574013.12	152123.02	DX	(17.4)	(16.8)	(18.1)	(14.0)	(10.7)	(14.5)	(16.8)	(14.6)	(16.5)	(16.5)	(19.7)	(13.3)	(12.3)	(12.4)	(18.9)	(18.4)	(18.5)	(17.1)	(17.5)	(18.5)	(18.5)	(18.5)	(18.5)	(18.5)	(16.0)
199-D8-99	574006.77	152364.37	DX	9.5	10.1	8.7	6.0	5.3	57.6	83.4	77.3	72.9	72.9	73.2	81.0	80.3	58.9	86.7	85.2	90.9	76.1	71.8	90.9	90.9	90.9	90.9	90.9	71.8
199-H1-5	574850.72	153090.30	DX	(19.0)	(19.0)	(19.3)	(13.6)	(11.5)	(16.2)	(18.8)	(19.4)	(14.4)	(14.4)	(10.8)	(14.6)	(14.1)	(3.8)	(15.7)	(15.6)	(17.4)	(17.0)	(17.5)	(17.4)	(17.4)	(17.4)	(17.4)	(17.4)	(19.0)
199-H4-80	575238.97	152568.16	DX	(14.6)	(14.1)	(15.4)	(13.9)	(12.4)	(13.5)	(16.5)	(14.7)	(15.0)	(15.0)	(12.9)	(16.6)	(16.0)	(3.8)	(15.7)	(15.6)	(17.4)	(17.0)	(17.6)	(17.4)	(17.4)	(17.4)	(17.4)	(17.4)	(12.5)
199-H4-81	575236.93	153035.36	DX	(14.7)	(14.5)	(15.2)	(13.5)	(12.4)	(12.4)	(15.5)	(14.6)	(14.8)	(14.8)	(13.4)	(15.8)	(15.7)	(4.1)	(15.0)	(15.1)	(16.4)	(16.1)	(16.9)	(16.4)	(16.4)	(16.4)	(16.4)	(16.4)	(17.0)
199-H4-82	574906.99	152677.72	DX	(0.2)	(10.1)	(12.7)	(10.3)	(7.7)	(15.6)	(19.0)	(19.5)	(15.5)	(15.5)	(11.1)	(17.4)	(16.9)	(3.8)	(17.6)	(17.5)	(18.4)	(17.9)	(17.8)	(18.4)	(18.4)	(18.4)	(18.4)	(18.4)	(12.0)
199-H4-14	577803.75	152752.36	HX	91.1	97.6	95.8	90.4	7.5	-	-	-	-	19.6	20.9	15.3	14.8	14.5	15.6	11.0	11.0	8.5	11.6	11.0	11.0	11.0	11.0	11.0	10.0
199-H4-15A	577906.00	153052.00	HX	(19.0)	(19.1)	(18.7)	(17.9)	(1.5)	-	-	-	-	(35.2)	(34.3)	(38.5)	(33.3)	(37.5)	(37.7)	(38.2)	(39.1)	(32.1)	(31.0)	(39.1)	(39.1)	(39.1)	(39.1)	(39.1)	-
199-H4-17	577779.18	153037.64	HX	52.2	51.3	53.9	49.1	11.5	-	-	-	-	8.5	10.8	11.6	9.6	10.3	9.2	7.1	5.8	5.4	6.7	5.8	5.8	5.8	5.8	5.8	-
199-H4-18	578018.29	152756.48	HX	40.4	50.3	46.5	42.8	3.5	-	-	-	-	22.2	13.7	12.8	12.2	12.1	13.2	11.7	11.4	9.5	7.3	11.4	11.4	11.4	11.4	11.4	-
199-H4-4	578060.86	152853.96	HX	-	(8.7)	(4.8)	(5.5)	(0.6)	-	-	-	-	(2.4)	(4.5)	(5.3)	(4.2)	(2.5)	(6.1)	(11.0)	(11.0)	(10.9)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)	-
199-H4-63	578185.83	152665.53	HX	(24.0)	(24.1)	(23.4)	(21.1)	(1.6)	-	-	-	-	(25.0)	(24.7)	(25.6)	(25.7)	(26.0)	(26.3)	(26.1)	(27.4)	(26.8)	(27.0)	(27.4)	(27.4)	(27.4)	(27.4)	(27.4)	(17.0)
199-H4-64	577946.11	153010.58	HX	-	-	-	-	-	-	-	-	-	(8.2)	(12.1)	(13.3)	(12.3)	(11.7)	(14.9)	(22.9)	(20.7)	(20.1)	(15.0)	(20.7)	(20.7)	(20.7)	(20.7)	(20.7)	-
199-H3-2C	577632.07	152750.30	HX	-	-	-	-	-	-	-	-	-	(46.0)	(45.5)	(45.6)	(47.4)	(48.0)	(47.8)	(46.8)	(50.0)	(49.4)	(50.0)	(50.0)	(50.0)	(50.0)	(50.0)	(50.0)	(50.0)
199-H4-12C	578011.77	152919.81	HX	-	-	-	-	-	-	-	-	-	(27.2)	(26.5)	(29.4)	(29.4)	(29.7)	(29.2)	(28.8)	(30.0)	(29.6)	(30.0)	(30.0)	(30.0)	(30.0)	(30.0)	(30.0)	(30.0)
199-H3-4	577544.29	152293.21	HX	-	-	-	-	-	-	-	-	-	(84.6)	(102.9)	(125.0)	(124.2)	(125.0)	(123.9)	(108.8)	(113.4)	(95.6)	(99.4)	(113.4)	(113.4)	(113.4)	(113.4)	(113.4)	(99.4)
199-H1-1	576702.31	153384.49	HX	-	-	-	-	-	-	-	-	-	(28.7)	(29.2)	(30.0)	(29.9)	(29.4)	(30.1)	(26.1)	(29.5)	(26.7)	(19.9)	(29.5)	(29.5)	(29.5)	(29.5)	(29.5)	*(19.9)*[3]
199-H1-2	576451.07	153378.26	HX	-	-	-	-	-	-	-	-	-	(3.1)	(2.6)	(2.4)	(2.1)	(1.9)	(1.9)	(2.2)	(4.6)	(6.1)	(6.9)	(4.6)	(4.6)	(4.6)	(4.6)	(4.6)	*(6.9)*
199-H1-20	575706.04	154183.61	HX	-	-	-	-	-	-	-	-	-	72.3	68.8	74.3	71.6	69.2	72.7	79.0	23.9	19.3	0.7	23.9	23.9	23.9	23.9	23.9	40.0
199-H1-21	575896.84	154163.80	HX	-	-	-	-	-	-	-	-	-	96.1	88.7	94.7	91.8	90.0	94.0	96.0	67.9	65.7	2.1	67.9	67.9	67.9	67.9	67.9	40.0
199-H1-25	576279.64	154069.97	HX	-	-	-	-	-	-	-	-	-	(17.5)	(24.5)	(28.9)	(28.6)	(26.6)	(28.4)	(28.7)	(29.1)	(26.3)	(16.1)	(29.1)	(29.1)	(29.1)	(29.1)	(29.1)	(10.0)
199-H1-27	576403.86	154024.21	HX	-	-	-	-	-	-	-	-	-	(11.2)	(18.0)	(22.1)	(21.5)	(18.7)	(23.8)	(28.7)	(29.6)	(26.4)	(19.0)	(29.6)	(29.6)	(29.6)	(29.6)	(29.6)	(19.0)
199-H1-32	576767.07	153766.00	HX	-	-	-	-	-	-	-	-	-	(1.3)	(1.7)	(1.5)	(1.4)	(0.3)	(1.7)	(9.5)	(18.5)	(19.7)	(19.0)	(18.5)	(18.5)	(18.5)	(18.5)	(18.5)	(19.0)
199-H1-33	576833.29	153716.23	HX	-	-	-	-	-	-	-	-	-	(4.8)	(7.6)	(11.5)	(6.6)	(0.2)	(6.2)	(22.8)	(27.8)	(25.3)	(19.9)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)	(19.9)
199-H1-34	576883.13	153667.06	HX	-	-	-	-	-	-	-	-	-	(11.2)	(13.9)	(14.4)	(13.3)	(11.0)	(15.1)	(25.3)	(27.4)	(27.6)	(27.8)	(27.4)	(27.4)	(27.4)	(27.4)	(27.4)	*(27.8)*
199-H1-35	576958.26	153628.14	HX	-	-	-	-	-	-	-	-	-	(23.6)	(25.3)	(28.5)	(27.4)	(23.1)	(25.0)	(26.3)	(22.0)	(26.5)	(26.8)	(22.0)	(22.0)	(22.0)	(22.0)	(22.0)	(26.8)
199-H1-36	576885.62	153486.51	HX	-	-	-	-	-	-	-	-	-	(8.1)	(7.1)	(6.9)	(6.3)	(5.3)	(4.7)	(7.7)	(9.0)	(8.9)	(8.9)	(9.0)	(9.0)	(9.0)	(9.0)	(9.0)	*(8.9)*
199-H1-37	577106.92	153641.63	HX	-	-	-	-	-	-	-	-	-	(7.8)	(10.7)	(12.8)	(7.7)	(3.0)	(10.1)	(27.5)	(27.8)	(27.6)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)
199-H1-38	577161.00	153555.01	HX	-	-	-	-	-	-	-	-	-	(6.1)	(4.3)	(4.0)	(3.4)	(4.3)	(6.3)	(13.5)	(24.4)	(24.5)	(24.9)	(24.4)	(24.4)	(24.4)	(24.4)	(24.4)	(24.9)
199-H1-39	577223.54	153533.40	HX	-	-	-	-	-	-	-	-	-	(1.9)	(1.8)	(1.1)	(1.0)	(0.6)	(2.3)	(32.9)	(41.1)	(37.6)	(29.8)	(41.1)	(41.1)	(41.1)	(41.1)	(41.1)	(29.8)

Table 3-3. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 2

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
199-H1-40	577279.34	153500.19	HX	-	-	-	-	-	-	-	-	-	(3.7)	(3.1)	(3.5)	(2.6)	(2.5)	(4.1)	(10.4)	(22.4)	(29.2)	(19.9)	(22.4)	(22.4)	(22.4)	(22.4)	(22.4)	(19.9)
199-H1-42	577127.18	153391.65	HX	-	-	-	-	-	-	-	-	-	(27.2)	(27.6)	(29.0)	(27.6)	(28.9)	(27.9)	(27.9)	(29.0)	(28.0)	(27.8)	(29.0)	(29.0)	(29.0)	(29.0)	(29.0)	*(27.8)*
199-H1-43	577213.74	153384.28	HX	-	-	-	-	-	-	-	-	-	(28.7)	(28.5)	(19.9)	(21.8)	(24.6)	(29.0)	(28.3)	(29.6)	(29.6)	(29.8)	(29.6)	(29.6)	(29.6)	(29.6)	(29.6)	(27.4)
199-H1-45	577240.96	153062.41	HX	-	-	-	-	-	-	-	-	-	(25.8)	(25.6)	(26.5)	(26.7)	(27.0)	(26.9)	(26.7)	(9.3)	(4.1)	(27.0)	(9.3)	(9.3)	(9.3)	(9.3)	(9.3)	(27.1)
199-H1-6	576037.81	153745.74	HX	-	-	-	-	-	-	-	-	-	(2.2)	(1.5)	(0.4)	(0.1)	(1.0)	(2.2)	(2.8)	(6.3)	(8.5)	(11.7)	(6.3)	(6.3)	(6.3)	(6.3)	(6.3)	*(11.7)*
199-H3-25	577410.36	152978.49	HX	-	-	-	-	-	-	-	-	-	44.1	49.1	53.3	51.3	49.8	53.3	65.9	90.7	88.2	94.0	90.7	90.7	90.7	90.7	90.7	70.0
199-H3-26	577440.83	152846.50	HX	-	-	-	-	-	-	-	-	-	41.0	42.7	45.2	43.9	42.7	45.5	55.9	83.8	83.9	89.4	83.8	83.8	83.8	83.8	83.8	70.0
199-H3-27	577567.05	152811.14	HX	-	-	-	-	-	-	-	-	-	35.0	36.8	39.0	37.8	36.6	39.5	55.0	73.5	70.9	75.1	73.5	73.5	73.5	73.5	73.5	60.0
199-H4-69	578014.05	152686.66	HX	-	-	-	-	-	-	-	-	-	(26.0)	(24.8)	(27.6)	(27.2)	(21.3)	(24.4)	(27.7)	(28.0)	(27.7)	(28.0)	(28.0)	(28.0)	(28.0)	(28.0)	(28.0)	(27.0)
199-H4-70	578003.82	152646.45	HX	-	-	-	-	-	-	-	-	-	(22.8)	(22.7)	(23.6)	(23.7)	(24.0)	(23.9)	(23.4)	(21.0)	(22.3)	(23.0)	(21.0)	(21.0)	(21.0)	(21.0)	(21.0)	(22.0)
199-H4-71	578010.64	152581.53	HX	-	-	-	-	-	-	-	-	-	27.8	31.7	33.6	32.2	31.1	34.2	43.5	60.7	58.8	62.9	60.7	60.7	60.7	60.7	60.7	55.0
199-H4-72	578036.28	152500.14	HX	-	-	-	-	-	-	-	-	-	14.7	20.2	23.1	22.2	20.7	24.2	33.6	58.9	58.6	62.7	58.9	58.9	58.9	58.9	58.9	55.0
199-H4-73	577940.58	152369.98	HX	-	-	-	-	-	-	-	-	-	18.4	23.9	25.9	24.6	22.5	25.6	34.9	54.7	53.6	57.7	54.7	54.7	54.7	54.7	54.7	50.0
199-H4-74	577239.07	152268.83	HX	-	-	-	-	-	-	-	-	-	34.3	33.8	35.7	34.7	33.5	36.1	45.7	66.8	68.9	75.7	66.8	66.8	66.8	66.8	66.8	64.0
199-H4-75	577212.36	152704.64	HX	-	-	-	-	-	-	-	-	-	(19.1)	(19.0)	(19.7)	(19.7)	(20.0)	(19.0)	(18.1)	(19.0)	(19.1)	(20.0)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)	(20.0)
199-H4-76	576787.32	152976.85	HX	-	-	-	-	-	-	-	-	-	(14.0)	(9.0)	(4.0)	(1.1)	-	-	(0.0)	(3.5)	(13.6)	(17.9)	(3.5)	(3.5)	(3.5)	(3.5)	(3.5)	*42.0*
199-H4-77	576487.79	152975.43	HX	-	-	-	-	-	-	-	-	-	(12.4)	(11.1)	(10.1)	(9.9)	(9.1)	(8.7)	(7.1)	(9.3)	(9.3)	(8.4)	(9.3)	(9.3)	(9.3)	(9.3)	(9.3)	*42.0*
199-H4-78	576168.23	152166.12	HX	-	-	-	-	-	-	-	-	-	50.7	54.6	58.2	55.8	52.2	56.2	71.8	101.2	96.1	122.2	101.2	101.2	101.2	101.2	101.2	*55.0*
199-H4-79	575659.13	151989.31	HX	-	-	-	-	-	-	-	-	-	38.8	58.4	69.3	65.8	62.0	70.1	67.2	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	58.0
199-H6-2	577886.50	152194.11	HX	-	-	-	-	-	-	-	-	-	15.1	18.1	20.3	19.2	17.7	20.5	29.9	49.9	52.3	56.2	49.9	49.9	49.9	49.9	49.9	50.0
HX-10	576249.00	153374.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(18.0)
HX-11	576048.24	152955.55	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*62.0*
HX-12	576064.00	152570.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*(25.0)*
HX-13	576879.00	152042.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	58.0
HX-16	576881.00	152563.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(18.0)
HX-7	576178.00	153765.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*(15.0)*
HX-8	576583.00	153898.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(18.0)
HX-9	577225.00	153229.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(18.0)
HX-20	575666.00	152949.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*62.0*
HX-21	575670.00	152548.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*(30.0)*

Table 3-3. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 2

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
HX-22	575254.00	153343.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*(25.0)*
HX-23	575243.00	153759.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*(25.0)*
HX-24	575668.00	153761.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*(20.0)*
HX-25	576468.00	153705.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*(20.0)*
HX-26	577823.00	152013.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(25.0)
HX-27	578238.00	152072.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(26.0)
HX-28	576083.00	151746.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(20.0)
HX-29	576710.00	151757.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(20.0)

[1] Pumping rates in gallons per minute (gpm)

[2] Values in parentheses indicate extraction

[3] Shaded cells indicate bioremediation

3.4.3 Alternative 3: RTD and Grouting of Waste Site and Increased Capacity Groundwater P&T for Groundwater

Alternative 3 considers the same operation of the RPO P&T for 2011-2012 as described earlier, and an aggressively expanded network of P&T extraction and injection wells after that. The required system capacity is significantly increased compared to RPO P&T as extraction and injection well locations and pumping rates were determined based on the COC plume distributions without consideration of any spatial restrictions and with the intent to further expedite the recovery process and attain cleanup targets.

The system capacities corresponding to the proposed well operation in DX and HX are 1,138 gpm and 1,358 gpm, respectively.

Figure 3-6 shows the extraction and injection well configuration for Alternative 3, with proposed wells depicted using red symbols. Detailed account of the pumping rates for all wells is included in Table 3-4.

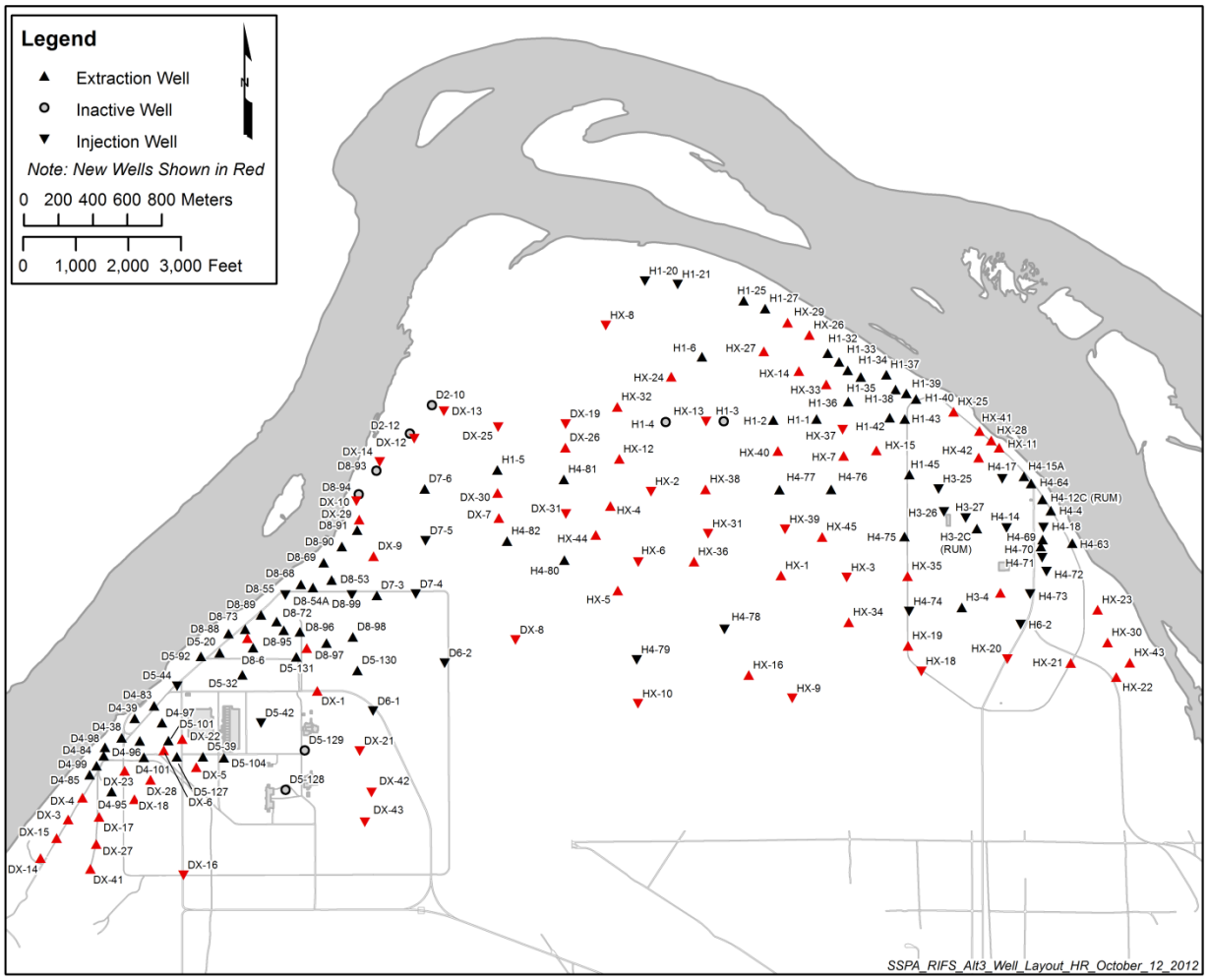


Figure 3-6. Extraction/Injection Well Configuration – Alternative 3.

Table 3-4. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 3

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
199-D5-104	573265.48	151422.43	DX	-	-	-	-	-	-	(17.1)[1,2]	(21.5)	(20.5)	(20.5)	(24.1)	(25.0)	(25.0)	(22.0)	(25.0)	(24.2)	(25.0)	(23.9)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)
199-D5-20	573239.97	152030.15	DX	-	-	-	-	-	-	(8.2)	(8.3)	(3.9)	(3.9)	(0.0)	-	-	-	(0.0)	(7.6)	(9.5)	(9.1)	(9.8)	(9.5)	(9.5)	(9.5)	(9.5)	(9.5)	(9.8)
199-D5-32	573372.04	151903.39	DX	(15.4)	(17.8)	(18.8)	(17.2)	(16.0)	(15.5)	(15.8)	(14.9)	(17.0)	(17.0)	(18.1)	(18.4)	(17.5)	(15.7)	(18.0)	(17.6)	(19.0)	(17.6)	(16.9)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)	(16.9)
199-D5-39	573142.86	151428.43	DX	-	-	-	-	-	-	(20.2)	(24.3)	(22.9)	(22.9)	(24.5)	(24.9)	(24.4)	(21.7)	(24.9)	(23.8)	(25.0)	(23.0)	(24.8)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)	(24.8)
199-D5-42	573479.77	151622.67	DX	-	-	-	-	-	-	31.5	33.2	28.0	28.0	22.7	23.7	23.0	17.0	24.4	25.9	25.3	22.6	24.6	25.3	25.3	25.3	25.3	25.3	25.0
199-D5-44	572993.58	151835.74	DX	86.5	87.1	66.1	40.7	34.2	33.7	43.9	46.6	45.3	45.3	44.5	46.9	45.7	35.3	39.9	34.2	26.7	25.7	26.4	26.7	26.7	26.7	26.7	26.7	40.0
199-D5-92	573131.93	152009.82	DX	-	-	-	-	-	-	(21.2)	(23.5)	(17.0)	(17.0)	(15.6)	(18.0)	(18.5)	(21.2)	(29.0)	(29.7)	(33.0)	(30.3)	(29.8)	(33.0)	(33.0)	(33.0)	(33.0)	(33.0)	(29.8)
199-D4-95	572613.00	151227.00	DX	(13.0)	(12.5)	(12.6)	(12.1)	(10.2)	(10.9)	(9.0)	(10.0)	(12.2)	(12.2)	(12.5)	(13.0)	(13.0)	(11.4)	(13.0)	(12.6)	(13.0)	(11.4)	(11.5)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)
199-D4-96	572777.00	151520.00	DX	(13.1)	(12.7)	(12.6)	(13.3)	(10.5)	(13.8)	(15.0)	(15.0)	(15.1)	(15.1)	(13.0)	(10.7)	(7.8)	(4.7)	(5.9)	(2.7)	(7.0)	(7.0)	(8.0)	(7.0)	(7.0)	(7.0)	(7.0)	(7.0)	(8.0)
199-D4-97	572906.53	151624.87	DX	(12.8)	(12.2)	(12.2)	(12.1)	(10.2)	(10.9)	(10.3)	(10.0)	(11.4)	(11.4)	(12.5)	(13.0)	(13.0)	(11.4)	(12.2)	(11.6)	(12.0)	(11.5)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)
199-D4-98	572575.59	151483.28	DX	(13.0)	(12.4)	(12.7)	(11.9)	(10.2)	(10.7)	(11.5)	(10.0)	(11.0)	(11.0)	(11.6)	(12.5)	(13.0)	(11.1)	(13.0)	(12.6)	(13.0)	(12.4)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)
199-D4-99	572526.48	151376.63	DX	(19.5)	(16.3)	(15.4)	(13.7)	(11.0)	(15.8)	(16.5)	(15.0)	(15.6)	(15.6)	(11.1)	(16.5)	(18.0)	(15.4)	(18.9)	(18.4)	(19.0)	(18.0)	(17.2)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)	(17.2)
199-D2-10	574470.70	153465.17	DX	2.7	2.5	0.4	0.4	0.8	-	-	-	0.1	0.1	0.6	0.1	0.1	5.1	1.1	0.6	-	-	-	-	-	-	-	-	-
199-D2-12	574343.40	153300.80	DX	8.8	10.4	4.0	2.1	1.2	-	-	-	0.4	0.4	5.5	3.3	2.4	3.4	5.7	2.8	0.0	-	-	0.0	0.0	0.0	0.0	0.0	-
199-D8-6	573434.69	152060.82	DX	(14.7)	(14.3)	(13.7)	(10.9)	-	-	-	-	-	-	-	-	-	-	-	-	-	(2.0)	(6.9)	-	-	-	-	-	(7.6)
199-D8-89	573479.46	152250.40	DX	(11.5)	(11.2)	(14.0)	(13.9)	(12.4)	(13.5)	(18.4)	(19.1)	(13.3)	(13.3)	(12.1)	(11.1)	(10.6)	(9.6)	(11.1)	(11.1)	(12.1)	(11.6)	(12.4)	(12.1)	(12.1)	(12.1)	(12.1)	(12.1)	(12.4)
199-D8-90	573948.74	152646.20	DX	(19.5)	(18.8)	(19.3)	(13.6)	(11.5)	(14.2)	(18.5)	(17.9)	(16.1)	(16.1)	(12.5)	(19.4)	(18.4)	(10.6)	(18.7)	(18.4)	(17.2)	(17.6)	(17.6)	(17.2)	(17.2)	(17.2)	(17.2)	(17.2)	(18.0)
199-D8-91	574037.21	152741.29	DX	(19.6)	(19.0)	(20.1)	(14.0)	(11.5)	(14.8)	(22.5)	(23.3)	(16.7)	(16.7)	(17.0)	(20.5)	(19.0)	(10.7)	(16.8)	(17.3)	(18.9)	(17.7)	(17.6)	(18.9)	(18.9)	(18.9)	(18.9)	(18.9)	(18.0)
199-D8-93	574148.99	153085.76	DX	13.4	14.6	14.8	8.5	2.1	-	-	-	-	-	0.2	(0.0)	(0.0)	(0.0)	(0.0)	-	-	-	-	-	-	-	-	-	-
199-D8-94	574047.13	152949.35	DX	5.9	1.4	2.8	1.9	0.9	-	-	-	-	-	-	2.9	7.4	5.1	8.8	3.9	0.0	-	-	0.0	0.0	0.0	0.0	0.0	-
DX-4	572444.00	151191.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(20.0)
DX-5	573104.00	151367.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(17.0)
DX-6	572916.00	151466.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(17.0)
DX-7	574859.00	152811.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(26.0)
DX-8	574956.00	152104.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65.0
DX-9	574133.00	152590.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(25.0)
DX-10	574034.00	152909.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	55.0

Table 3-4. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 3

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
DX-11	574168.00	153136.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	55.0
DX-12	574369.00	153271.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52.0
DX-13	574540.00	153430.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.0
DX-14	572202.00	150840.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
DX-15	572294.00	150956.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(20.0)
DX-16	573030.00	150742.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65.0
DX-17	572541.00	151079.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(23.0)
DX-18	572745.00	151182.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
DX-19	575247.00	153355.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45.0
DX-20	573746.00	152057.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
DX-21	574053.00	151461.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	55.0
DX-22	573023.00	151531.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(17.0)
DX-23	572689.00	151347.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(24.0)
DX-24	573402.00	152115.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(17.0)
DX-25	574855.00	153338.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45.0
DX-26	575246.00	153219.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(26.0)
DX-27	572524.00	150923.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(28.0)
DX-28	572839.00	151295.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(17.0)
DX-29	574049.00	152802.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(17.0)
DX-30	574852.00	152956.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(26.0)
DX-31	575249.00	152835.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.0
DX-3	572361.00	151065.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(20.0)
DX-1	573806.00	151810.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(17.0)
DX-41	572491.00	150778.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
DX-42	574121.00	151221.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80.0
DX-43	574083.00	151049.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	90.1
199-D8-53	573889.86	152452.26	DX	(17.0)	(15.6)	(15.1)	(14.4)	(1.0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(7.2)
199-D8-54A	573781.17	152408.03	DX	(18.6)	(19.9)	(19.7)	(17.3)	(1.0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(14.5)
199-D8-68	573711.67	152427.10	DX	(52.0)	(50.8)	(53.8)	(49.9)	(3.3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(40.0)
199-D8-72	573570.48	152211.77	DX	(3.7)	(8.4)	(7.4)	(7.2)	(0.7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(11.1)

Table 3-4. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 3

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
199-D4-38	572671.32	151537.86	DX	(8.0)	(7.5)	(7.6)	(7.4)	(6.3)	(7.5)	(8.9)	(7.7)	(8.1)	(8.1)	(5.8)	-	-	-	(6.2)	(7.7)	(8.0)	(7.5)	(8.0)	(8.0)	(8.0)	(8.0)	(8.0)	(8.0)	(8.0)
199-D4-39	572747.45	151650.84	DX	(16.4)	(15.5)	(16.0)	(13.8)	(11.0)	(17.1)	(15.4)	(13.6)	(14.4)	(14.4)	(16.1)	(15.4)	(15.0)	(13.2)	(15.9)	(15.5)	(14.5)	(12.4)	(13.8)	(14.5)	(14.5)	(14.5)	(14.5)	(14.5)	(13.8)
199-D4-83	572859.43	151723.42	DX	-	-	-	(0.1)	-	-	-	-	-	-	-	-	-	-	-	-	(5.0)	(9.3)	(11.0)	(5.0)	(5.0)	(5.0)	(5.0)	(5.0)	(11.0)
199-D4-84	572568.04	151433.52	DX	(10.7)	(11.2)	(11.9)	(11.6)	(9.9)	(10.9)	(10.3)	(10.0)	(9.4)	(9.4)	(9.1)	(9.6)	(9.7)	(7.9)	(9.4)	(10.1)	(11.0)	(10.3)	(11.2)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)	(11.2)
199-D4-85	572486.16	151324.20	DX	(19.7)	(18.7)	(18.8)	(13.8)	(12.4)	(16.6)	(16.6)	(15.0)	(15.7)	(15.7)	(11.1)	(13.1)	(14.1)	(16.3)	(16.5)	(18.2)	(19.0)	(17.6)	(17.1)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)	(10.0)
199-D8-55	573620.95	152364.35	DX	20.9	15.8	11.2	8.7	2.9	2.3	3.3	3.5	3.4	3.4	2.9	1.4	3.6	2.2	4.0	3.4	2.7	1.6	2.5	2.7	2.7	2.7	2.7	2.7	2.5
199-D8-69	573843.61	152552.20	DX	(18.8)	(19.0)	(19.4)	(14.3)	(12.4)	(14.9)	(18.8)	(18.1)	(17.0)	(17.0)	(18.1)	(19.2)	(17.9)	(10.7)	(20.6)	(20.1)	(20.9)	(19.6)	(20.2)	(20.9)	(20.9)	(20.9)	(20.9)	(20.9)	(20.2)
199-D8-73	573388.70	152167.38	DX	(3.2)	(3.2)	(3.8)	(3.8)	(3.3)	(3.1)	(3.7)	(3.6)	(3.0)	(3.0)	(2.8)	(3.1)	(2.9)	(1.1)	(0.1)	(4.6)	(5.4)	(5.1)	(5.4)	(5.4)	(5.4)	(5.4)	(5.4)	(5.4)	(5.4)
199-D8-88	573292.33	152141.26	DX	-	-	(0.4)	(0.6)	(0.0)	(3.3)	(2.8)	(1.9)	(2.2)	(2.2)	(2.3)	(3.6)	(3.8)	(3.7)	(4.8)	(6.0)	(6.3)	(6.2)	(7.7)	(6.3)	(6.3)	(6.3)	(6.3)	(6.3)	(7.7)
199-D4-101	572800.10	151425.94	DX	(2.5)	(4.3)	(2.2)	(0.0)	(0.0)	(0.0)	-	(0.0)	(0.0)	(0.0)	-	-	-	-	(6.8)	(8.2)	(4.9)	-	(3.8)	(4.9)	(4.9)	(4.9)	(4.9)	(4.9)	(3.8)
199-D8-97	573859.56	152087.42	DX	(17.5)	(17.2)	(19.5)	(14.8)	(12.4)	(16.3)	(19.1)	(19.4)	(18.9)	(18.9)	(21.2)	(21.1)	(19.1)	(11.5)	(17.8)	(17.5)	(18.9)	(17.7)	(17.6)	(18.9)	(18.9)	(18.9)	(18.9)	(18.9)	(17.6)
199-D5-101	572943.04	151521.52	DX	(23.0)	(21.0)	(21.3)	(15.1)	(11.0)	(20.2)	(22.2)	(22.7)	(17.9)	(17.9)	(26.1)	(26.3)	(26.0)	(22.9)	(26.9)	(26.1)	(27.0)	(25.9)	(25.1)	(27.0)	(27.0)	(27.0)	(27.0)	(27.0)	(25.1)
199-D8-95	573611.96	152160.61	DX	(16.4)	(16.3)	(16.9)	(13.8)	(12.4)	(14.0)	(15.9)	(14.6)	(14.4)	(14.4)	(17.7)	(15.7)	(17.1)	(10.7)	(17.8)	(17.7)	(17.9)	(17.0)	(17.6)	(17.9)	(17.9)	(17.9)	(17.9)	(17.9)	(17.6)
199-D5-130	574039.20	151928.51	DX	(14.5)	(13.8)	(15.0)	(13.1)	(13.3)	(12.0)	(13.2)	(14.6)	(14.8)	(14.8)	(15.5)	(15.8)	(14.7)	(10.5)	(12.0)	(11.6)	(12.0)	(11.1)	(8.8)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)	(8.8)
199-D5-127	572992.26	151428.31	DX	(17.8)	(17.6)	(14.3)	(13.0)	(11.0)	(13.2)	(13.8)	(10.9)	(8.5)	(8.5)	(3.9)	-	-	-	(0.0)	-	-	-	(4.7)	-	-	-	-	-	(4.7)
199-D6-1	574129.87	151691.71	DX	10.6	3.1	16.3	14.7	11.5	32.9	48.2	51.8	47.0	47.0	47.4	52.4	50.4	27.2	51.0	43.9	47.4	40.8	39.2	47.4	47.4	47.4	47.4	47.4	37.5
199-D8-99	574006.77	152364.37	DX	9.5	10.1	8.7	6.0	5.3	57.6	83.4	77.3	72.9	72.9	73.2	81.0	80.3	58.9	86.7	85.2	90.9	76.1	71.8	90.9	90.9	90.9	90.9	90.9	60.0
199-D7-4	574377.07	152369.64	DX	21.6	25.5	22.6	17.5	15.1	31.1	33.6	39.8	37.5	37.5	37.3	41.6	41.7	29.7	50.4	78.5	101.7	103.1	115.1	101.7	101.7	101.7	101.7	101.7	90.0
199-H4-80	575238.97	152568.16	DX	(14.6)	(14.1)	(15.4)	(13.9)	(12.4)	(13.5)	(16.5)	(14.7)	(15.0)	(15.0)	(12.9)	(16.6)	(16.0)	(3.8)	(15.7)	(15.6)	(17.4)	(17.0)	(17.6)	(17.4)	(17.4)	(17.4)	(17.4)	(17.4)	(17.6)
199-H4-81	575236.93	153035.36	DX	(14.7)	(14.5)	(15.2)	(13.5)	(12.4)	(12.4)	(15.5)	(14.6)	(14.8)	(14.8)	(13.4)	(15.8)	(15.7)	(4.1)	(15.0)	(15.1)	(16.4)	(16.1)	(16.9)	(16.4)	(16.4)	(16.4)	(16.4)	(16.4)	(16.9)
199-D7-3	574151.38	152363.41	DX	(18.4)	(19.0)	(18.0)	(14.3)	(11.5)	(14.4)	(16.7)	(14.7)	(17.6)	(17.6)	(19.7)	(20.2)	(18.4)	(10.6)	(15.9)	(16.1)	(17.0)	(16.1)	(17.2)	(17.0)	(17.0)	(17.0)	(17.0)	(17.0)	(17.2)
199-D5-129	573733.26	151465.18	DX	85.0	87.1	92.2	78.0	65.6	73.5	88.0	83.8	81.2	81.2	79.0	83.0	80.8	62.5	87.8	90.7	99.0	95.6	98.6	99.0	99.0	99.0	99.0	99.0	-
199-D5-131	573684.39	152006.75	DX	(17.2)	(15.8)	(15.5)	(13.3)	(12.4)	(13.4)	(13.7)	(14.6)	(15.1)	(15.1)	(17.9)	(18.2)	(17.9)	(15.7)	(18.0)	(17.4)	(17.5)	(16.7)	(17.2)	(17.5)	(17.5)	(17.5)	(17.5)	(17.5)	(17.2)
199-D8-98	574013.12	152123.02	DX	(17.4)	(16.8)	(18.1)	(14.0)	(10.7)	(14.5)	(16.8)	(14.6)	(16.5)	(16.5)	(19.7)	(13.3)	(12.3)	(12.4)	(18.9)	(18.4)	(18.5)	(17.1)	(17.5)	(18.5)	(18.5)	(18.5)	(18.5)	(18.5)	(17.5)
199-D8-96	573706.00	152152.24	DX	(21.8)	(22.1)	(22.5)	(15.2)	(12.8)	(14.6)	(16.4)	(14.6)	(18.3)	(18.3)	(23.2)	(23.7)	(23.9)	(20.9)	(23.9)	(23.2)	(24.0)	(22.3)	(21.0)	(24.0)	(24.0)	(24.0)	(24.0)	(24.0)	(21.0)
199-D6-2	574544.61	151970.20	DX	52.0	49.6	71.1	70.2	62.0	48.4	54.4	54.4	51.2	51.2	50.9	45.3	36.0	24.9	36.3	30.9	24.1	25.9	28.9	24.1	24.1	24.1	24.1	24.1	26.0
199-D7-5	574434.31	152678.72	DX	53.3	48.0	68.0	67.0	59.3	46.7	44.2	39.1	36.5	36.5	36.5	41.0	40.6	28.5	41.1	42.7	51.2	52.3	58.8	51.2	51.2	51.2	51.2	51.2	50.0
199-H4-82	574906.99	152677.72	DX	(0.2)	(10.1)	(12.7)	(10.3)	(7.7)	(15.6)	(19.0)	(19.5)	(15.5)	(15.5)	(11.1)	(17.4)	(16.9)	(3.8)	(17.6)	(17.5)	(18.4)	(17.9)	(17.8)	(18.4)	(18.4)	(18.4)	(18.4)	(18.4)	(17.8)
199-H1-5	574850.72	153090.30	DX	(19.0)	(19.0)	(19.3)	(13.6)	(11.5)	(16.2)	(18.8)	(19.4)	(14.4)	(14.4)	(10.8)	(14.6)	(14.1)	(3.8)	(15.7)	(15.6)	(17.4)	(17.0)	(17.5)	(17.4)	(17.4)	(17.4)	(17.4)	(17.4)	(17.5)
199-D7-6	574429.20	152980.43	DX	(16.7)	(16.3)	(16.4)	(12.9)	(11.5)	(14.2)	(14.9)	(12.3)	(14.7)	(14.7)	(12.0)	(14.6)	(14.1)	(3.8)	(15.7)	(15.6)	(17.4)	(17.0)	(17.5)	(17.4)	(17.4)	(17.4)	(17.4)	(17.4)	(17.5)

Table 3-4. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 3

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
199-D5-128	573622.04	151237.06	DX	77.0	80.4	80.3	72.5	61.0	68.4	81.4	78.0	75.5	75.5	73.4	77.1	75.2	58.1	81.7	84.0	91.3	87.6	90.1	91.3	91.3	91.3	91.3	91.3	-
199-H4-14	577803.75	152752.36	HX	91.1	97.6	95.8	90.4	7.5	-	-	-	-	19.6	20.9	15.3	14.8	14.5	15.6	11.0	11.0	8.5	11.6	11.0	11.0	11.0	11.0	11.0	11.6
199-H4-15A	577906.00	153052.00	HX	(19.0)	(19.1)	(18.7)	(17.9)	(1.5)	-	-	-	-	(35.2)	(34.3)	(38.5)	(33.3)	(37.5)	(37.7)	(38.2)	(39.1)	(32.1)	(31.0)	(39.1)	(39.1)	(39.1)	(39.1)	(39.1)	(31.0)
199-H4-17	577779.18	153037.64	HX	52.2	51.3	53.9	49.1	11.5	-	-	-	-	8.5	10.8	11.6	9.6	10.3	9.2	7.1	5.8	5.4	6.7	5.8	5.8	5.8	5.8	5.8	5.0
199-H4-18	578018.29	152756.48	HX	40.4	50.3	46.5	42.8	3.5	-	-	-	-	22.2	13.7	12.8	12.2	12.1	13.2	11.7	11.4	9.5	7.3	11.4	11.4	11.4	11.4	11.4	7.0
199-H4-4	578060.86	152853.96	HX	-	(8.7)	(4.8)	(5.5)	(0.6)	-	-	-	-	(2.4)	(4.5)	(5.3)	(4.2)	(2.5)	(6.1)	(11.0)	(11.0)	(10.9)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)
199-H4-63	578185.83	152665.53	HX	(24.0)	(24.1)	(23.4)	(21.1)	(1.6)	-	-	-	-	(25.0)	(24.7)	(25.6)	(25.7)	(26.0)	(26.3)	(26.1)	(27.4)	(26.8)	(27.0)	(27.4)	(27.4)	(27.4)	(27.4)	(27.4)	(27.0)
199-H4-64	577946.11	153010.58	HX	-	-	-	-	-	-	-	-	-	(8.2)	(12.1)	(13.3)	(12.3)	(11.7)	(14.9)	(22.9)	(20.7)	(20.1)	(15.0)	(20.7)	(20.7)	(20.7)	(20.7)	(20.7)	(15.0)
199-H3-2C	577632.07	152750.30	HX	-	-	-	-	-	-	-	-	-	(46.0)	(45.5)	(45.6)	(47.4)	(48.0)	(47.8)	(46.8)	(50.0)	(49.4)	(50.0)	(50.0)	(50.0)	(50.0)	(50.0)	(50.0)	(50.0)
199-H3-4	577544.29	152293.21	HX	-	-	-	-	-	-	-	-	-	(84.6)	(102.9)	(125.0)	(124.2)	(125.0)	(123.9)	(108.8)	(113.4)	(95.6)	(99.4)	(113.4)	(113.4)	(113.4)	(113.4)	(113.4)	(115.0)
199-H4-12C	578011.77	152919.81	HX	-	-	-	-	-	-	-	-	-	(27.2)	(26.5)	(29.4)	(29.4)	(29.7)	(29.2)	(28.8)	(30.0)	(29.6)	(30.0)	(30.0)	(30.0)	(30.0)	(30.0)	(30.0)	(30.0)
199-H1-38	577161.00	153555.01	HX	-	-	-	-	-	-	-	-	-	(6.1)	(4.3)	(4.0)	(3.4)	(4.3)	(6.3)	(13.5)	(24.4)	(24.5)	(24.9)	(24.4)	(24.4)	(24.4)	(24.4)	(24.4)	(24.9)
199-H1-37	577106.92	153641.63	HX	-	-	-	-	-	-	-	-	-	(7.8)	(10.7)	(12.8)	(7.7)	(3.0)	(10.1)	(27.5)	(27.8)	(27.6)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)
199-H1-32	576767.07	153766.00	HX	-	-	-	-	-	-	-	-	-	(1.3)	(1.7)	(1.5)	(1.4)	(0.3)	(1.7)	(9.5)	(18.5)	(19.7)	(19.0)	(18.5)	(18.5)	(18.5)	(18.5)	(18.5)	(19.0)
199-H1-36	576885.62	153486.51	HX	-	-	-	-	-	-	-	-	-	(8.1)	(7.1)	(6.9)	(6.3)	(5.3)	(4.7)	(7.7)	(9.0)	(8.9)	(8.9)	(9.0)	(9.0)	(9.0)	(9.0)	(9.0)	(8.9)
199-H1-40	577279.34	153500.19	HX	-	-	-	-	-	-	-	-	-	(3.7)	(3.1)	(3.5)	(2.6)	(2.5)	(4.1)	(10.4)	(22.4)	(29.2)	(19.9)	(22.4)	(22.4)	(22.4)	(22.4)	(22.4)	(19.9)
199-H1-33	576833.29	153716.23	HX	-	-	-	-	-	-	-	-	-	(4.8)	(7.6)	(11.5)	(6.6)	(0.2)	(6.2)	(22.8)	(27.8)	(25.3)	(19.9)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)	(19.9)
199-H1-35	576958.26	153628.14	HX	-	-	-	-	-	-	-	-	-	(23.6)	(25.3)	(28.5)	(27.4)	(23.1)	(25.0)	(26.3)	(22.0)	(26.5)	(26.8)	(22.0)	(22.0)	(22.0)	(22.0)	(22.0)	(26.8)
199-H1-42	577127.18	153391.65	HX	-	-	-	-	-	-	-	-	-	(27.2)	(27.6)	(29.0)	(27.6)	(28.9)	(27.9)	(27.9)	(29.0)	(28.0)	(27.8)	(29.0)	(29.0)	(29.0)	(29.0)	(29.0)	(27.8)
199-H1-34	576883.13	153667.06	HX	-	-	-	-	-	-	-	-	-	(11.2)	(13.9)	(14.4)	(13.3)	(11.0)	(15.1)	(25.3)	(27.4)	(27.6)	(27.8)	(27.4)	(27.4)	(27.4)	(27.4)	(27.4)	(27.8)
199-H1-39	577223.54	153533.40	HX	-	-	-	-	-	-	-	-	-	(1.9)	(1.8)	(1.1)	(1.0)	(0.6)	(2.3)	(32.9)	(41.1)	(37.6)	(29.8)	(41.1)	(41.1)	(41.1)	(41.1)	(41.1)	(29.8)
199-H3-25	577410.36	152978.49	HX	-	-	-	-	-	-	-	-	-	44.1	49.1	53.3	51.3	49.8	53.3	65.9	90.7	88.2	94.0	90.7	90.7	90.7	90.7	90.7	65.0
199-H1-21	575896.84	154163.80	HX	-	-	-	-	-	-	-	-	-	96.1	88.7	94.7	91.8	90.0	94.0	96.0	67.9	65.7	2.1	67.9	67.9	67.9	67.9	67.9	42.0
199-H1-20	575706.04	154183.61	HX	-	-	-	-	-	-	-	-	-	72.3	68.8	74.3	71.6	69.2	72.7	79.0	23.9	19.3	0.7	23.9	23.9	23.9	23.9	23.9	42.0
199-H3-27	577567.05	152811.14	HX	-	-	-	-	-	-	-	-	-	35.0	36.8	39.0	37.8	36.6	39.5	55.0	73.5	70.9	75.1	73.5	73.5	73.5	73.5	73.5	62.0
199-H3-26	577440.83	152846.50	HX	-	-	-	-	-	-	-	-	-	41.0	42.7	45.2	43.9	42.7	45.5	55.9	83.8	83.9	89.4	83.8	83.8	83.8	83.8	83.8	72.0
199-H1-45	577240.96	153062.41	HX	-	-	-	-	-	-	-	-	-	(25.8)	(25.6)	(26.5)	(26.7)	(27.0)	(26.9)	(26.7)	(9.3)	(4.1)	(27.0)	(9.3)	(9.3)	(9.3)	(9.3)	(9.3)	(27.0)
199-H1-25	576279.64	154069.97	HX	-	-	-	-	-	-	-	-	-	(17.5)	(24.5)	(28.9)	(28.6)	(26.6)	(28.4)	(28.7)	(29.1)	(26.3)	(16.1)	(29.1)	(29.1)	(29.1)	(29.1)	(29.1)	(16.1)
199-H1-27	576403.86	154024.21	HX	-	-	-	-	-	-	-	-	-	(11.2)	(18.0)	(22.1)	(21.5)	(18.7)	(23.8)	(28.7)	(29.6)	(26.4)	(19.0)	(29.6)	(29.6)	(29.6)	(29.6)	(29.6)	(19.0)
199-H4-70	578003.82	152646.45	HX	-	-	-	-	-	-	-	-	-	(22.8)	(22.7)	(23.6)	(23.7)	(24.0)	(23.9)	(23.4)	(21.0)	(22.3)	(23.0)	(21.0)	(21.0)	(21.0)	(21.0)	(21.0)	(23.0)

Table 3-4. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 3

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
199-H4-73	577940.58	152369.98	HX	-	-	-	-	-	-	-	-	-	18.4	23.9	25.9	24.6	22.5	25.6	34.9	54.7	53.6	57.7	54.7	54.7	54.7	54.7	54.7	50.0
199-H4-69	578014.05	152686.66	HX	-	-	-	-	-	-	-	-	-	(26.0)	(24.8)	(27.6)	(27.2)	(21.3)	(24.4)	(27.7)	(28.0)	(27.7)	(28.0)	(28.0)	(28.0)	(28.0)	(28.0)	(28.0)	(28.0)
199-H4-71	578010.64	152581.53	HX	-	-	-	-	-	-	-	-	-	27.8	31.7	33.6	32.2	31.1	34.2	43.5	60.7	58.8	62.9	60.7	60.7	60.7	60.7	60.7	55.0
199-H4-72	578036.28	152500.14	HX	-	-	-	-	-	-	-	-	-	14.7	20.2	23.1	22.2	20.7	24.2	33.6	58.9	58.6	62.7	58.9	58.9	58.9	58.9	58.9	55.0
199-H6-2	577886.50	152194.11	HX	-	-	-	-	-	-	-	-	-	15.1	18.1	20.3	19.2	17.7	20.5	29.9	49.9	52.3	56.2	49.9	49.9	49.9	49.9	49.9	50.0
199-H1-43	577213.74	153384.28	HX	-	-	-	-	-	-	-	-	-	(28.7)	(28.5)	(19.9)	(21.8)	(24.6)	(29.0)	(28.3)	(29.6)	(29.6)	(29.8)	(29.6)	(29.6)	(29.6)	(29.6)	(29.6)	(29.8)
199-H1-3	576163.00	153372.00	HX	-	-	-	-	-	-	-	-	-	(0.1)	(0.0)	-	-	-	-	-	(0.0)	(0.0)	-	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	-
199-H1-2	576451.07	153378.26	HX	-	-	-	-	-	-	-	-	-	(3.1)	(2.6)	(2.4)	(2.1)	(1.9)	(1.9)	(2.2)	(4.6)	(6.1)	(6.9)	(4.6)	(4.6)	(4.6)	(4.6)	(4.6)	(6.9)
199-H1-1	576702.31	153384.49	HX	-	-	-	-	-	-	-	-	-	(28.7)	(29.2)	(30.0)	(29.9)	(29.4)	(30.1)	(26.1)	(29.5)	(26.7)	(19.9)	(29.5)	(29.5)	(29.5)	(29.5)	(29.5)	(30.0)
199-H4-79	575659.13	151989.31	HX	-	-	-	-	-	-	-	-	-	38.8	58.4	69.3	65.8	62.0	70.1	67.2	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	60.0
199-H4-76	576787.32	152976.85	HX	-	-	-	-	-	-	-	-	-	(14.0)	(9.0)	(4.0)	(1.1)	-	-	(0.0)	(3.5)	(13.6)	(17.9)	(3.5)	(3.5)	(3.5)	(3.5)	(3.5)	(17.9)
199-H4-78	576168.23	152166.12	HX	-	-	-	-	-	-	-	-	-	50.7	54.6	58.2	55.8	52.2	56.2	71.8	101.2	96.1	122.2	101.2	101.2	101.2	101.2	101.2	60.0
199-H4-75	577212.36	152704.64	HX	-	-	-	-	-	-	-	-	-	(19.1)	(19.0)	(19.7)	(19.7)	(20.0)	(19.0)	(18.1)	(19.0)	(19.1)	(20.0)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)	(20.0)
199-H4-74	577239.07	152268.83	HX	-	-	-	-	-	-	-	-	-	34.3	33.8	35.7	34.7	33.5	36.1	45.7	66.8	68.9	75.7	66.8	66.8	66.8	66.8	66.8	75.7
199-H1-4	575826.78	153366.87	HX	-	-	-	-	-	-	-	-	-	(1.3)	(0.6)	(0.0)	(0.0)	-	(0.0)	(0.2)	(0.2)	(0.0)	-	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	-
199-H4-77	576487.79	152975.43	HX	-	-	-	-	-	-	-	-	-	(12.4)	(11.1)	(10.1)	(9.9)	(9.1)	(8.7)	(7.1)	(9.3)	(9.3)	(8.4)	(9.3)	(9.3)	(9.3)	(9.3)	(9.3)	(8.4)
199-H1-6	576037.81	153745.74	HX	-	-	-	-	-	-	-	-	-	(2.2)	(1.5)	(0.4)	(0.1)	(1.0)	(2.2)	(2.8)	(6.3)	(8.5)	(11.7)	(6.3)	(6.3)	(6.3)	(6.3)	(6.3)	(11.7)
HX-1	576496.00	152478.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(30.0)
HX-3	576877.00	152466.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.0
HX-9	576561.00	151766.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80.0
HX-10	575667.00	151735.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80.0
HX-11	577762.00	153219.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-12	575558.00	153153.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(25.0)
HX-13	576061.00	153370.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45.0
HX-14	576600.00	153663.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-15	577049.00	153203.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(25.0)
HX-16	576309.00	151901.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(25.0)
HX-17	577769.00	152377.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-18	577311.00	151922.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60.0
HX-19	577233.00	152071.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)

Table 3-4. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 3

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
HX-20	577809.00	151993.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40.0
HX-21	578177.00	151971.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-22	578441.00	151889.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-23	578333.00	152279.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-24	575859.00	153629.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(17.0)
HX-25	577497.00	153427.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-26	576661.00	153871.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-27	576397.00	153776.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-28	577715.00	153261.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-29	576534.00	153942.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-30	578390.00	152090.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-31	576073.00	152720.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45.0
HX-32	575546.00	153455.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(17.0)
HX-33	576759.00	153585.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-34	576889.00	152207.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(25.0)
HX-35	577230.00	152474.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
HX-36	575991.00	152558.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(35.0)
HX-37	576854.00	153322.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26.0
HX-38	576059.00	152977.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(25.0)
HX-39	576520.00	152745.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45.0
HX-40	576478.00	153199.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(25.0)
HX-41	577647.00	153315.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
HX-42	577643.00	153161.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
HX-43	578520.00	151973.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
HX-2	575742.00	152964.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40.0
HX-4	575507.00	152880.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(25.0)
HX-5	575550.00	152391.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(30.0)
HX-6	575668.00	152556.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.0
HX-7	576860.00	153171.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-8	575480.00	153927.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	85.0

Table 3-4. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 3

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
HX-44	575422.00	152713.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(20.0)
HX-45	576735.00	152701.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(30.0)

[1] Pumping rates in gallons per minute (gpm)

[2] Values in parentheses indicate extraction

3.4.4 Alternative 4: RTD Optimized with Other Technologies and Groundwater P&T

The well layout in Alternative 4 is similar to the design proposed under Alternative 2, including additional extraction and injection wells to encompass a larger area and expedite hydraulic containment and recovery. Unlike the proposed design in Alternative 2, no in-situ remediation is considered and therefore the currently available RPO system capacity is maintained, reduced by 15% to account for any scheduled/unforeseen system shutdowns and reduced pumping rates caused by seasonal changes in river levels. Well locations were determined based on the COC plume distributions, although spatial restrictions due to cultural and other constraints were considered.

The same operation of the RPO P&T is assumed for the first two years (2011-2012) as described earlier. The expanded system is operational for the remaining 75-year period to help evaluate aquifer cleanup times under this design. The P&T system capacity is assumed to be reduced by 15% to account for scheduled/unforeseen shutdown periods and reduced pumping rates caused by seasonal changes in river levels.

Figure 3-7 shows the extraction and injection well configuration for Alternative 4, with proposed wells depicted using red symbols. Detailed account of the pumping rates for all wells is included in Table 3-5.

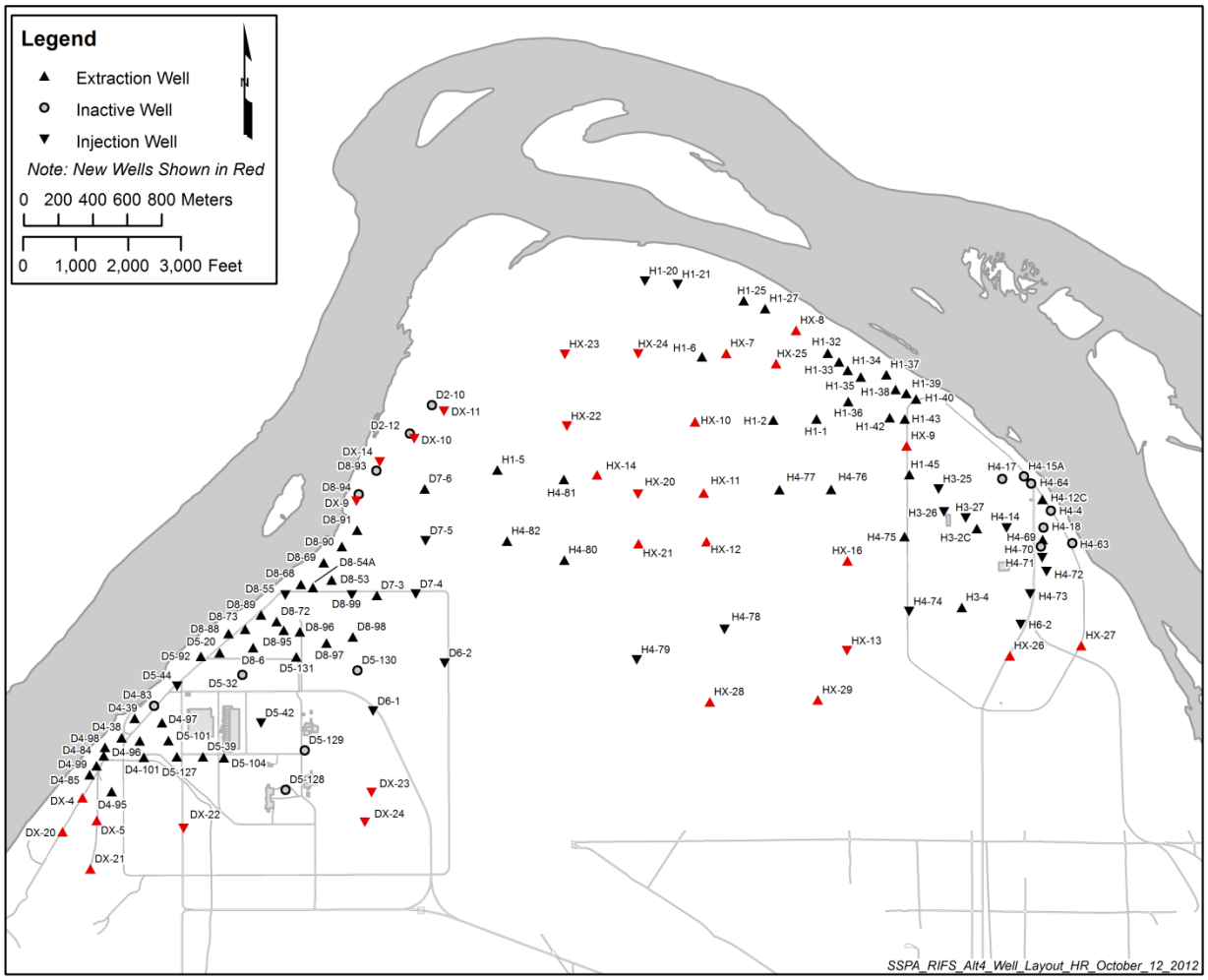


Figure 3-7. Extraction/Injection Well Configuration – Alternative 4.

Table 3-5. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 4

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
199-D5-104	573265.48	151422.43	DX	-	-	-	-	-	-	(17.1)[1,2]	(21.5)	(20.5)	(20.5)	(24.1)	(25.0)	(25.0)	(22.0)	(25.0)	(24.2)	(25.0)	(23.9)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)	(11.0)
199-D5-20	573239.97	152030.15	DX	-	-	-	-	-	-	(8.2)	(8.3)	(3.9)	(3.9)	(0.0)	-	-	-	(0.0)	(7.6)	(9.5)	(9.1)	(9.8)	(9.5)	(9.5)	(9.5)	(9.5)	(9.5)	(9.0)
199-D5-32	573372.04	151903.39	DX	(15.4)	(17.8)	(18.8)	(17.2)	(16.0)	(15.5)	(15.8)	(14.9)	(17.0)	(17.0)	(18.1)	(18.4)	(17.5)	(15.7)	(18.0)	(17.6)	(19.0)	(17.6)	(16.9)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)	-
199-D5-39	573142.86	151428.43	DX	-	-	-	-	-	-	(20.2)	(24.3)	(22.9)	(22.9)	(24.5)	(24.9)	(24.4)	(21.7)	(24.9)	(23.8)	(25.0)	(23.0)	(24.8)	(25.0)	(25.0)	(25.0)	(25.0)	(25.0)	(18.0)
199-D5-42	573479.77	151622.67	DX	-	-	-	-	-	-	31.5	33.2	28.0	28.0	22.7	23.7	23.0	17.0	24.4	25.9	25.3	22.6	24.6	25.3	25.3	25.3	25.3	25.3	20.0
199-D5-44	572993.58	151835.74	DX	86.5	87.1	66.1	40.7	34.2	33.7	43.9	46.6	45.3	45.3	44.5	46.9	45.7	35.3	39.9	34.2	26.7	25.7	26.4	26.7	26.7	26.7	26.7	26.7	20.0
199-D5-92	573131.93	152009.82	DX	-	-	-	-	-	-	(21.2)	(23.5)	(17.0)	(17.0)	(15.6)	(18.0)	(18.5)	(21.2)	(29.0)	(29.7)	(33.0)	(30.3)	(29.8)	(33.0)	(33.0)	(33.0)	(33.0)	(33.0)	(18.0)
199-D4-95	572613.00	151227.00	DX	(13.0)	(12.5)	(12.6)	(12.1)	(10.2)	(10.9)	(9.0)	(10.0)	(12.2)	(12.2)	(12.5)	(13.0)	(13.0)	(11.4)	(13.0)	(12.6)	(13.0)	(11.4)	(11.5)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)	(10.0)
199-D4-96	572777.00	151520.00	DX	(13.1)	(12.7)	(12.6)	(13.3)	(10.5)	(13.8)	(15.0)	(15.0)	(15.1)	(15.1)	(13.0)	(10.7)	(7.8)	(4.7)	(5.9)	(2.7)	(7.0)	(7.0)	(8.0)	(7.0)	(7.0)	(7.0)	(7.0)	(7.0)	(8.0)
199-D4-97	572906.53	151624.87	DX	(12.8)	(12.2)	(12.2)	(12.1)	(10.2)	(10.9)	(10.3)	(10.0)	(11.4)	(11.4)	(12.5)	(13.0)	(13.0)	(11.4)	(12.2)	(11.6)	(12.0)	(11.5)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)	(8.0)
199-D4-98	572575.59	151483.28	DX	(13.0)	(12.4)	(12.7)	(11.9)	(10.2)	(10.7)	(11.5)	(10.0)	(11.0)	(11.0)	(11.6)	(12.5)	(13.0)	(11.1)	(13.0)	(12.6)	(13.0)	(12.4)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)	(13.0)	(10.0)
199-D4-99	572526.48	151376.63	DX	(19.5)	(16.3)	(15.4)	(13.7)	(11.0)	(15.8)	(16.5)	(15.0)	(15.6)	(15.6)	(11.1)	(16.5)	(18.0)	(15.4)	(18.9)	(18.4)	(19.0)	(18.0)	(17.2)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)	(12.0)
199-D2-10	574470.70	153465.17	DX	2.7	2.5	0.4	0.4	0.8	-	-	-	0.1	0.1	0.6	0.1	0.1	5.1	1.1	0.6	-	-	-	-	-	-	-	-	-
199-D2-12	574343.40	153300.80	DX	8.8	10.4	4.0	2.1	1.2	-	-	-	0.4	0.4	5.5	3.3	2.4	3.4	5.7	2.8	0.0	-	-	0.0	0.0	0.0	0.0	0.0	-
199-D8-6	573434.69	152060.82	DX	(14.7)	(14.3)	(13.7)	(10.9)	-	-	-	-	-	-	-	-	-	-	-	-	-	(2.0)	(6.9)	-	-	-	-	-	(6.8)
199-D8-89	573479.46	152250.40	DX	(11.5)	(11.2)	(14.0)	(13.9)	(12.4)	(13.5)	(18.4)	(19.1)	(13.3)	(13.3)	(12.1)	(11.1)	(10.6)	(9.6)	(11.1)	(11.1)	(12.1)	(11.6)	(12.4)	(12.1)	(12.1)	(12.1)	(12.1)	(12.1)	(11.0)
199-D8-90	573948.74	152646.20	DX	(19.5)	(18.8)	(19.3)	(13.6)	(11.5)	(14.2)	(18.5)	(17.9)	(16.1)	(16.1)	(12.5)	(19.4)	(18.4)	(10.6)	(18.7)	(18.4)	(17.2)	(17.6)	(17.6)	(17.2)	(17.2)	(17.2)	(17.2)	(17.2)	(18.0)
199-D8-91	574037.21	152741.29	DX	(19.6)	(19.0)	(20.1)	(14.0)	(11.5)	(14.8)	(22.5)	(23.3)	(16.7)	(16.7)	(17.0)	(20.5)	(19.0)	(10.7)	(16.8)	(17.3)	(18.9)	(17.7)	(17.6)	(18.9)	(18.9)	(18.9)	(18.9)	(18.9)	(18.0)
199-D8-93	574148.99	153085.76	DX	13.4	14.6	14.8	8.5	2.1	-	-	-	-	-	0.2	(0.0)	(0.0)	(0.0)	(0.0)	-	-	-	-	-	-	-	-	-	-
199-D8-94	574047.13	152949.35	DX	5.9	1.4	2.8	1.9	0.9	-	-	-	-	-	-	2.9	7.4	5.1	8.8	3.9	0.0	-	-	0.0	0.0	0.0	0.0	0.0	-
DX-10	574369.00	153271.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25.0
DX-11	574540.00	153430.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.0
DX-14	574168.00	153136.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.0
DX-4	572444.00	151191.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(10.0)
DX-5	572527.00	151059.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(10.0)
DX-9	574034.00	152909.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40.0
DX-20	572329.00	150994.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(12.0)
DX-21	572491.00	150778.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(12.0)
DX-22	573030.00	151013.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60.0
DX-23	574121.00	151221.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40.0

Table 3-5. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 4

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
DX-24	574083.00	151049.00	DX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35.0
199-D8-53	573889.86	152452.26	DX	(17.0)	(15.6)	(15.1)	(14.4)	(1.0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(7.2)
199-D8-54A	573781.17	152408.03	DX	(18.6)	(19.9)	(19.7)	(17.3)	(1.0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(12.5)
199-D8-68	573711.67	152427.10	DX	(52.0)	(50.8)	(53.8)	(49.9)	(3.3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(11.5)
199-D8-72	573570.48	152211.77	DX	(3.7)	(8.4)	(7.4)	(7.2)	(0.7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(10.5)
199-D4-101	572800.10	151425.94	DX	(2.5)	(4.3)	(2.2)	(0.0)	(0.0)	(0.0)	-	(0.0)	(0.0)	(0.0)	-	-	-	-	(6.8)	(8.2)	(4.9)	-	(3.8)	(4.9)	(4.9)	(4.9)	(4.9)	(4.9)	(3.8)
199-D4-38	572671.32	151537.86	DX	(8.0)	(7.5)	(7.6)	(7.4)	(6.3)	(7.5)	(8.9)	(7.7)	(8.1)	(8.1)	(5.8)	-	-	-	(6.2)	(7.7)	(8.0)	(7.5)	(8.0)	(8.0)	(8.0)	(8.0)	(8.0)	(8.0)	(8.0)
199-D4-39	572747.45	151650.84	DX	(16.4)	(15.5)	(16.0)	(13.8)	(11.0)	(17.1)	(15.4)	(13.6)	(14.4)	(14.4)	(16.1)	(15.4)	(15.0)	(13.2)	(15.9)	(15.5)	(14.5)	(12.4)	(13.8)	(14.5)	(14.5)	(14.5)	(14.5)	(14.5)	(10.0)
199-D4-83	572859.43	151723.42	DX	-	-	-	(0.1)	-	-	-	-	-	-	-	-	-	-	-	-	(5.0)	(9.3)	(11.0)	(5.0)	(5.0)	(5.0)	(5.0)	(5.0)	-
199-D4-84	572568.04	151433.52	DX	(10.7)	(11.2)	(11.9)	(11.6)	(9.9)	(10.9)	(10.3)	(10.0)	(9.4)	(9.4)	(9.1)	(9.6)	(9.7)	(7.9)	(9.4)	(10.1)	(11.0)	(10.3)	(11.2)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)
199-D4-85	572486.16	151324.20	DX	(19.7)	(18.7)	(18.8)	(13.8)	(12.4)	(16.6)	(16.6)	(15.0)	(15.7)	(15.7)	(11.1)	(13.1)	(14.1)	(16.3)	(16.5)	(18.2)	(19.0)	(17.6)	(17.1)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)	(12.0)
199-D5-101	572943.04	151521.52	DX	(23.0)	(21.0)	(21.3)	(15.1)	(11.0)	(20.2)	(22.2)	(22.7)	(17.9)	(17.9)	(26.1)	(26.3)	(26.0)	(22.9)	(26.9)	(26.1)	(27.0)	(25.9)	(25.1)	(27.0)	(27.0)	(27.0)	(27.0)	(27.0)	(20.0)
199-D5-127	572992.26	151428.31	DX	(17.8)	(17.6)	(14.3)	(13.0)	(11.0)	(13.2)	(13.8)	(10.9)	(8.5)	(8.5)	(3.9)	-	-	-	(0.0)	-	-	-	(4.7)	-	-	-	-	-	(4.7)
199-D5-128	573622.04	151237.06	DX	77.0	80.4	80.3	72.5	61.0	68.4	81.4	78.0	75.5	75.5	73.4	77.1	75.2	58.1	81.7	84.0	91.3	87.6	90.1	91.3	91.3	91.3	91.3	91.3	-
199-D5-129	573733.26	151465.18	DX	85.0	87.1	92.2	78.0	65.6	73.5	88.0	83.8	81.2	81.2	79.0	83.0	80.8	62.5	87.8	90.7	99.0	95.6	98.6	99.0	99.0	99.0	99.0	99.0	-
199-D5-130	574039.20	151928.51	DX	(14.5)	(13.8)	(15.0)	(13.1)	(13.3)	(12.0)	(13.2)	(14.6)	(14.8)	(14.8)	(15.5)	(15.8)	(14.7)	(10.5)	(12.0)	(11.6)	(12.0)	(11.1)	(8.8)	(12.0)	(12.0)	(12.0)	(12.0)	(12.0)	-
199-D5-131	573684.39	152006.75	DX	(17.2)	(15.8)	(15.5)	(13.3)	(12.4)	(13.4)	(13.7)	(14.6)	(15.1)	(15.1)	(17.9)	(18.2)	(17.9)	(15.7)	(18.0)	(17.4)	(17.5)	(16.7)	(17.2)	(17.5)	(17.5)	(17.5)	(17.5)	(17.5)	(14.0)
199-D6-1	574129.87	151691.71	DX	10.6	3.1	16.3	14.7	11.5	32.9	48.2	51.8	47.0	47.0	47.4	52.4	50.4	27.2	51.0	43.9	47.4	40.8	39.2	47.4	47.4	47.4	47.4	47.4	35.0
199-D6-2	574544.61	151970.20	DX	52.0	49.6	71.1	70.2	62.0	48.4	54.4	54.4	51.2	51.2	50.9	45.3	36.0	24.9	36.3	30.9	24.1	25.9	28.9	24.1	24.1	24.1	24.1	24.1	25.0
199-D7-3	574151.38	152363.41	DX	(18.4)	(19.0)	(18.0)	(14.3)	(11.5)	(14.4)	(16.7)	(14.7)	(17.6)	(17.6)	(19.7)	(20.2)	(18.4)	(10.6)	(15.9)	(16.1)	(17.0)	(16.1)	(17.2)	(17.0)	(17.0)	(17.0)	(17.0)	(17.0)	(12.0)
199-D7-4	574377.07	152369.64	DX	21.6	25.5	22.6	17.5	15.1	31.1	33.6	39.8	37.5	37.5	37.3	41.6	41.7	29.7	50.4	78.5	101.7	103.1	115.1	101.7	101.7	101.7	101.7	101.7	55.0
199-D7-5	574434.31	152678.72	DX	53.3	48.0	68.0	67.0	59.3	46.7	44.2	39.1	36.5	36.5	36.5	41.0	40.6	28.5	41.1	42.7	51.2	52.3	58.8	51.2	51.2	51.2	51.2	51.2	40.0
199-D7-6	574429.20	152980.43	DX	(16.7)	(16.3)	(16.4)	(12.9)	(11.5)	(14.2)	(14.9)	(12.3)	(14.7)	(14.7)	(12.0)	(14.6)	(14.1)	(3.8)	(15.7)	(15.6)	(17.4)	(17.0)	(17.5)	(17.4)	(17.4)	(17.4)	(17.4)	(17.4)	(15.0)
199-D8-55	573620.95	152364.35	DX	20.9	15.8	11.2	8.7	2.9	2.3	3.3	3.5	3.4	3.4	2.9	1.4	3.6	2.2	4.0	3.4	2.7	1.6	2.5	2.7	2.7	2.7	2.7	2.7	2.5
199-D8-69	573843.61	152552.20	DX	(18.8)	(19.0)	(19.4)	(14.3)	(12.4)	(14.9)	(18.8)	(18.1)	(17.0)	(17.0)	(18.1)	(19.2)	(17.9)	(10.7)	(20.6)	(20.1)	(20.9)	(19.6)	(20.2)	(20.9)	(20.9)	(20.9)	(20.9)	(20.9)	(16.5)
199-D8-73	573388.70	152167.38	DX	(3.2)	(3.2)	(3.8)	(3.8)	(3.3)	(3.1)	(3.7)	(3.6)	(3.0)	(3.0)	(2.8)	(3.1)	(2.9)	(1.1)	(0.1)	(4.6)	(5.4)	(5.1)	(5.4)	(5.4)	(5.4)	(5.4)	(5.4)	(5.4)	(5.4)
199-D8-88	573292.33	152141.26	DX	-	-	(0.4)	(0.6)	(0.0)	(3.3)	(2.8)	(1.9)	(2.2)	(2.2)	(2.3)	(3.6)	(3.8)	(3.7)	(4.8)	(6.0)	(6.3)	(6.2)	(7.7)	(6.3)	(6.3)	(6.3)	(6.3)	(6.3)	(7.7)
199-D8-95	573611.96	152160.61	DX	(16.4)	(16.3)	(16.9)	(13.8)	(12.4)	(14.0)	(15.9)	(14.6)	(14.4)	(14.4)	(17.7)	(15.7)	(17.1)	(10.7)	(17.8)	(17.7)	(17.9)	(17.0)	(17.6)	(17.9)	(17.9)	(17.9)	(17.9)	(17.9)	(15.0)
199-D8-96	573706.00	152152.24	DX	(21.8)	(22.1)	(22.5)	(15.2)	(12.8)	(14.6)	(16.4)	(14.6)	(18.3)	(18.3)	(23.2)	(23.7)	(23.9)	(20.9)	(23.9)	(23.2)	(24.0)	(22.3)	(21.0)	(24.0)	(24.0)	(24.0)	(24.0)	(24.0)	(18.0)
199-D8-97	573859.56	152087.42	DX	(17.5)	(17.2)	(19.5)	(14.8)	(12.4)	(16.3)	(19.1)	(19.4)	(18.9)	(18.9)	(21.2)	(21.1)	(19.1)	(11.5)	(17.8)	(17.5)	(18.9)	(17.7)	(17.6)	(18.9)	(18.9)	(18.9)	(18.9)	(18.9)	(16.0)

Table 3-5. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 4

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
199-D8-98	574013.12	152123.02	DX	(17.4)	(16.8)	(18.1)	(14.0)	(10.7)	(14.5)	(16.8)	(14.6)	(16.5)	(16.5)	(19.7)	(13.3)	(12.3)	(12.4)	(18.9)	(18.4)	(18.5)	(17.1)	(17.5)	(18.5)	(18.5)	(18.5)	(18.5)	(18.5)	(16.0)
199-D8-99	574006.77	152364.37	DX	9.5	10.1	8.7	6.0	5.3	57.6	83.4	77.3	72.9	72.9	73.2	81.0	80.3	58.9	86.7	85.2	90.9	76.1	71.8	90.9	90.9	90.9	90.9	90.9	71.8
199-H1-5	574850.72	153090.30	DX	(19.0)	(19.0)	(19.3)	(13.6)	(11.5)	(16.2)	(18.8)	(19.4)	(14.4)	(14.4)	(10.8)	(14.6)	(14.1)	(3.8)	(15.7)	(15.6)	(17.4)	(17.0)	(17.5)	(17.4)	(17.4)	(17.4)	(17.4)	(17.4)	(19.0)
199-H4-80	575238.97	152568.16	DX	(14.6)	(14.1)	(15.4)	(13.9)	(12.4)	(13.5)	(16.5)	(14.7)	(15.0)	(15.0)	(12.9)	(16.6)	(16.0)	(3.8)	(15.7)	(15.6)	(17.4)	(17.0)	(17.6)	(17.4)	(17.4)	(17.4)	(17.4)	(17.4)	(12.5)
199-H4-81	575236.93	153035.36	DX	(14.7)	(14.5)	(15.2)	(13.5)	(12.4)	(12.4)	(15.5)	(14.6)	(14.8)	(14.8)	(13.4)	(15.8)	(15.7)	(4.1)	(15.0)	(15.1)	(16.4)	(16.1)	(16.9)	(16.4)	(16.4)	(16.4)	(16.4)	(16.4)	(17.0)
199-H4-82	574906.99	152677.72	DX	(0.2)	(10.1)	(12.7)	(10.3)	(7.7)	(15.6)	(19.0)	(19.5)	(15.5)	(15.5)	(11.1)	(17.4)	(16.9)	(3.8)	(17.6)	(17.5)	(18.4)	(17.9)	(17.8)	(18.4)	(18.4)	(18.4)	(18.4)	(18.4)	(12.0)
199-H4-14	577803.75	152752.36	HX	91.1	97.6	95.8	90.4	7.5	-	-	-	-	19.6	20.9	15.3	14.8	14.5	15.6	11.0	11.0	8.5	11.6	11.0	11.0	11.0	11.0	11.0	10.0
199-H4-15A	577906.00	153052.00	HX	(19.0)	(19.1)	(18.7)	(17.9)	(1.5)	-	-	-	-	(35.2)	(34.3)	(38.5)	(33.3)	(37.5)	(37.7)	(38.2)	(39.1)	(32.1)	(31.0)	(39.1)	(39.1)	(39.1)	(39.1)	(39.1)	-
199-H4-17	577779.18	153037.64	HX	52.2	51.3	53.9	49.1	11.5	-	-	-	-	8.5	10.8	11.6	9.6	10.3	9.2	7.1	5.8	5.4	6.7	5.8	5.8	5.8	5.8	5.8	-
199-H4-18	578018.29	152756.48	HX	40.4	50.3	46.5	42.8	3.5	-	-	-	-	22.2	13.7	12.8	12.2	12.1	13.2	11.7	11.4	9.5	7.3	11.4	11.4	11.4	11.4	11.4	-
199-H4-4	578060.86	152853.96	HX	-	(8.7)	(4.8)	(5.5)	(0.6)	-	-	-	-	(2.4)	(4.5)	(5.3)	(4.2)	(2.5)	(6.1)	(11.0)	(11.0)	(10.9)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)	(11.0)	-
199-H4-63	578185.83	152665.53	HX	(24.0)	(24.1)	(23.4)	(21.1)	(1.6)	-	-	-	-	(25.0)	(24.7)	(25.6)	(25.7)	(26.0)	(26.3)	(26.1)	(27.4)	(26.8)	(27.0)	(27.4)	(27.4)	(27.4)	(27.4)	(27.4)	-
199-H4-64	577946.11	153010.58	HX	-	-	-	-	-	-	-	-	-	(8.2)	(12.1)	(13.3)	(12.3)	(11.7)	(14.9)	(22.9)	(20.7)	(20.1)	(15.0)	(20.7)	(20.7)	(20.7)	(20.7)	(20.7)	-
199-H3-2C	577632.07	152750.30	HX	-	-	-	-	-	-	-	-	-	(46.0)	(45.5)	(45.6)	(47.4)	(48.0)	(47.8)	(46.8)	(50.0)	(49.4)	(50.0)	(50.0)	(50.0)	(50.0)	(50.0)	(50.0)	(50.0)
199-H4-12C	578011.77	152919.81	HX	-	-	-	-	-	-	-	-	-	(27.2)	(26.5)	(29.4)	(29.4)	(29.7)	(29.2)	(28.8)	(30.0)	(29.6)	(30.0)	(30.0)	(30.0)	(30.0)	(30.0)	(30.0)	(30.0)
199-H3-4	577544.29	152293.21	HX	-	-	-	-	-	-	-	-	-	(84.6)	(102.9)	(125.0)	(124.2)	(125.0)	(123.9)	(108.8)	(113.4)	(95.6)	(99.4)	(113.4)	(113.4)	(113.4)	(113.4)	(113.4)	(56.0)
199-H1-1	576702.31	153384.49	HX	-	-	-	-	-	-	-	-	-	(28.7)	(29.2)	(30.0)	(29.9)	(29.4)	(30.1)	(26.1)	(29.5)	(26.7)	(19.9)	(29.5)	(29.5)	(29.5)	(29.5)	(29.5)	(14.0)
199-H1-2	576451.07	153378.26	HX	-	-	-	-	-	-	-	-	-	(3.1)	(2.6)	(2.4)	(2.1)	(1.9)	(1.9)	(2.2)	(4.6)	(6.1)	(6.9)	(4.6)	(4.6)	(4.6)	(4.6)	(4.6)	(6.0)
199-H1-20	575706.04	154183.61	HX	-	-	-	-	-	-	-	-	-	72.3	68.8	74.3	71.6	69.2	72.7	79.0	23.9	19.3	0.7	23.9	23.9	23.9	23.9	23.9	37.0
199-H1-21	575896.84	154163.80	HX	-	-	-	-	-	-	-	-	-	96.1	88.7	94.7	91.8	90.0	94.0	96.0	67.9	65.7	2.1	67.9	67.9	67.9	67.9	67.9	37.0
199-H1-25	576279.64	154069.97	HX	-	-	-	-	-	-	-	-	-	(17.5)	(24.5)	(28.9)	(28.6)	(26.6)	(28.4)	(28.7)	(29.1)	(26.3)	(16.1)	(29.1)	(29.1)	(29.1)	(29.1)	(29.1)	(10.0)
199-H1-27	576403.86	154024.21	HX	-	-	-	-	-	-	-	-	-	(11.2)	(18.0)	(22.1)	(21.5)	(18.7)	(23.8)	(28.7)	(29.6)	(26.4)	(19.0)	(29.6)	(29.6)	(29.6)	(29.6)	(29.6)	(15.0)
199-H1-32	576767.07	153766.00	HX	-	-	-	-	-	-	-	-	-	(1.3)	(1.7)	(1.5)	(1.4)	(0.3)	(1.7)	(9.5)	(18.5)	(19.7)	(19.0)	(18.5)	(18.5)	(18.5)	(18.5)	(18.5)	(14.0)
199-H1-33	576833.29	153716.23	HX	-	-	-	-	-	-	-	-	-	(4.8)	(7.6)	(11.5)	(6.6)	(0.2)	(6.2)	(22.8)	(27.8)	(25.3)	(19.9)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)	(16.0)
199-H1-34	576883.13	153667.06	HX	-	-	-	-	-	-	-	-	-	(11.2)	(13.9)	(14.4)	(13.3)	(11.0)	(15.1)	(25.3)	(27.4)	(27.6)	(27.8)	(27.4)	(27.4)	(27.4)	(27.4)	(27.4)	(19.0)
199-H1-35	576958.26	153628.14	HX	-	-	-	-	-	-	-	-	-	(23.6)	(25.3)	(28.5)	(27.4)	(23.1)	(25.0)	(26.3)	(22.0)	(26.5)	(26.8)	(22.0)	(22.0)	(22.0)	(22.0)	(22.0)	(19.0)
199-H1-36	576885.62	153486.51	HX	-	-	-	-	-	-	-	-	-	(8.1)	(7.1)	(6.9)	(6.3)	(5.3)	(4.7)	(7.7)	(9.0)	(8.9)	(8.9)	(9.0)	(9.0)	(9.0)	(9.0)	(9.0)	(8.0)
199-H1-37	577106.92	153641.63	HX	-	-	-	-	-	-	-	-	-	(7.8)	(10.7)	(12.8)	(7.7)	(3.0)	(10.1)	(27.5)	(27.8)	(27.6)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)	(27.8)	(19.0)
199-H1-38	577161.00	153555.01	HX	-	-	-	-	-	-	-	-	-	(6.1)	(4.3)	(4.0)	(3.4)	(4.3)	(6.3)	(13.5)	(24.4)	(24.5)	(24.9)	(24.4)	(24.4)	(24.4)	(24.4)	(24.4)	(20.0)
199-H1-39	577223.54	153533.40	HX	-	-	-	-	-	-	-	-	-	(1.9)	(1.8)	(1.1)	(1.0)	(0.6)	(2.3)	(32.9)	(41.1)	(37.6)	(29.8)	(41.1)	(41.1)	(41.1)	(41.1)	(41.1)	(21.0)

Table 3-5. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 4

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
199-H1-40	577279.34	153500.19	HX	-	-	-	-	-	-	-	-	-	(3.7)	(3.1)	(3.5)	(2.6)	(2.5)	(4.1)	(10.4)	(22.4)	(29.2)	(19.9)	(22.4)	(22.4)	(22.4)	(22.4)	(22.4)	(15.0)
199-H1-42	577127.18	153391.65	HX	-	-	-	-	-	-	-	-	-	(27.2)	(27.6)	(29.0)	(27.6)	(28.9)	(27.9)	(27.9)	(29.0)	(28.0)	(27.8)	(29.0)	(29.0)	(29.0)	(29.0)	(29.0)	(21.0)
199-H1-43	577213.74	153384.28	HX	-	-	-	-	-	-	-	-	-	(28.7)	(28.5)	(19.9)	(21.8)	(24.6)	(29.0)	(28.3)	(29.6)	(29.6)	(29.8)	(29.6)	(29.6)	(29.6)	(29.6)	(29.6)	(21.0)
199-H1-45	577240.96	153062.41	HX	-	-	-	-	-	-	-	-	-	(25.8)	(25.6)	(26.5)	(26.7)	(27.0)	(26.9)	(26.7)	(9.3)	(4.1)	(27.0)	(9.3)	(9.3)	(9.3)	(9.3)	(9.3)	(21.0)
199-H1-6	576037.81	153745.74	HX	-	-	-	-	-	-	-	-	-	(2.2)	(1.5)	(0.4)	(0.1)	(1.0)	(2.2)	(2.8)	(6.3)	(8.5)	(11.7)	(6.3)	(6.3)	(6.3)	(6.3)	(6.3)	(11.0)
199-H3-25	577410.36	152978.49	HX	-	-	-	-	-	-	-	-	-	44.1	49.1	53.3	51.3	49.8	53.3	65.9	90.7	88.2	94.0	90.7	90.7	90.7	90.7	90.7	50.0
199-H3-26	577440.83	152846.50	HX	-	-	-	-	-	-	-	-	-	41.0	42.7	45.2	43.9	42.7	45.5	55.9	83.8	83.9	89.4	83.8	83.8	83.8	83.8	83.8	50.0
199-H3-27	577567.05	152811.14	HX	-	-	-	-	-	-	-	-	-	35.0	36.8	39.0	37.8	36.6	39.5	55.0	73.5	70.9	75.1	73.5	73.5	73.5	73.5	73.5	50.0
199-H4-69	578014.05	152686.66	HX	-	-	-	-	-	-	-	-	-	(26.0)	(24.8)	(27.6)	(27.2)	(21.3)	(24.4)	(27.7)	(28.0)	(27.7)	(28.0)	(28.0)	(28.0)	(28.0)	(28.0)	(28.0)	(20.0)
199-H4-70	578003.82	152646.45	HX	-	-	-	-	-	-	-	-	-	(22.8)	(22.7)	(23.6)	(23.7)	(24.0)	(23.9)	(23.4)	(21.0)	(22.3)	(23.0)	(21.0)	(21.0)	(21.0)	(21.0)	(21.0)	-
199-H4-71	578010.64	152581.53	HX	-	-	-	-	-	-	-	-	-	27.8	31.7	33.6	32.2	31.1	34.2	43.5	60.7	58.8	62.9	60.7	60.7	60.7	60.7	60.7	35.0
199-H4-72	578036.28	152500.14	HX	-	-	-	-	-	-	-	-	-	14.7	20.2	23.1	22.2	20.7	24.2	33.6	58.9	58.6	62.7	58.9	58.9	58.9	58.9	58.9	35.0
199-H4-73	577940.58	152369.98	HX	-	-	-	-	-	-	-	-	-	18.4	23.9	25.9	24.6	22.5	25.6	34.9	54.7	53.6	57.7	54.7	54.7	54.7	54.7	54.7	35.0
199-H4-74	577239.07	152268.83	HX	-	-	-	-	-	-	-	-	-	34.3	33.8	35.7	34.7	33.5	36.1	45.7	66.8	68.9	75.7	66.8	66.8	66.8	66.8	66.8	40.0
199-H4-75	577212.36	152704.64	HX	-	-	-	-	-	-	-	-	-	(19.1)	(19.0)	(19.7)	(19.7)	(20.0)	(19.0)	(18.1)	(19.0)	(19.1)	(20.0)	(19.0)	(19.0)	(19.0)	(19.0)	(19.0)	(15.0)
199-H4-76	576787.32	152976.85	HX	-	-	-	-	-	-	-	-	-	(14.0)	(9.0)	(4.0)	(1.1)	-	-	(0.0)	(3.5)	(13.6)	(17.9)	(3.5)	(3.5)	(3.5)	(3.5)	(3.5)	(14.0)
199-H4-77	576487.79	152975.43	HX	-	-	-	-	-	-	-	-	-	(12.4)	(11.1)	(10.1)	(9.9)	(9.1)	(8.7)	(7.1)	(9.3)	(9.3)	(8.4)	(9.3)	(9.3)	(9.3)	(9.3)	(9.3)	(8.0)
199-H4-78	576168.23	152166.12	HX	-	-	-	-	-	-	-	-	-	50.7	54.6	58.2	55.8	52.2	56.2	71.8	101.2	96.1	122.2	101.2	101.2	101.2	101.2	101.2	44.0
199-H4-79	575659.13	151989.31	HX	-	-	-	-	-	-	-	-	-	38.8	58.4	69.3	65.8	62.0	70.1	67.2	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	45.0
199-H6-2	577886.50	152194.11	HX	-	-	-	-	-	-	-	-	-	15.1	18.1	20.3	19.2	17.7	20.5	29.9	49.9	52.3	56.2	49.9	49.9	49.9	49.9	49.9	35.0
HX-10	575997.00	153368.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(14.0)
HX-11	576048.24	152955.55	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(12.0)
HX-12	576064.00	152675.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(14.0)
HX-13	576879.00	152042.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45.0
HX-14	575429.00	153062.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
HX-16	576881.00	152563.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(14.0)
HX-7	576178.00	153765.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(13.0)
HX-8	576583.00	153898.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
HX-9	577225.00	153229.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
HX-20	575666.00	152949.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36.0

Table 3-5. Names, Geographic Coordinates, and Extraction and Injection Rates of 100-HR-3 Wells – Alternative 4

Well Name	Easting	Northing	SYSTEM	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	≤75-year System Operation
HX-21	575670.00	152663.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
HX-22	575254.00	153343.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45.0
HX-23	575243.00	153759.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.0
HX-24	575668.00	153761.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.0
HX-25	576468.00	153705.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
HX-26	577823.00	152013.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0)
HX-27	578238.00	152072.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(19.0)
HX-28	576083.00	151746.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(20.0)
HX-29	576710.00	151757.00	HX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(20.0)

[1] Pumping rates in gallons per minute (gpm)

[2] Values in parentheses indicate extraction

3.5 Model Assumptions and Limitations

The principal assumptions and limitations of the modeling analyses are described below:

- The Ringold Upper Mud Formation is present throughout 100-HR-3 and is considered a vertical no-flow boundary. However, recent drilling within the RUM has identified the presence of groundwater contaminated by Cr(VI) in the vicinity of the former 100-H reactor area. The most recent RUM data in the 100-HR-3 OU showed Cr(VI) concentrations ranging between non-detect and 180 ppb. The current Conceptual Site Model (CSM) for the contamination identified in the RUM assumes that most contamination in the RUM is associated with former operations at 100-HR3-H, although some contamination arose from of the migration of contaminated groundwater across the Horn area. In ECF-100HR3-12-0025, Rev. 0, screening-level calculations are performed in support of the 100-HR-3 RI/FS to evaluate time-dependent zones-of-contribution and contaminant recovery under various pumping scenarios from wells screened in the upper portion on the RUM. Sensitivity analysis should be performed to examine the effects, if any, of possible flow across the bottom of the model on plume migration and on the effectiveness of the proposed remedies across the 100 Areas.

- The initial Cr(VI) distribution is based on currently available data from a finite number of sampling points. Acquisition of new data (including new sampling locations) could lead to different plume distributions and different projections of plume migration and mass recovery.

- Small-scale heterogeneity and its effect on Cr(VI) transport are incorporated in the model through a dual-domain formulation. However, the parameters that describe mass transfer between the mobile and immobile phases are calculated based on limited information from soil column experiments. Actual field-scale values could vary significantly and should be evaluated through model calibration when remedy mass recovery data are collected.

- The model does not include continuing sources in the vadoze zone or the RUM. The presence of such sources could significantly prolong aquifer cleanup times. This assumption assumes that source area remediation will be successful at removing continuing sources and that groundwater monitoring will identify any continuing sources for further remediation.

- Any scheduled or unforeseen shut-down periods of the proposed treatment systems (or components of them) will have direct impacts on plume migration. The nature and extent of those impacts cannot be determined a-priori and they can result in remedy performance that differs from that presented in this report.

- Effects of river stage are modeled through the duration of active remediation (i.e., for the period 2010-2037). After 2037 average annual river stage is simulated to reduce the associated computation time required for the simulations. As a result of the averaging, simulated concentrations for that period - especially near the river - do not reflect the effect of river-stage / river-water mixing induced dilution since the river is always a discharge boundary. It is therefore expected that use of the annual average river stage results in slightly higher concentrations simulated at and near the shoreline, versus concentrations that would be simulated using a fluctuating river stage. Nonetheless, the corresponding plume migration patterns for that period reflect the effect of average ambient flow conditions.

As a result of the above – and consistent with recommendations made throughout the remedy design process - simulated COC distributions in the future, under a variety of potential remedy alternatives, should be interpreted as relative estimates and not as absolute predictions of actual plume migration

patterns. Upon implementation of any remedy design, monitoring data should be compiled and analyzed to further improve estimation of the parameters associated with the simulation of the fate and transport of the COCs and performance of the implemented remedies. The model should be updated to provide improving estimates of remedy performance. The same procedure should be followed if well operation and performance in the future are different from those described for each Alternative, as predicted plume migration patterns are contingent upon the extraction/injection well operation and performance that those predictions were based on.

4. Software Applications, Descriptions, Installation & Checkout, and Statements of Validity

Software use for this calculation was in accordance with PRC-PRO-IRM-309, Controlled Software Management.

4.1 Approved Software

The following software was used to perform calculations and was approved and compliant with PRC-PRO-IRM-309 (PRC-PRO-IRM-309, Controlled Software Management). These software are managed under the following documents consistent with PRC-PRO-IRM-309:

- CHPRC-00257 Rev 1, MODFLOW and Related Codes Functional Requirements Document.
- CHPRC-00258 Rev 2, MODFLOW and Related Codes Software Management Plan.
- CHPRC-00259 Rev 2, MODFLOW and Related Codes Software Test Plan.
- CHPRC-00260 Rev 5, MODFLOW and Related Codes Acceptance Test Report.
- CHPRC-00261 Rev 5, MODFLOW and Related Codes Requirements Traceability Matrix.

CHPRC-00258 Rev. 2 distinguishes between safety software and support software based on whether the software managed calculates reportable results or provides run support, visualization, or other similar functions. Brief descriptions of the software are provided below.

4.2 Descriptions

4.2.1 MODFLOW (Controlled Calculation Software)

- Software Title: MODFLOW-2000 (Open File Report 00-92, MODFLOW-2000, the US. Geological Survey Modular Ground-water model -- User Guide to Modularization Concepts and the Ground- Water Flow); solves transient groundwater flow equations using the finite-difference discretization technique.
- Software Version: Version 1.19.01 modified by S.S. Papadopulos and Associates, Inc. (SSP&A) to address dry cell issues and to use the Orthomnin solver; approved as CHPRC Build 0006 using a version of the executable “mf2k-mst-chprc0006dp.exe” (compiled to default double precision for real variables and optimized for speed).
- Hanford Information Systems Inventory (HISI) Identification Number: 2517 (Safety Software, graded Level C).
- Workstation type and property number (from which software is run):
    - S.S. Papadopulos and Assoc, Inc, FE454, FE455.

4.2.2 MT3DMS (Controlled Calculation Software)

- Software Title: MT3DMS (Zheng and Wang 1999), MT3DMS: A Modular Three-dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems; Documentation and User's Guide); MT3DMS V5.3 Supplemental User’s Guide [Zheng 2010])
- Software Version: Version 5.3 modified by S.S. Papadopulos and Associates, Inc. (SSP&A) to address dry cell issues; approved as CHPRC Build 0006 using a version of the executable “mt3d-mst-chprc0006dp.exe” (compiled to default double precision for real variables and optimized for speed).
- HISI Identification Number: 2518 (Safety Software, graded Level C).
- Workstation type and property number (from which software is run):
    - S.S. Papadopulos and Assoc, Inc, FE454, FE455.

4.2.3 MODPATH (Controlled Calculation Software)

- Software Title: MODPATH (Pollock, 1994): A particle-tracking post-processor developed for use with the MODFLOW codes, was used to evaluate the approximate directions and rates of groundwater flow and the approximate extent of hydraulic capture developed by proposed P&T well configurations.
- Software Version: Version 5.0 modified by S.S. Papadopulos and Associates, Inc. (SSP&A) to address dry cell issues; approved as CHPRC Build 0006 using executable "modpath-mst-chprc0006sp.exe".
- Workstation type and property number (from which software is run):
    - S.S. Papadopulos and Assoc, Inc, FE454, FE455.

4.2.4 MODFLOW Support Software

Support software is used that has been identified in CHPRC-00258, Rev. 2, or is scheduled by the software owner to be included as support software in the next revision to that document. Software with a trademark designation is commercial software. Software listed without a trademark has been developed internally.

- **ALLOCATEQWELL**: Constructs a MODFLOW well package (WEL) or a multi-node well (MNW) package file.
- **READ-LST-BUDGET**: Tabulates volumetric budget terms for the MODFLOW simulations.
- **READ-MT3D-OUT-BUDGET**: Tabulates mass budget terms for the MT3D simulations.
- **READEND_WRITECAPTURE.EXE**: Reads ENDPOINT file generated by MODPATH and calculates the simulated capture frequency.
- **READBIN_WRITEASC.EXE**: Reads binary output files generated by MODFLOW or MT3D and creates ASC files for plotting the spatial distribution of heads or concentrations, respectively.
- **CALCMASS.EXE**: Reads MODFLOW/MT3D output files and calculates contaminant plume mass and volume timeseries.
- **Concmass_vs_t.exe**: Reads MODFLOW/MT3D output files and calculates concentration and mass timeseries at the extractionwells.
- **Postproccalsmassconc.exe:** calculates blended influent concentration at each treatment system.
- **Groundwater Vistas™[2]:** (*Guide to Using Groundwater Vistas* [Rumbaugh and Rumbaugh, 2007].) Provided graphical tools used for model quality assurance and model input/output review.
- **ArcGIS™[3]:** (*The ESRI Guide to GIS Analysis, Volume 1: Geographic Patterns and Relationships* [Mitchell, 1999].) Provided visualization tool for assessing simulated plume distributions, identifying extraction/injection well coordinates and mapping auxiliary data.
- **R:** The R programming environment, a language and environment for statistical computing and graphics, (*R: A Language and Environment for Statistical Computing*, by R Core Team, R Foundation for Statistical Computing, Vienna, Austria, 2012. ISBN 3-900051-07-0, *http://www.R-project.org*.; *R: A Language for Data Analysis and Graphics*, Journal of Computational and Graphical Statistics, ***5***, 299–314, Ihaka & Gentleman, 1996) was used to perform a variety of data processing including post-processing of model results and plot generation of aggregate data timeseries.
- **Surfer™[4]:** Data interpolation for visualization, model implementation and quality assurance purposes.

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[2] Groundwater Vistas is a trademark of Environmental Simulations Incorporated, Reinholds, PA.

[3] ArcGIS is a trademark of ESRI, Redlands, CA.

[4] Surfer is a trademark of Golden Software, Golden, CO.

4.2.5 Software Installation and Checkout

Safety Software (CHPRC Build 0006 of MODFLOW-2000-SSPA) is checked out in accordance with procedures specified in CHPRC-00258 Rev. 2. Executables are obtained from the CHPRC software owner who maintains the configuration managed copies in MKS Integrity, installation tests identified in CHPRC-00259 Rev. 2 performed and successful installation confirmed, and Software Installation and Checkout Forms are required and must be approved for installations used to perform model runs. Approved Users are registered in HISI for safety software.

4.2.6 Statement of Valid Software Application

- The software identified above was used consistent with intended use for CHPRC as identified in CHPRC-00257 Rev. 1 and is a valid use of this software for the problem addressed in this application.
- The software was used within its limitations as identified in CHPRC-00257 Rev 1.
- R has not been identified in CHPRC-00258, Rev. 2, but is scheduled by the software owner to be included as support software in the next revision to that document. It is publically available, open-source freeware.

5. Calculation

The 100-Area groundwater flow and contaminant transport model was used for the simulation of the alternative remedy designs in 100-HR-3 and model results were post-processed to evaluate system performance under each alternative. Upon completion of model simulations for all alternatives and COCs and post-processing of the model results, the following maps and graphs were constructed to provide the basis for evaluation of system performance:

1. Map of hydraulic capture frequency (i.e. SCFM) for 2012.
2. Maps depicting the simulated spatial distribution of each COC at selected intervals to illustrate plume migration and aquifer cleanup.
3. Summary plots of concentration statistics timeseries for each alternative and COC.
4. Graphs of affected shoreline length over time for each alternative and COC.
5. Summary plots of plume mass and volume timeseries for each alternative and COC.
6. P&T influent concentration timeseries for each COC for Alternatives 2, 3 and 4.

Statistical calculations were based on the simulated spatial COC distribution as calculated by the model and mapped by post-processing the model outputs. COC concentrations were considered in the calculations based on values at all model cells within geographically defined areas corresponding to 100-D South (D-South), 100-D North (D-North), the Horn and 100-H (Figure 5-1). The extent of the COC spatial distribution was determined at each simulation time-step considering all concentration values above a selected lower limit (cut-off). This lower limit was defined as the applicable standard for each COC for all calculations except for the the summary concentration statistics where 1% of the applicable standard was used. This was done to ensure that a realistic representation of the COC plume extents and corresponding concentration statistics are calculated at each time step and that the performance metrics are consistent and directly comparable for each alternative, COC and area.

Concentration statistics were calculated within each sub-area and its corresponding shoreline and included:

- maximum;
- mean;
- median; and
- 90th percentile;

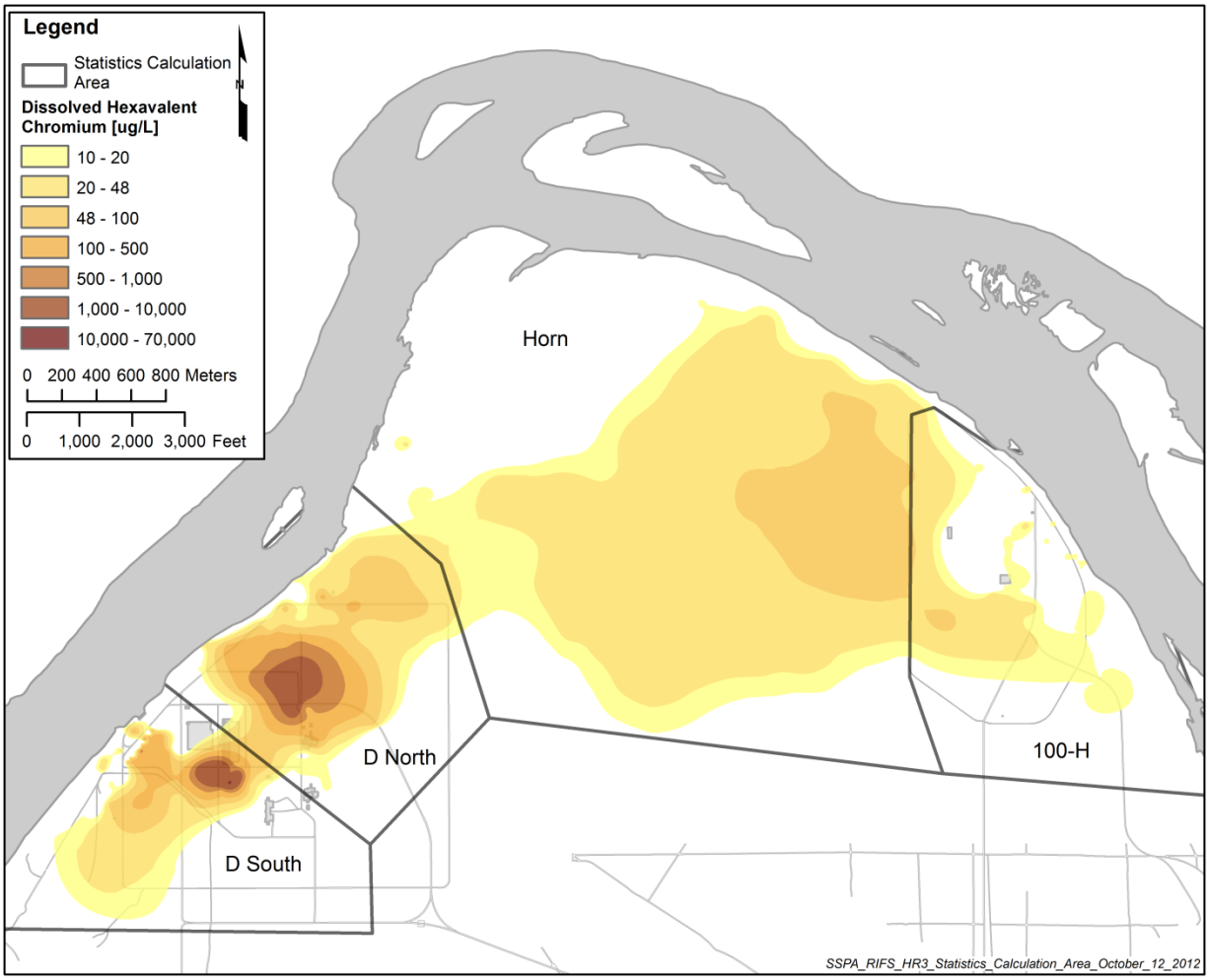

Figure 5-1. Area Boundaries for Concentration Statistics.

Concentrations above 1% of the applicable standard for each COC were considered for the calculation of concentration statistics. The applicable standard was considered for all other calculations. The applicable standard for each COC and the corresponding cut-off limit are listed in Table 5-1:

Table 5-1: COC Concentration Statistics – Applicable Standards and Cut-Offs

COC	Applicable Standard	Cut-Off Limit
CrVI	10 ug/L	0.1 ug/L
Strontium-90	8 pCi/L	0.08 pCi/L
Nitrate	45 mg/L	0.45 mg/L

Influent concentrations reflect mixing of the extracted water from each well and calculation of a blended concentration, based on the effluent concentration at the corresponding extraction well, as calculated by the model. The wells were grouped based on the assigned P&T plant rather than their geographic location.

The total pumping rates reflect the plant capacities as defined by current operating conditions or assumed future system expansion, depending on the design alternative.

Plume mass summary plots depict the reduction of COC mass in the aquifer as the result of plume recovery (via the operation of extraction wells and above-ground treatment) and/or contaminant discharge to the river. Mass is calculated in kilograms (Kg) for Cr(VI) and Nitrate. Radioactivity, calculated in curies (Ci), is reported for the radionuclides (Strontium-90). Plume volume is calculated in cubic meters.

Although contaminant mass values should be monotonically reducing over time, given the operation of the P&T systems and the discharge to the river, concentration and mass/volume statistics can show temporary increase in a particular sub-area. This is due to plume migration relative to the boundaries of the sub-areas.

Occasional spikes in maximum concentration values (e.g. Figure 5.41, maximum concentration in D-North under Alternative 3) correspond to localized variations in the water table elevation within the periodically rewetted zone and/or areas where the water table fluctuates across two or more layers of the groundwater model. In such cases, a limited number of model cells in a particular layer become periodically dry as pumping draws the water table below the bottom of the layer under low river-stage conditions. When high river-stage conditions occur, the water table rises and those cells are rewetted and the concentrations in those cells are reintroduced in the aquifer. When this phenomenon occurs in cells with elevated concentrations, spikes in the maximum concentration plots are observed. It should be noted that the occurrence of such high concentrations in rewetted cells is rather localized and the effects of those elevated concentrations to the overall system performance are minimal, as concentrations dissipate quickly within a few model cells.

The model results and corresponding plots and graphs are grouped per COC and type in the following sequence:

1. Hydraulic Capture Frequency: depiction of the simulated capture frequency corresponding to well operations in 2012.
2. For each COC:
    a. Simulated COC distribution at selected time intervals for each alternative (all areas);
    b. Summary concentration statistics per area (all alternatives);
    c. Summary concentration statistics per alternative (all areas);
    d. Affected shoreline length above clean-up standard (all areas and alternatives);
    e. Calculated plume mass and volume (all areas and alternatives);
    f. Calculated influent concentration at each P&T (all areas and alternatives).
    g. Tabulated estimated cleanup times based on the calculated concentration statistics and the corresponding applicable standard.

5.1 Simulated Capture Frequency Map

Figures 5-1 depicts the SCFM, as calculated from the model results for CY2012. Given that the well configuration is the same for all alternative designs during the period 2011-2012, a single SCFM was developed.

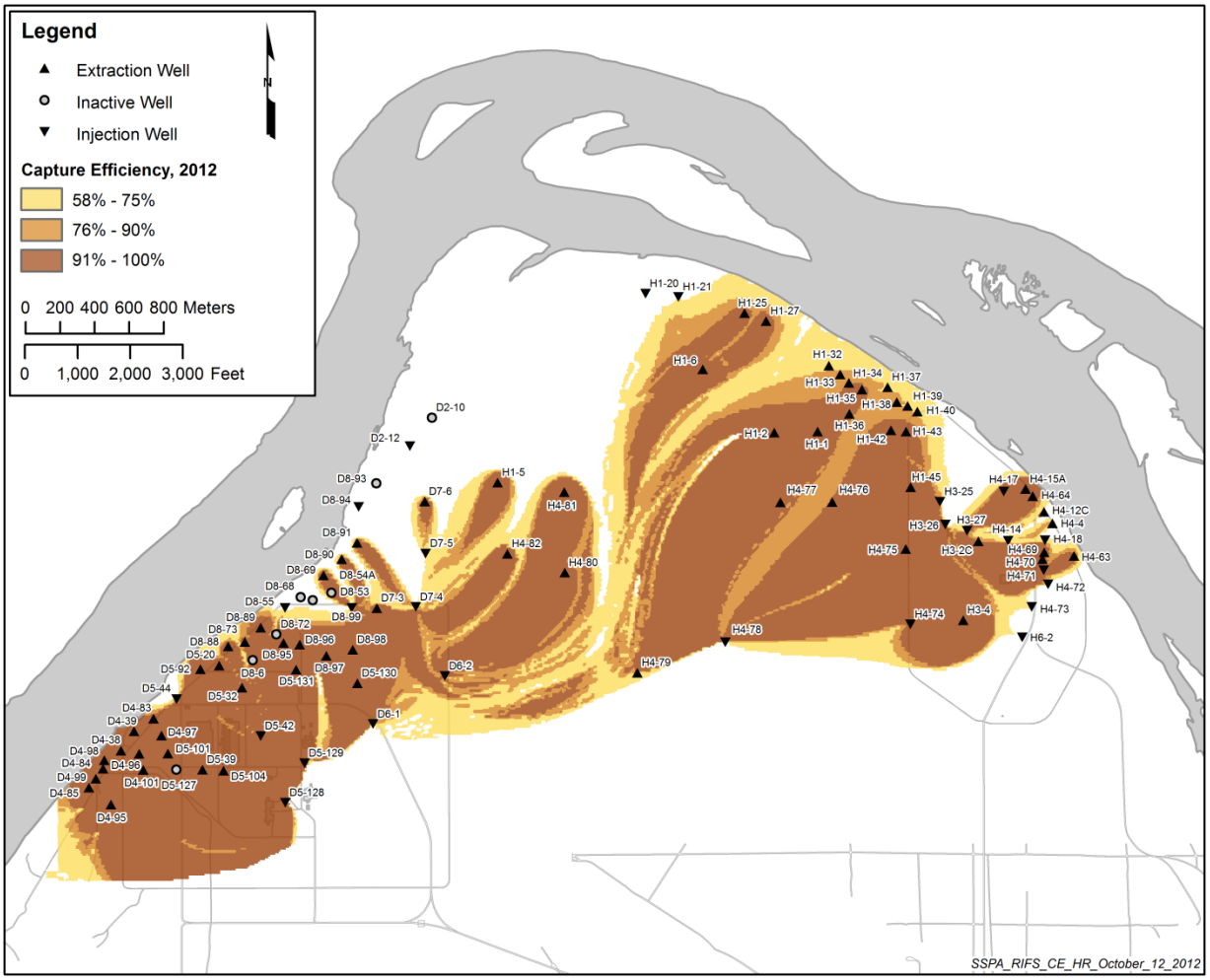

Figure 5-2. Simulated Capture Frequency Map for CY2012.

5.2 Simulated Contaminant Distributions – Concentration Statistics

5.2.1 Simulated Contaminant Distributions – Concentration Statistics: Cr(VI)

The model results for Cr(VI) are grouped in the following sets of figures:

1. Figures 5-3 to 5-38: simulated distributions for each alternative.
2. Figures 5-39 to 5-42: summary concentration statistics for each area (all alternatives).
3. Figures 5-43 to 5-46: summary concentration statistics for each alternative (all areas).
4. Figure 5-47: Affected shoreline length above clean-up standard (all areas and alternatives).
5. Figure 5-48: Calculated plume mass and volume (all areas and alternatives).
6. Figure 5-49: Calculated influent concentration at each P&T (all areas and alternatives).

Estimated cleanup times based on the calculated concentration statistics are summarized in Table 5-2. The estimated cleanup times are based on both the Cr(VI) drinking water standard (DWS) of 48 ug/L and the ambient water quality standard (AWQS) of 10 ug/L.

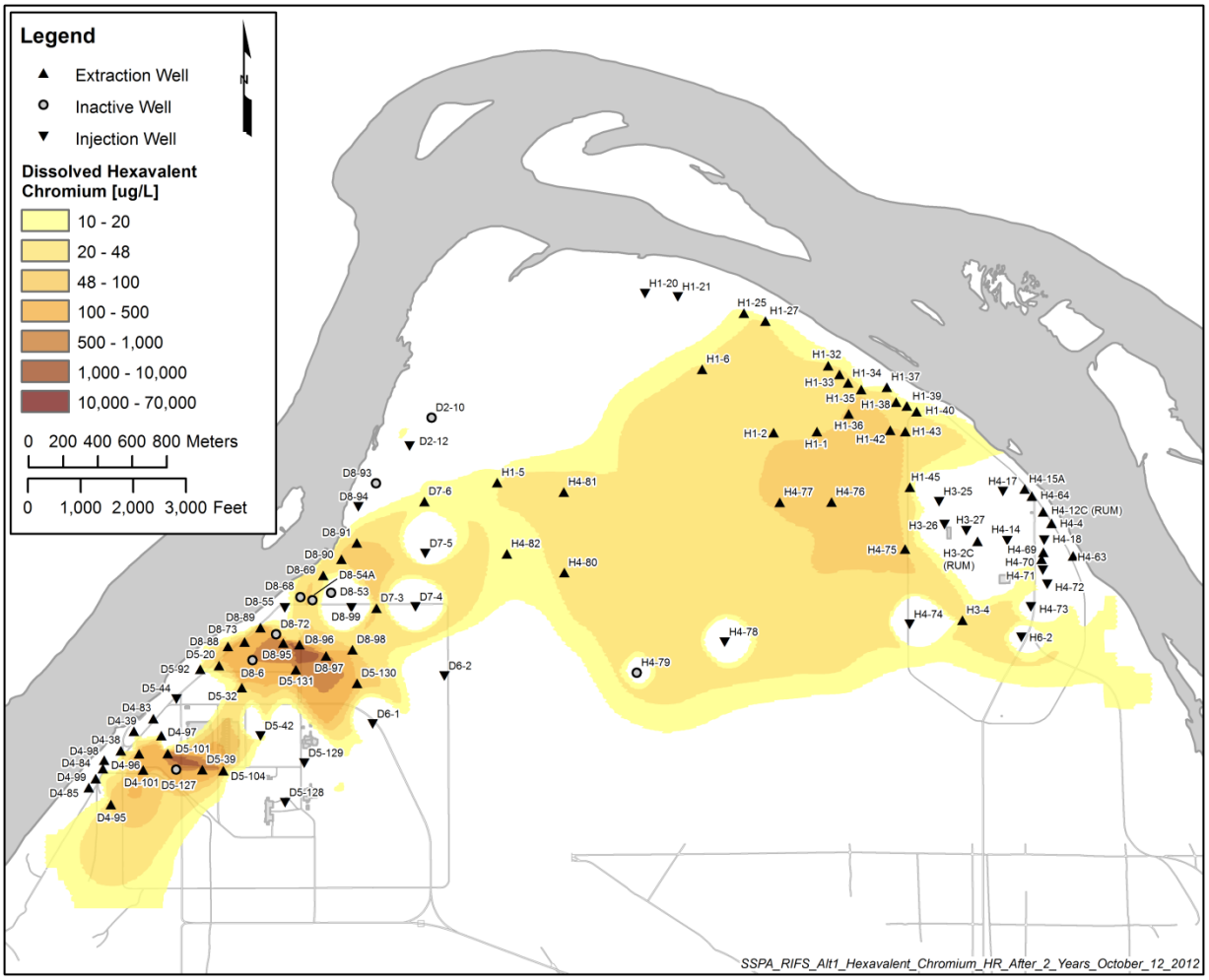

Figure 5-3. Simulated Distribution of Cr(VI) after 2 Years – Alternative 1.

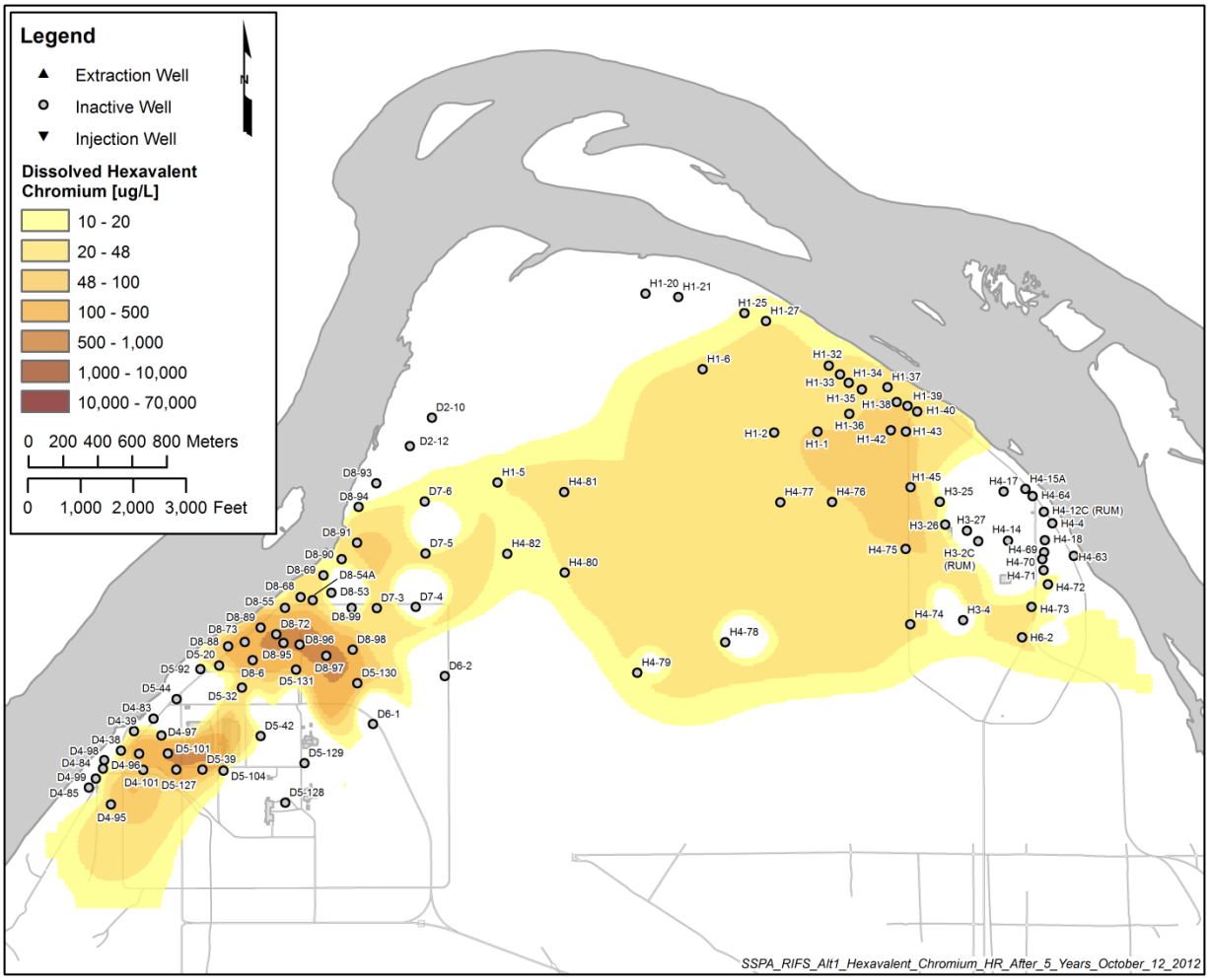

Figure 5-4. Simulated Distribution of Cr(VI) after 5 Years – Alternative 1.

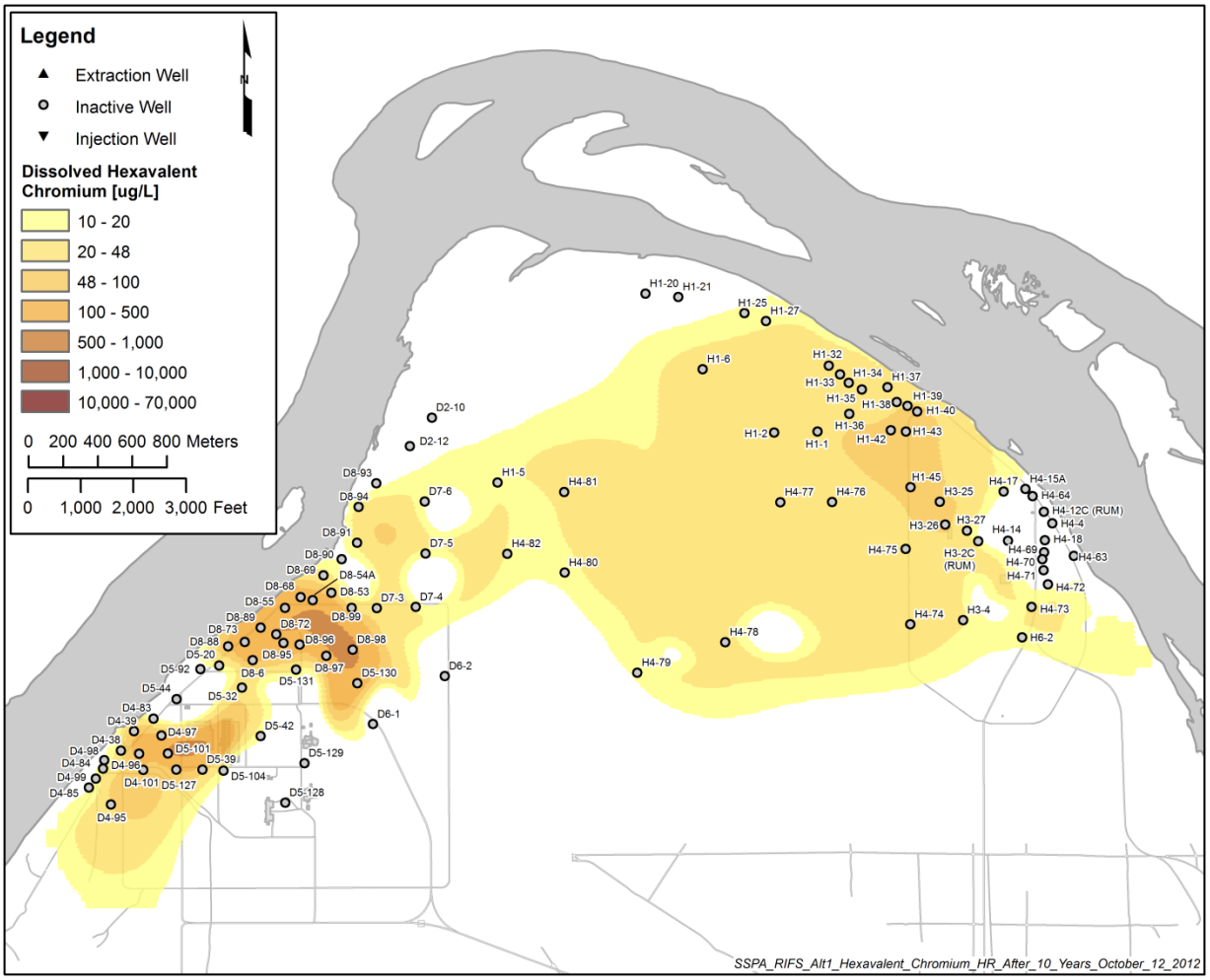

Figure 5-5. Simulated Distribution of Cr(VI) after 10 Years – Alternative 1.

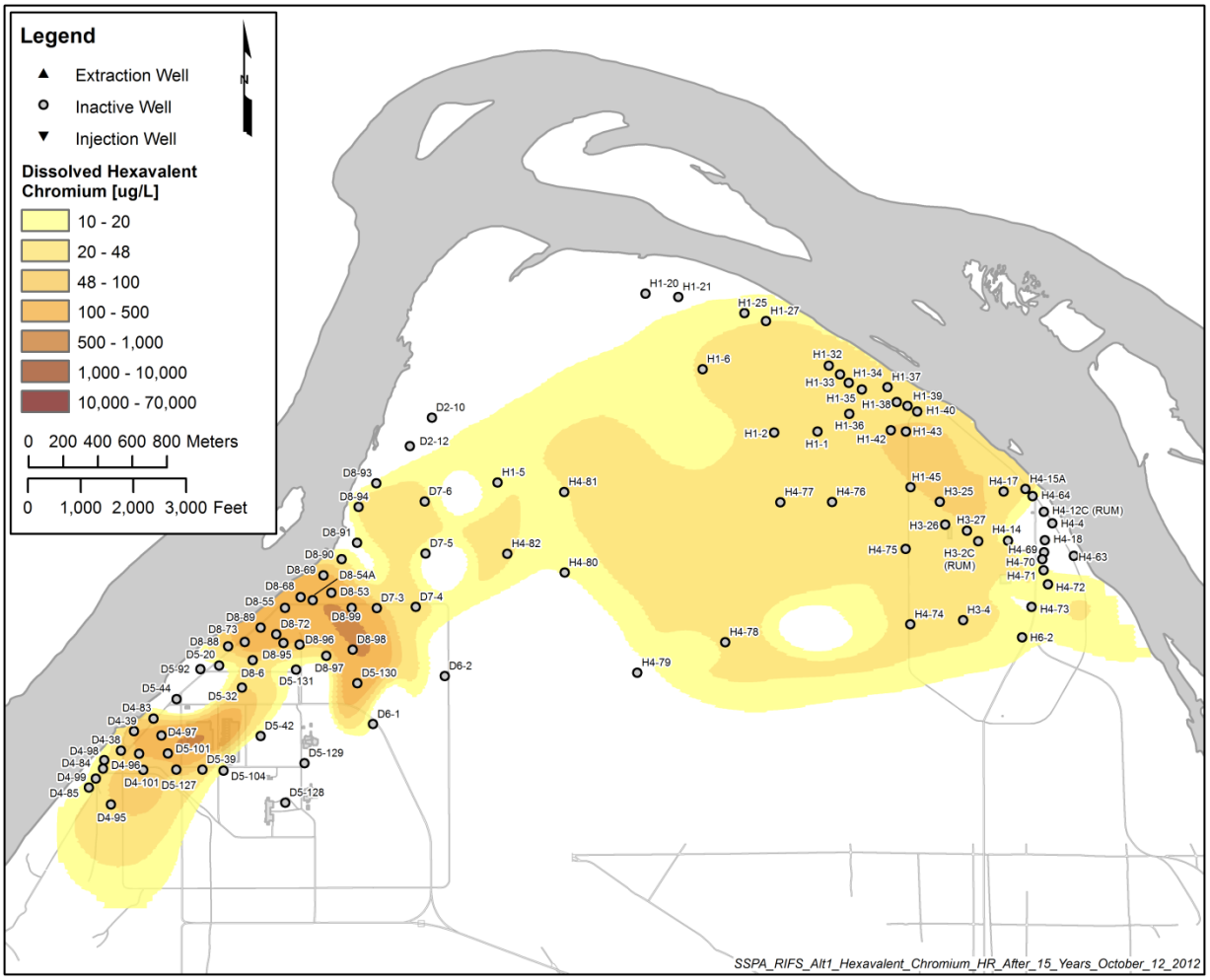

Figure 5-6. Simulated Distribution of Cr(VI) after 15 Years – Alternative 1.

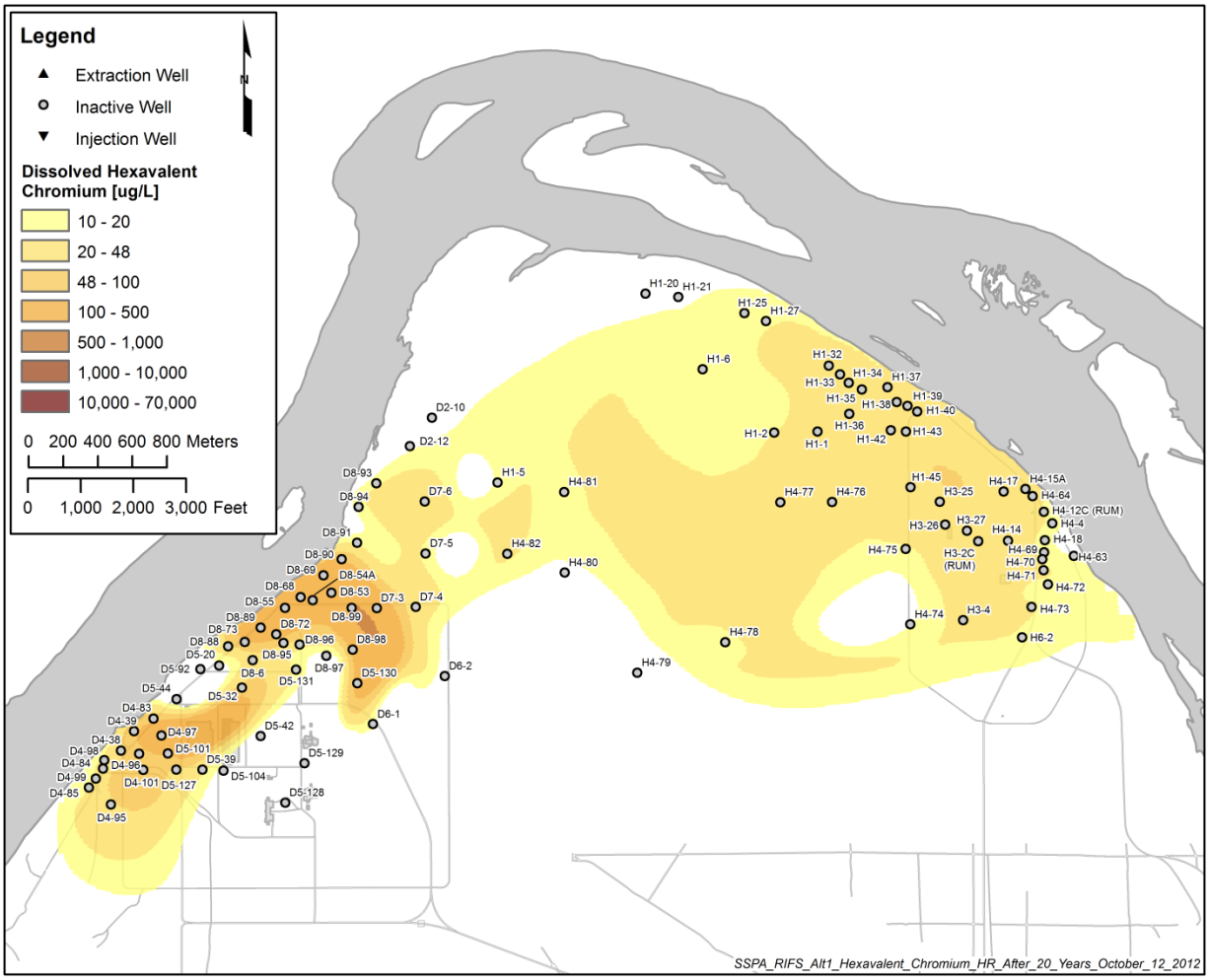

Figure 5-7. Simulated Distribution of Cr(VI) after 20 Years – Alternative 1.

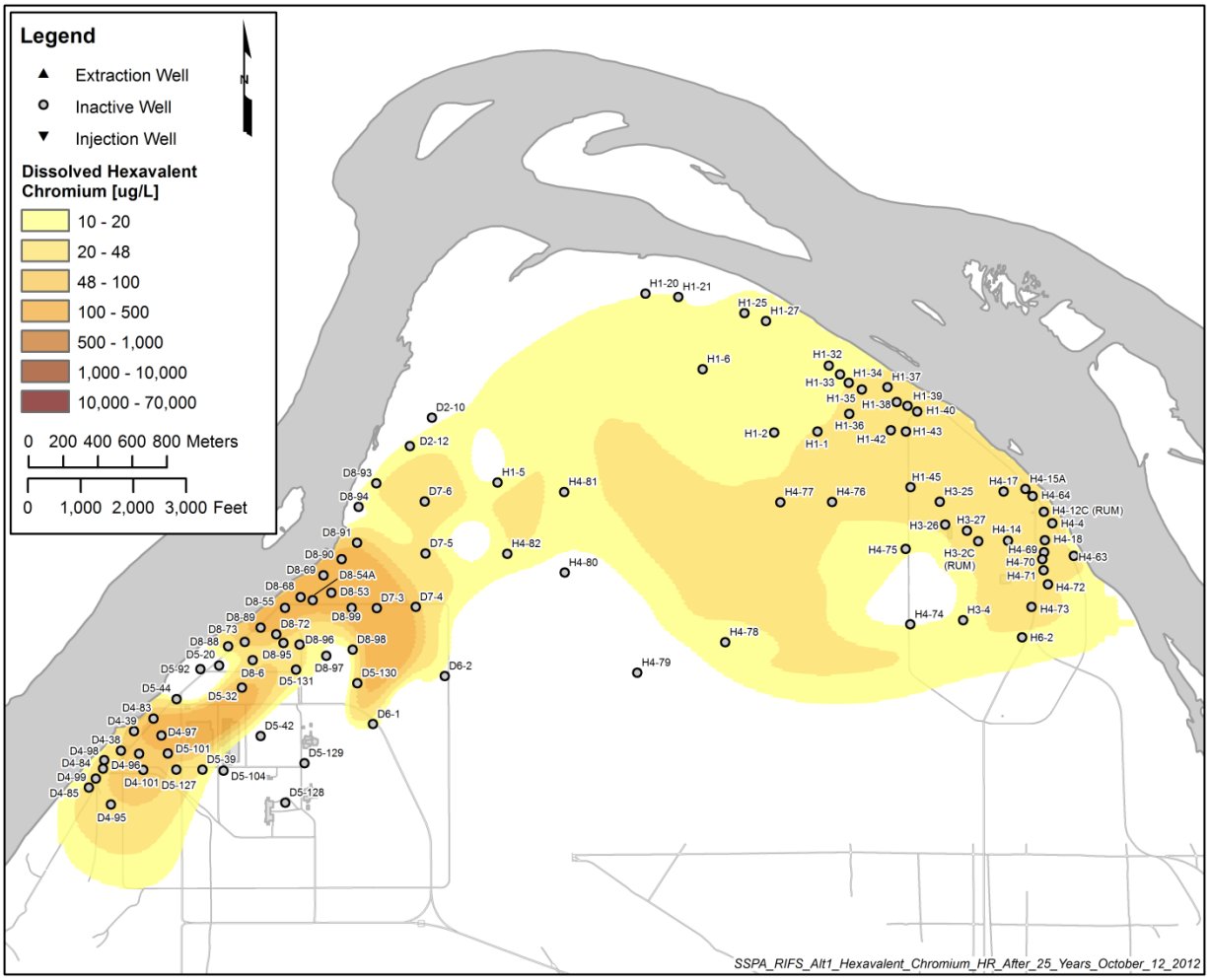

Figure 5-8. Simulated Distribution of Cr(VI) after 25 Years – Alternative 1.

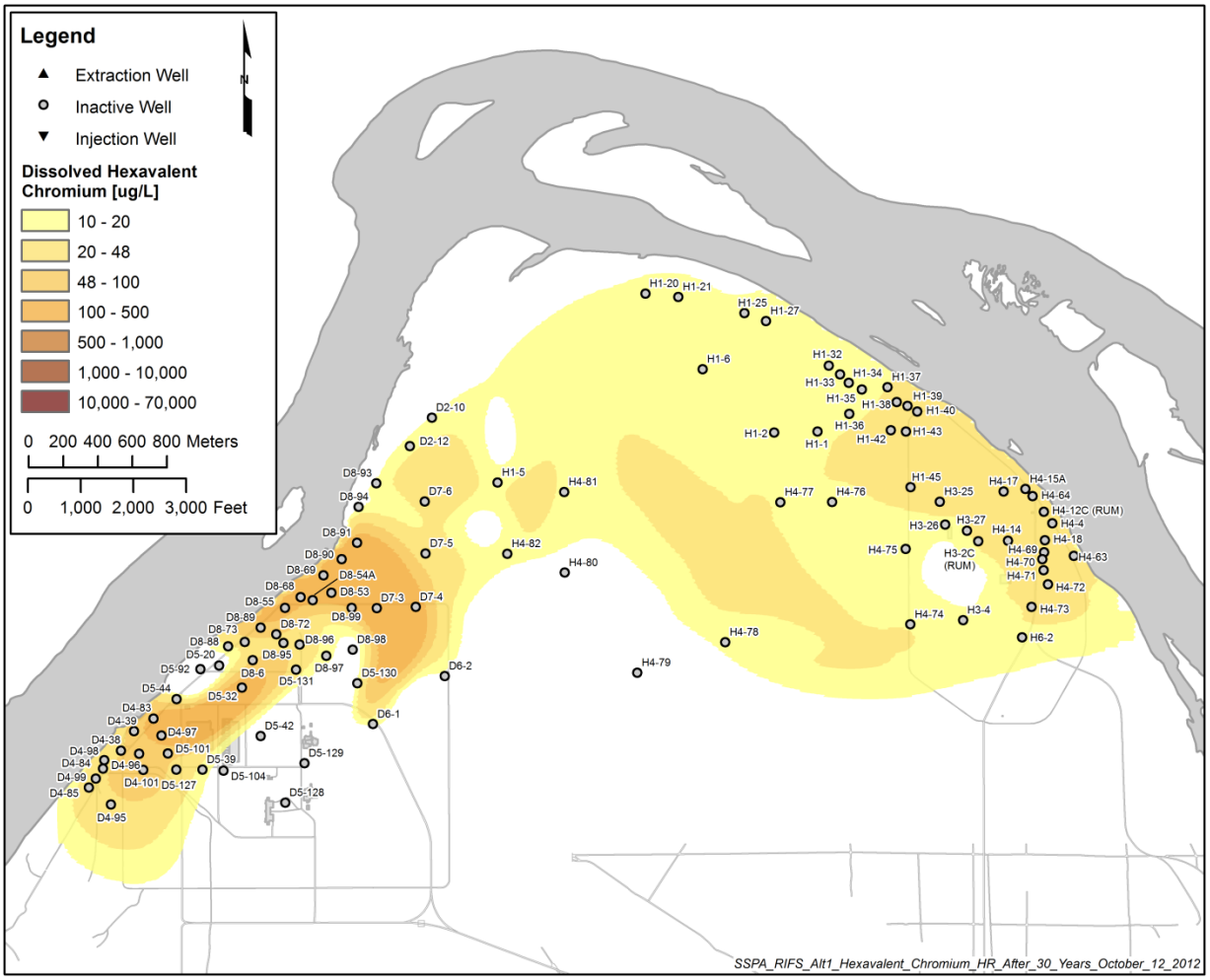

Figure 5-9. Simulated Distribution of Cr(VI) after 30 Years – Alternative 1.

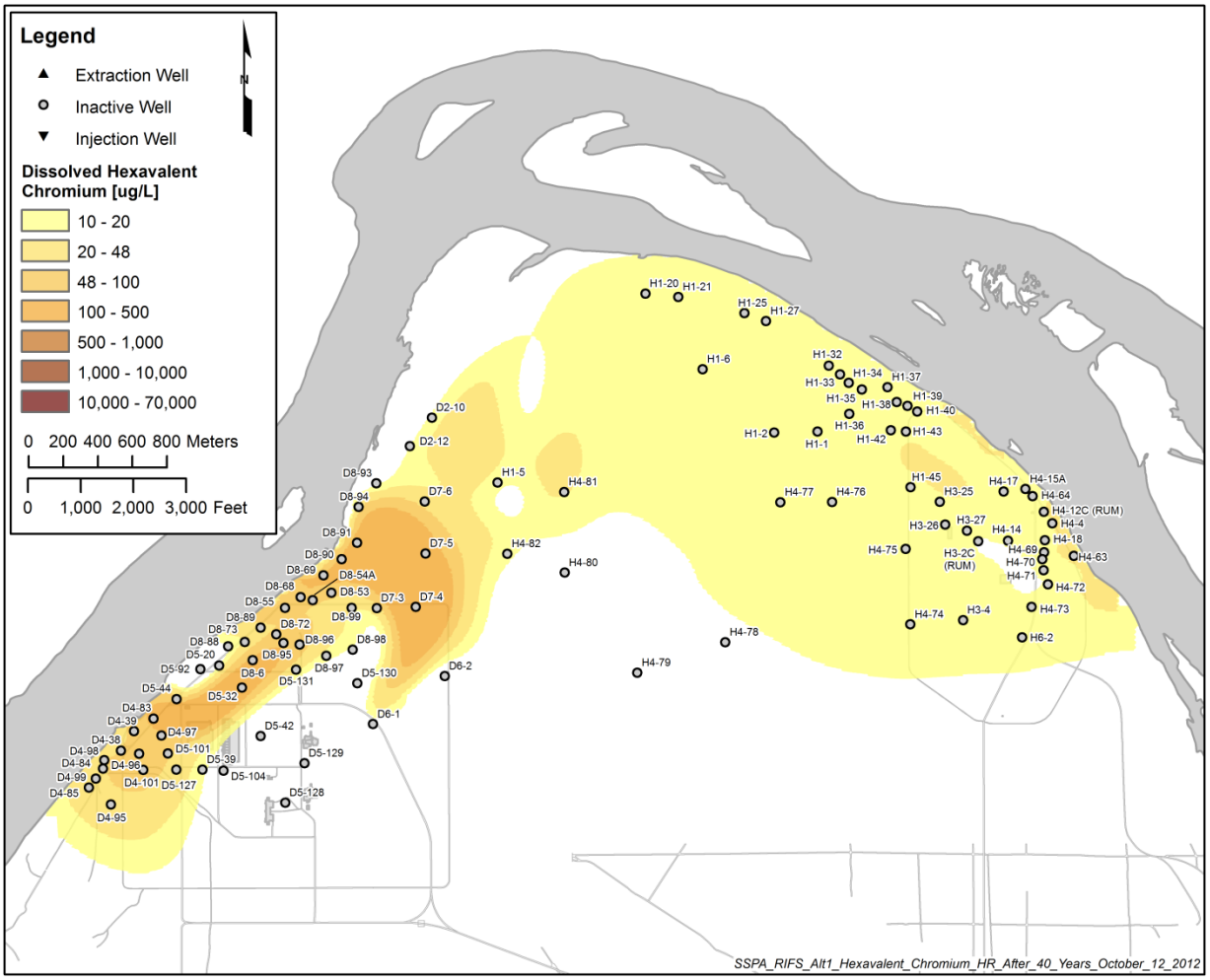

Figure 5-10. Simulated Distribution of Cr(VI) after 40 Years – Alternative 1.

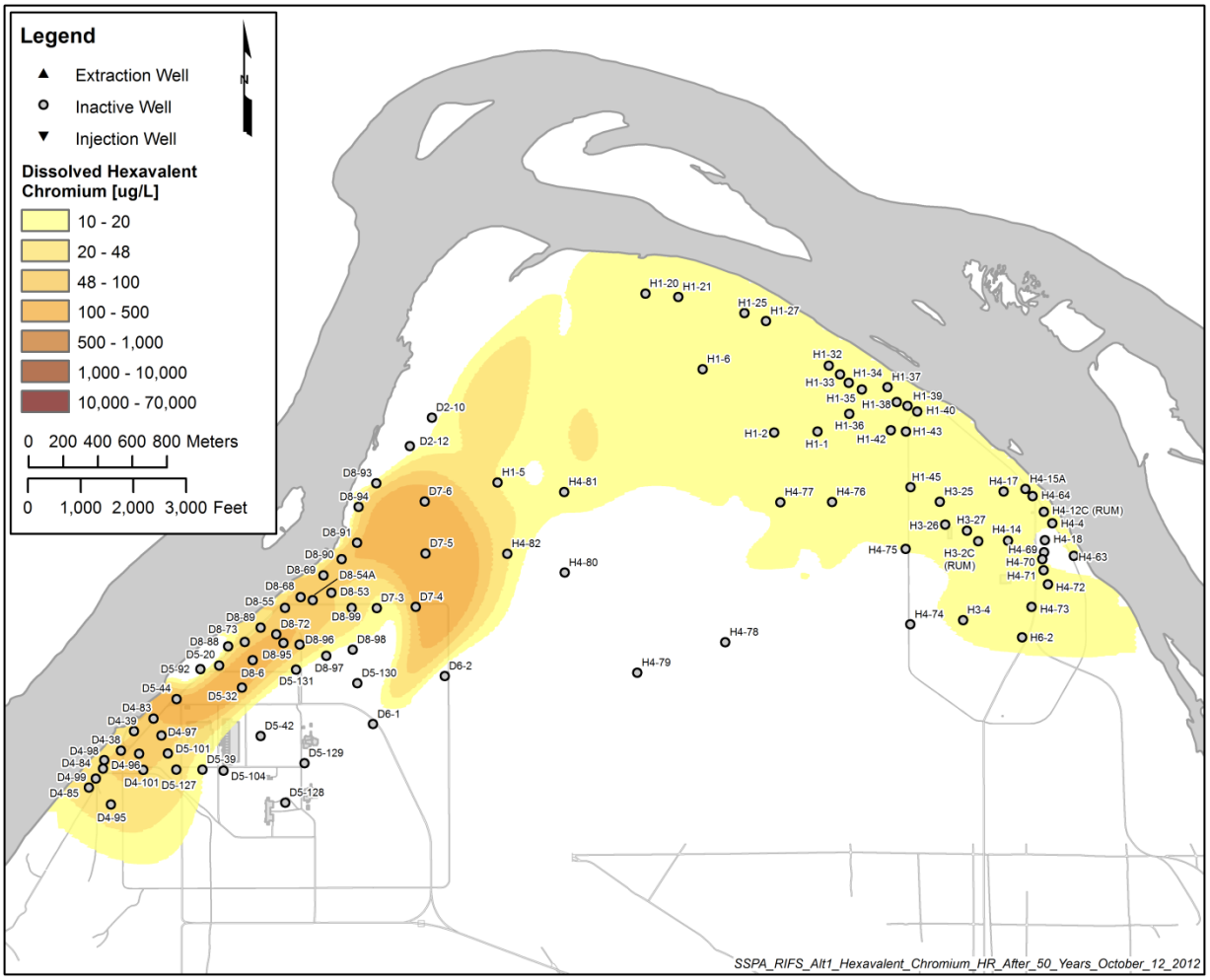

Figure 5-11. Simulated Distribution of Cr(VI) after 50 Years – Alternative 1.

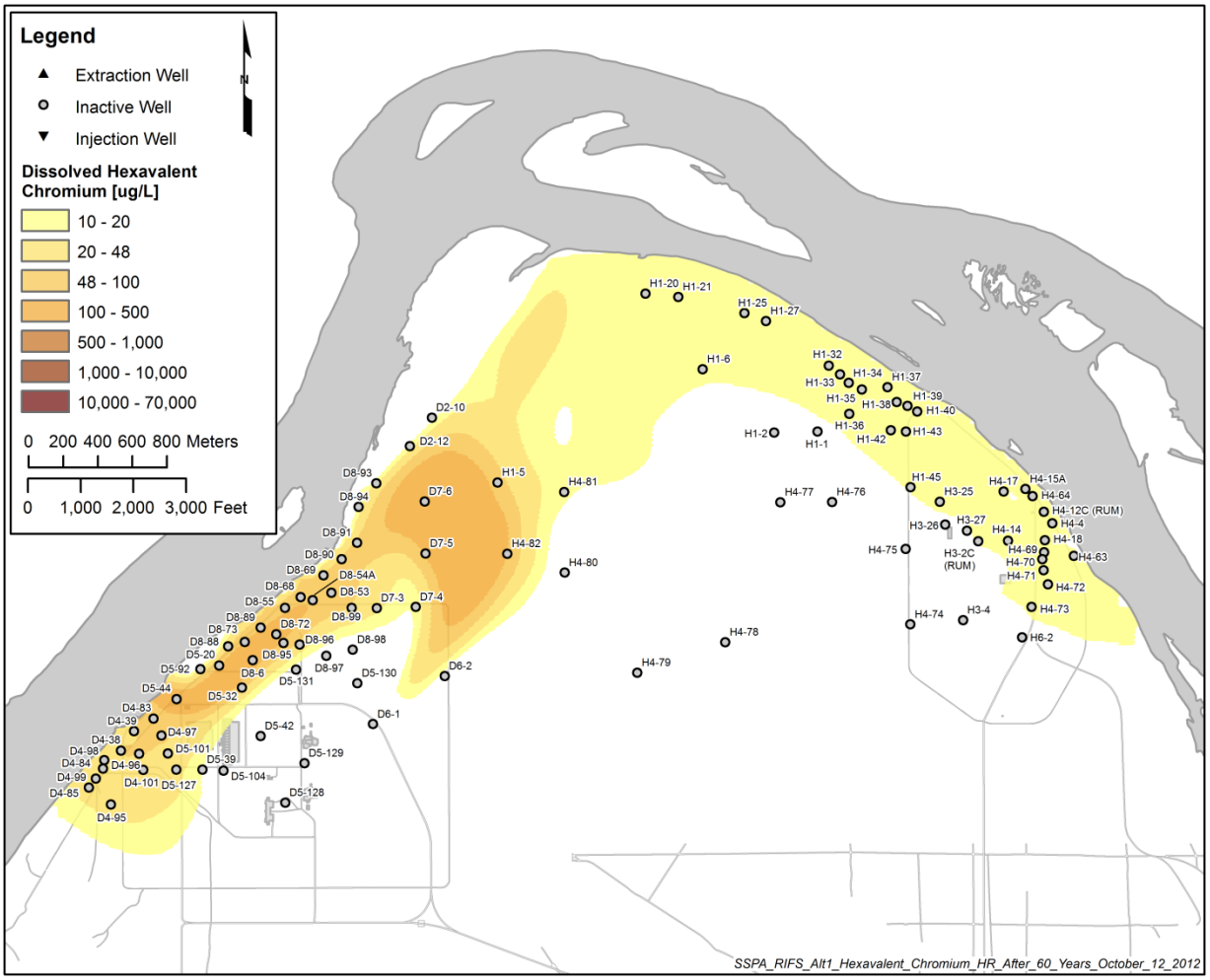

Figure 5-12. Simulated Distribution of Cr(VI) after 60 Years – Alternative 1.

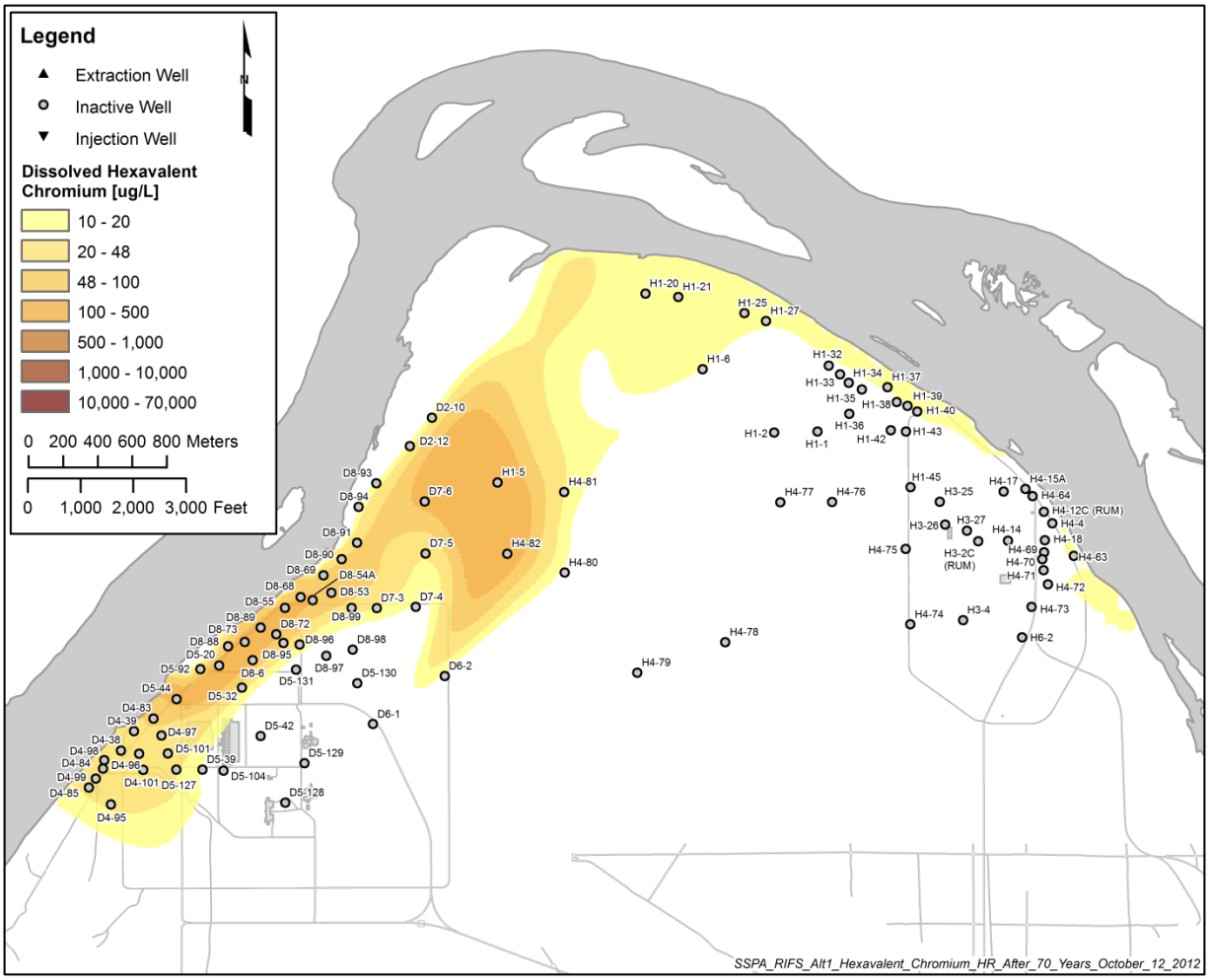

Figure 5-13. Simulated Distribution of Cr(VI) after 70 Years – Alternative 1.

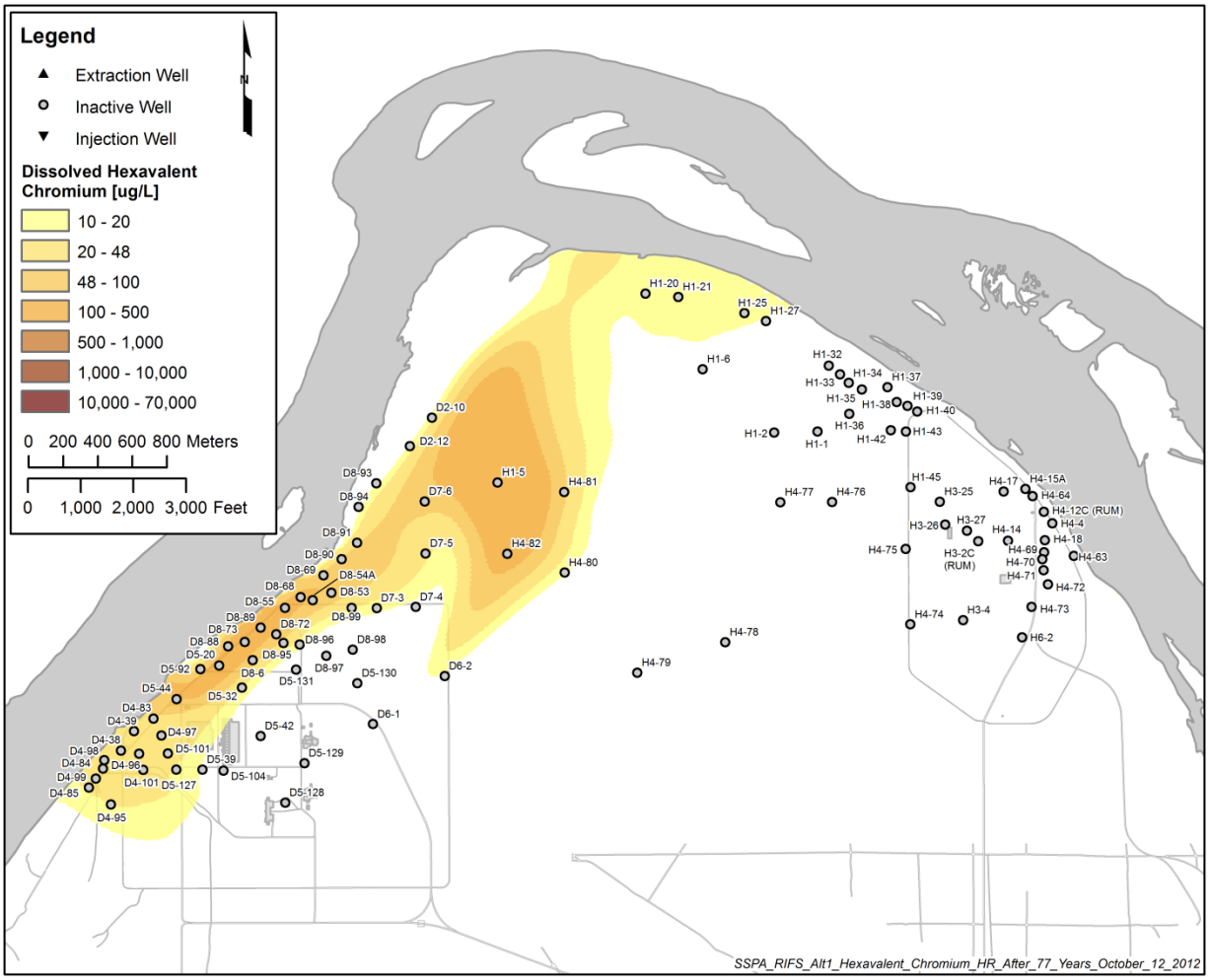

Figure 5-14. Simulated Distribution of Cr(VI) after 77 Years – Alternative 1.

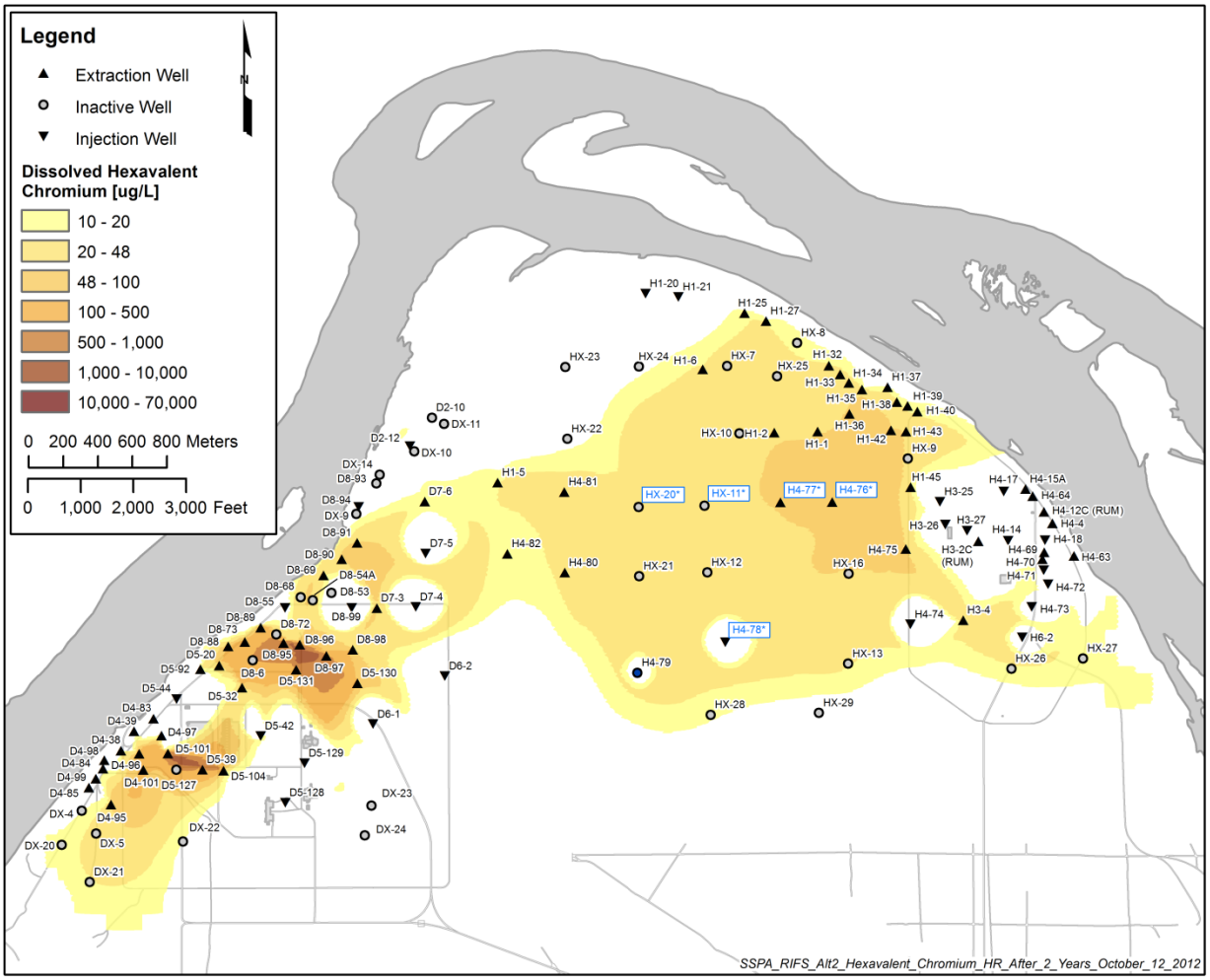

Figure 5-15. Simulated Distribution of Cr(VI) after 2 Years – Alternative 2.

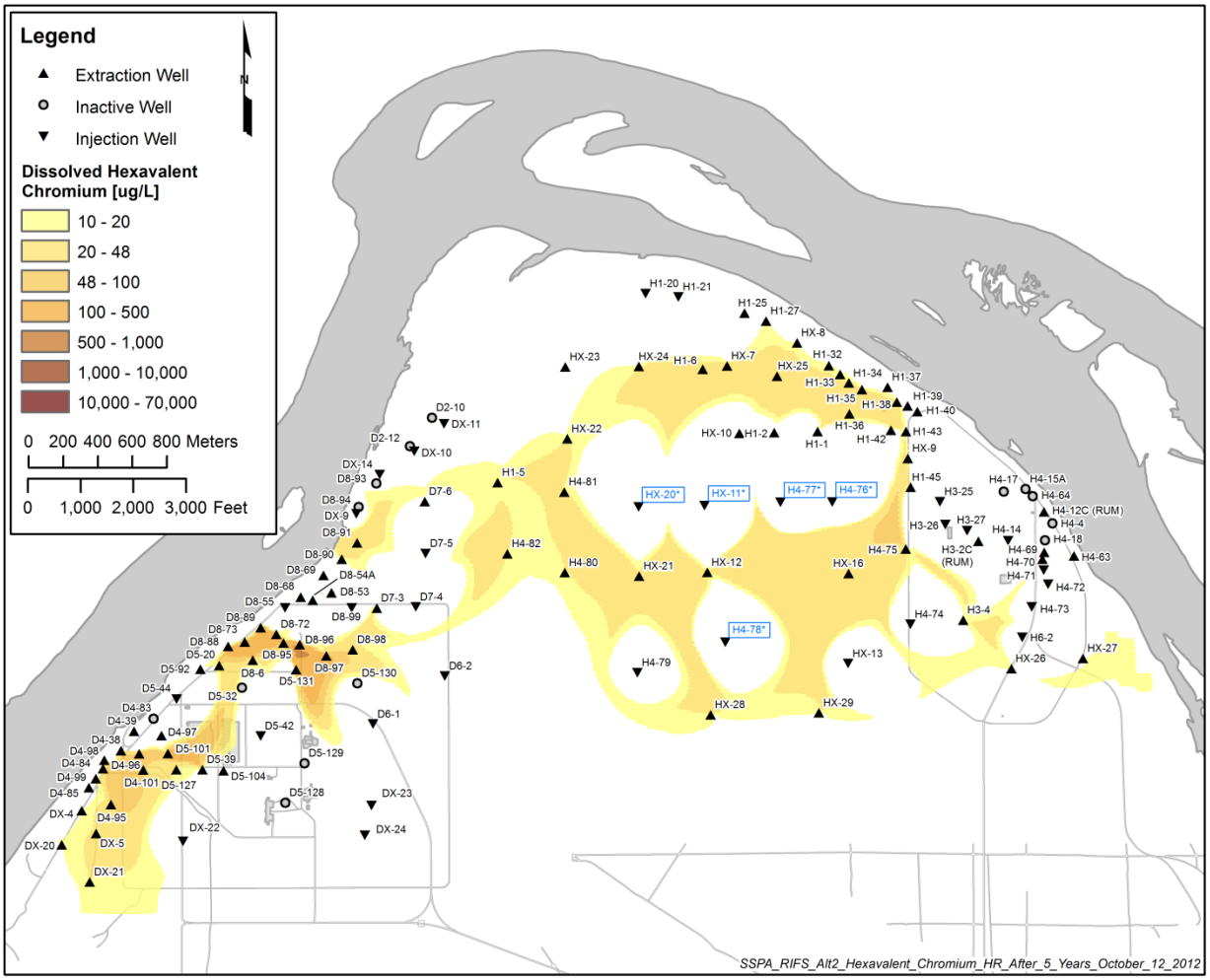

Figure 5-16. Simulated Distribution of Cr(VI) after 5 Years – Alternative 2.

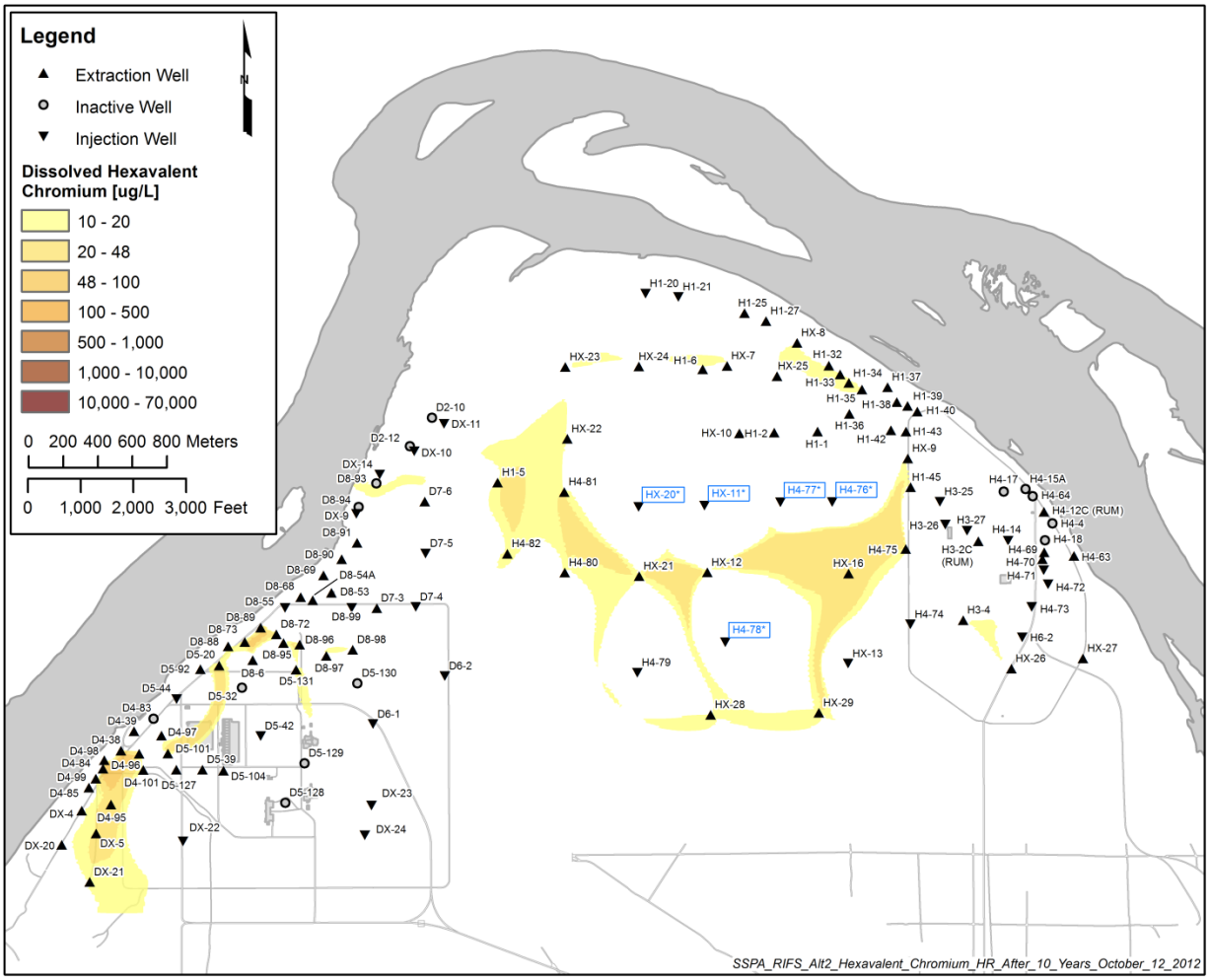

Figure 5-17. Simulated Distribution of Cr(VI) after 10 Years – Alternative 2.

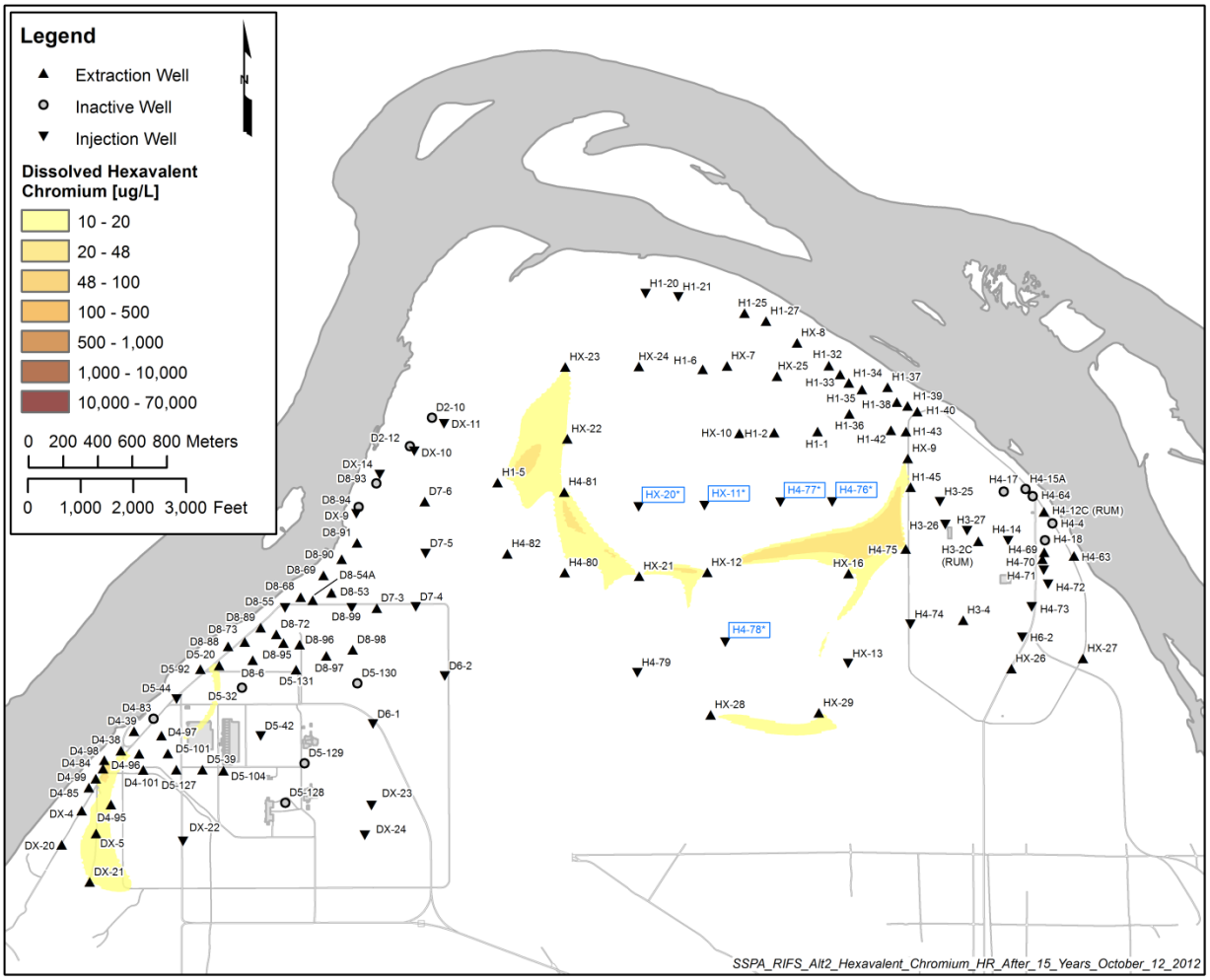

Figure 5-18. Simulated Distribution of Cr(VI) after 15 Years – Alternative 2.

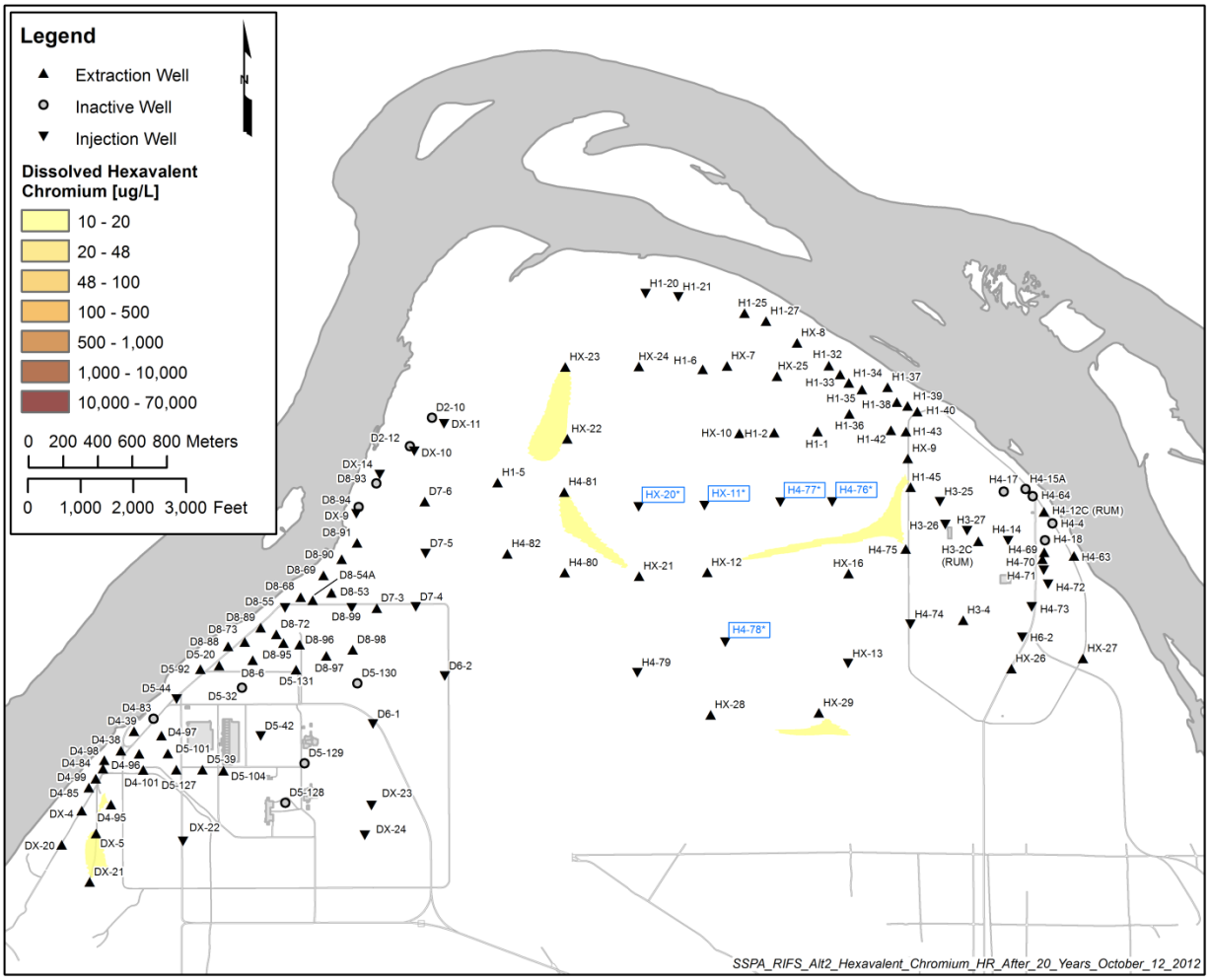

Figure 5-19. Simulated Distribution of Cr(VI) after 20 Years – Alternative 2.

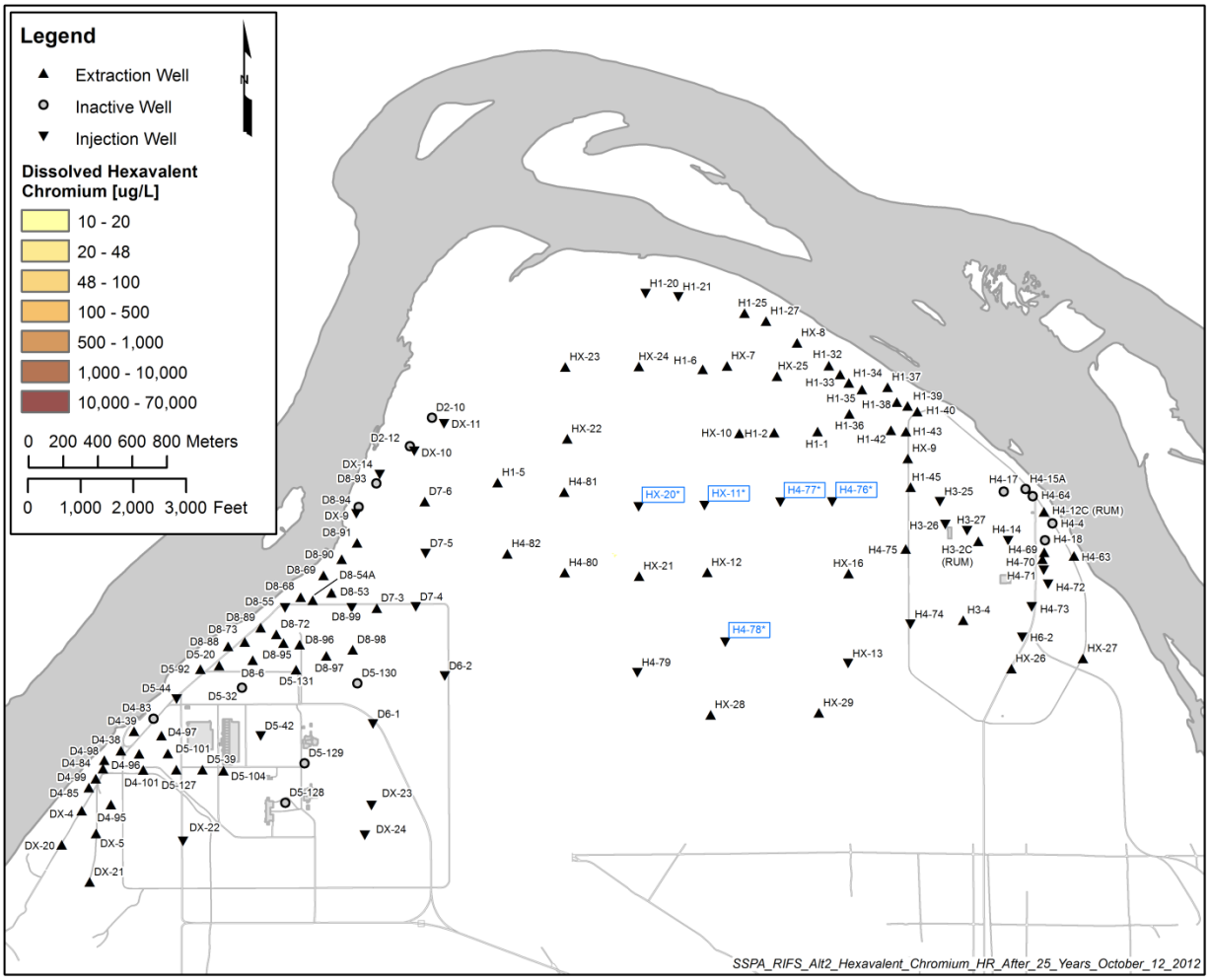

Figure 5-20. Simulated Distribution of Cr(VI) after 25 Years – Alternative 2.

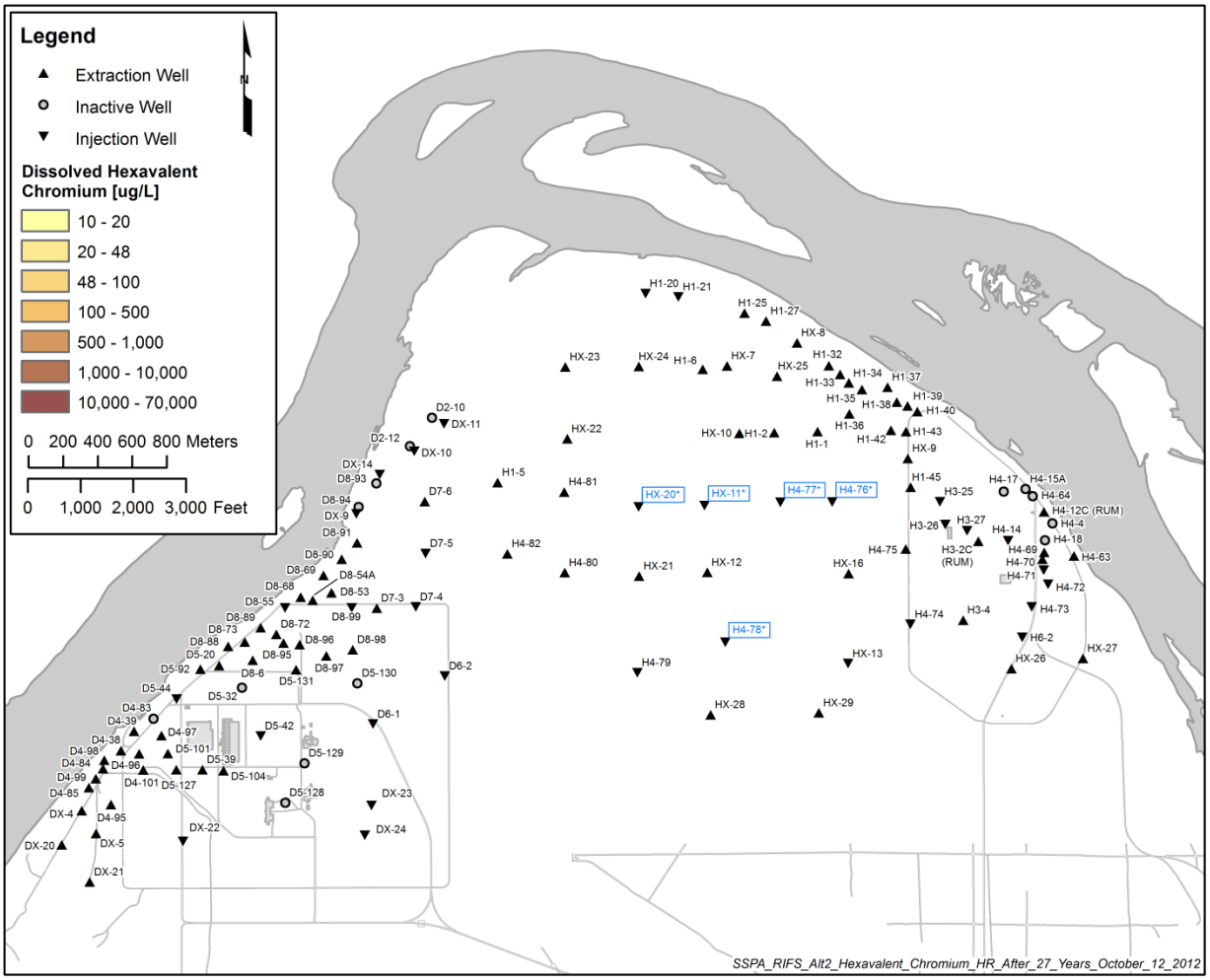

Figure 5-21. Simulated Distribution of Cr(VI) after 27 Years – Alternative 2.

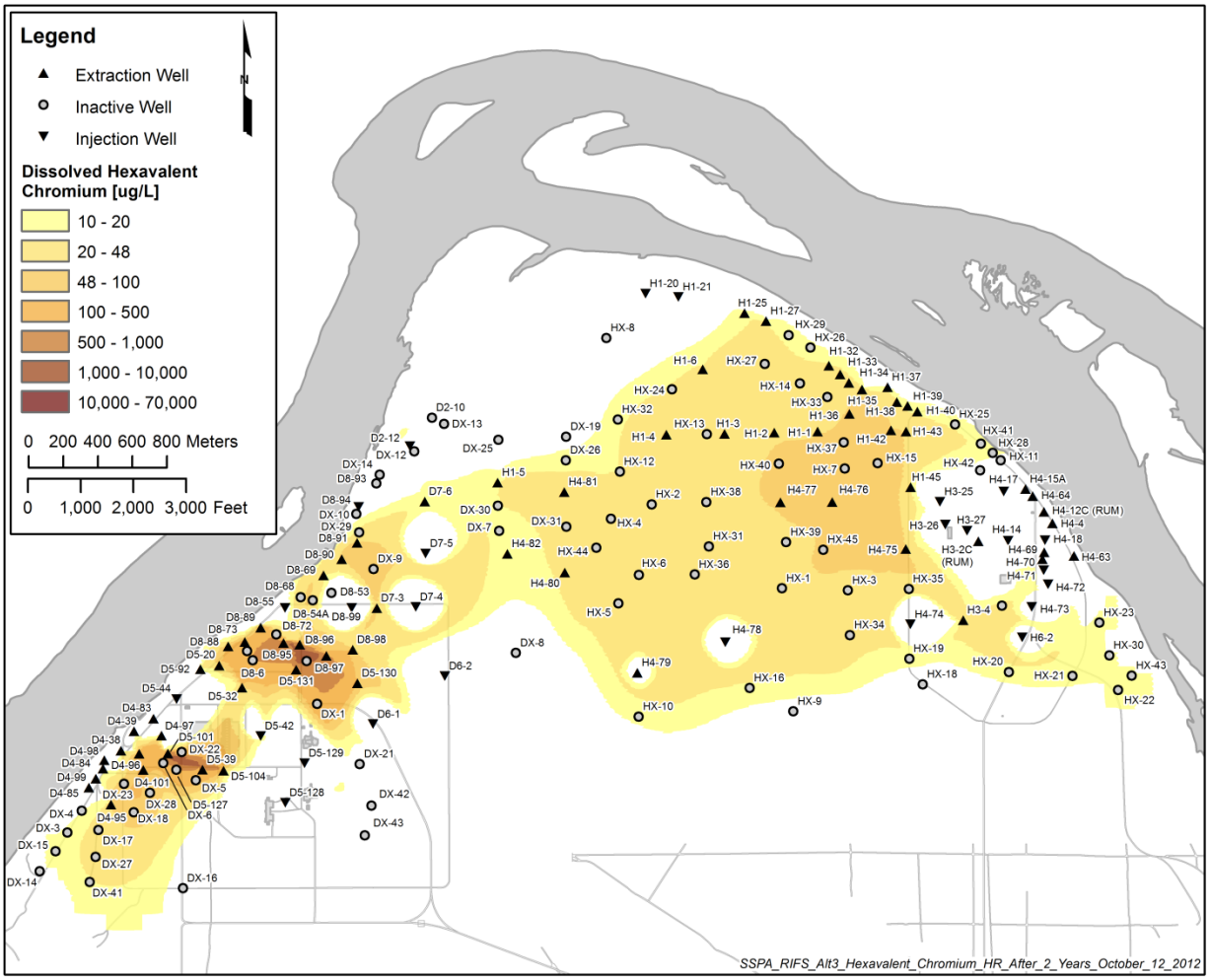

Figure 5-22. Simulated Distribution of Cr(VI) after 2 Years – Alternative 3.

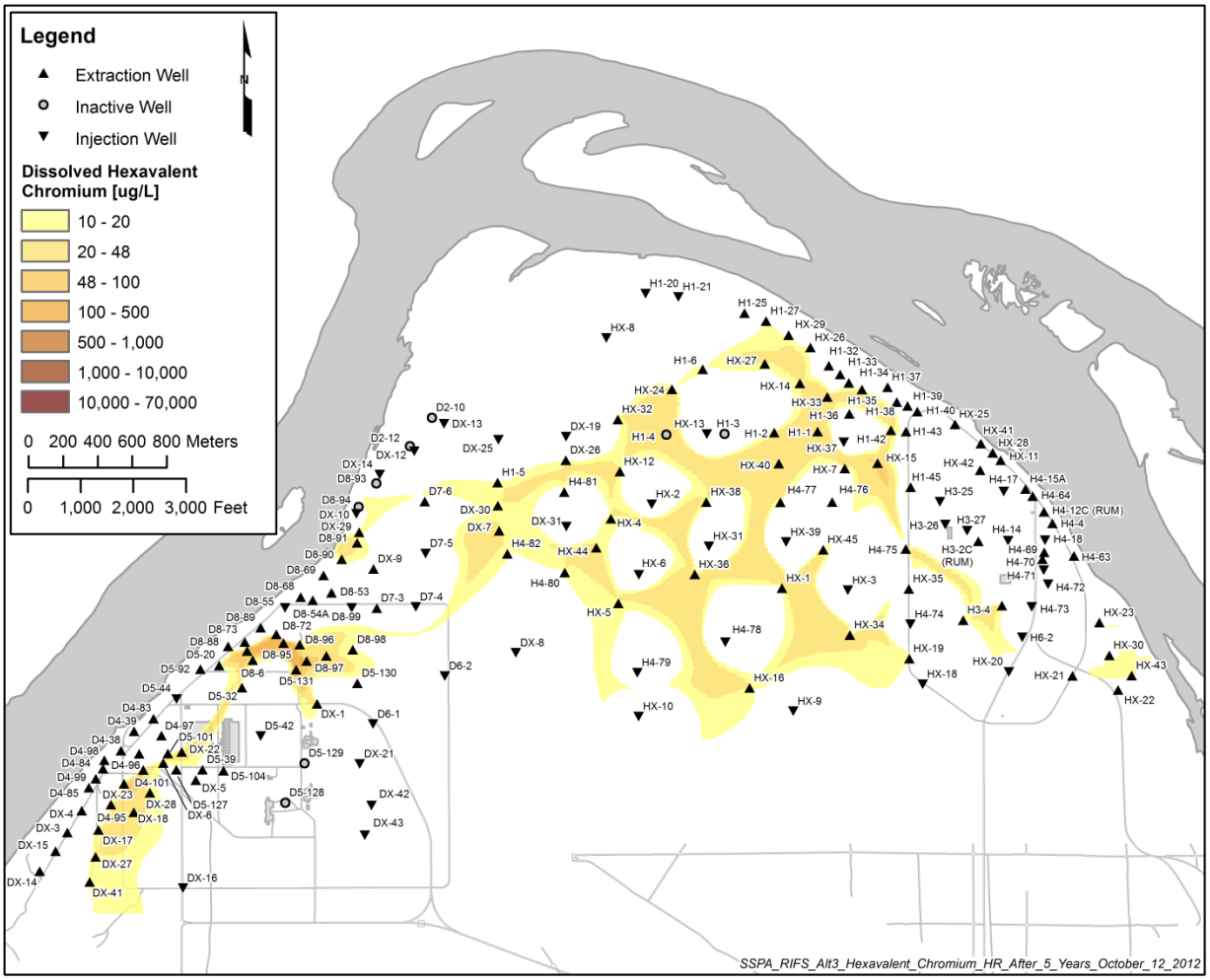

Figure 5-23. Simulated Distribution of Cr(VI) after 5 Years – Alternative 3.

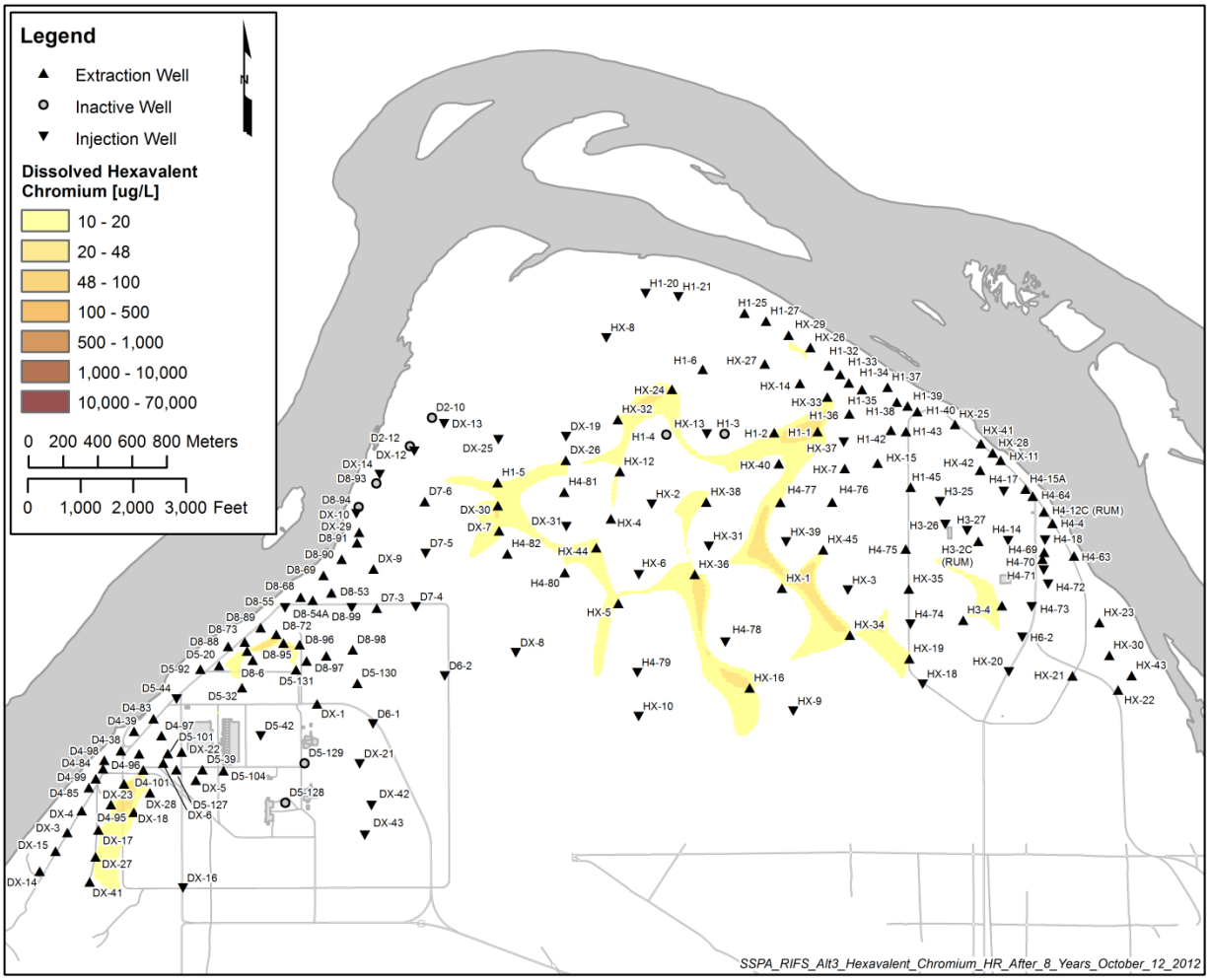

Figure 5-24. Simulated Distribution of Cr(VI) after 8 Years – Alternative 3.

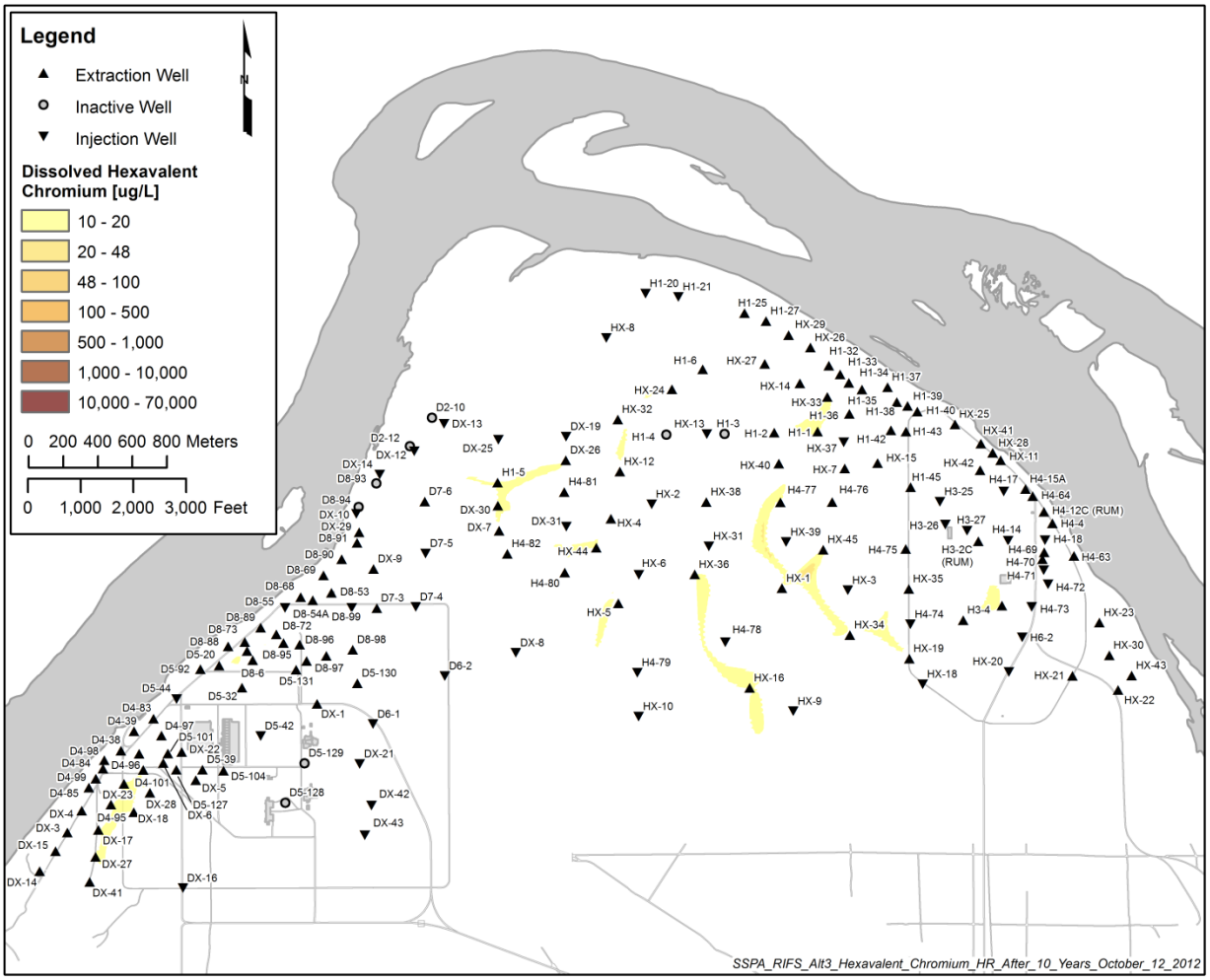

Figure 5-25. Simulated Distribution of Cr(VI) after 10 Years – Alternative 3.

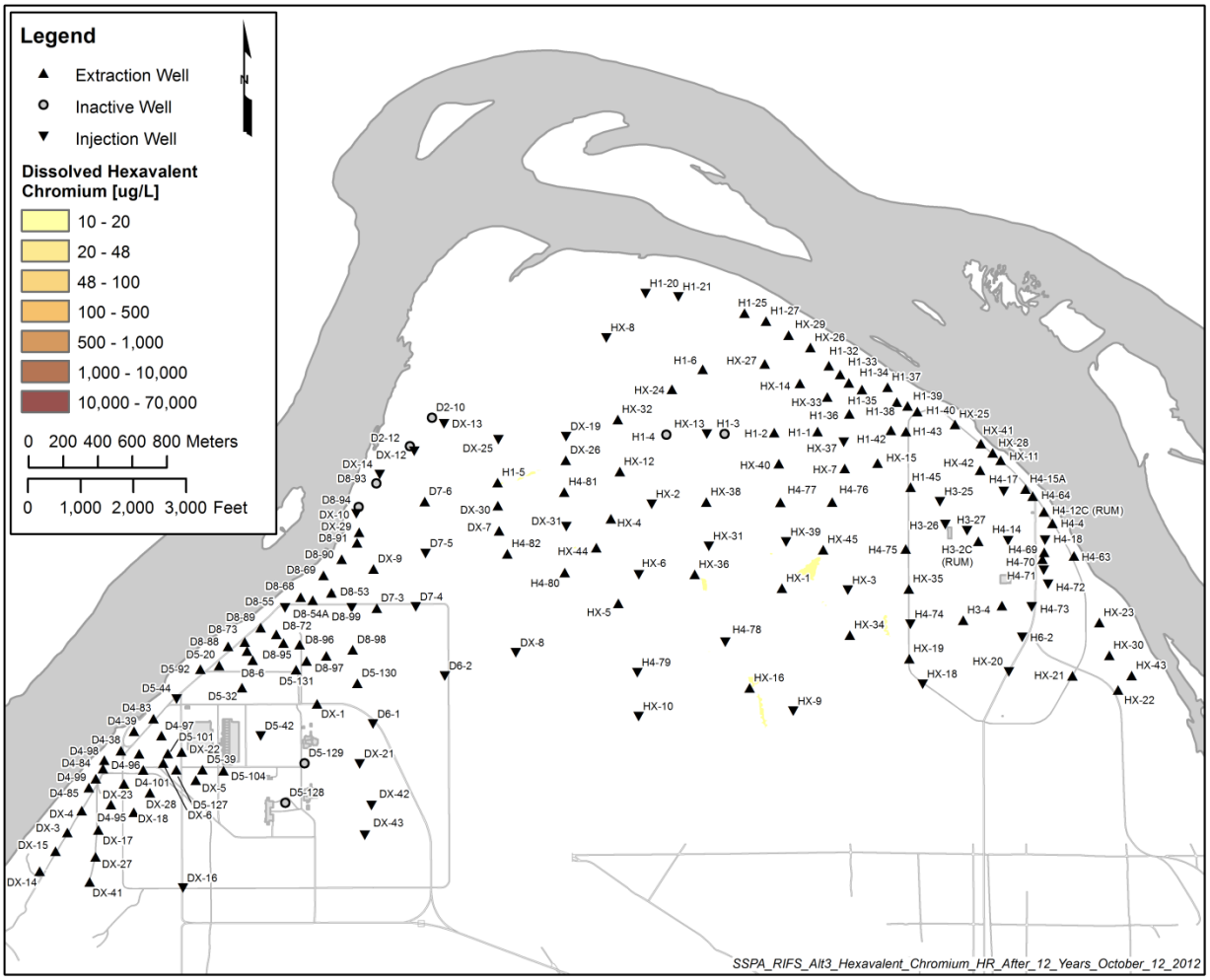

Figure 5-26. Simulated Distribution of Cr(VI) after 12 Years – Alternative 3.

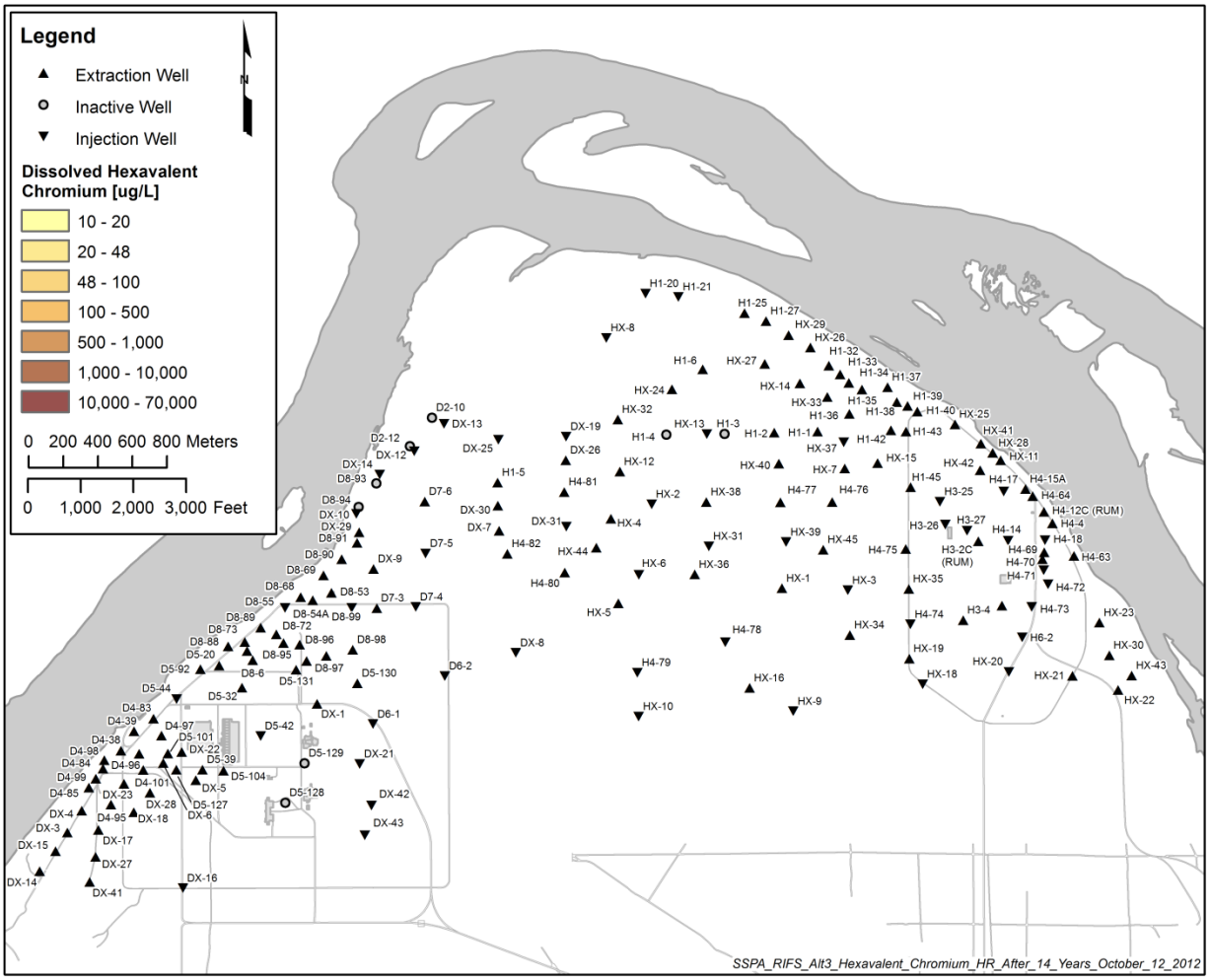

Figure 5-27. Simulated Distribution of Cr(VI) after 14 Years – Alternative 3.

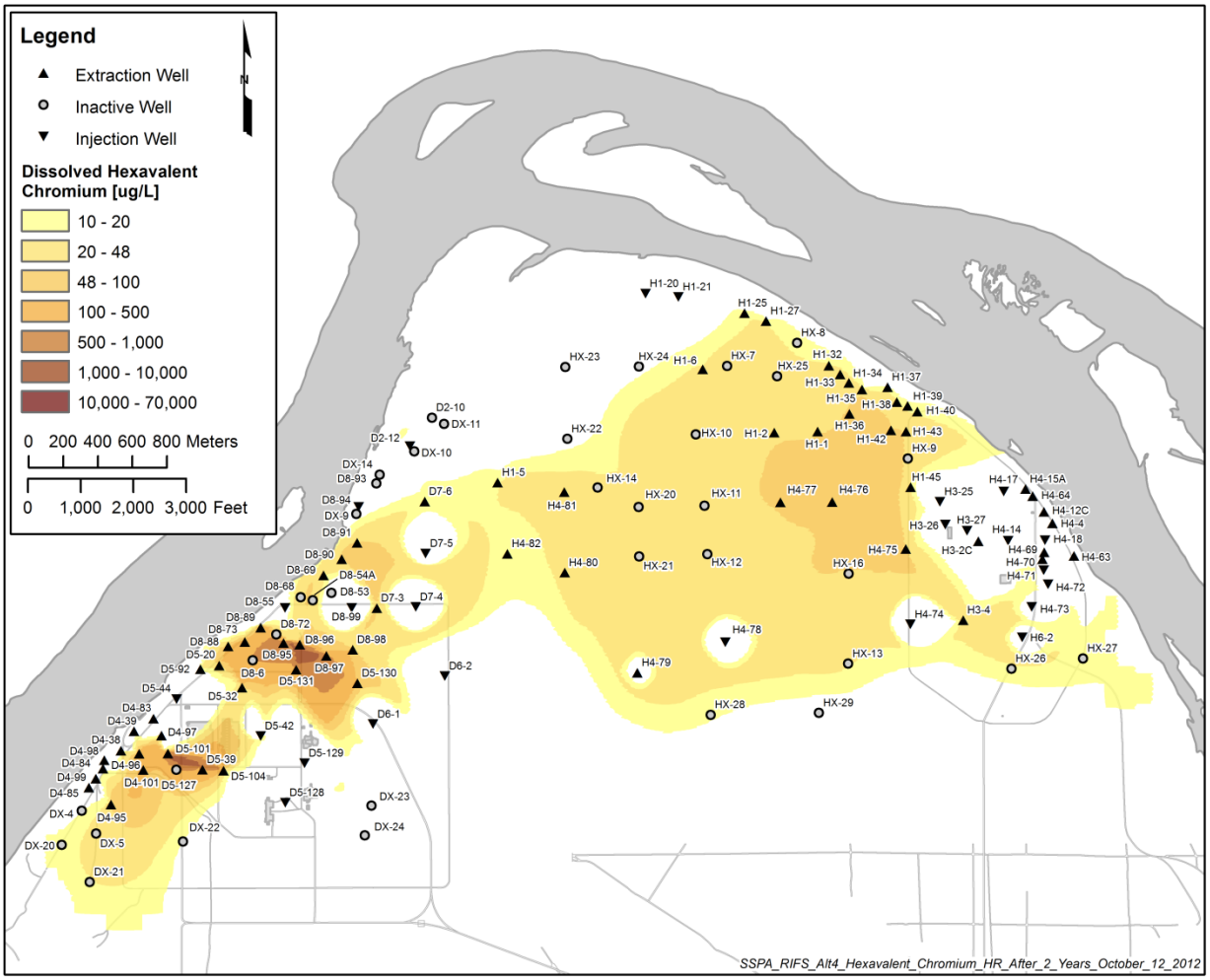

Figure 5-28. Simulated Distribution of Cr(VI) after 2 Years – Alternative 4.

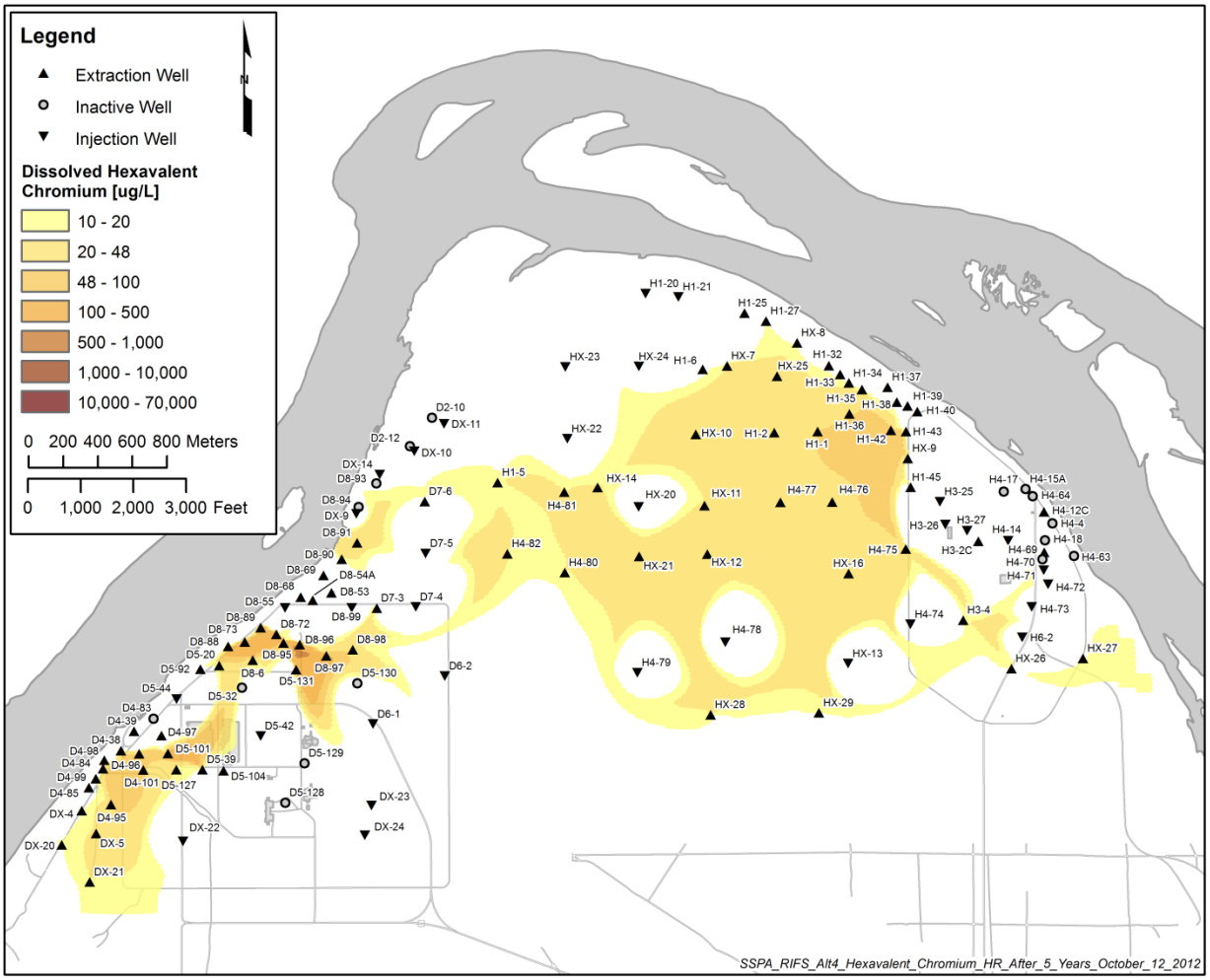

Figure 5-29. Simulated Distribution of Cr(VI) after 5 Years – Alternative 4.

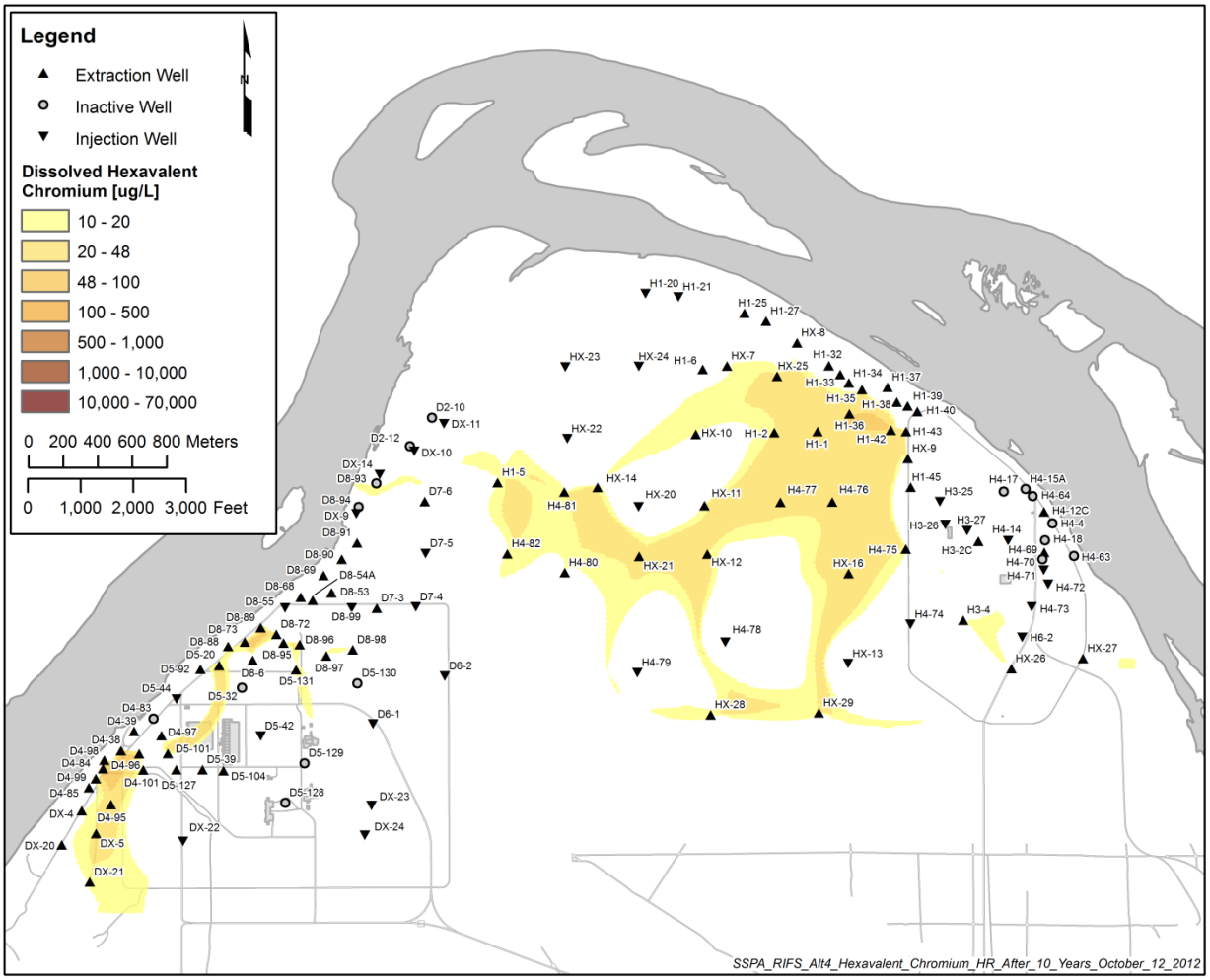

Figure 5-30. Simulated Distribution of Cr(VI) after 10 Years – Alternative 4.

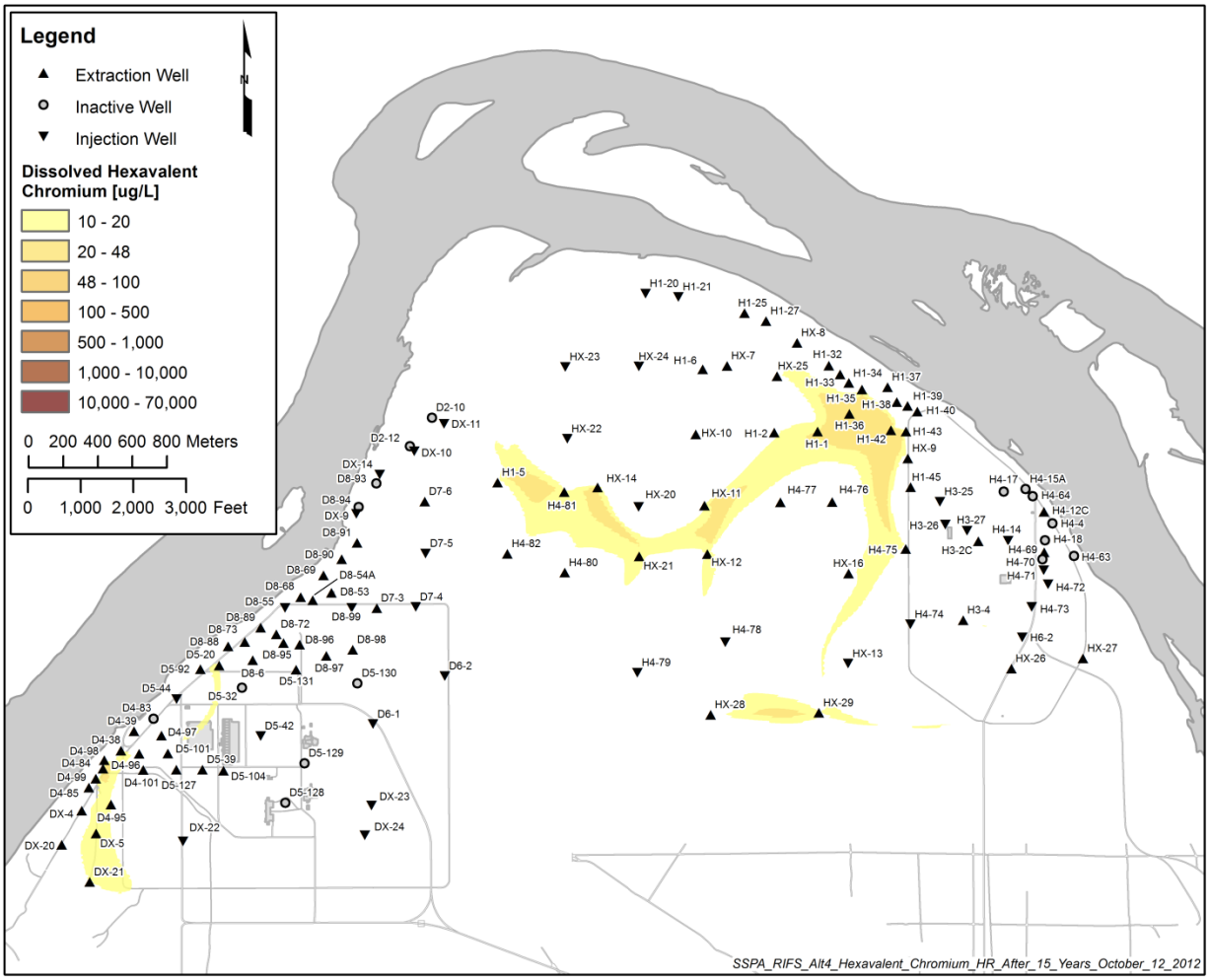

Figure 5-31. Simulated Distribution of Cr(VI) after 15 Years – Alternative 4.

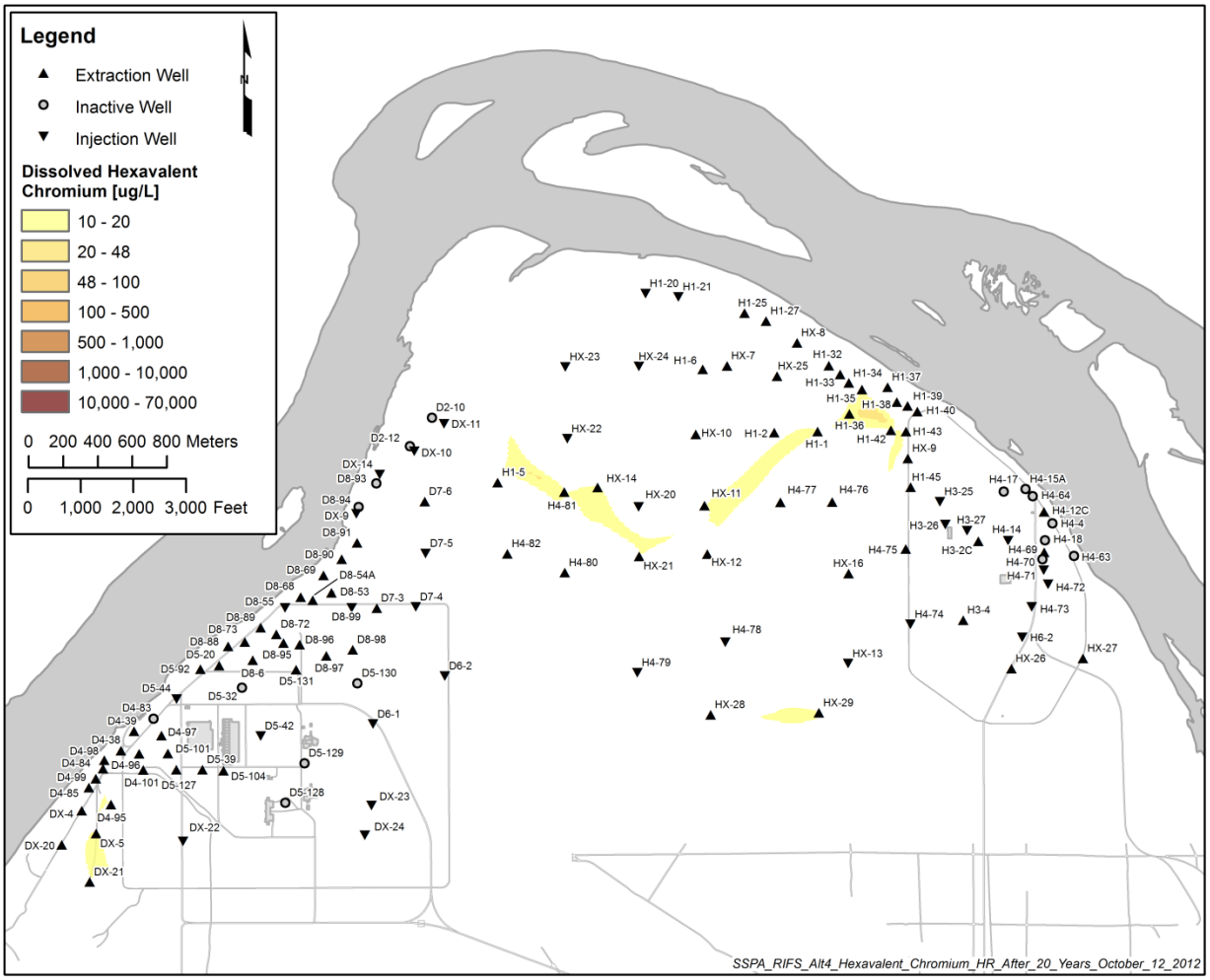

Figure 5-32. Simulated Distribution of Cr(VI) after 20 Years – Alternative 4.

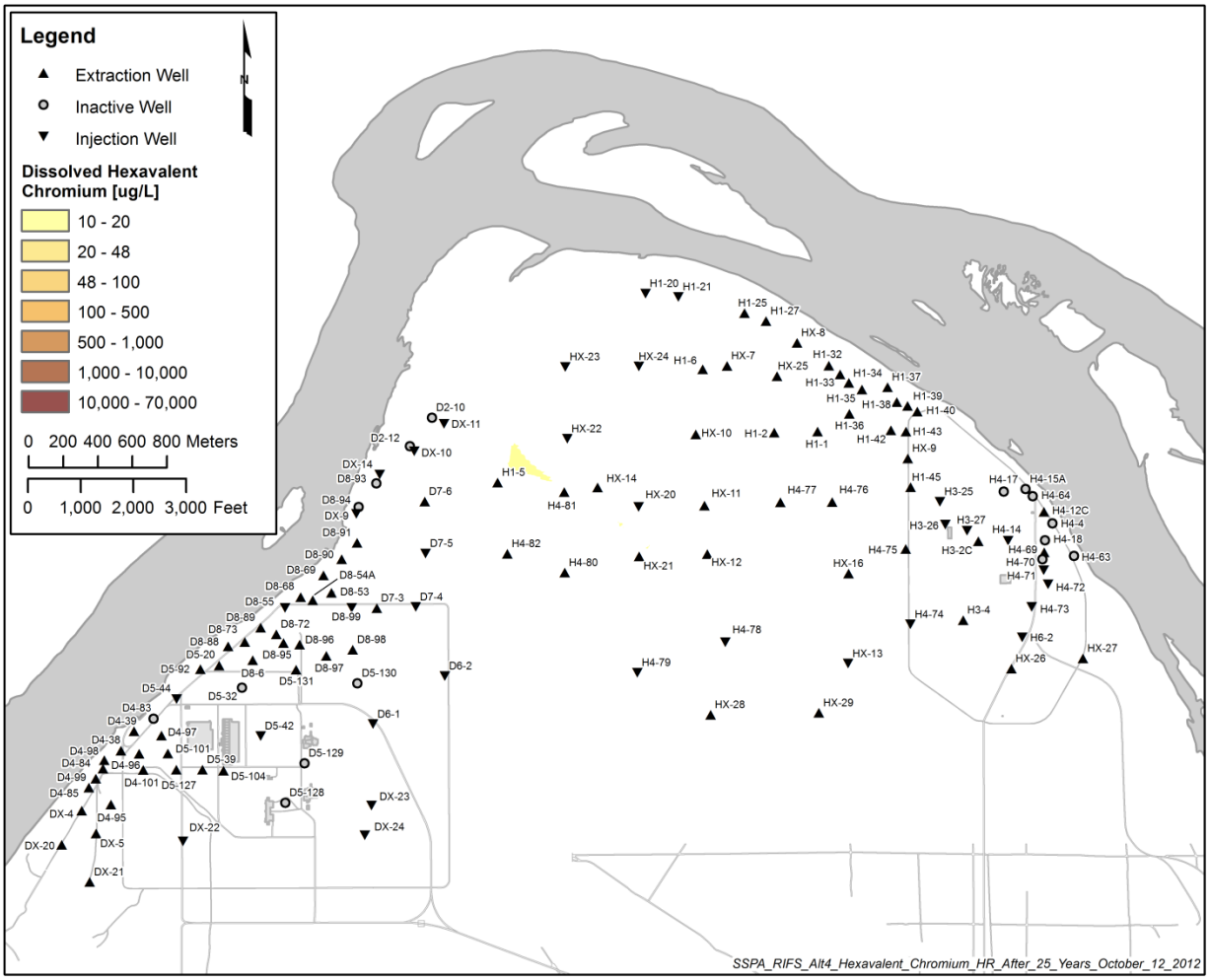

Figure 5-33. Simulated Distribution of Cr(VI) after 25 Years – Alternative 4.

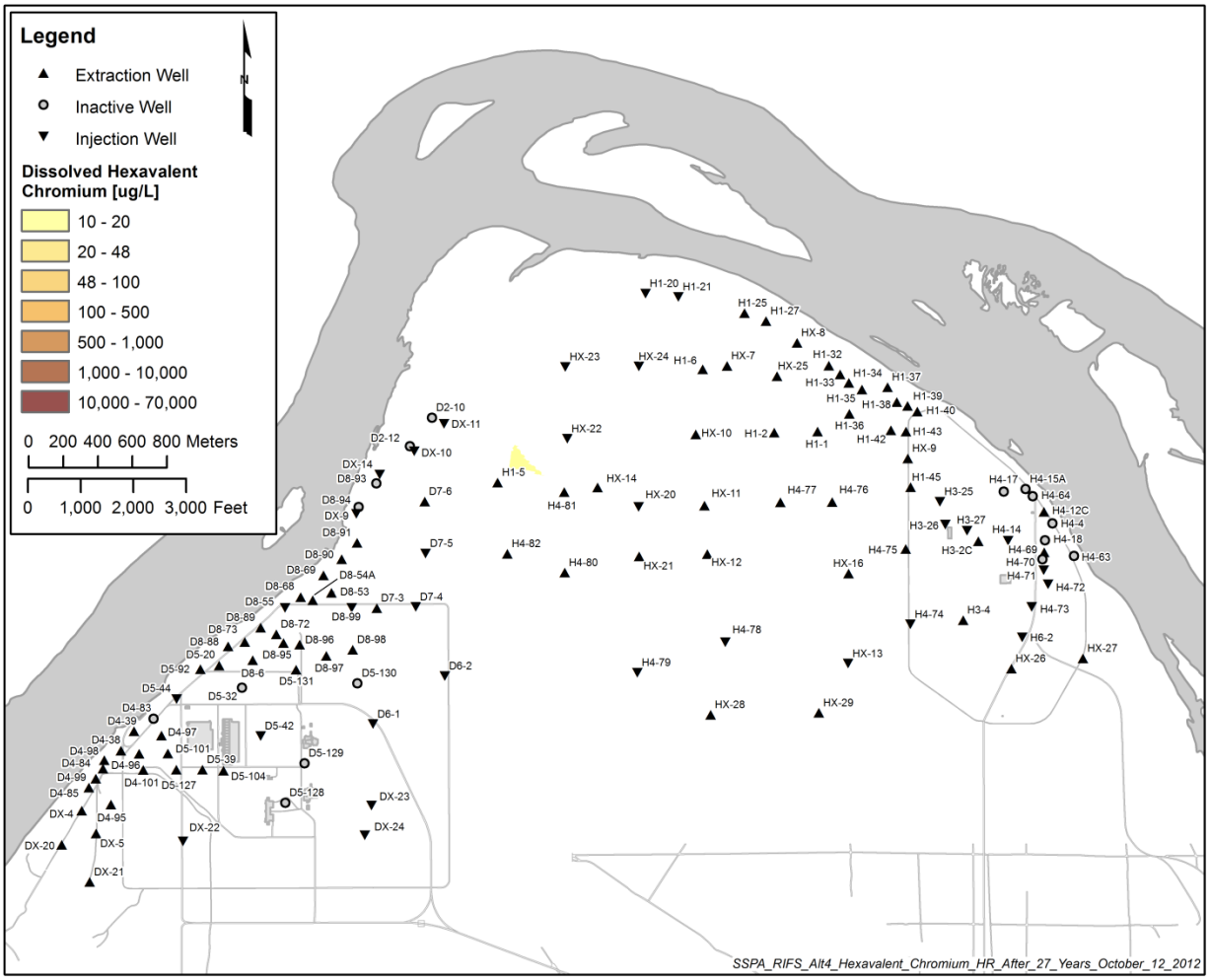

Figure 5-34. Simulated Distribution of Cr(VI) after 27 Years – Alternative 4.

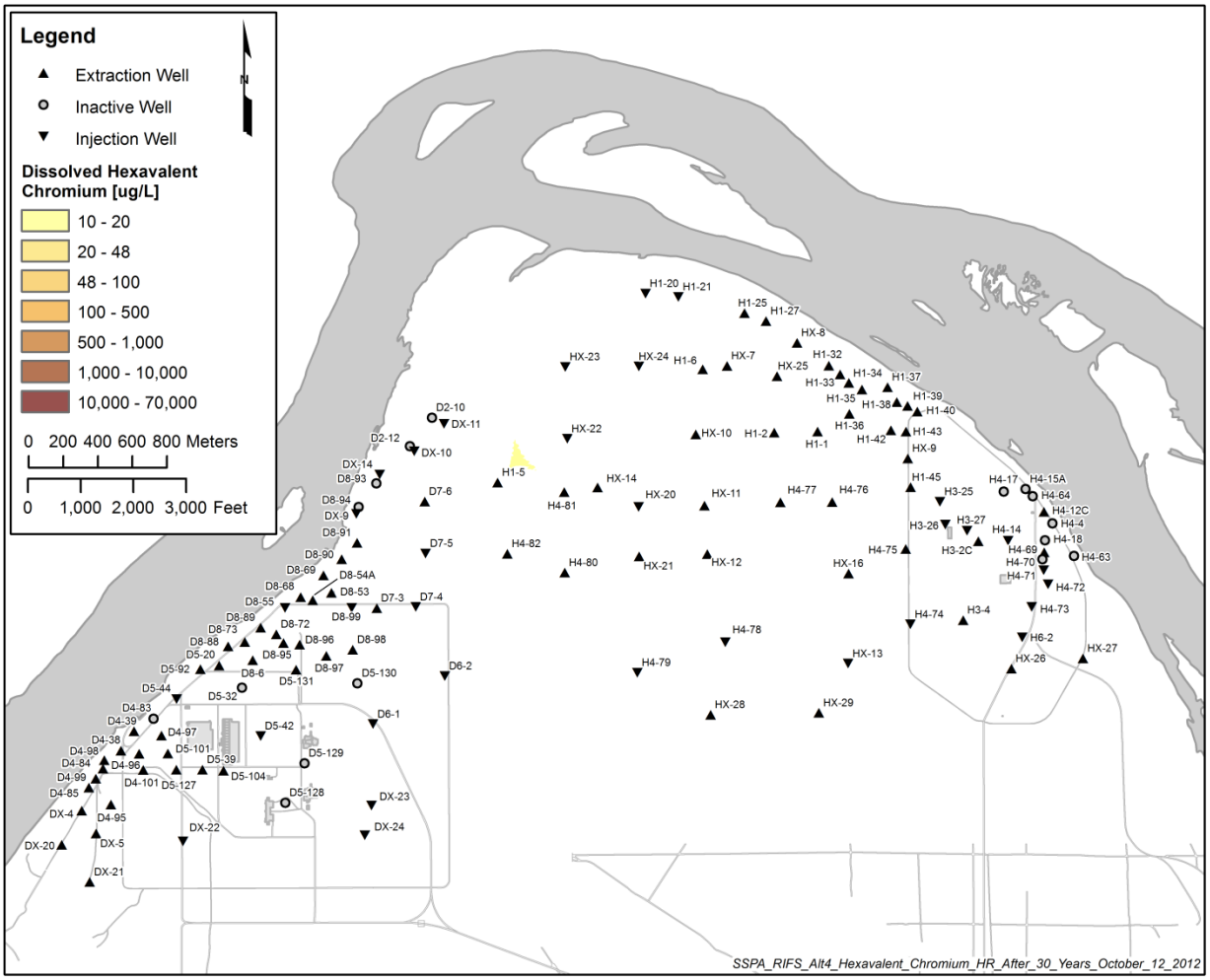

Figure 5-35. Simulated Distribution of Cr(VI) after 30 Years – Alternative 4.

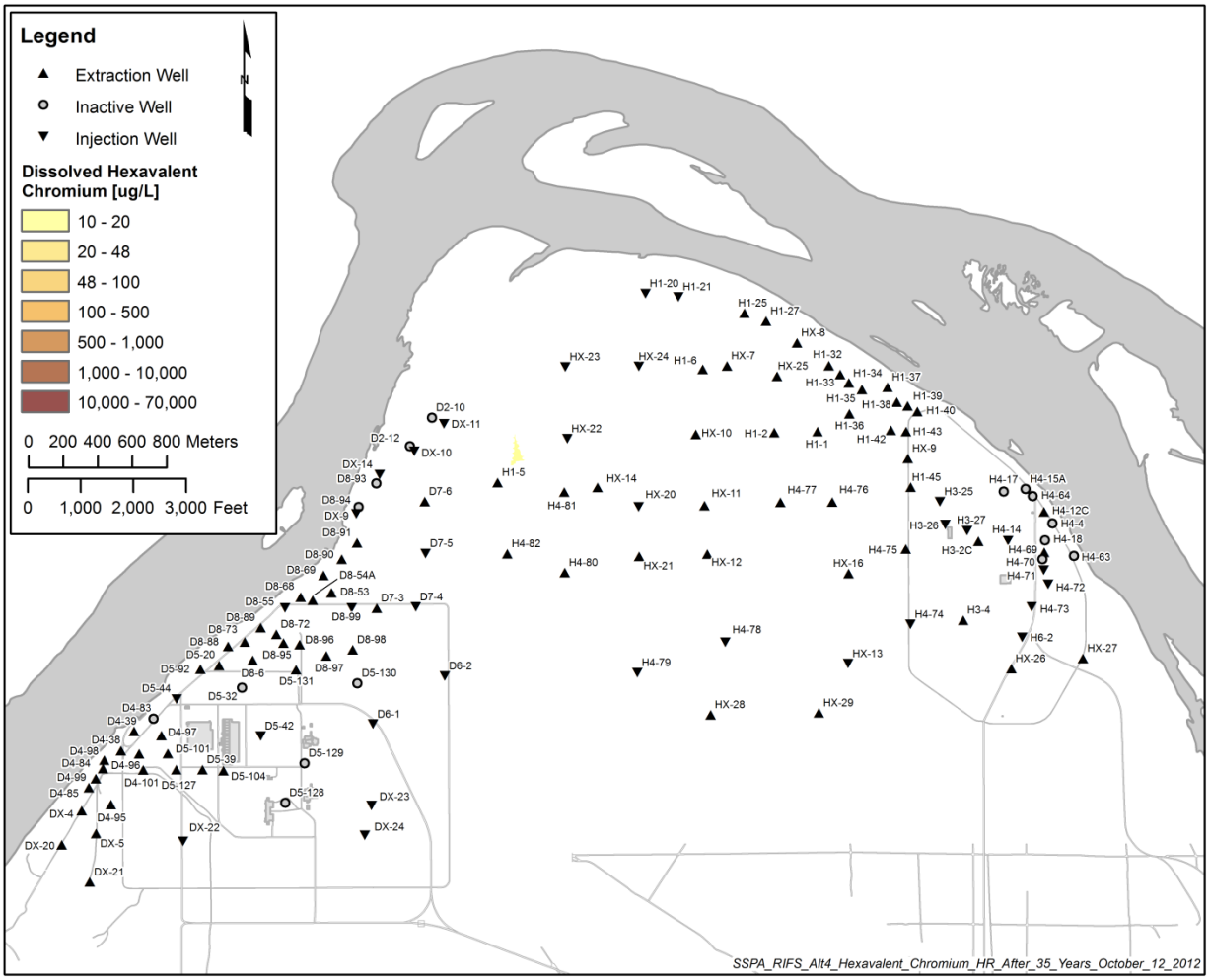

Figure 5-36. Simulated Distribution of Cr(VI) after 35 Years – Alternative 4.

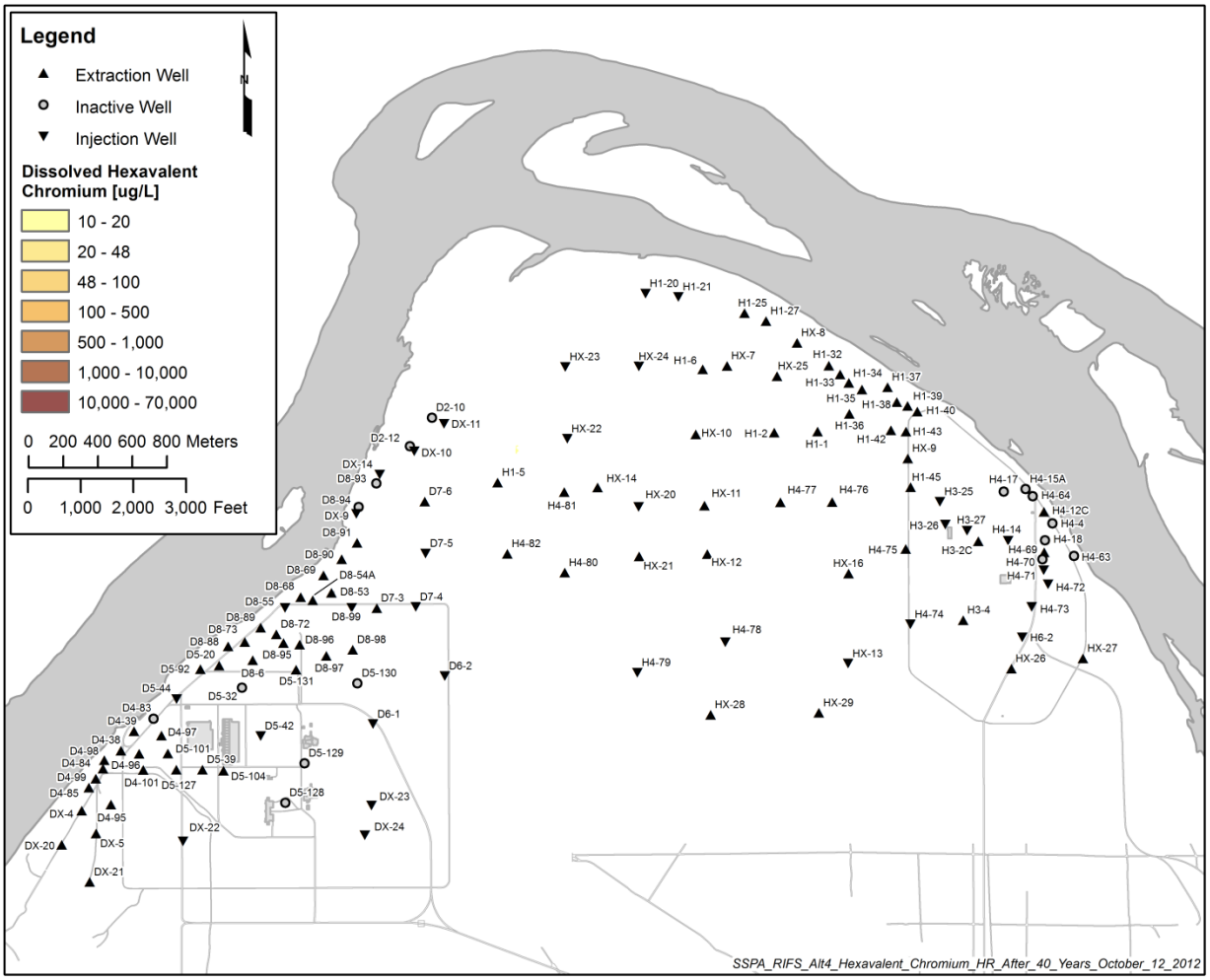

Figure 5-37. Simulated Distribution of Cr(VI) after 40 Years – Alternative 4.

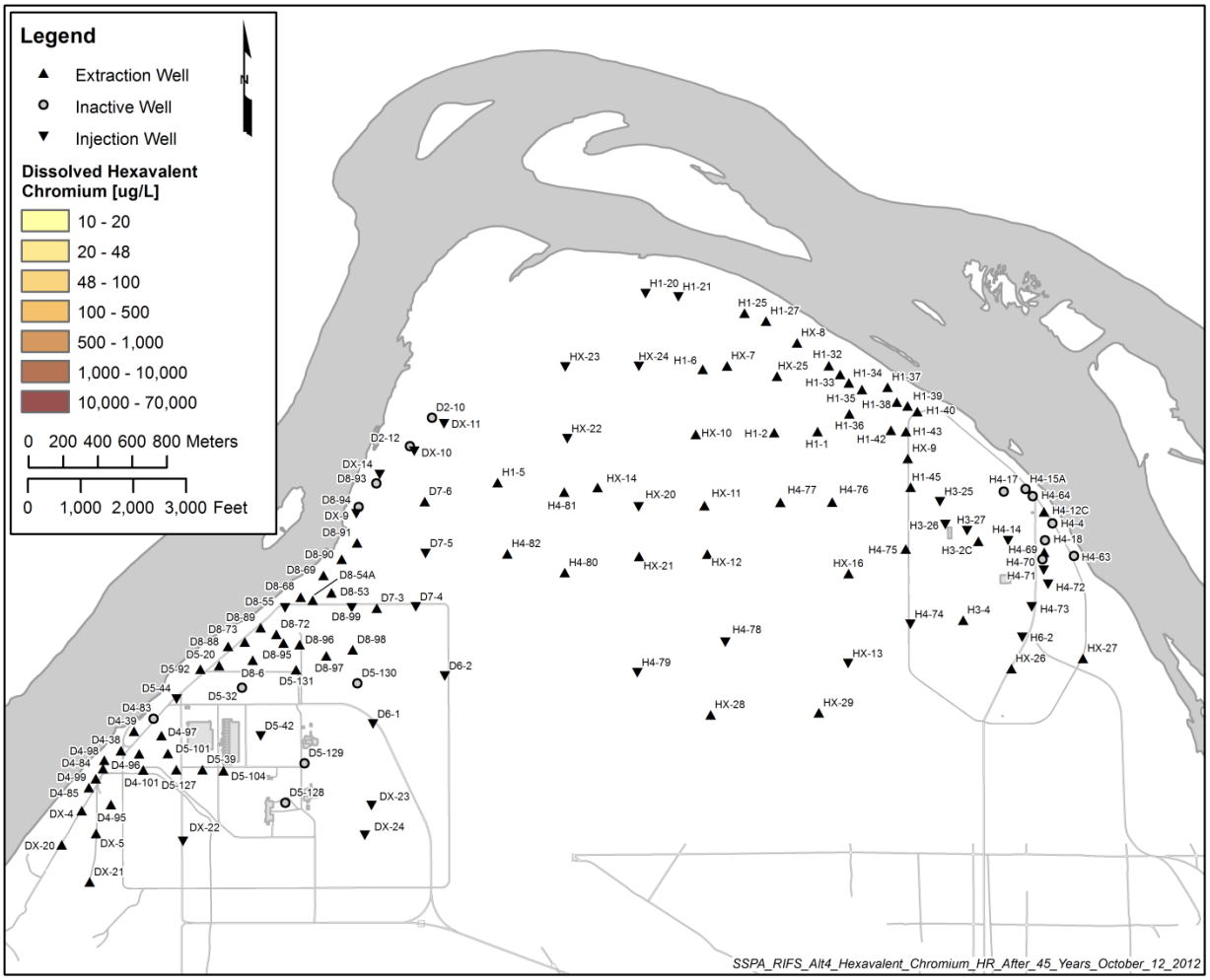

Figure 5-38. Simulated Distribution of Cr(VI) after 45 Years – Alternative 4.

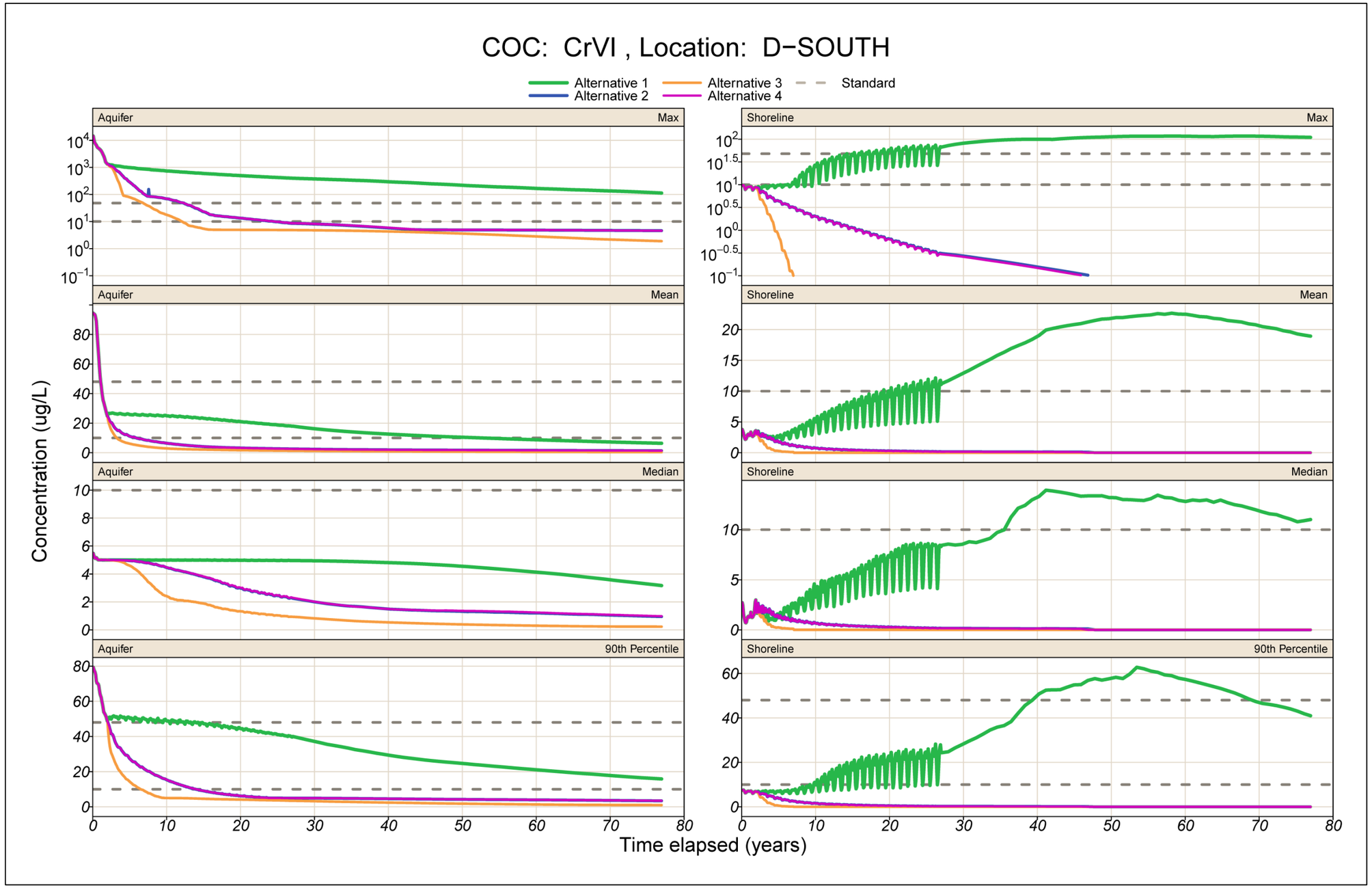

Figure 5-39. Cr(VI): Concentration Statistics – D-South (All Alternatives).

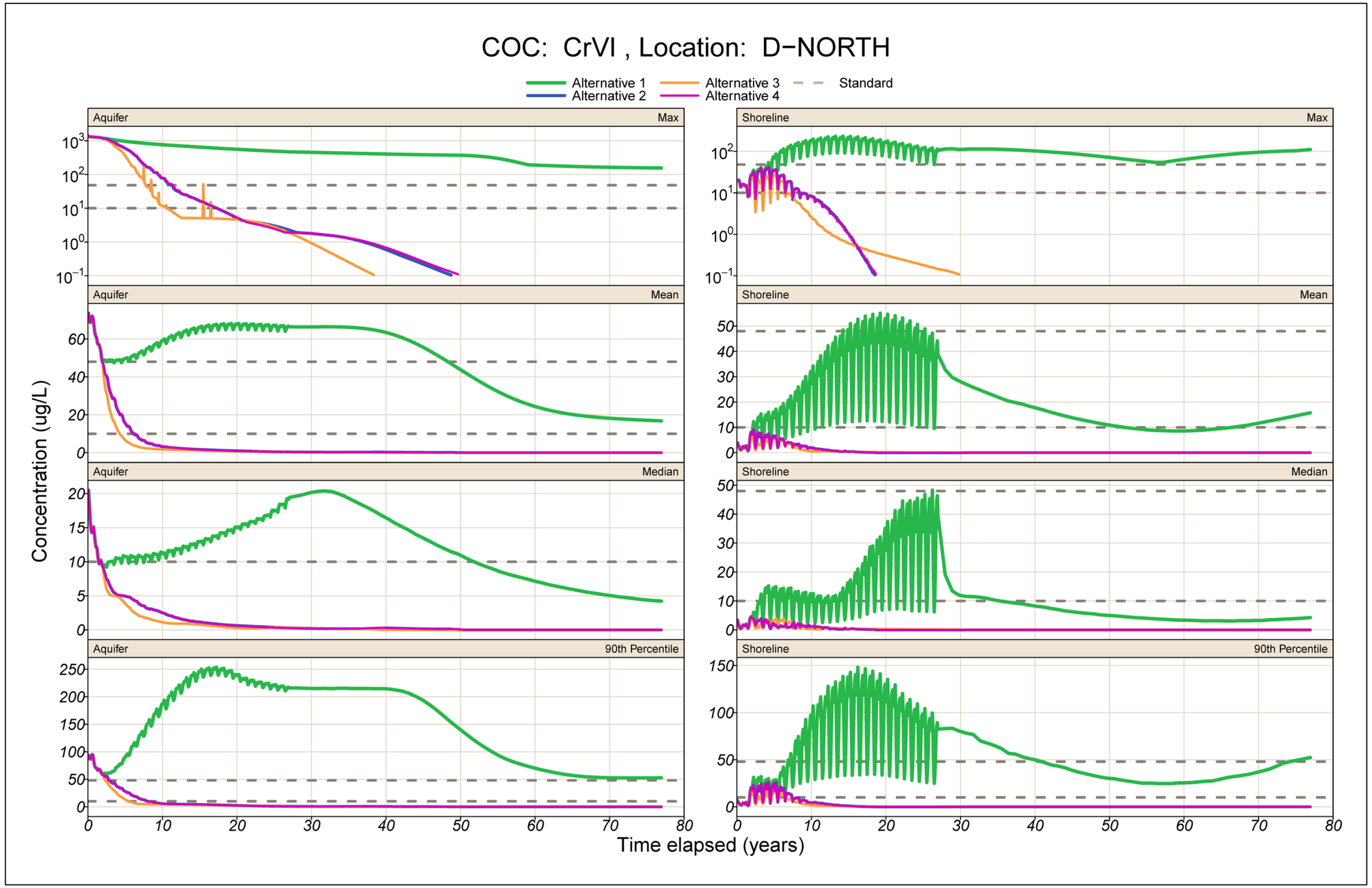

Figure 5-40. Cr(VI): Concentration Statistics – D-North (All Alternatives).

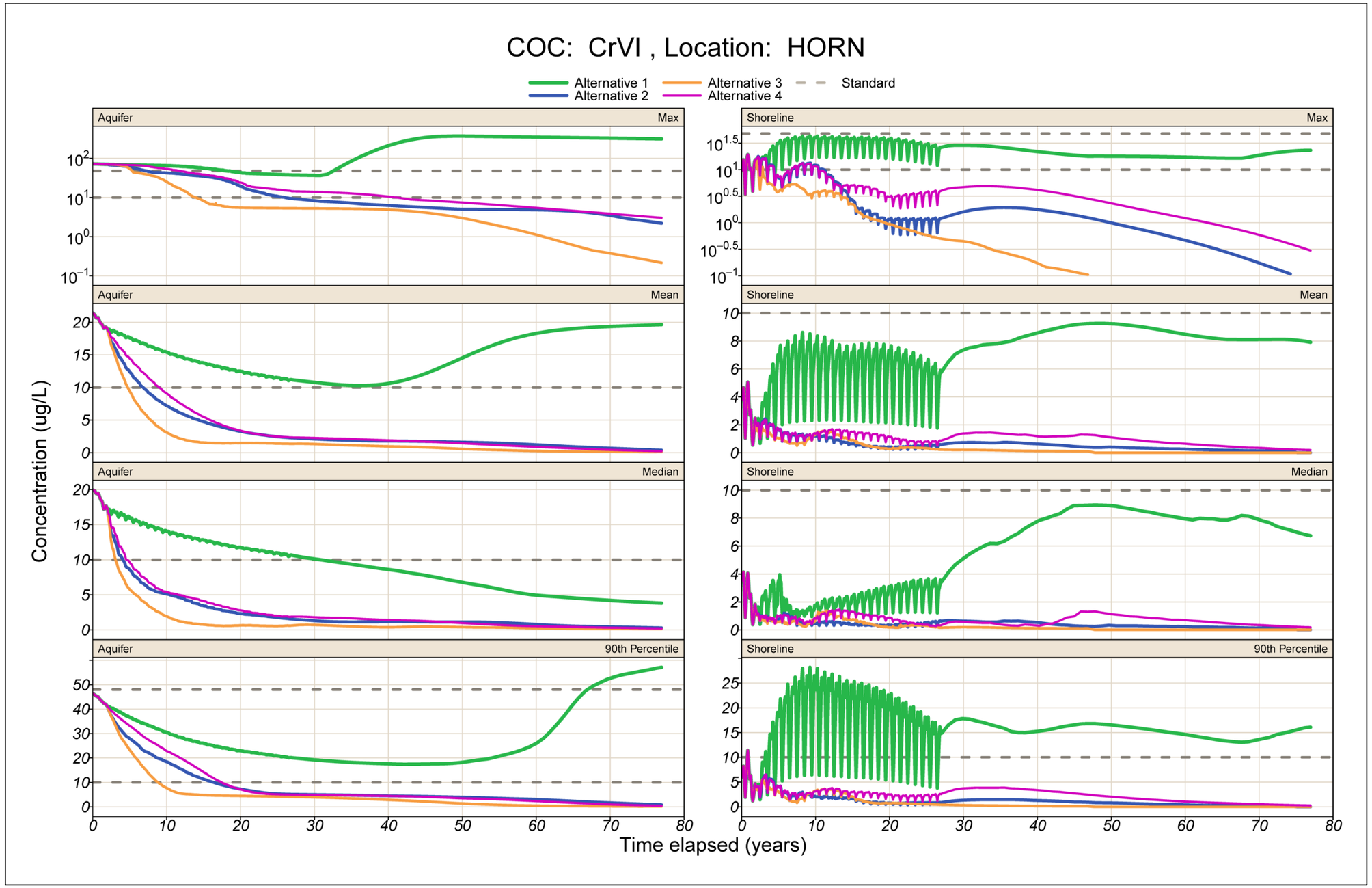

Figure 5-41. Cr(VI): Concentration Statistics – Horn (All Alternatives).

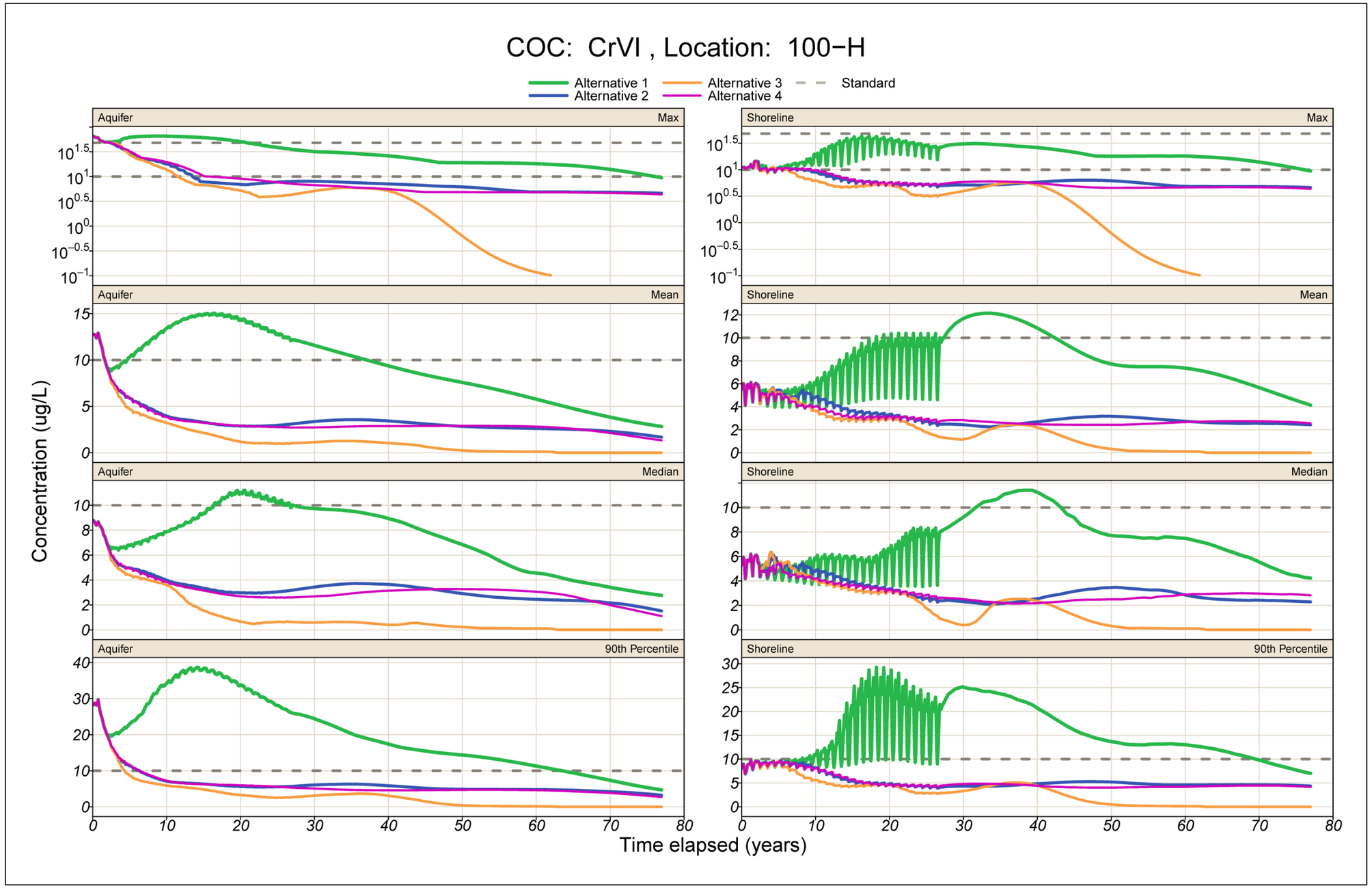

Figure 5-42. Cr(VI): Concentration Statistics – 100-H (All Alternatives).

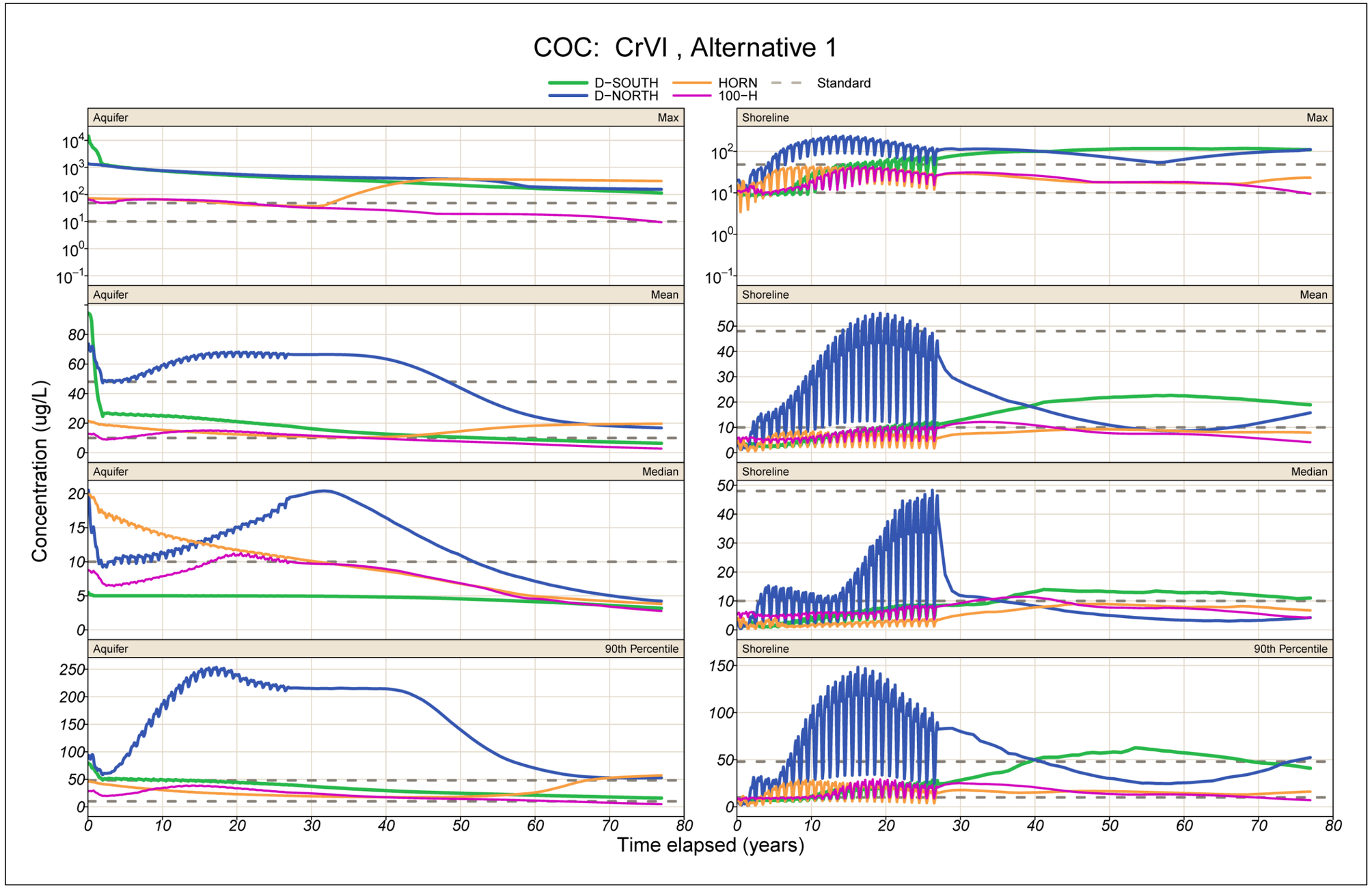

Figure 5-43. Cr(VI): Concentration Statistics – Alternative 1 (All Areas).

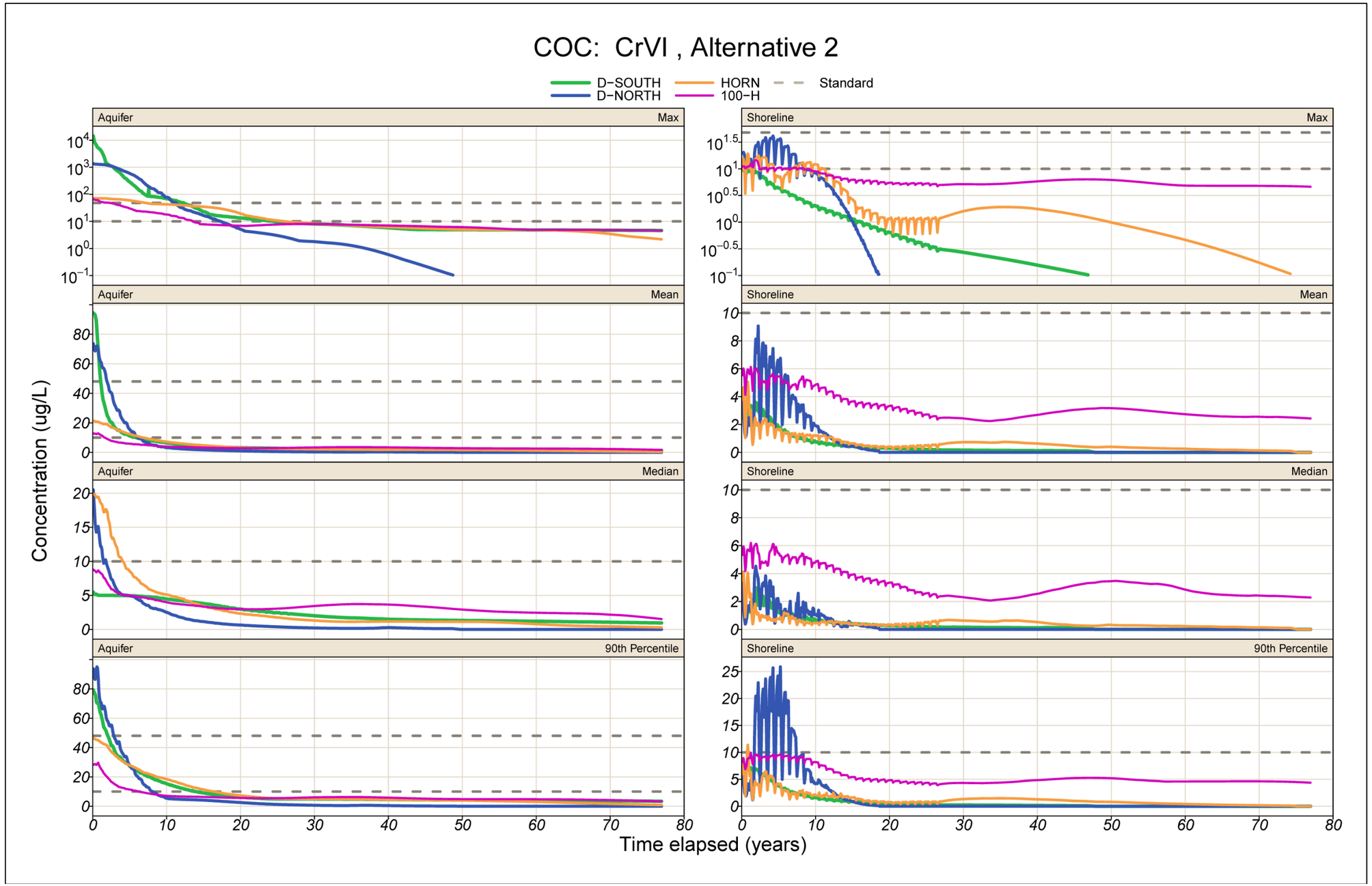

Figure 5-44. Cr(VI): Concentration Statistics – Alternative 2 (All Areas).

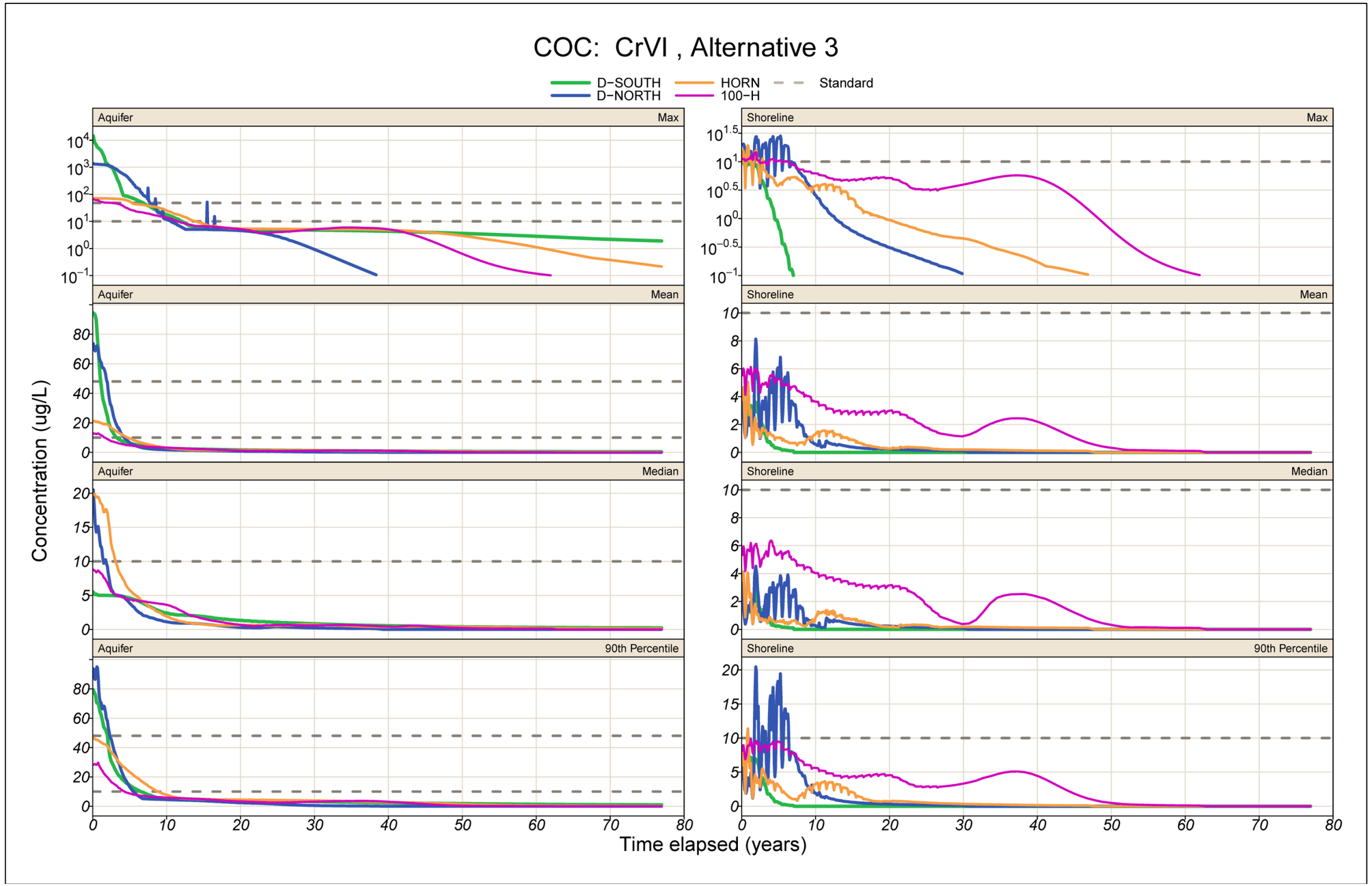

Figure 5-45. Cr(VI): Concentration Statistics – Alternative 3 (All Areas).

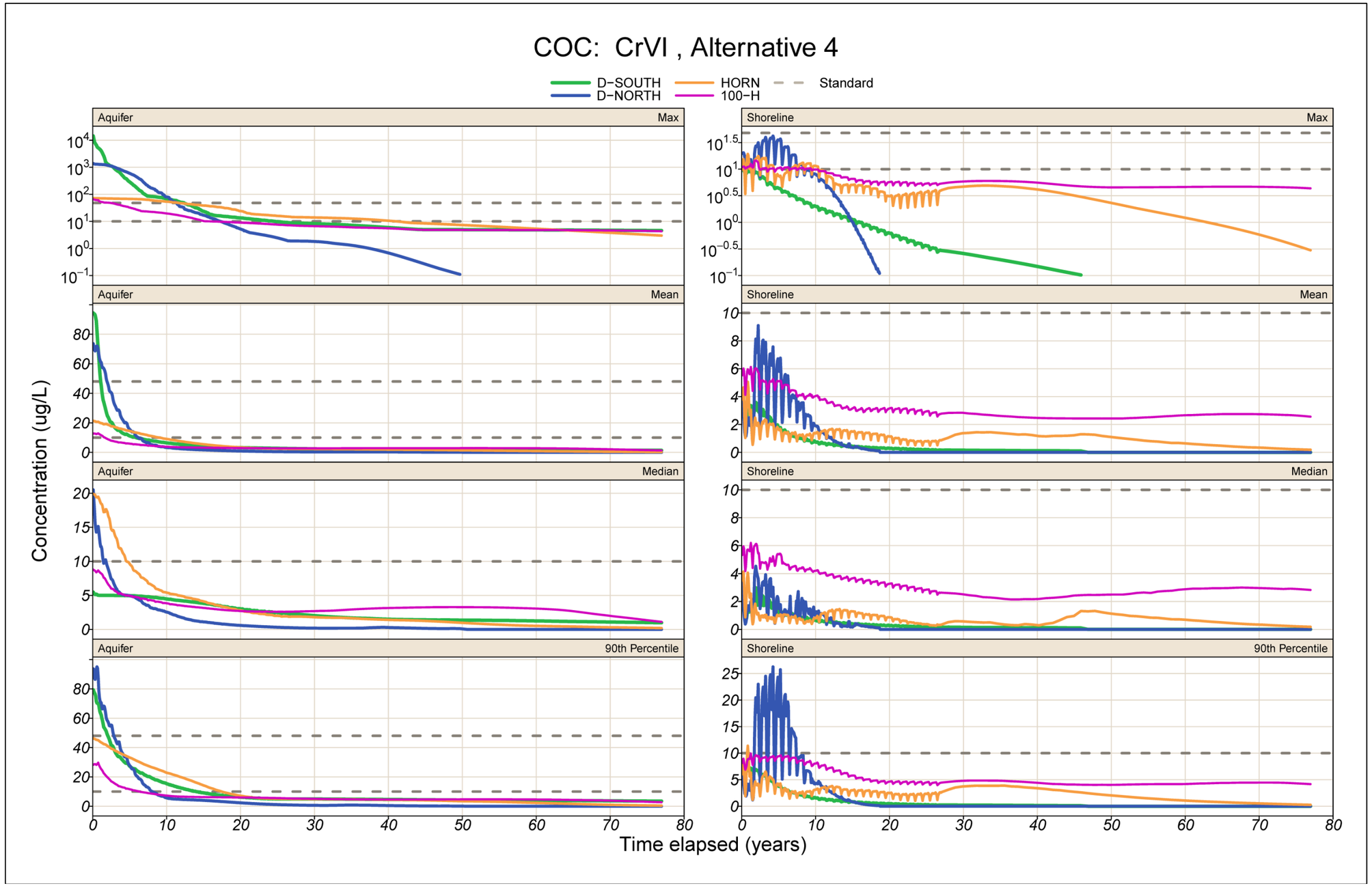

Figure 5-46. Cr(VI): Concentration Statistics – Alternative 4 (All Areas).

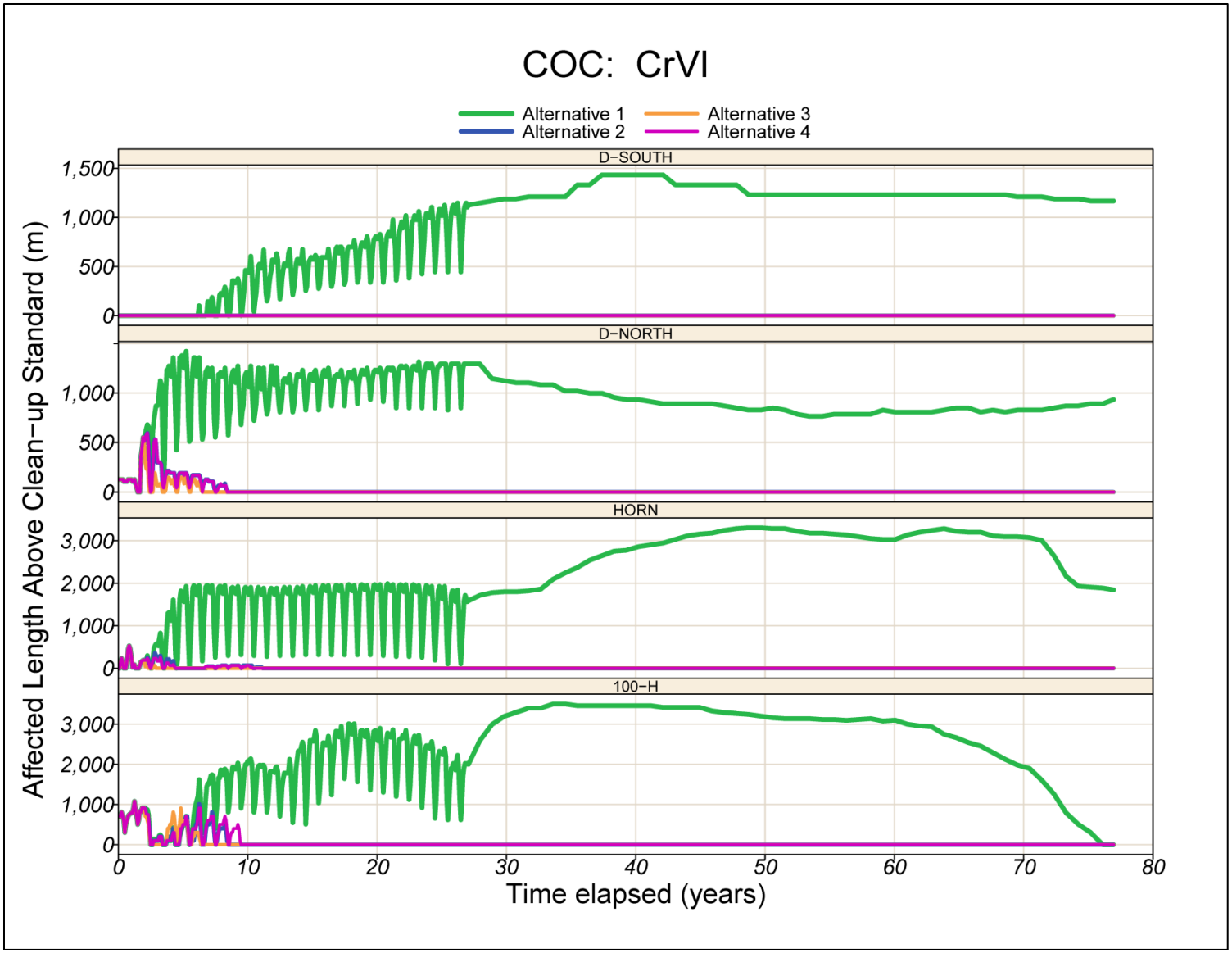

Figure 5-47. Cr(VI): Affected Shoreline Length Above Clean-Up Standard (All Areas-Alternatives).

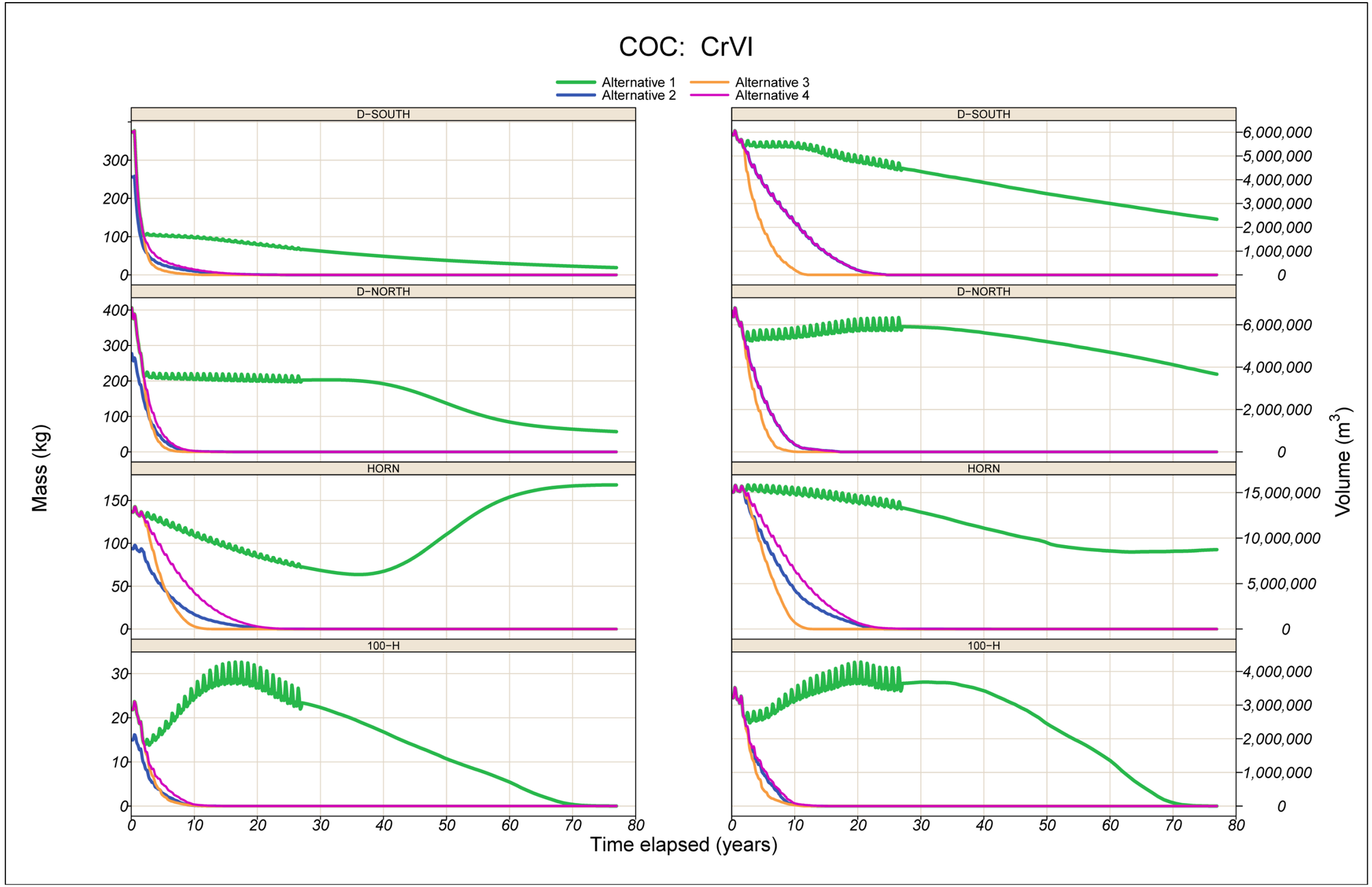

Figure 5-48. Cr(VI): Calculated Mass and Volume – (All Areas-Alternatives).

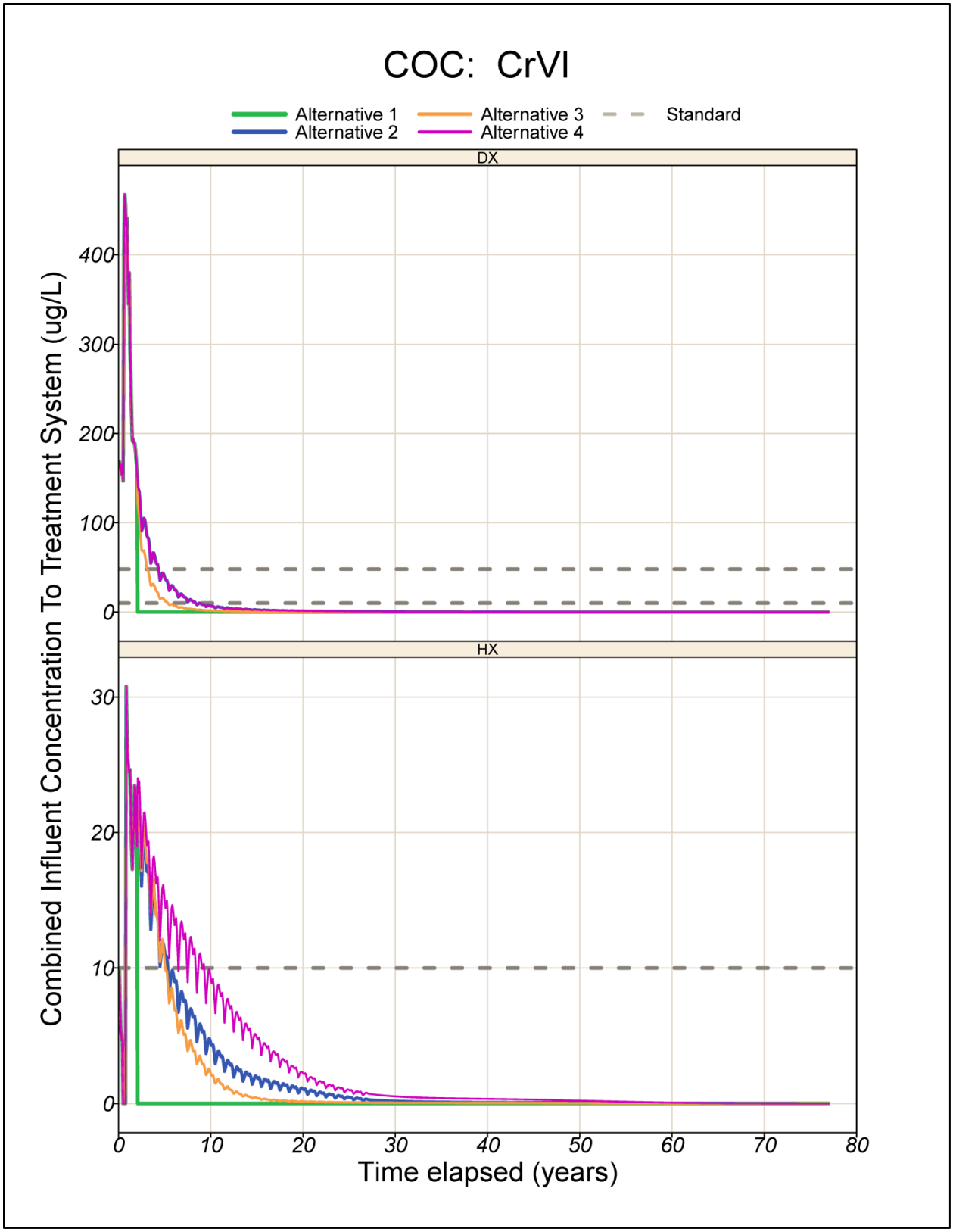

Figure 5-49. Cr(VI): Calculated Influent Concentration at P&T (All Areas-Alternatives)

Table 5-2: Cr(VI) Cleanup Times.

Alternative	Statistic	Cr(VI) Cleanup Time DWS (48 ug/L)	Cr(VI) Cleanup Time AQWS (10 ug/L)
Alternative 1 - D-South	Max	Exceedance[1]	Exceedance
	90th Percentile	15	Exceedance
	Mean	2	53
	Median	A.B.S.[2]	A.B.S.
Alternative 1 - D-North	Max	Exceedance	Exceedance
	90th Percentile	Exceedance	Exceedance
	Mean	48	Exceedance
	Median	A.B.S.	52
Alternative 1 - Horn	Max	Exceedance	Exceedance
	90th Percentile	Exceedance	Exceedance
	Mean	A.B.S.	Exceedance
	Median	A.B.S.	31
Alternative 1 - 100 H	Max	21	76
	90th Percentile	A.B.S.	63
	Mean	A.B.S.	37
	Median	A.B.S.	28
Alternative 2 - D-South	Max	13	25
	90th Percentile	3	14
	Mean	2	6
	Median	A.B.S.	A.B.S.
Alternative 2 - D-North	Max	12	18
	90th Percentile	3	9
	Mean	2	7
	Median	A.B.S.	2
Alternative 2 - Horn	Max	8	27
	90th Percentile	A.B.S.	17
	Mean	A.B.S.	7
	Median	A.B.S.	5
Alternative 2 - 100 H	Max	3	14

Table 5-2: Cr(VI) Cleanup Times.

Alternative	Statistic	Cr(VI) Cleanup Time DWS (48 ug/L)	Cr(VI) Cleanup Time AQWS (10 ug/L)
	90th Percentile	A.B.S.	7
	Mean	A.B.S.	2
	Median	A.B.S.	A.B.S.
Alternative 3 - D-South	Max	7	13
	90th Percentile	3	7
	Mean	2	4
	Median	A.B.S.	A.B.S.
Alternative 3 - D-North	Max	8	11
	90th Percentile	3	6
	Mean	2	5
	Median	A.B.S.	2
Alternative 3 - Horn	Max	6	14
	90th Percentile	A.B.S.	9
	Mean	A.B.S.	5
	Median	A.B.S.	4
Alternative 3 - 100 H	Max	3	12
	90th Percentile	A.B.S.	5
	Mean	A.B.S.	2
	Median	A.B.S.	A.B.S.
Alternative 4 - D-South	Max	13	25
	90th Percentile	3	14
	Mean	2	6
	Median	A.B.S.	A.B.S.
Alternative 4 - D-North	Max	12	18
	90th Percentile	3	9
	Mean	2	7
	Median	A.B.S.	2
Alternative 4 - Horn	Max	12	41
	90th Percentile	A.B.S.	18

Table 5-2: Cr(VI) Cleanup Times.

Alternative	Statistic	Cr(VI) Cleanup Time DWS (48 ug/L)	Cr(VI) Cleanup Time AQWS (10 ug/L)
	Mean	A.B.S.	10
	Median	A.B.S.	5
Alternative 4 - 100 H	Max	3	16
	90th Percentile	A.B.S.	7
	Mean	A.B.S.	2
	Median	A.B.S.	A.B.S.

[1] The calculated concentration is always higher than the corresponding standard.

[2] The calculated concentration is always lower than the corresponding standard.

5.2.2 Simulated Contaminant Distributions – Concentration Statistics: Strontium-90

The model results for Strontium-90 are grouped in the following sets of figures:

1. Figures 5-50 to 5-90: simulated distributions for each alternative.
2. Figures 5-91 to 5-94: summary concentration statistics for each area (all alternatives).
3. Figures 5-95 to 5-98: summary concentration statistics for each alternative (all areas).
4. Figure 5-99: Affected shoreline length above clean-up standard (all areas and alternatives).
5. Figure 5-100: Calculated plume mass and volume (all areas and alternatives).
6. Figure 5-101: Calculated influent concentration at each P&T (all areas and alternatives).

Estimated cleanup times based on the calculated concentration statistics are summarized in Table 5-3.

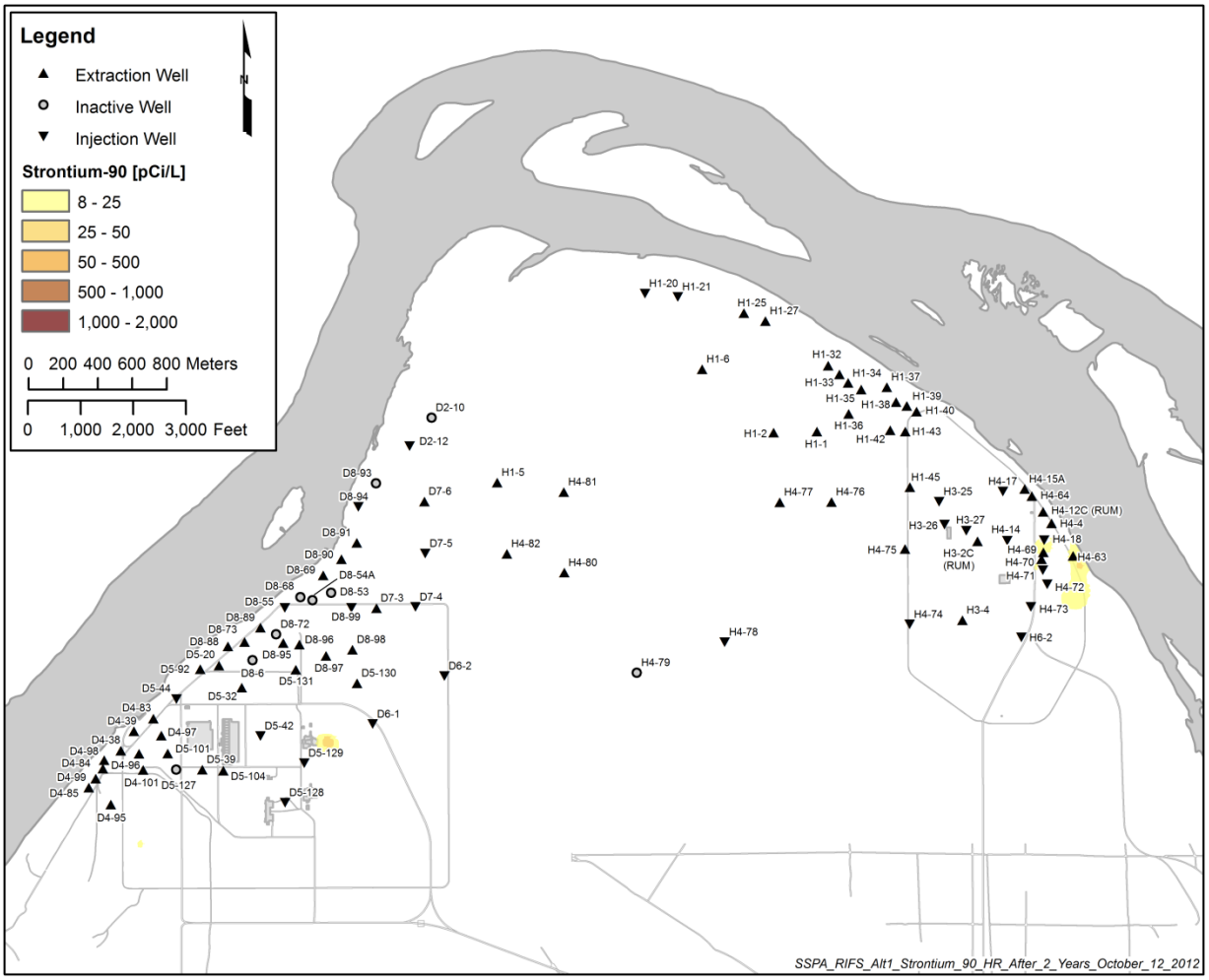

Figure 5-50. Simulated Distribution of Strontium-90 after 2 Years – Alternative 1.

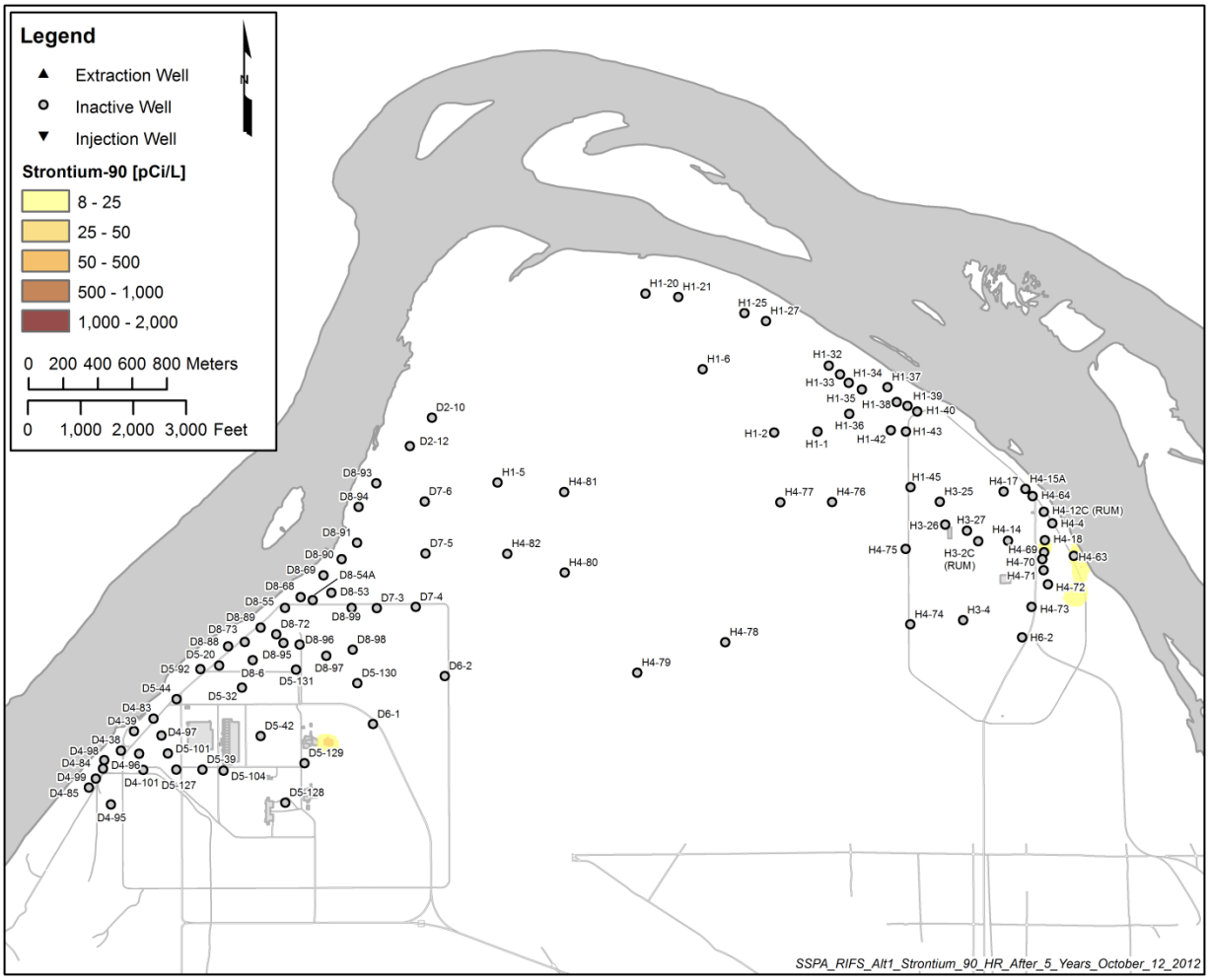

Figure 5-51. Simulated Distribution of Strontium-90 after 5 Years – Alternative 1.

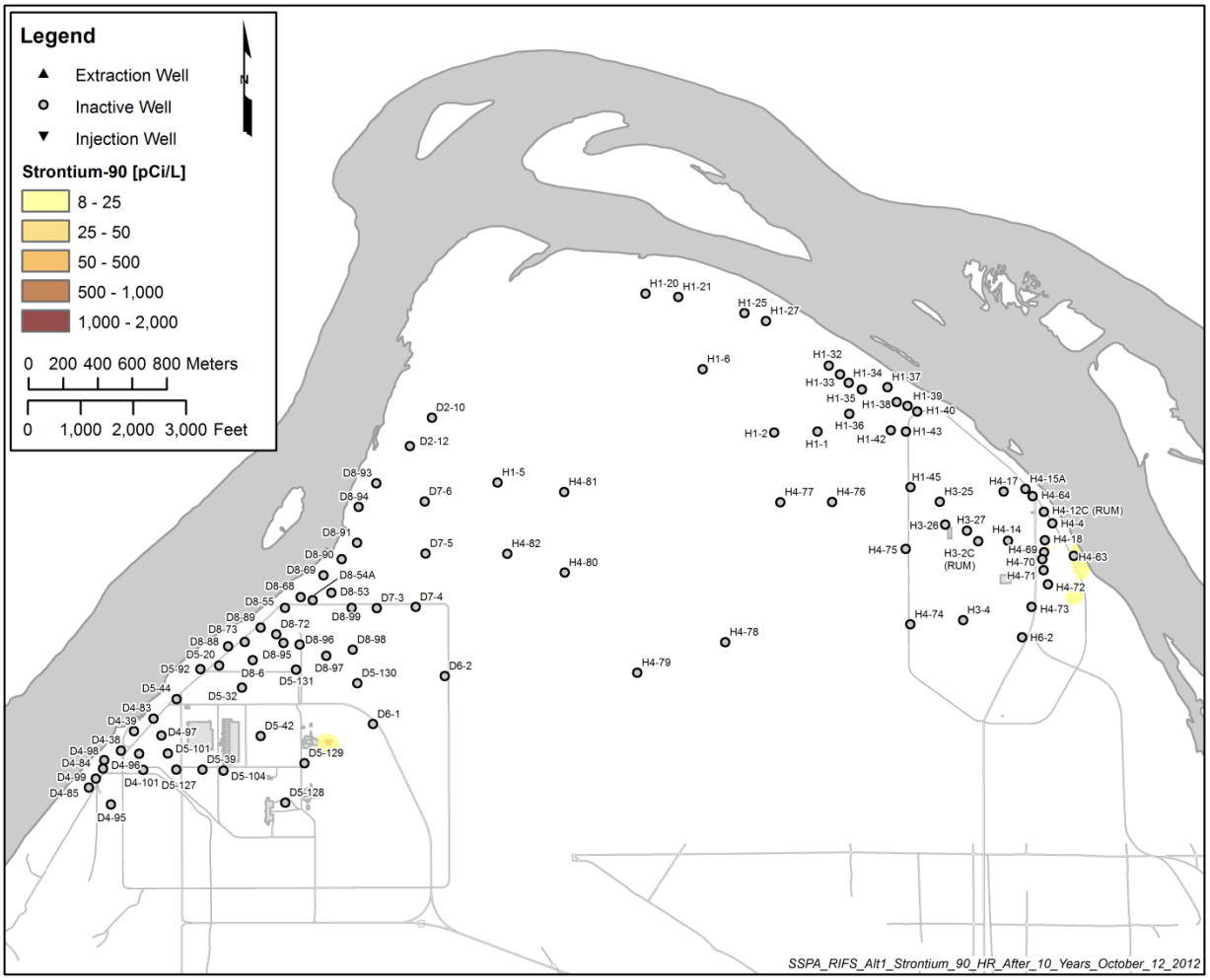

Figure 5-52. Simulated Distribution of Strontium-90 after 10 Years – Alternative 1.

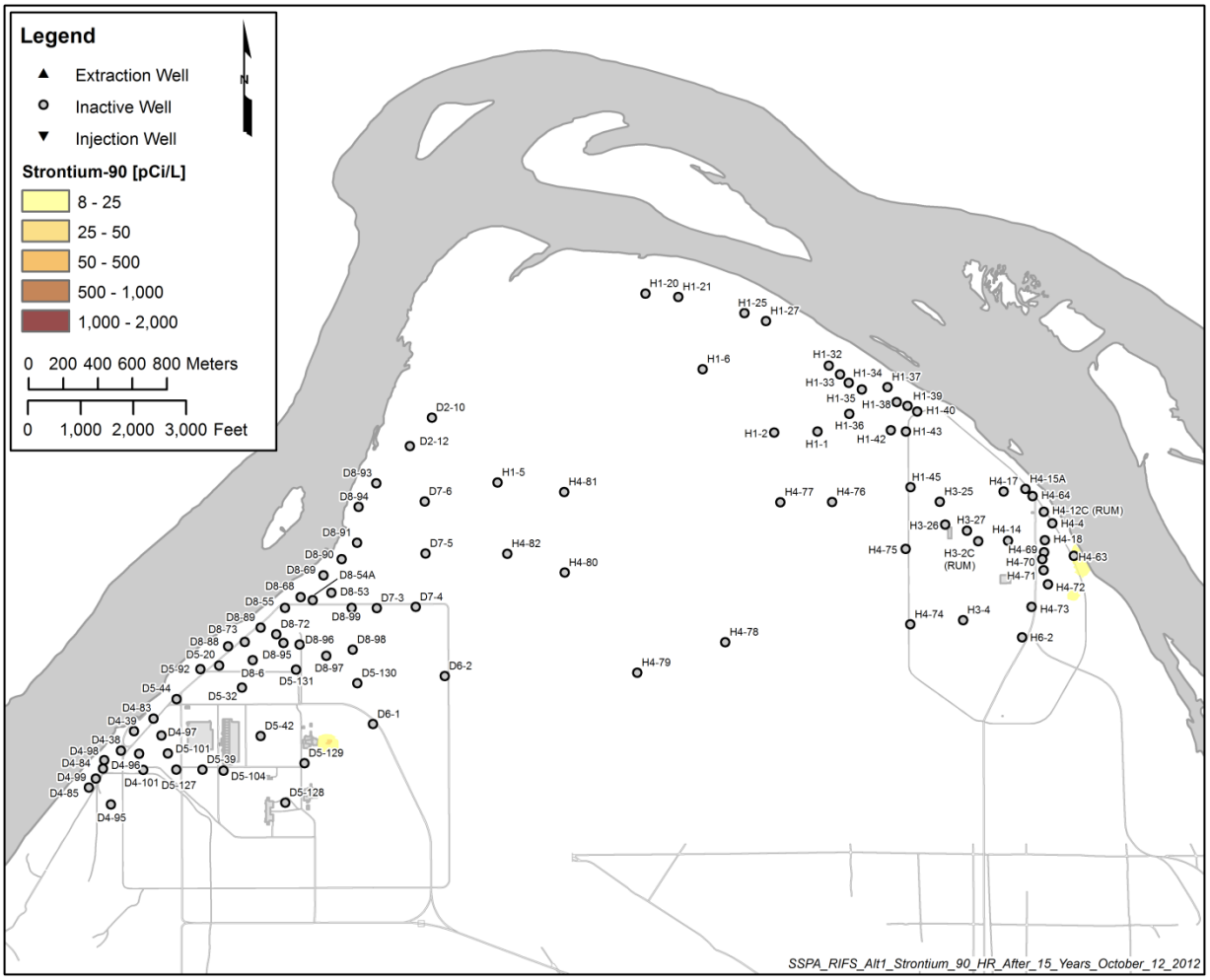

Figure 5-53. Simulated Distribution of Strontium-90 after 15 Years – Alternative 1.

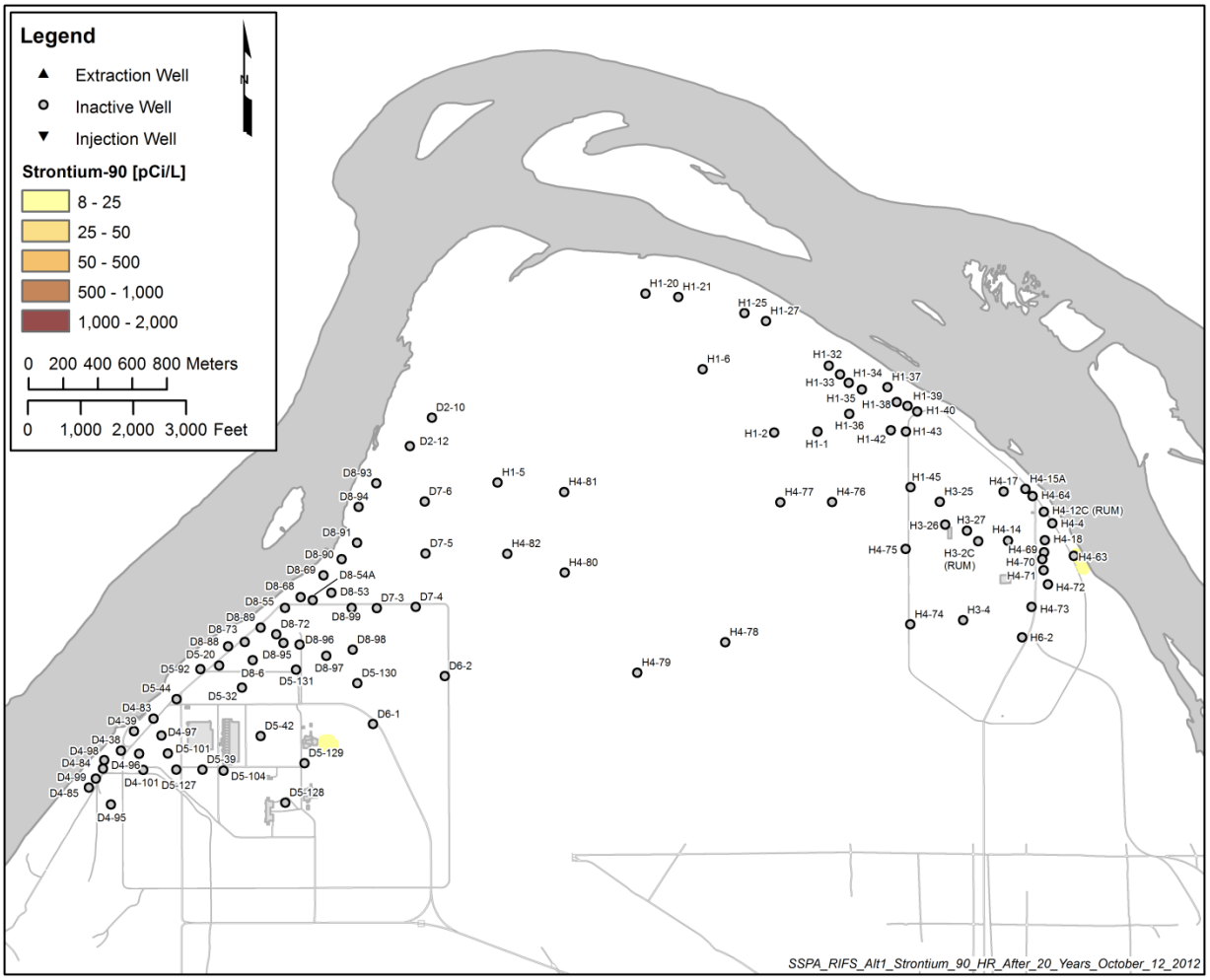

Figure 5-54. Simulated Distribution of Strontium-90 after 20 Years – Alternative 1.

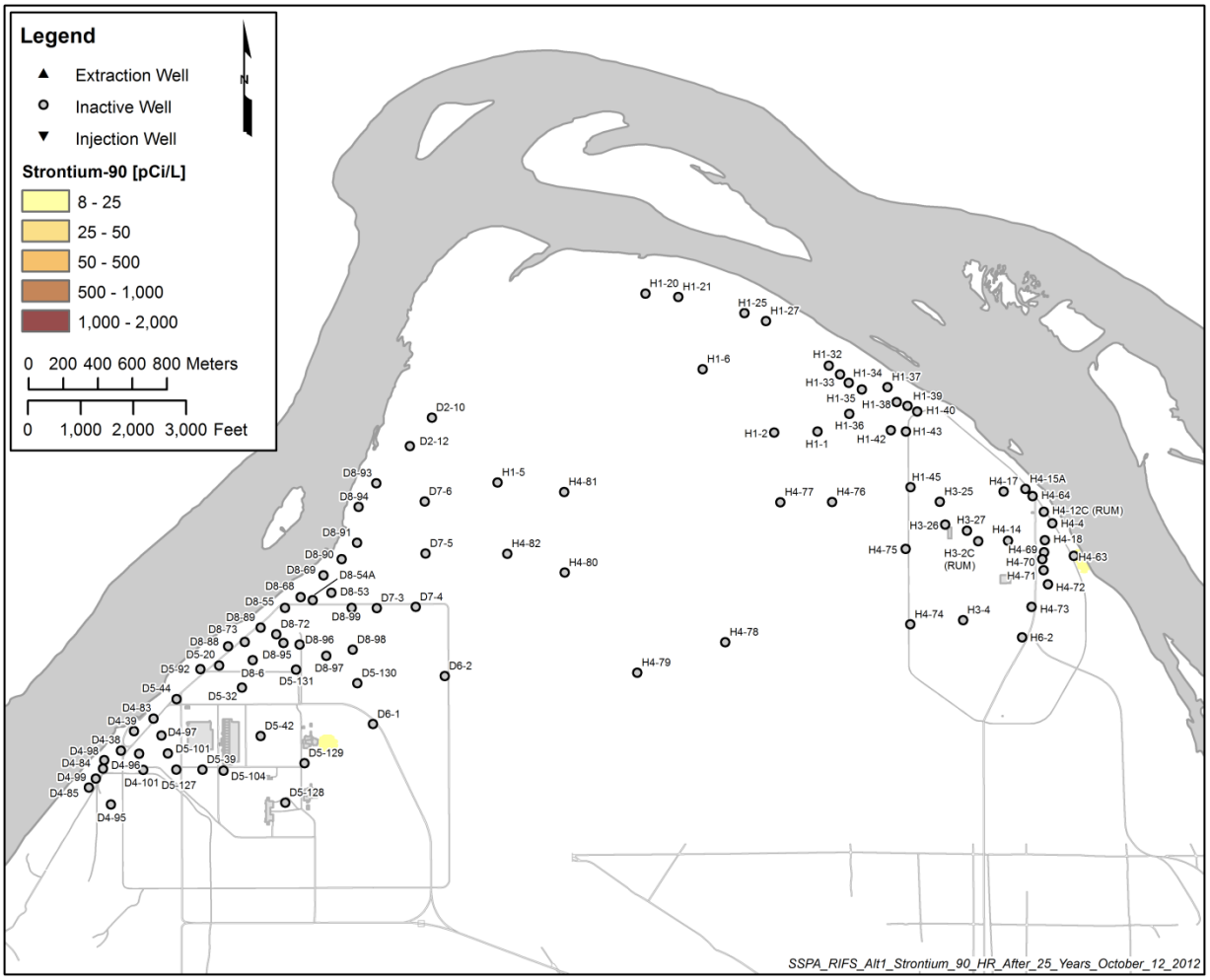

Figure 5-55. Simulated Distribution of Strontium-90 after 25 Years – Alternative 1.

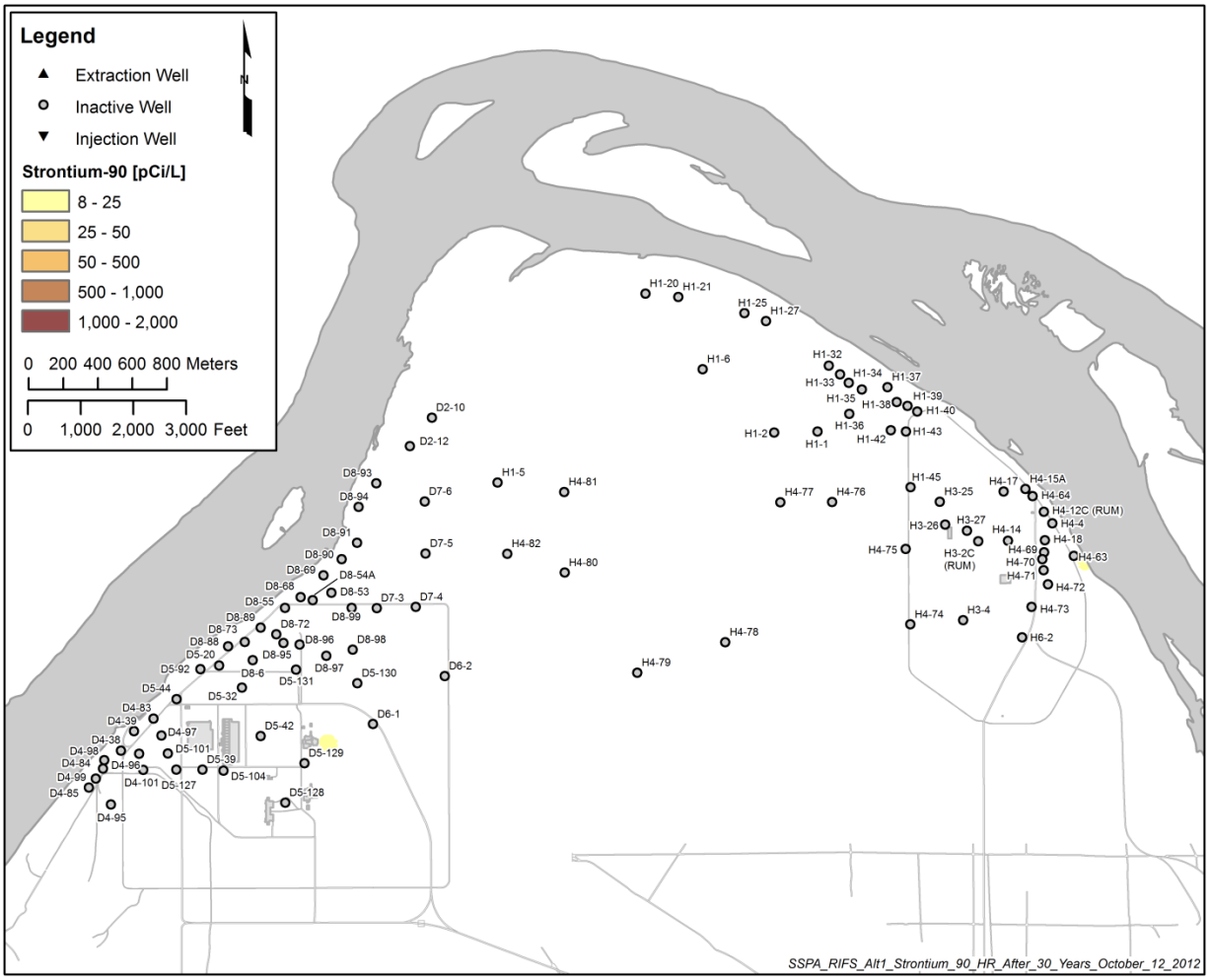

Figure 5-56. Simulated Distribution of Strontium-90 after 30 Years – Alternative 1.

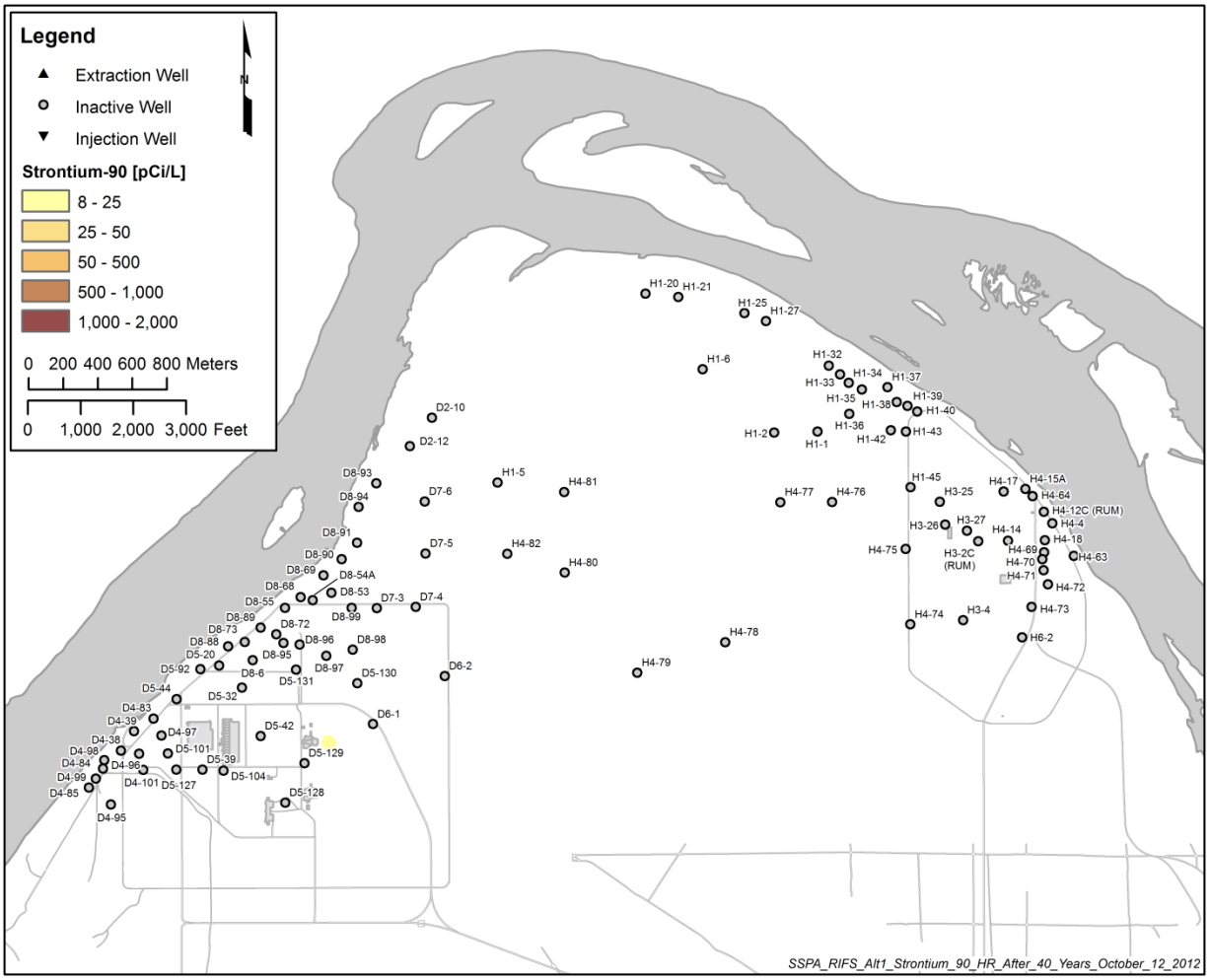

Figure 5-57. Simulated Distribution of Strontium-90 after 40 Years – Alternative 1.

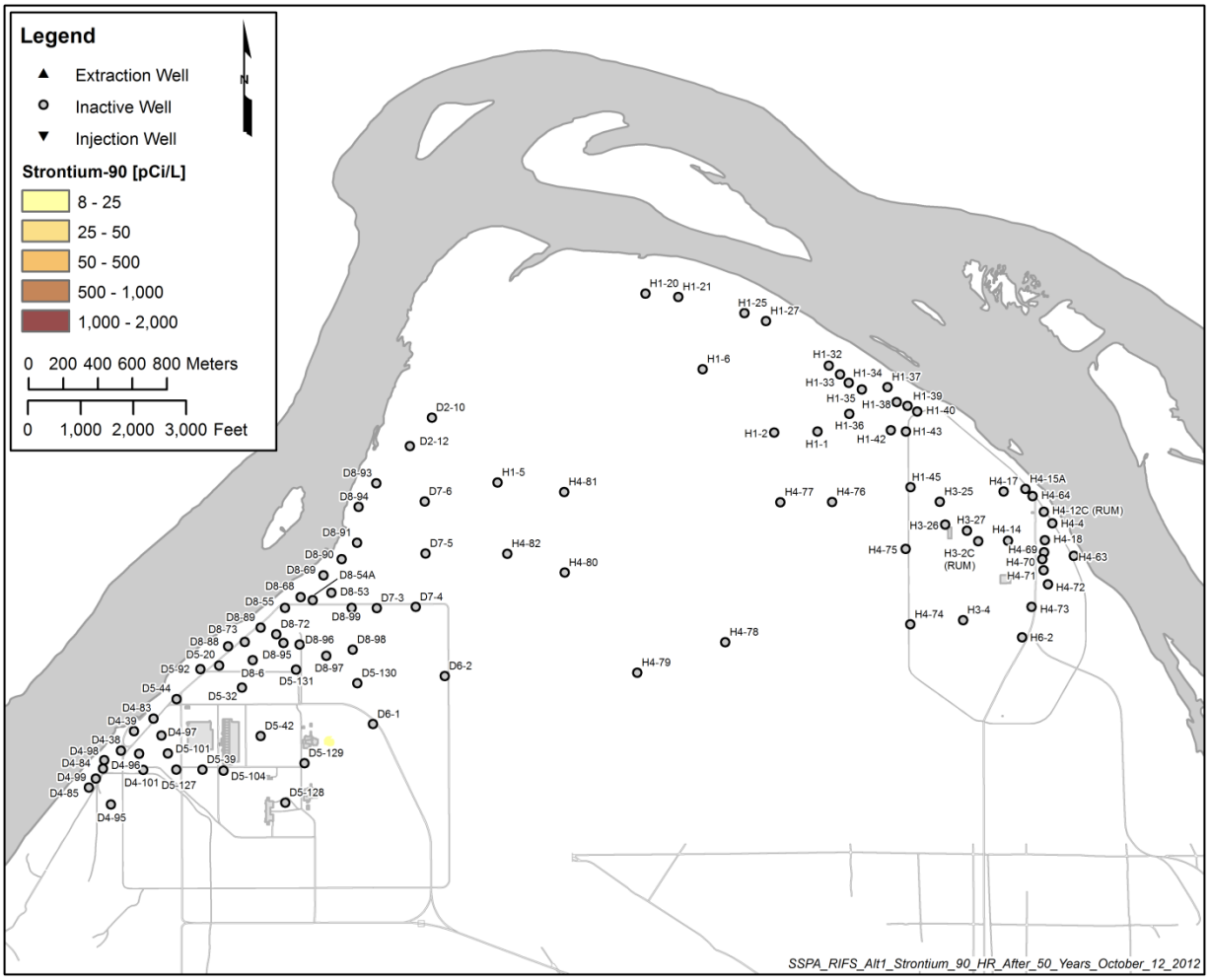

Figure 5-58. Simulated Distribution of Strontium-90 after 50 Years – Alternative 1.

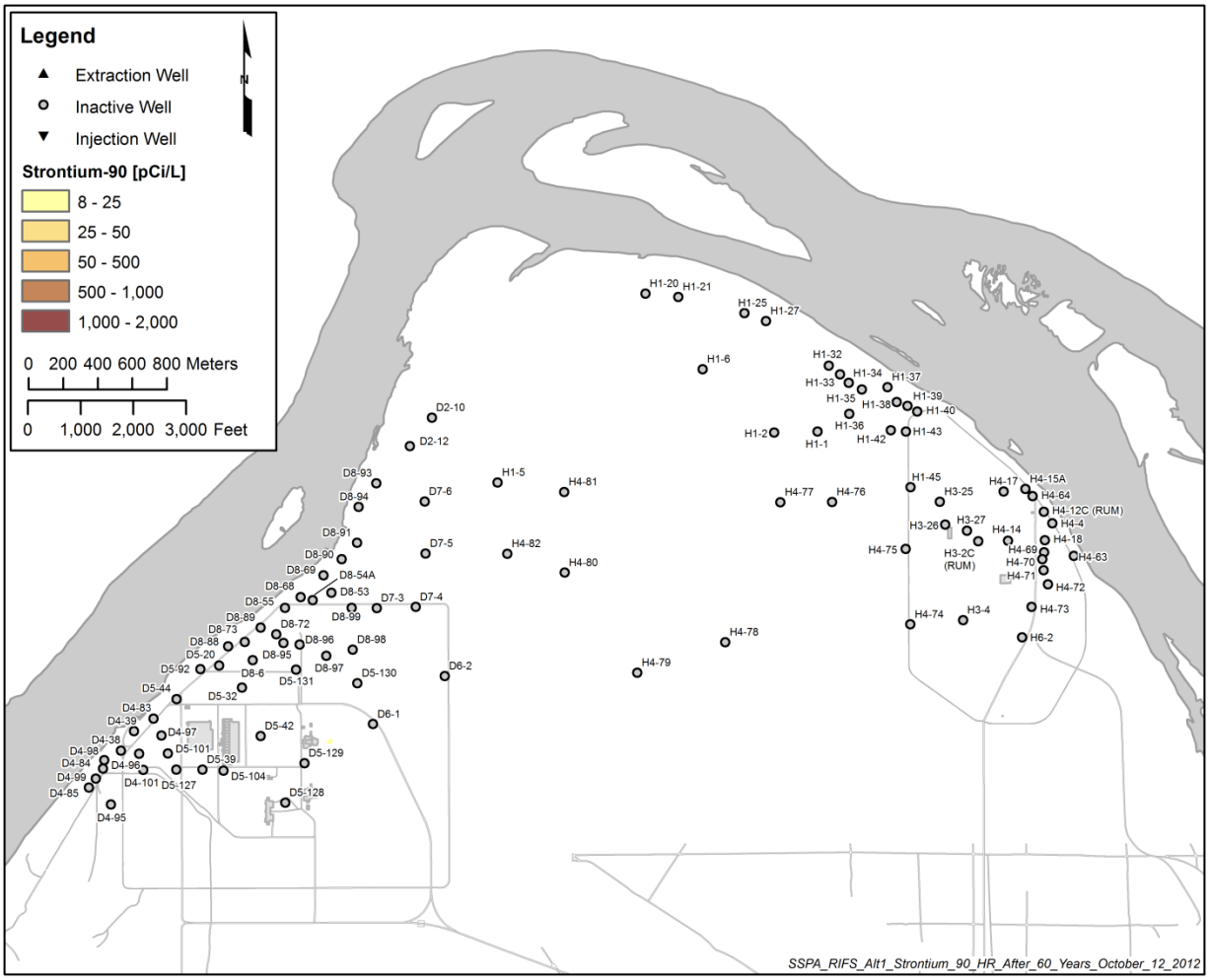

Figure 5-59. Simulated Distribution of Strontium-90 after 60 Years – Alternative 1.

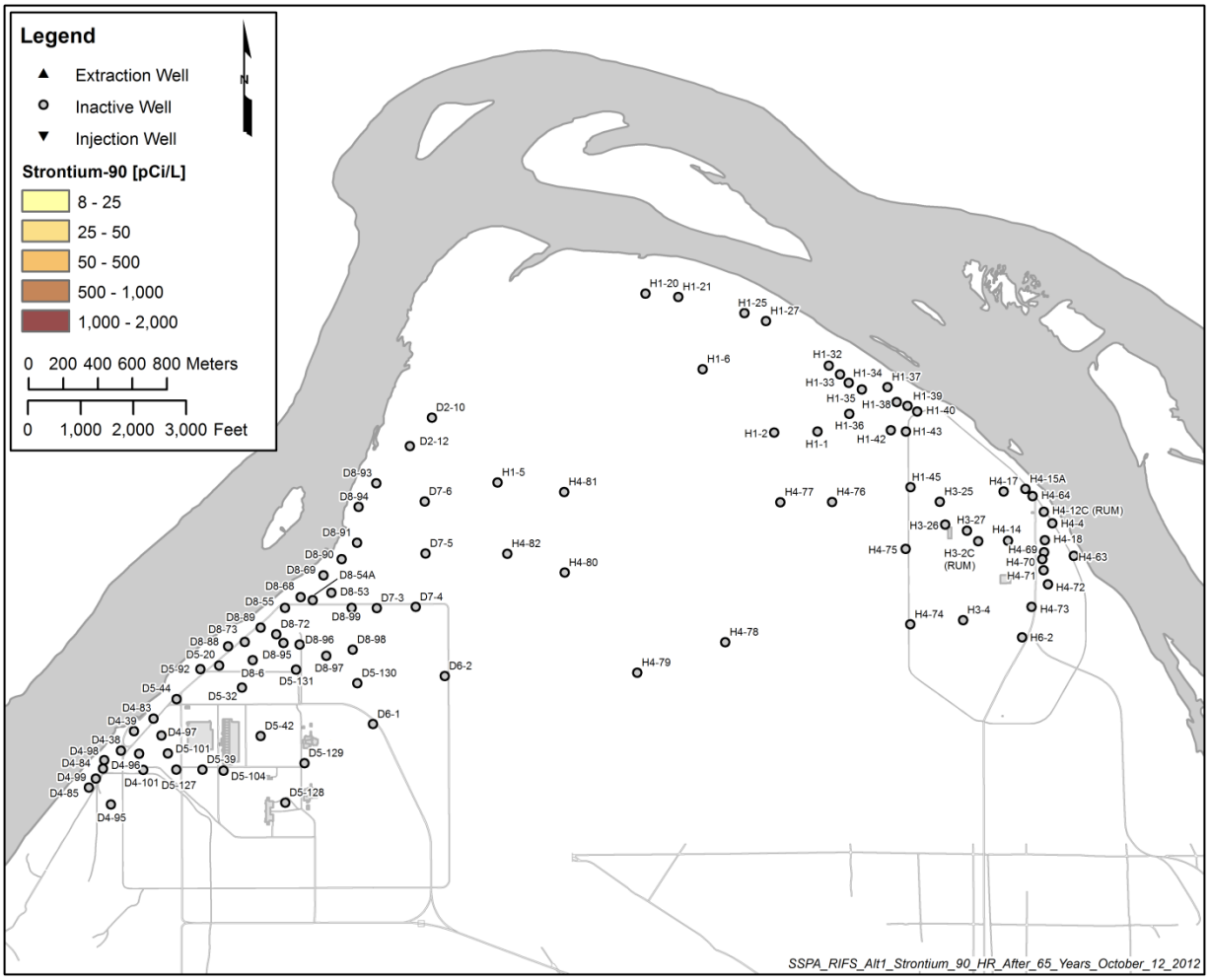

Figure 5-60. Simulated Distribution of Strontium-90 after 65 Years – Alternative 1.

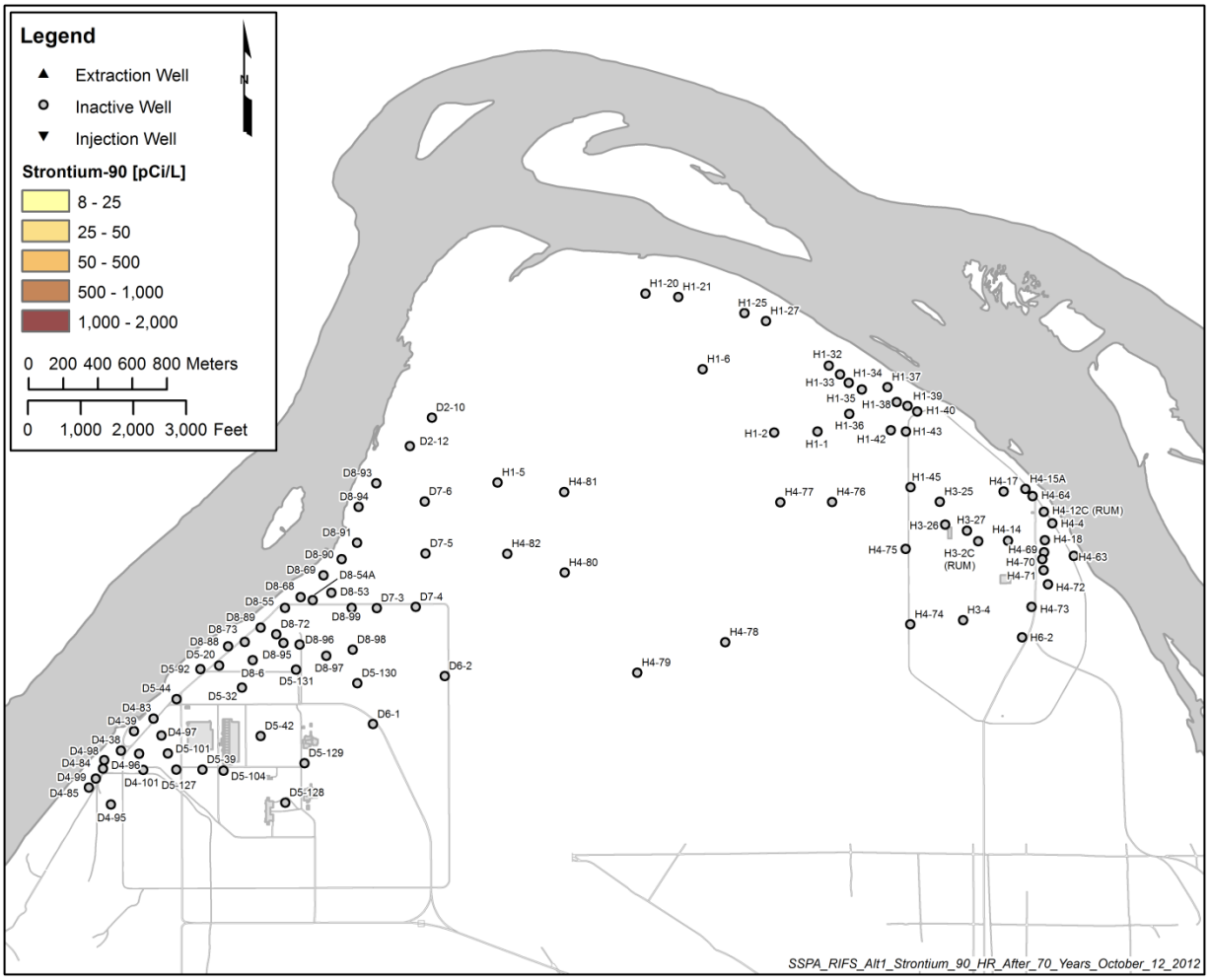

Figure 5-61. Simulated Distribution of Strontium-90 after 70 Years – Alternative 1.

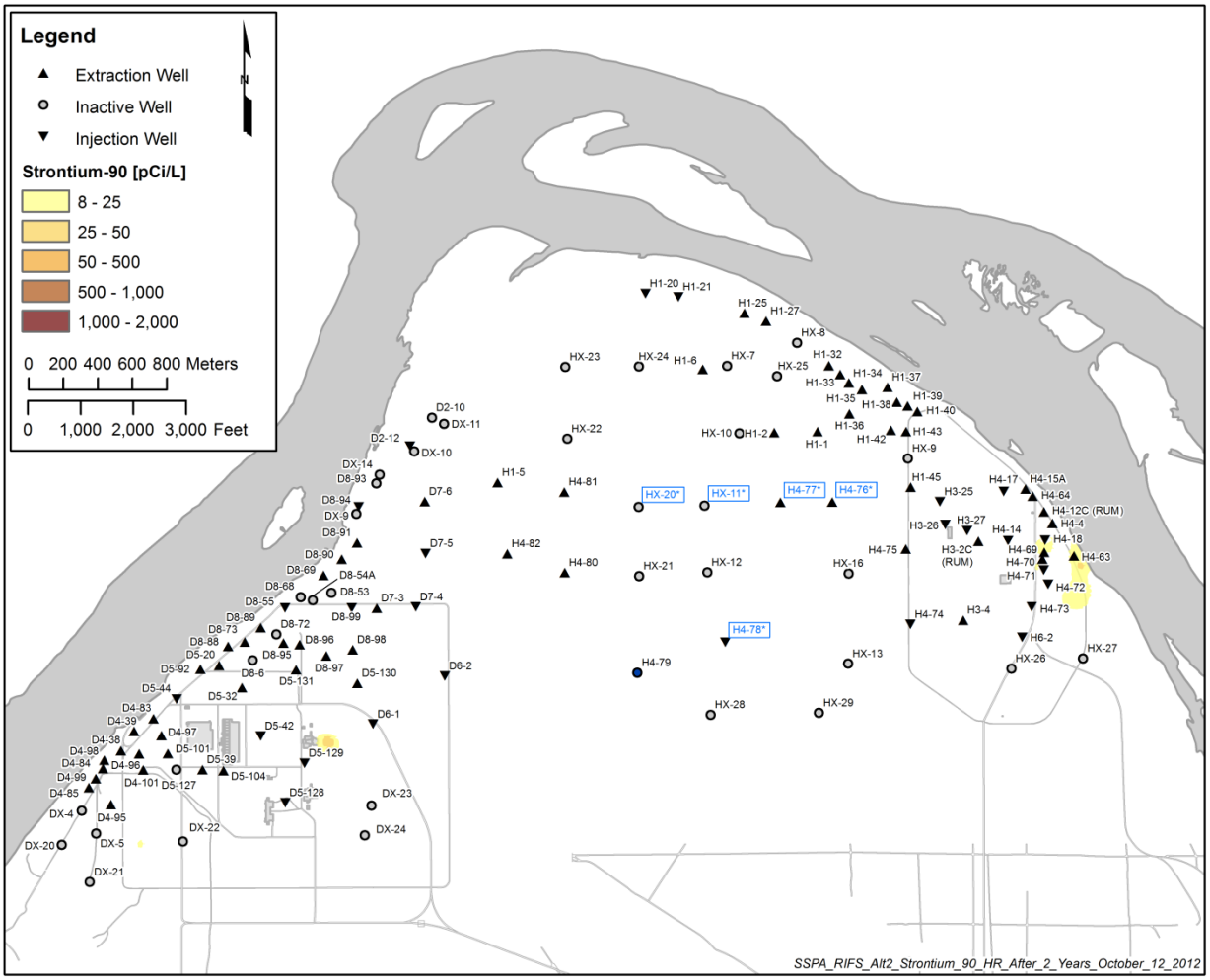

Figure 5-62. Simulated Distribution of Strontium-90 after 2 Years – Alternative 2.

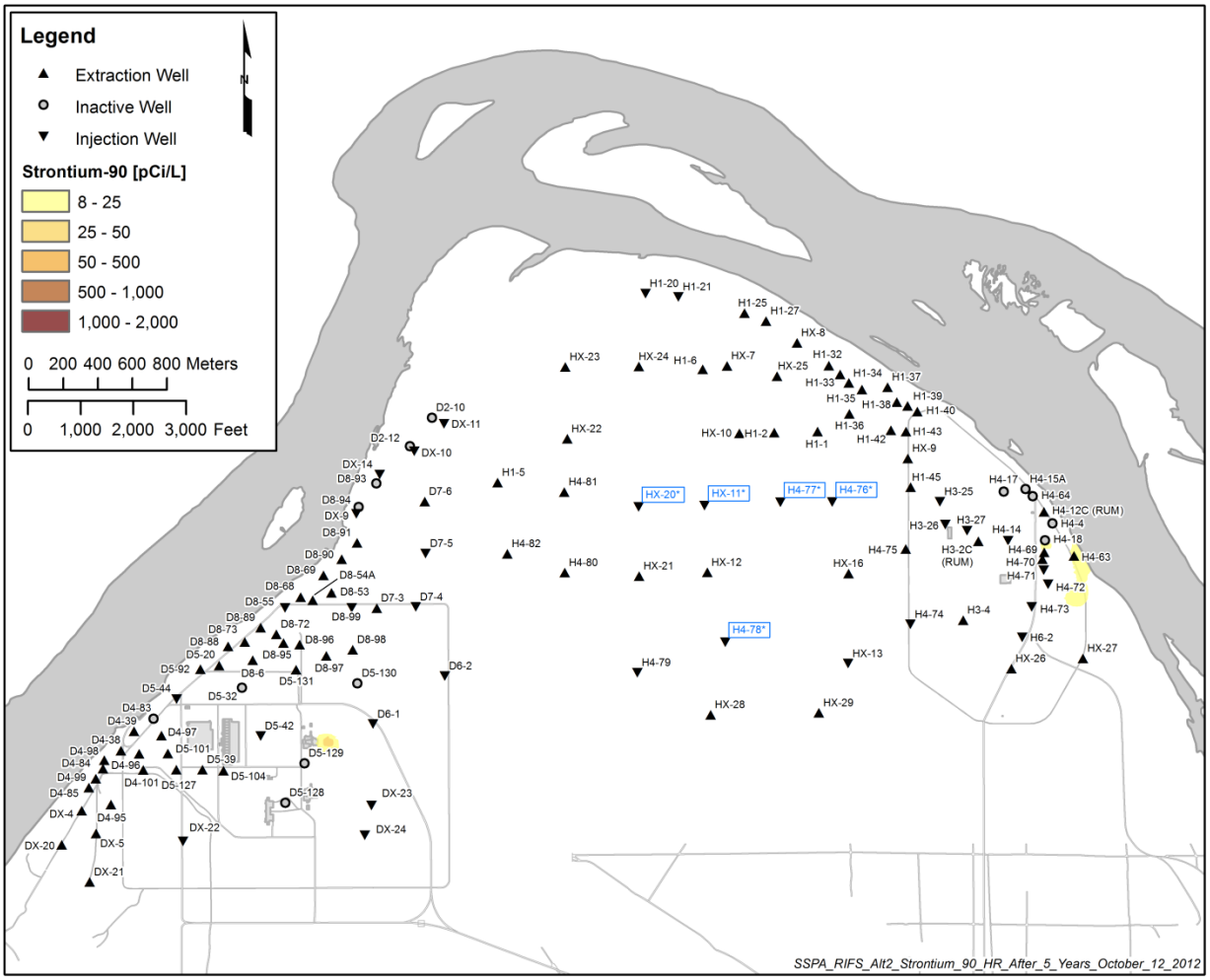

Figure 5-63. Simulated Distribution of Strontium-90 after 5 Years – Alternative 2.

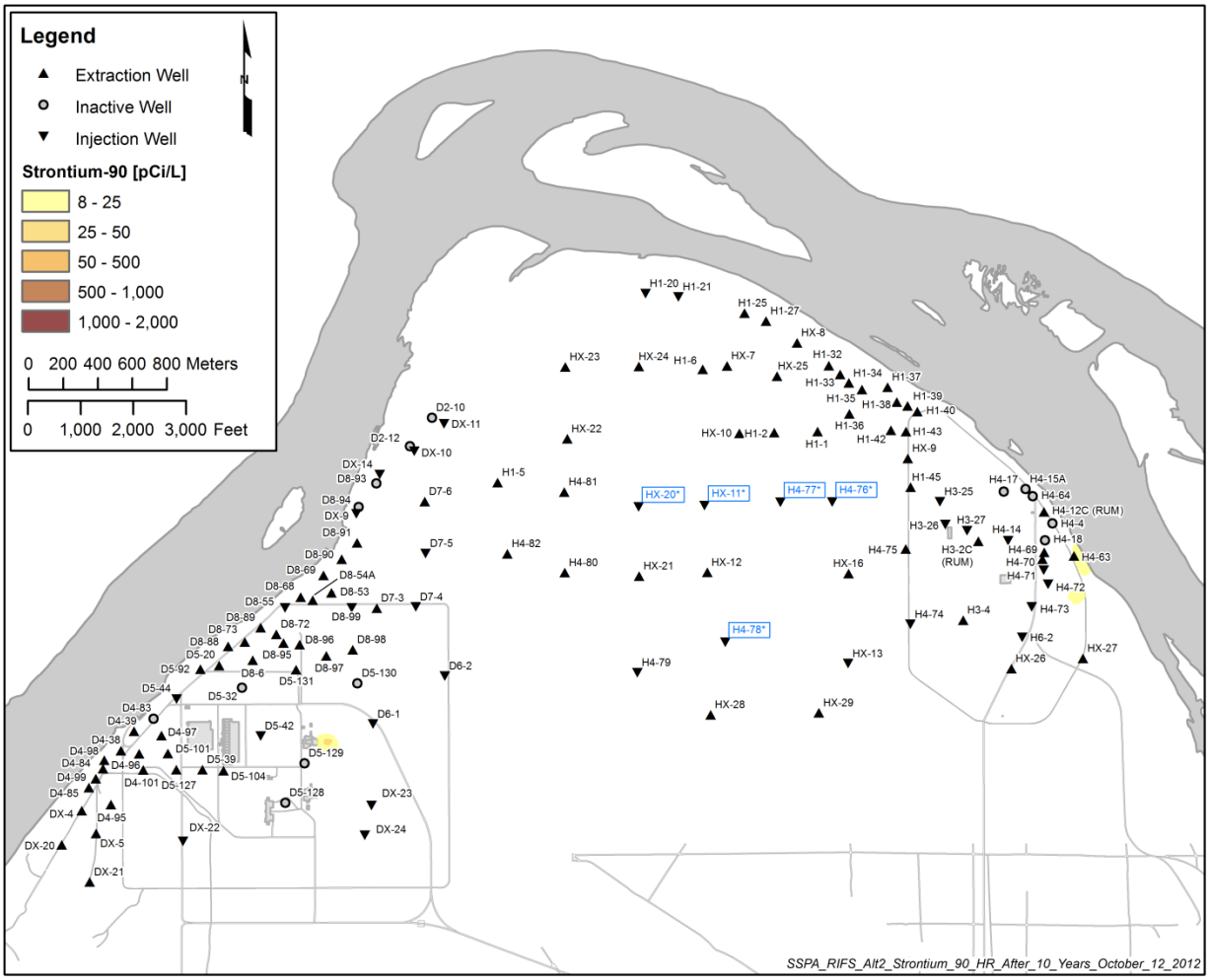

Figure 5-64. Simulated Distribution of Strontium-90 after 10 Years – Alternative 2.

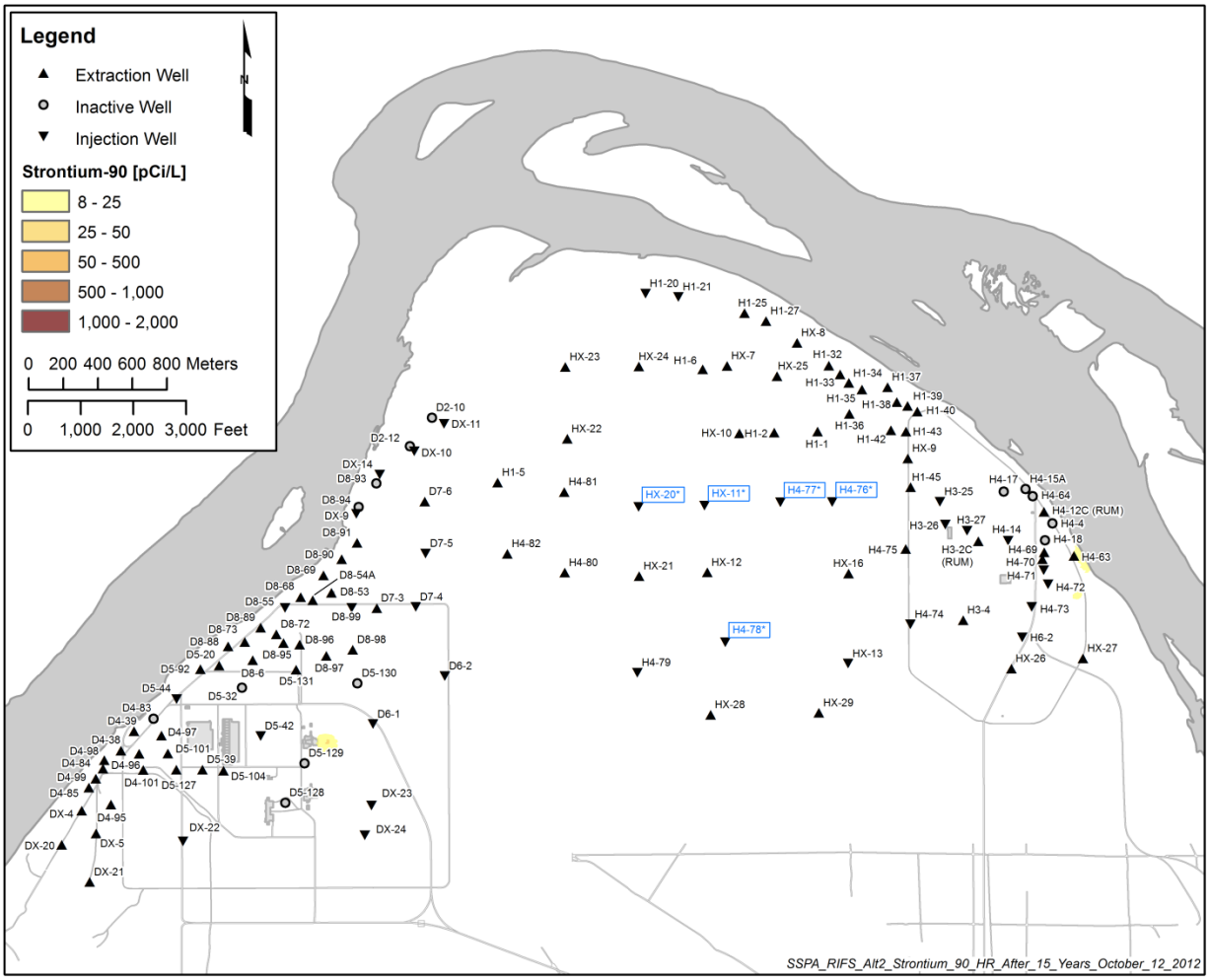

Figure 5-65. Simulated Distribution of Strontium-90 after 15 Years – Alternative 2.

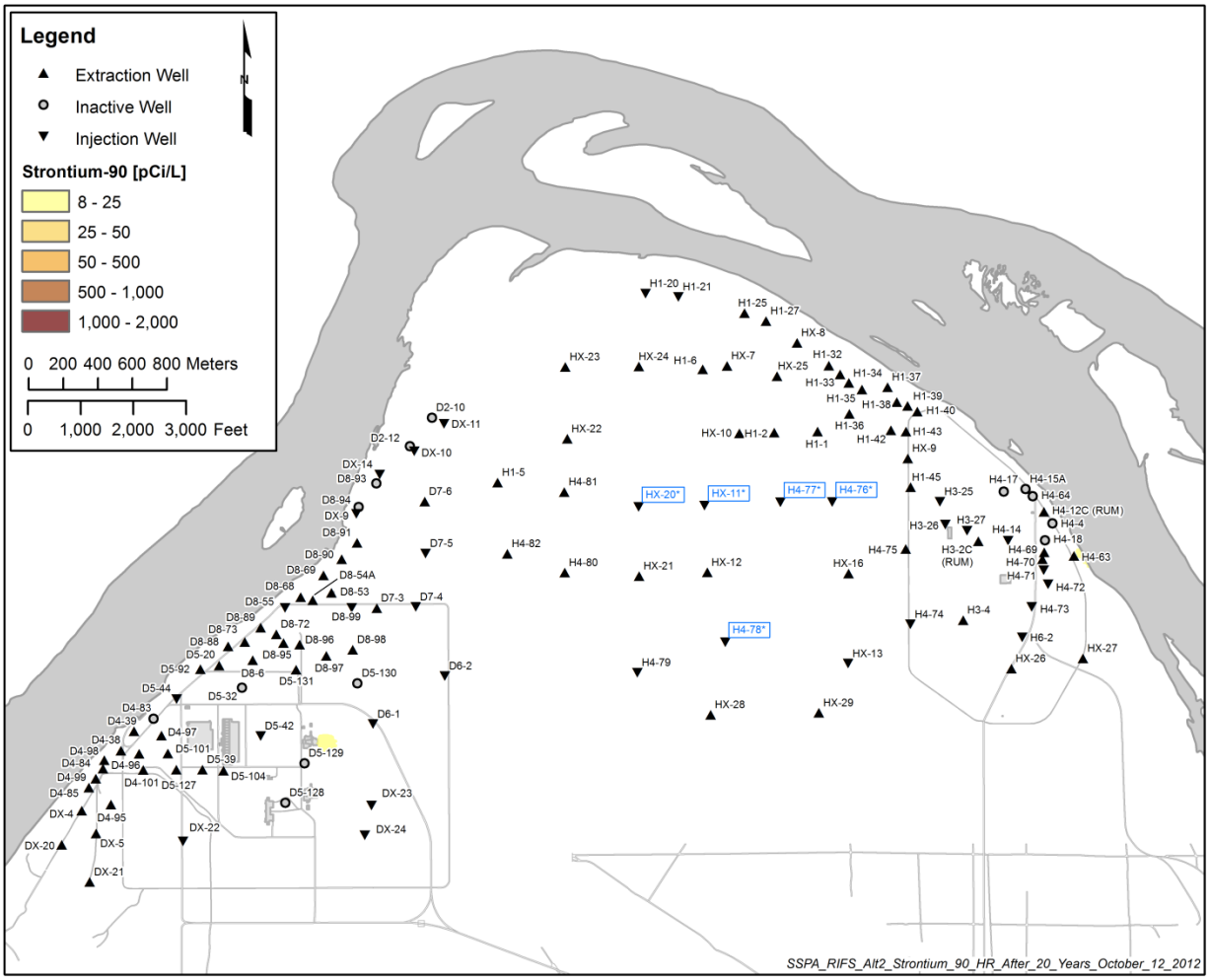

Figure 5-66. Simulated Distribution of Strontium-90 after 20 Years – Alternative 2.

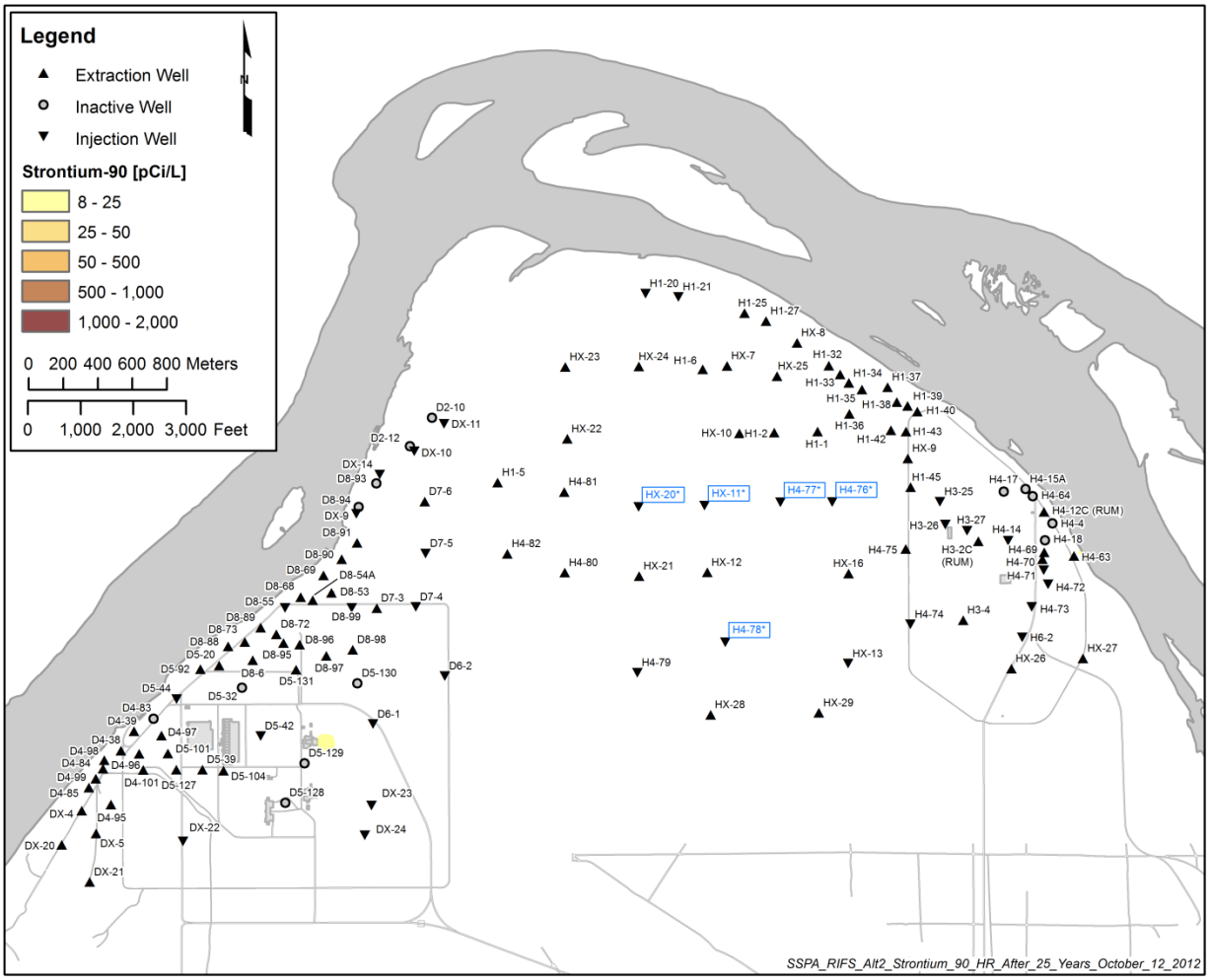

Figure 5-67. Simulated Distribution of Strontium-90 after 25 Years – Alternative 2.

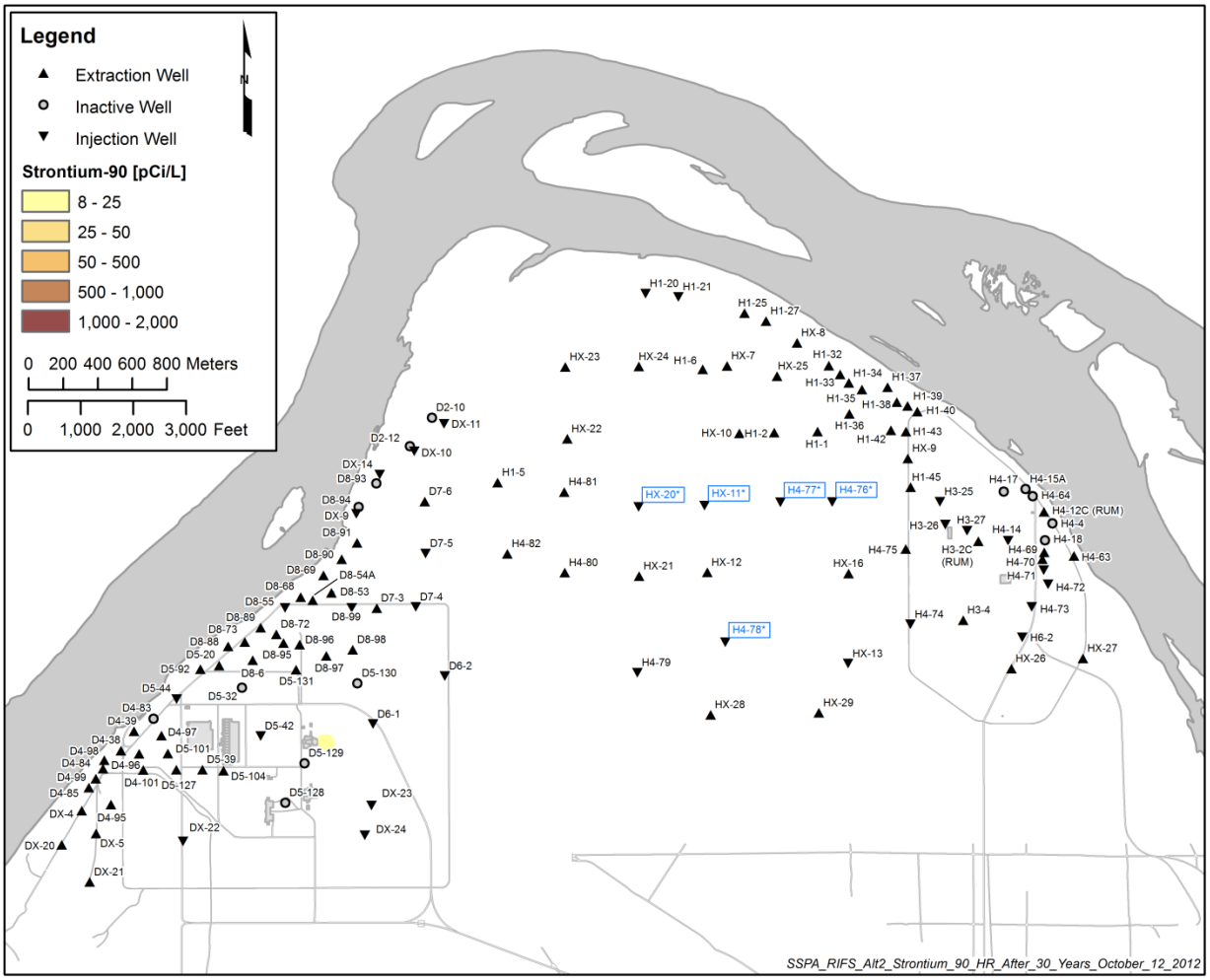

Figure 5-68. Simulated Distribution of Strontium-90 after 30 Years – Alternative 2.

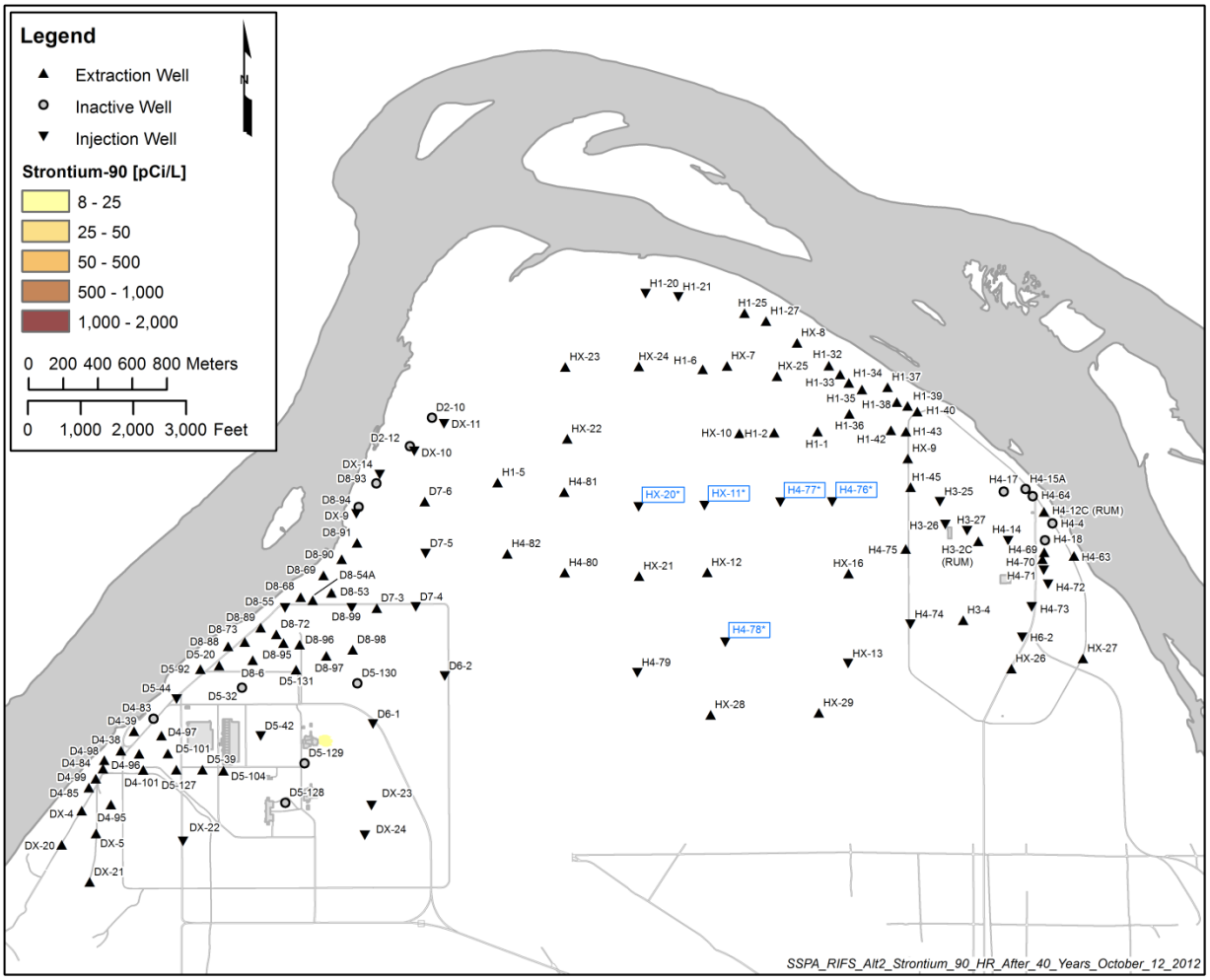

Figure 5-69. Simulated Distribution of Strontium-90 after 40 Years – Alternative 2.

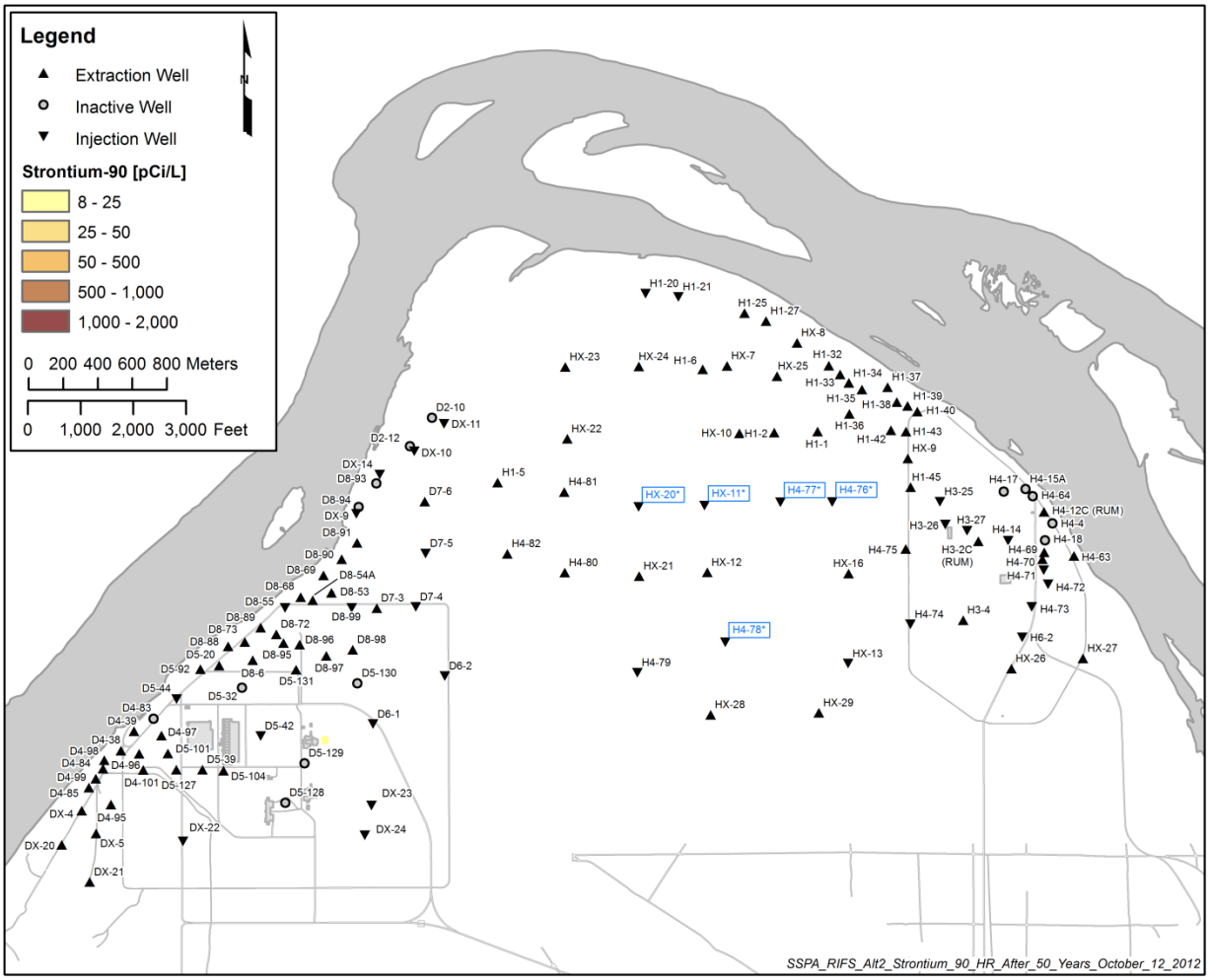

Figure 5-70. Simulated Distribution of Strontium-90 after 50 Years – Alternative 2.

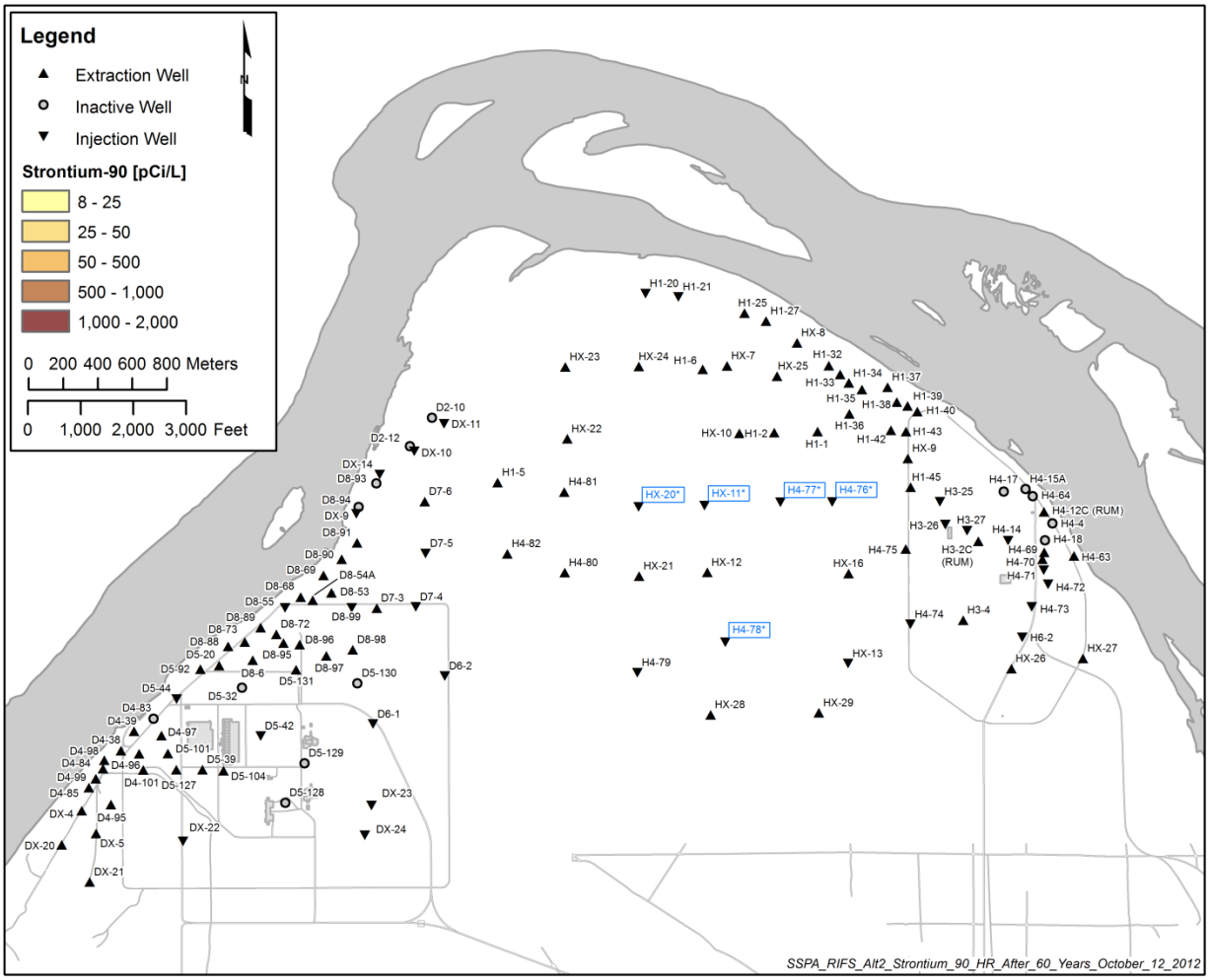

Figure 5-71. Simulated Distribution of Strontium-90 after 60 Years – Alternative 2.

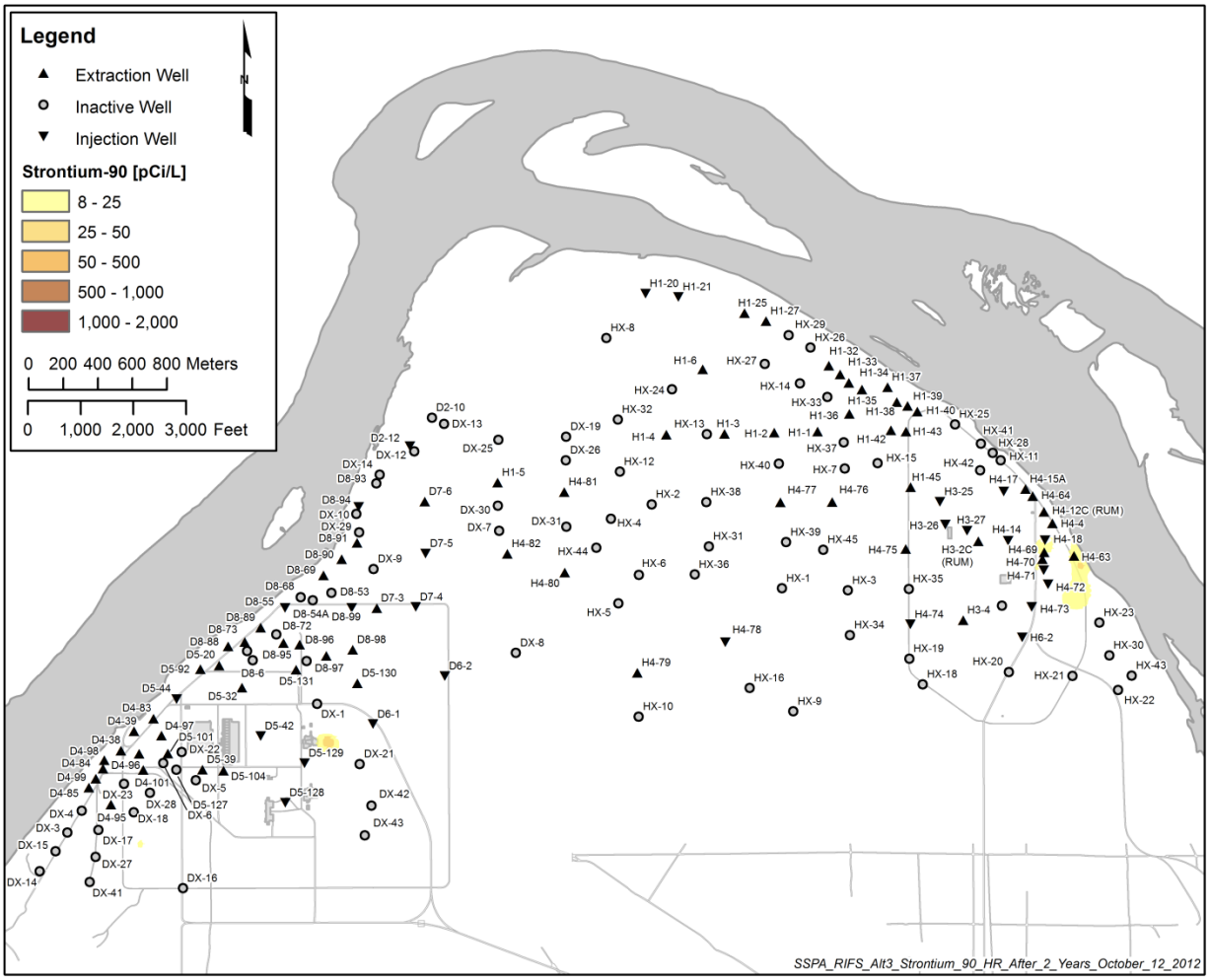

Figure 5-72. Simulated Distribution of Strontium-90 after 2 Years – Alternative 3.

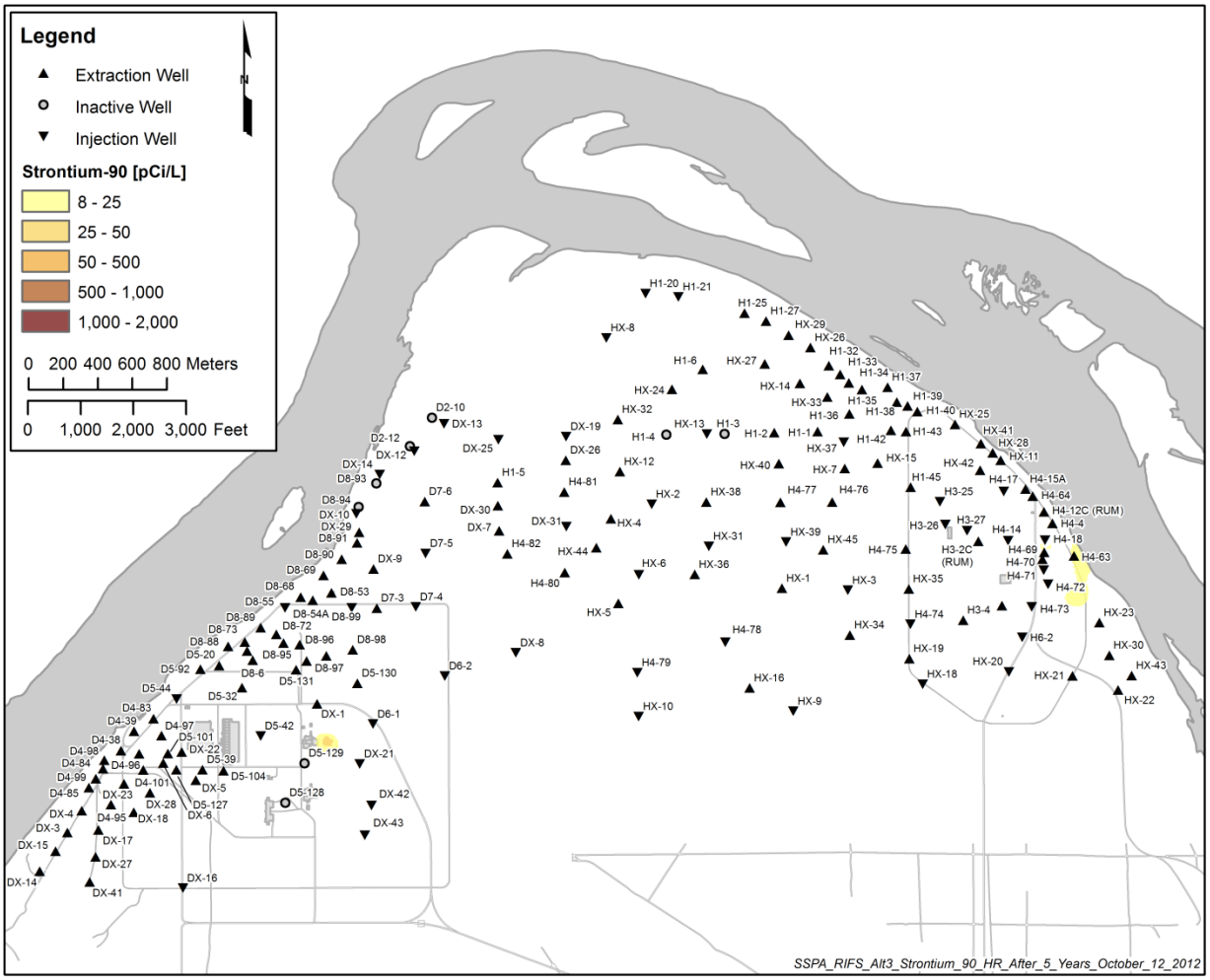

Figure 5-73. Simulated Distribution of Strontium-90 after 5 Years – Alternative 3.

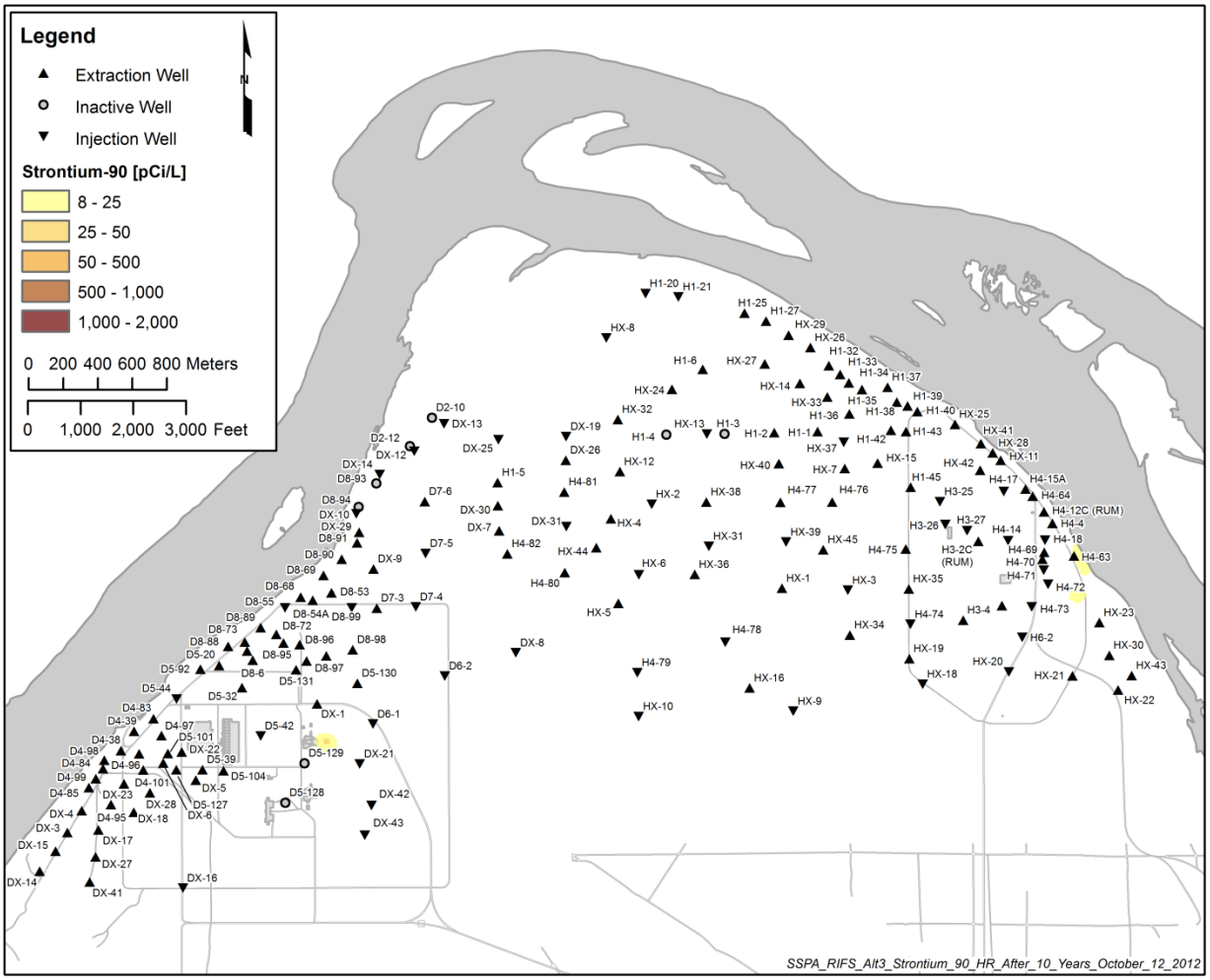

Figure 5-74. Simulated Distribution of Strontium-90 after 10 Years – Alternative 3.

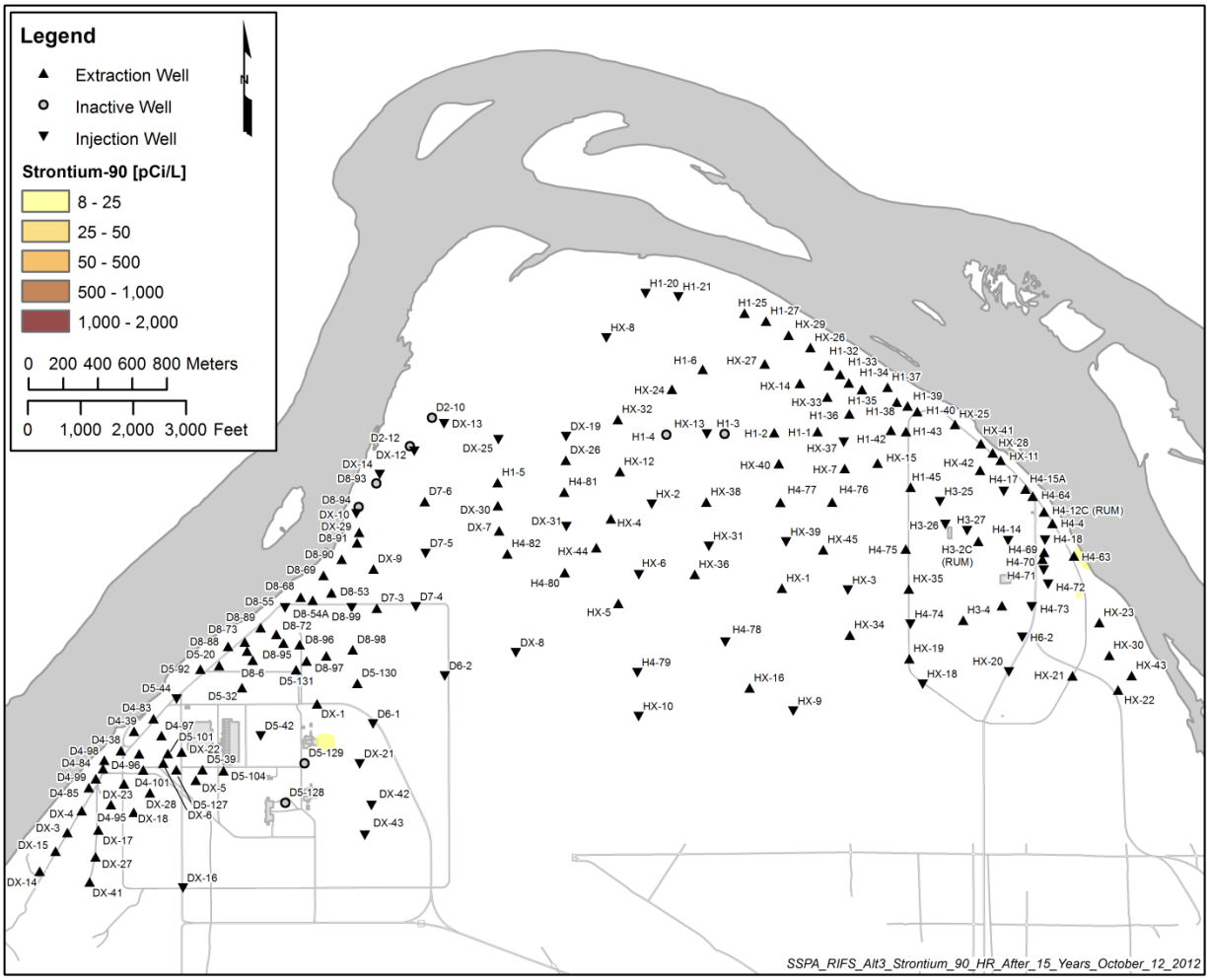

Figure 5-75. Simulated Distribution of Strontium-90 after 15 Years – Alternative 3.

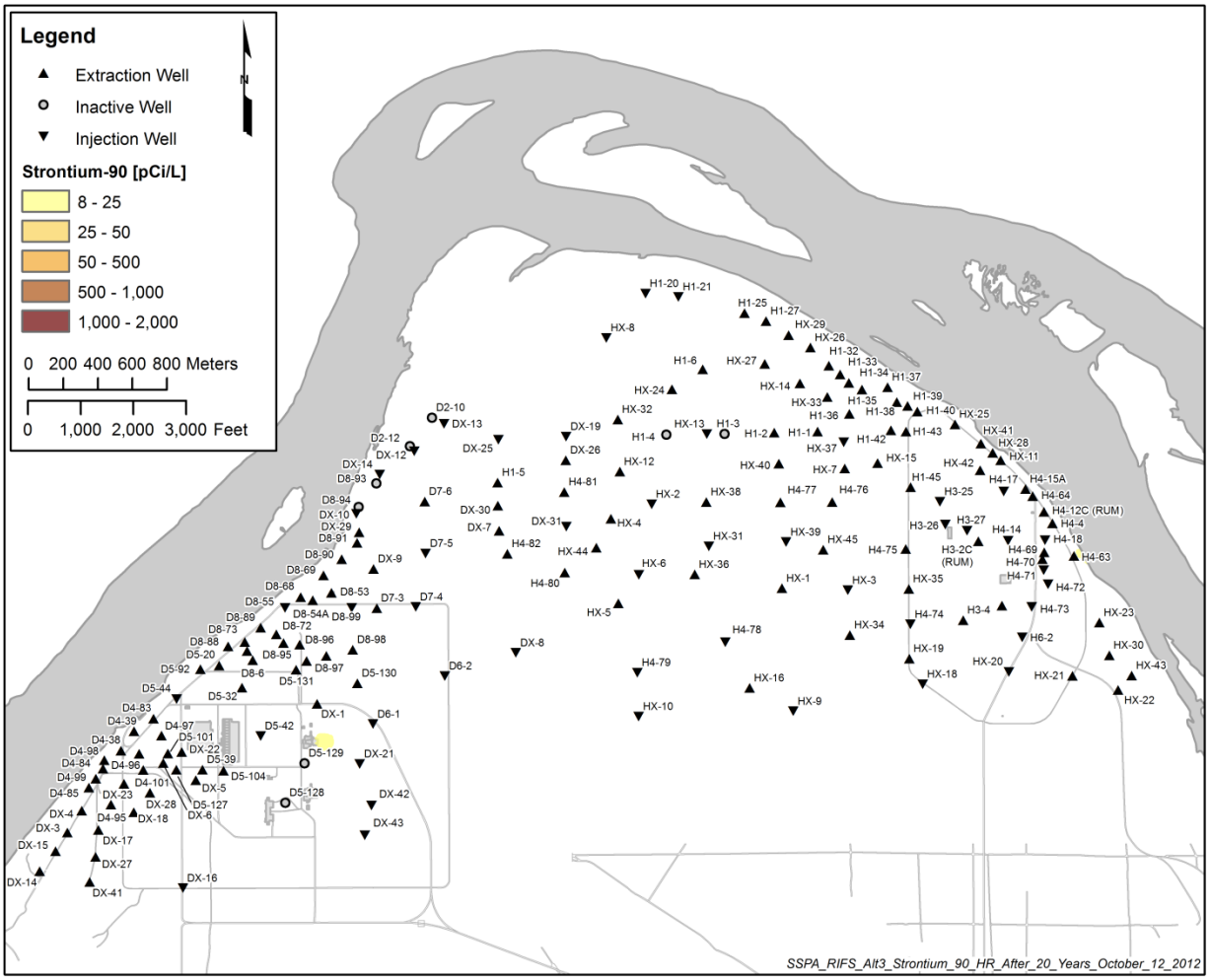

Figure 5-76. Simulated Distribution of Strontium-90 after 20 Years – Alternative 3.

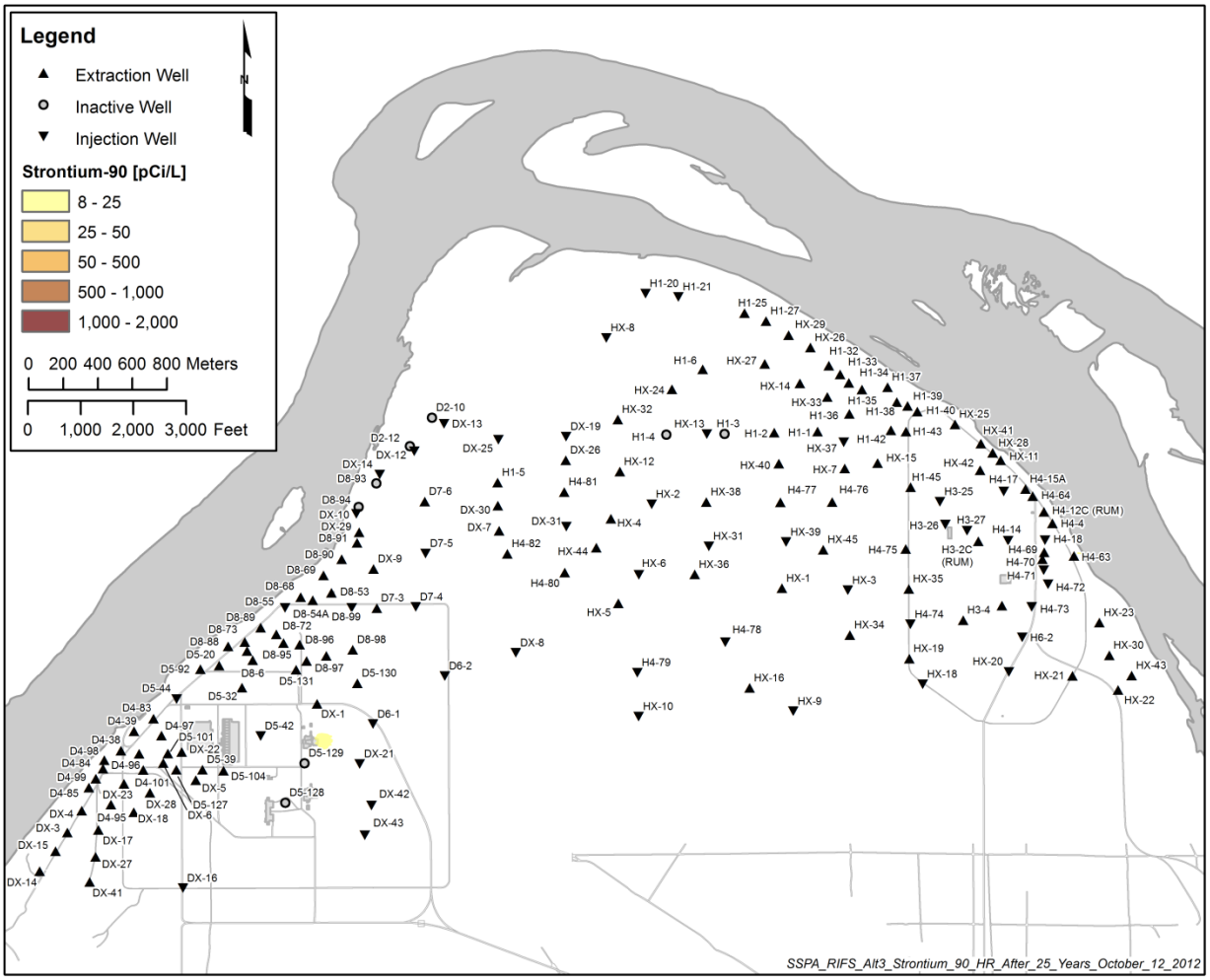

Figure 5-77. Simulated Distribution of Strontium-90 after 25 Years – Alternative 3.

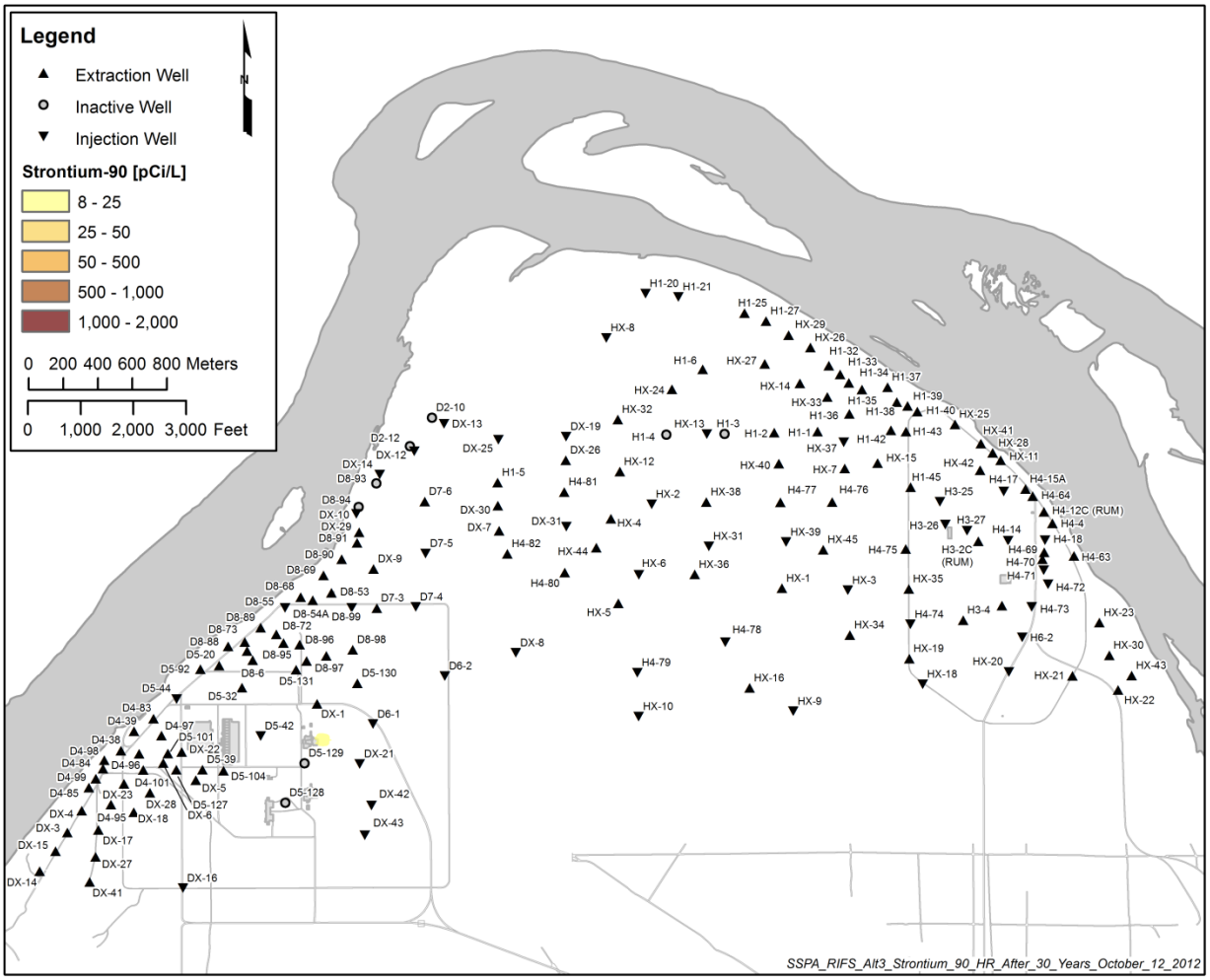

Figure 5-78. Simulated Distribution of Strontium-90 after 30 Years – Alternative 3.

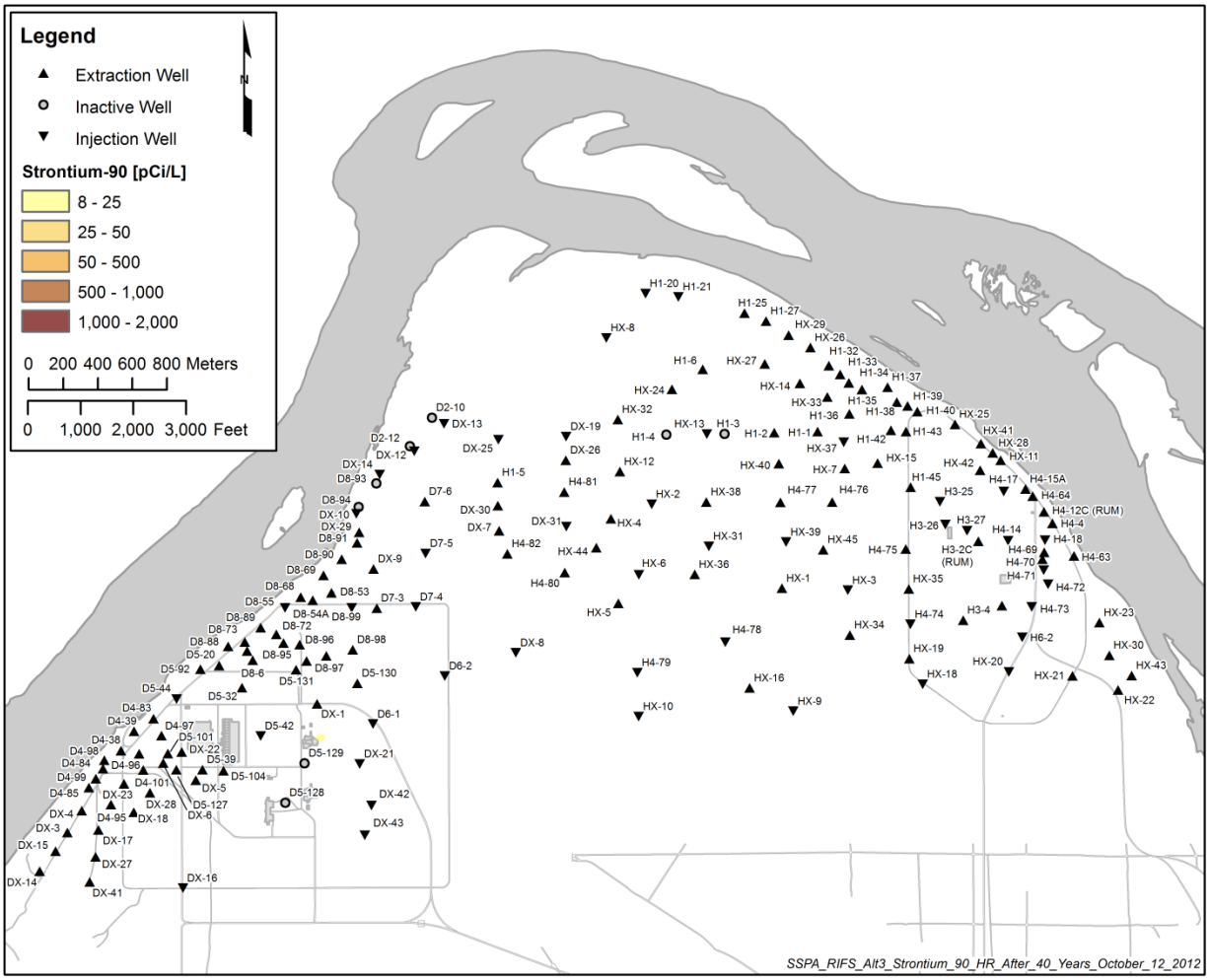

Figure 5-79. Simulated Distribution of Strontium-90 after 40 Years – Alternative 3.

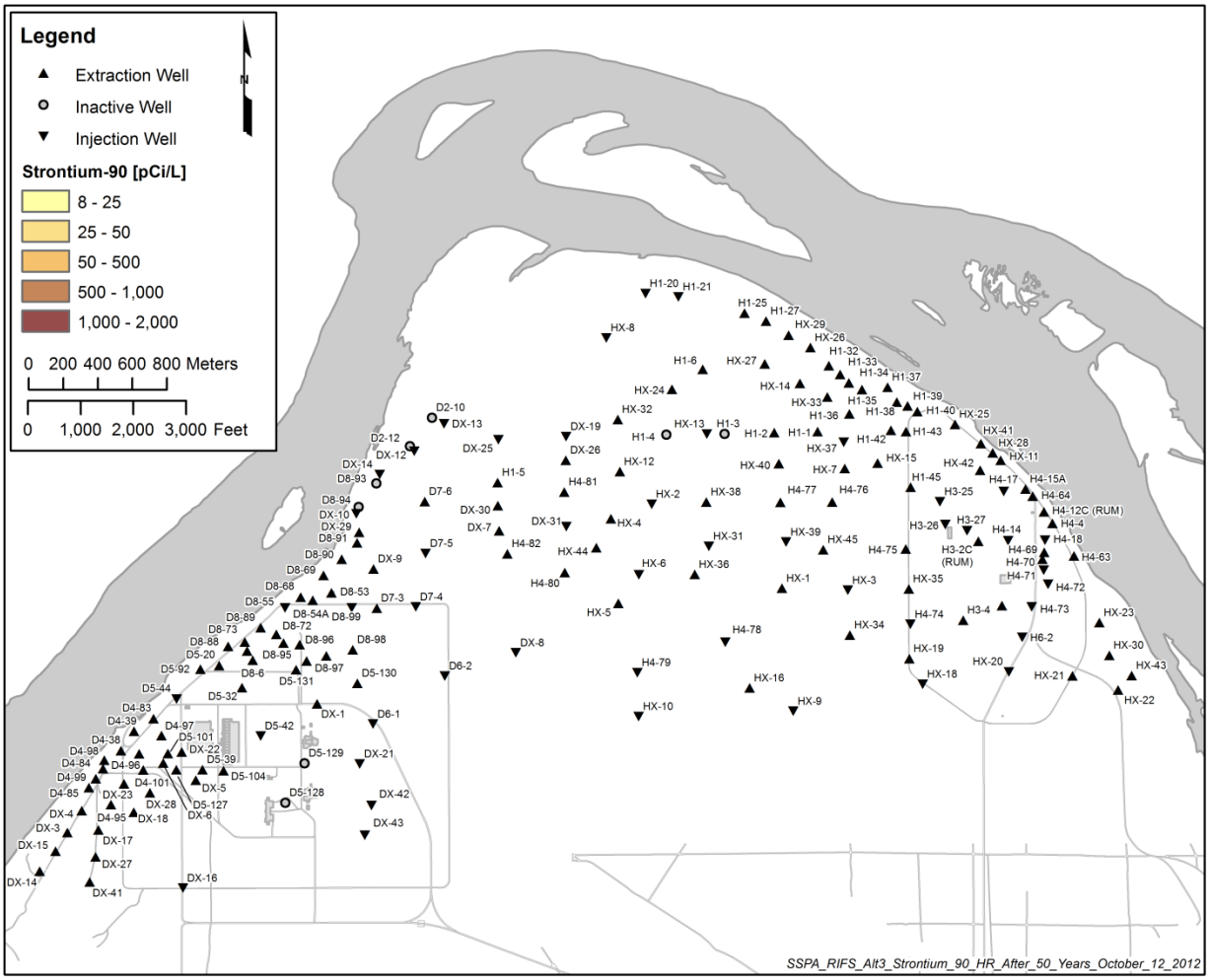

Figure 5-80. Simulated Distribution of Strontium-90 after 50 Years – Alternative 3.

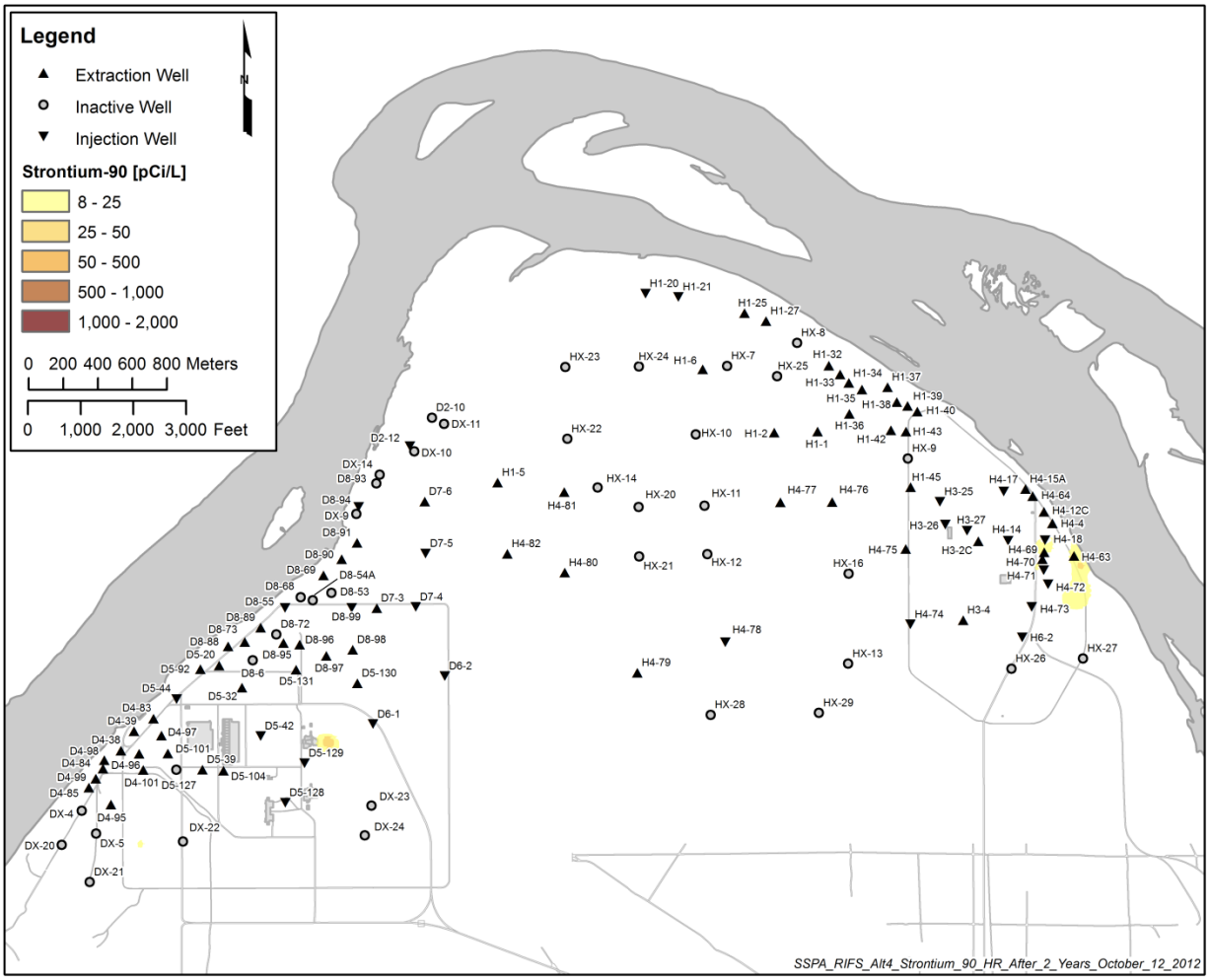

Figure 5-81. Simulated Distribution of Strontium-90 after 2 Years – Alternative 4.

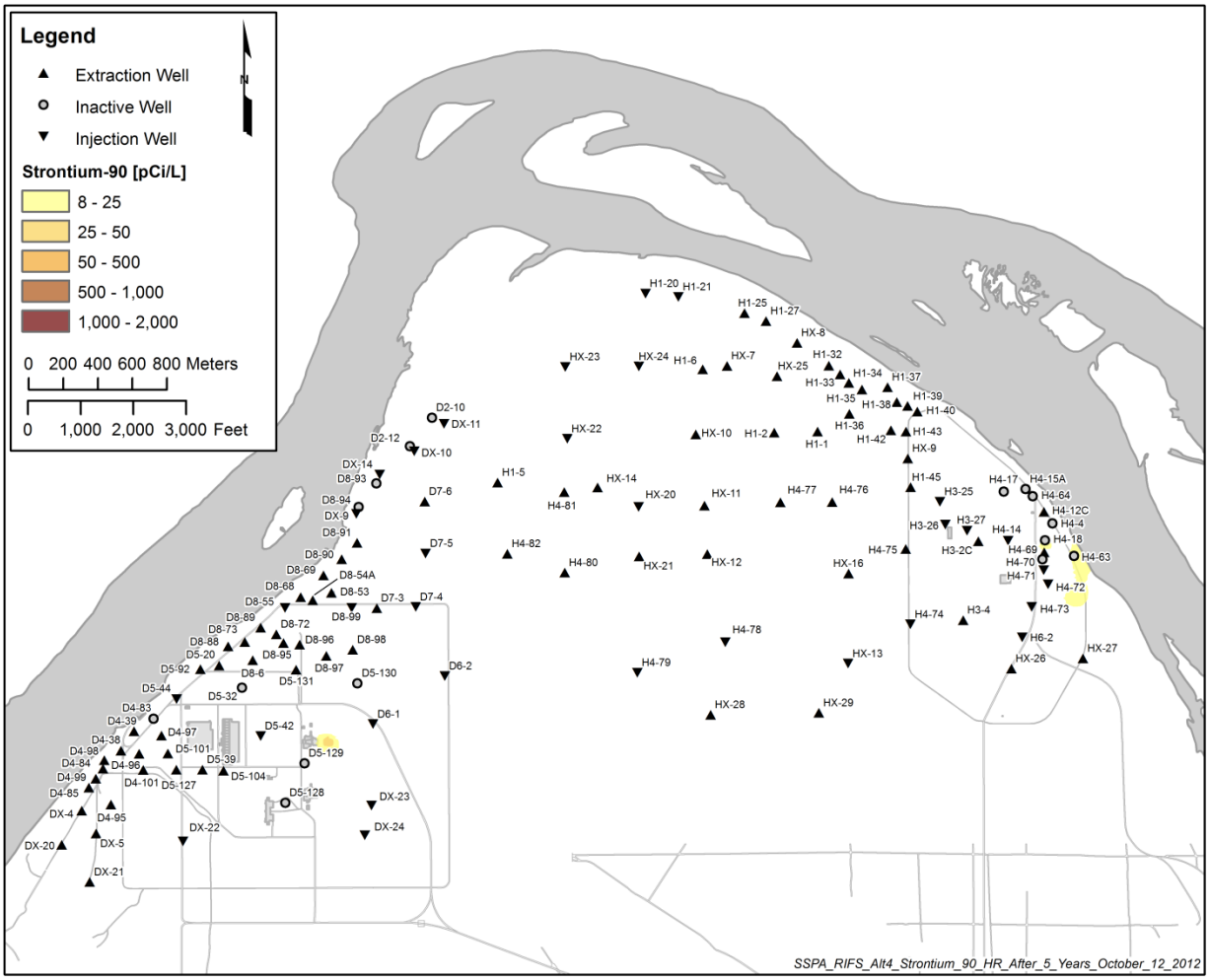

Figure 5-82. Simulated Distribution of Strontium-90 after 5 Years – Alternative 4.

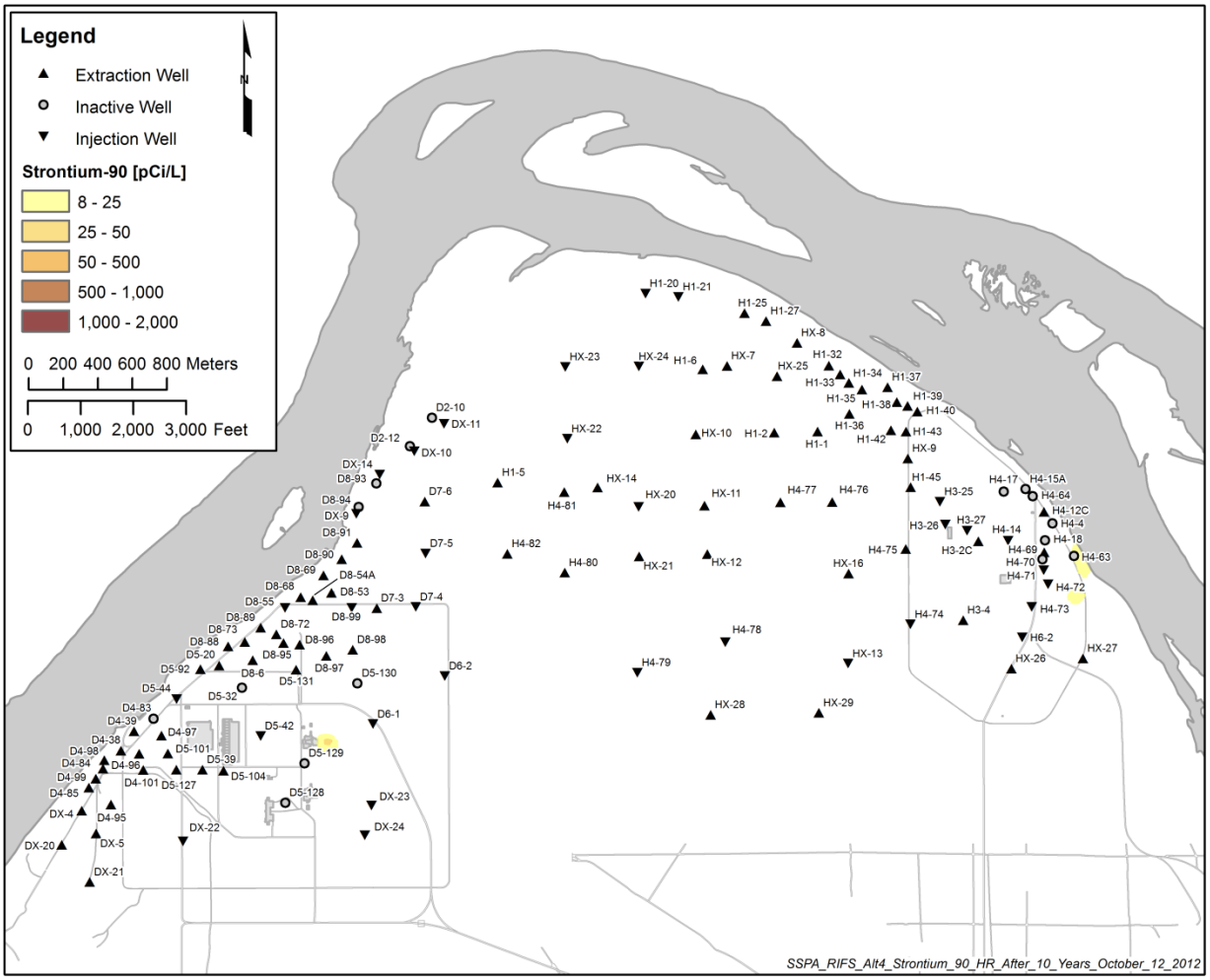

Figure 5-83. Simulated Distribution of Strontium-90 after 10 Years – Alternative 4.

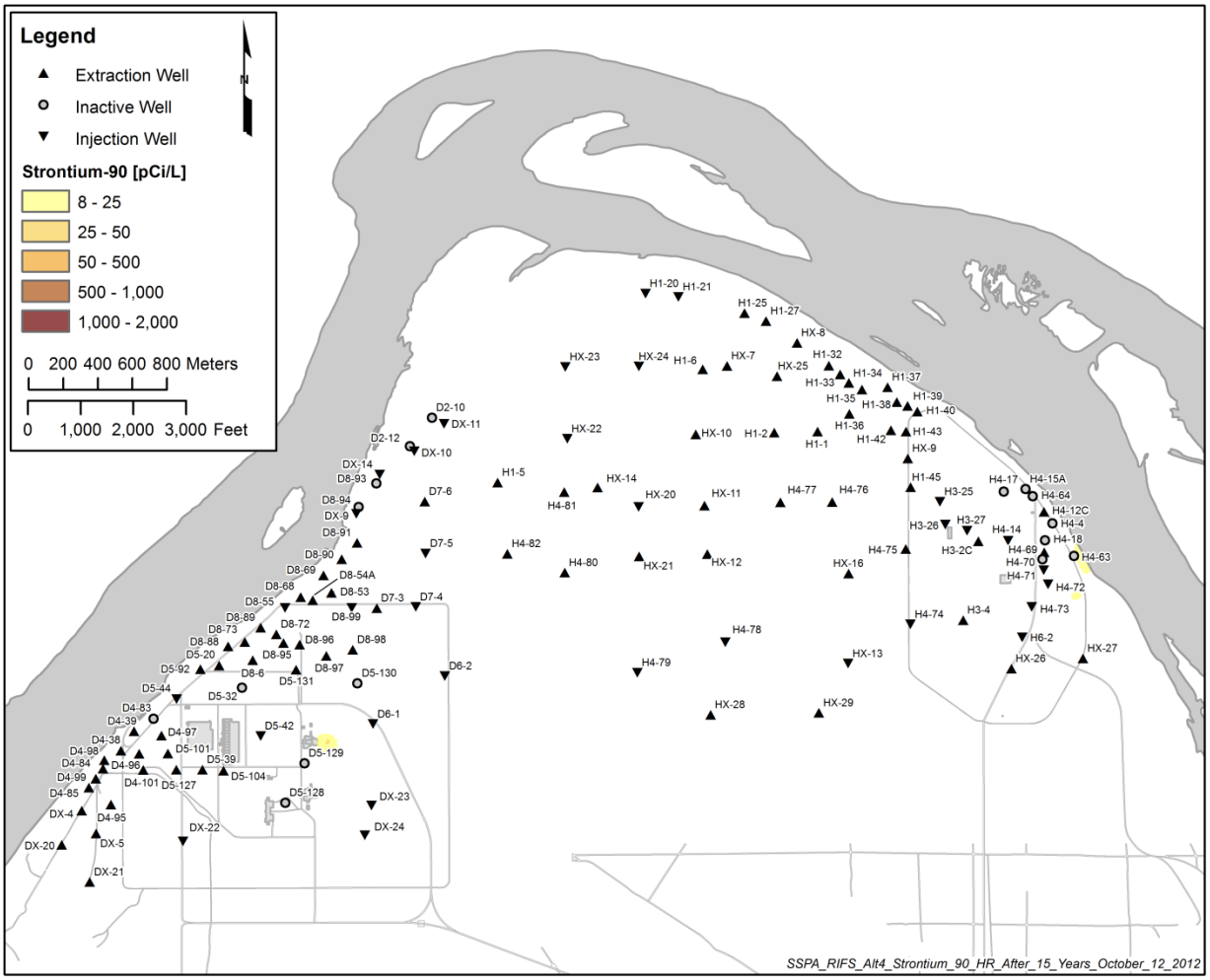

Figure 5-84. Simulated Distribution of Strontium-90 after 15 Years – Alternative 4.

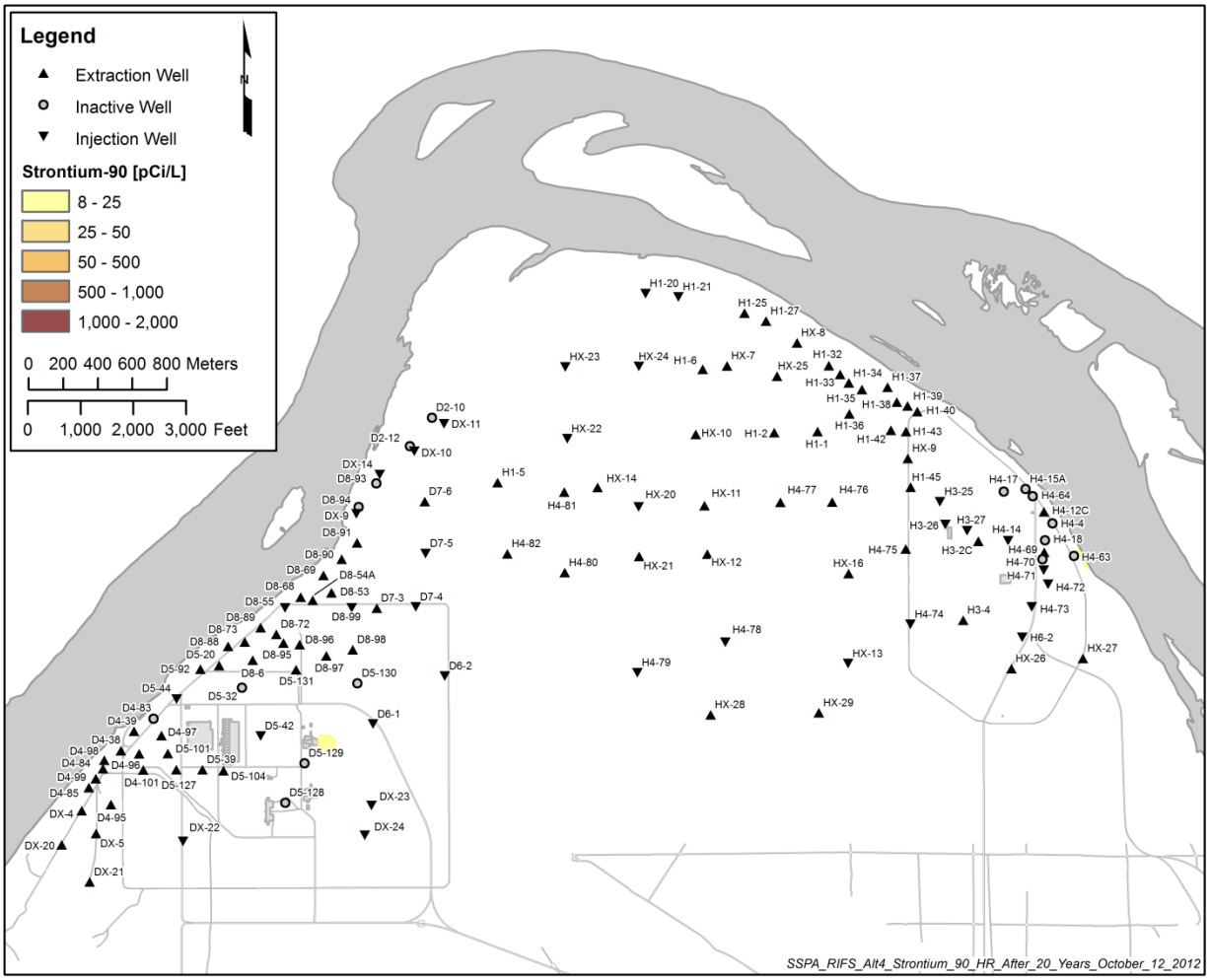

Figure 5-85. Simulated Distribution of Strontium-90 after 20 Years – Alternative 4.

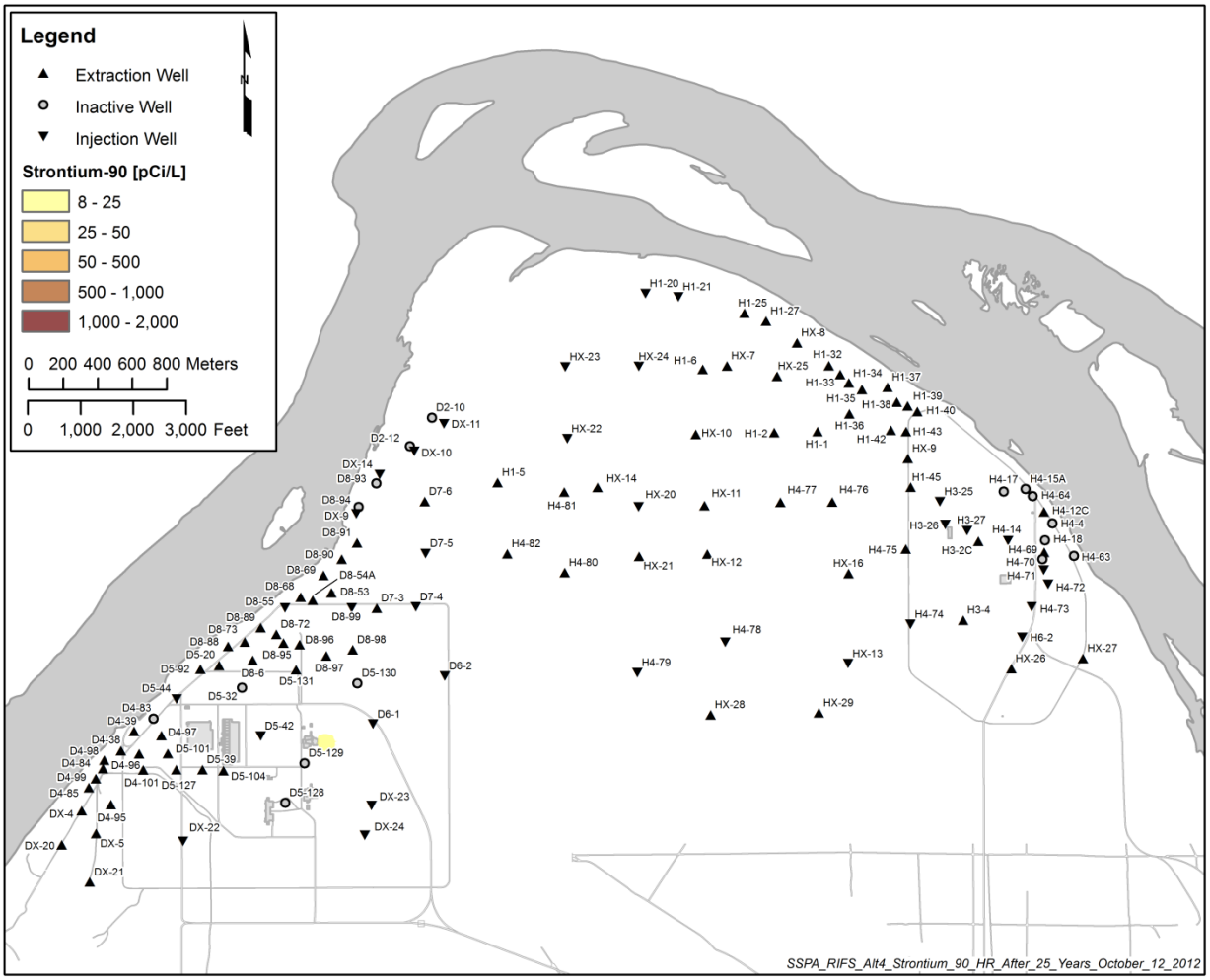

Figure 5-86. Simulated Distribution of Strontium-90 after 25 Years – Alternative 4.

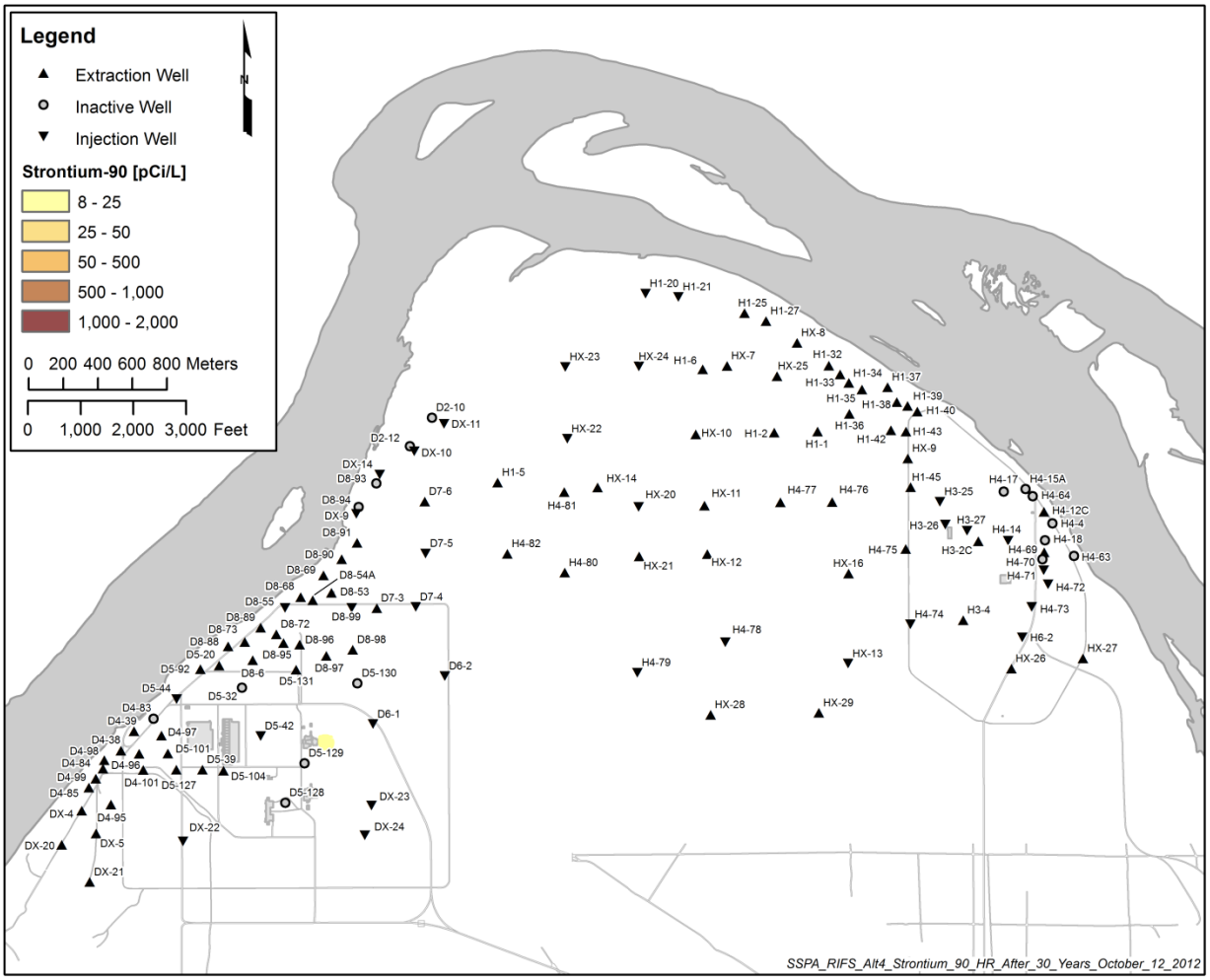

Figure 5-87. Simulated Distribution of Strontium-90 after 30 Years – Alternative 4.

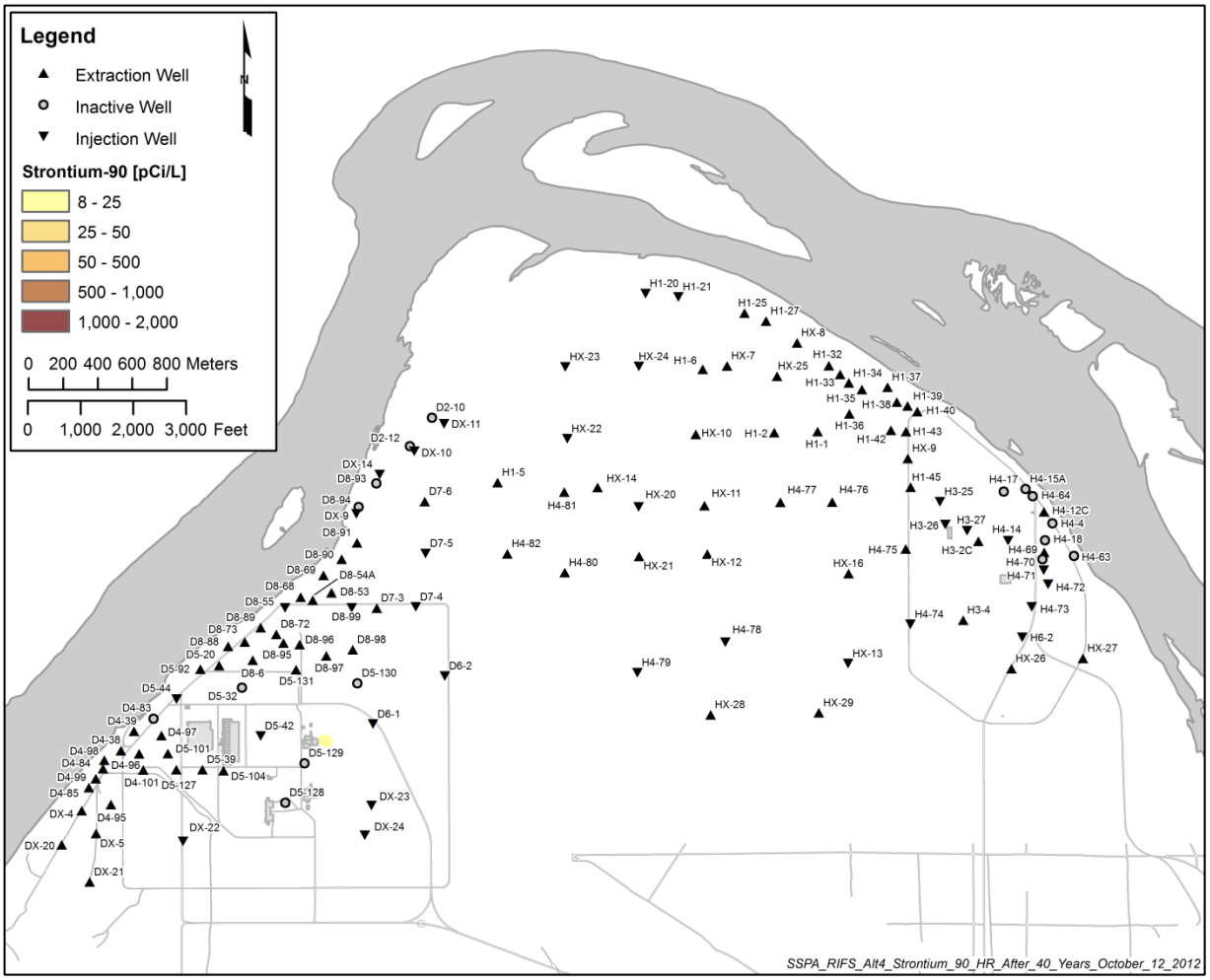

Figure 5-88. Simulated Distribution of Strontium-90 after 40 Years – Alternative 4.

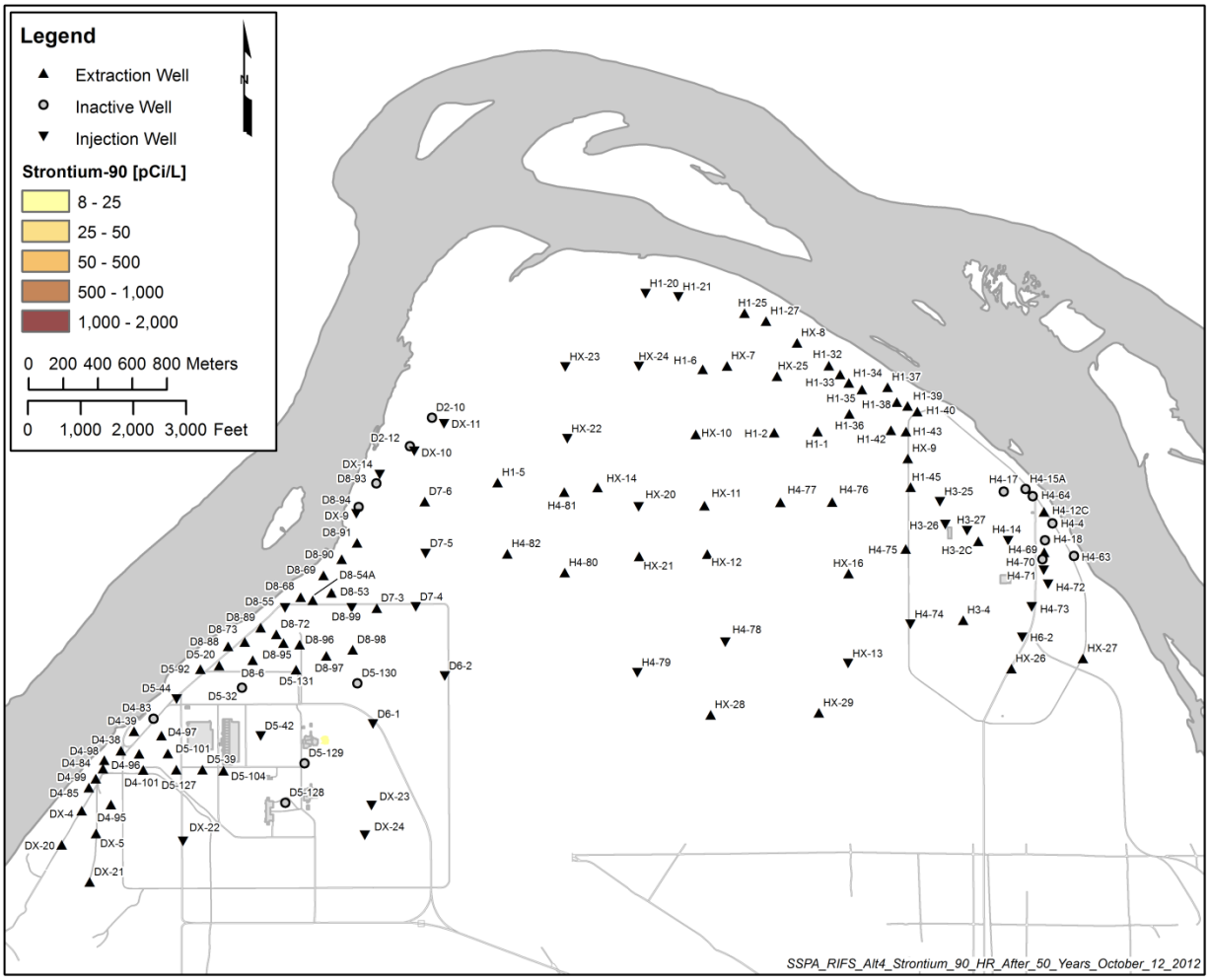

Figure 5-89. Simulated Distribution of Strontium-90 after 50 Years – Alternative 4.

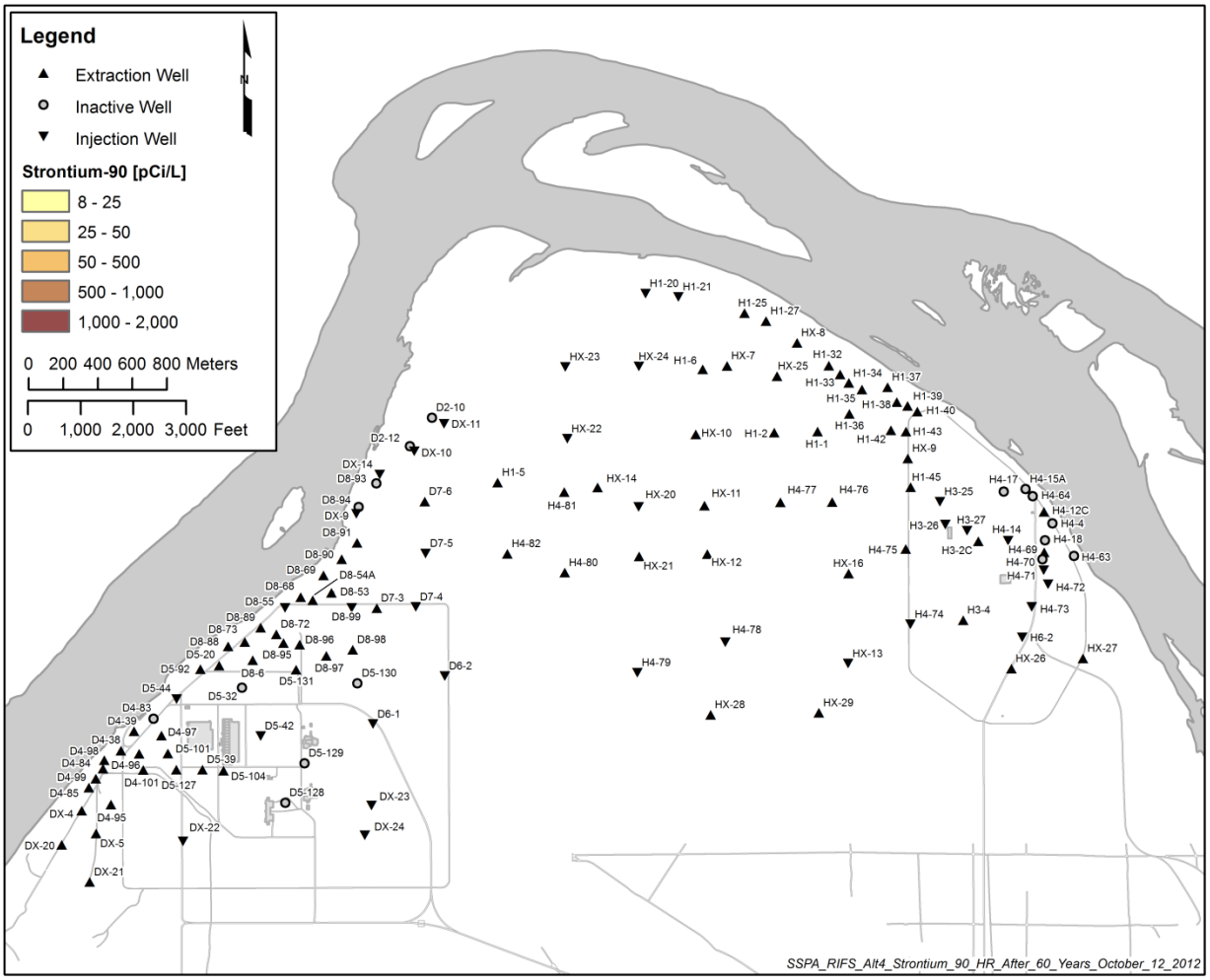

Figure 5-90. Simulated Distribution of Strontium-90 after 60 Years – Alternative 4.

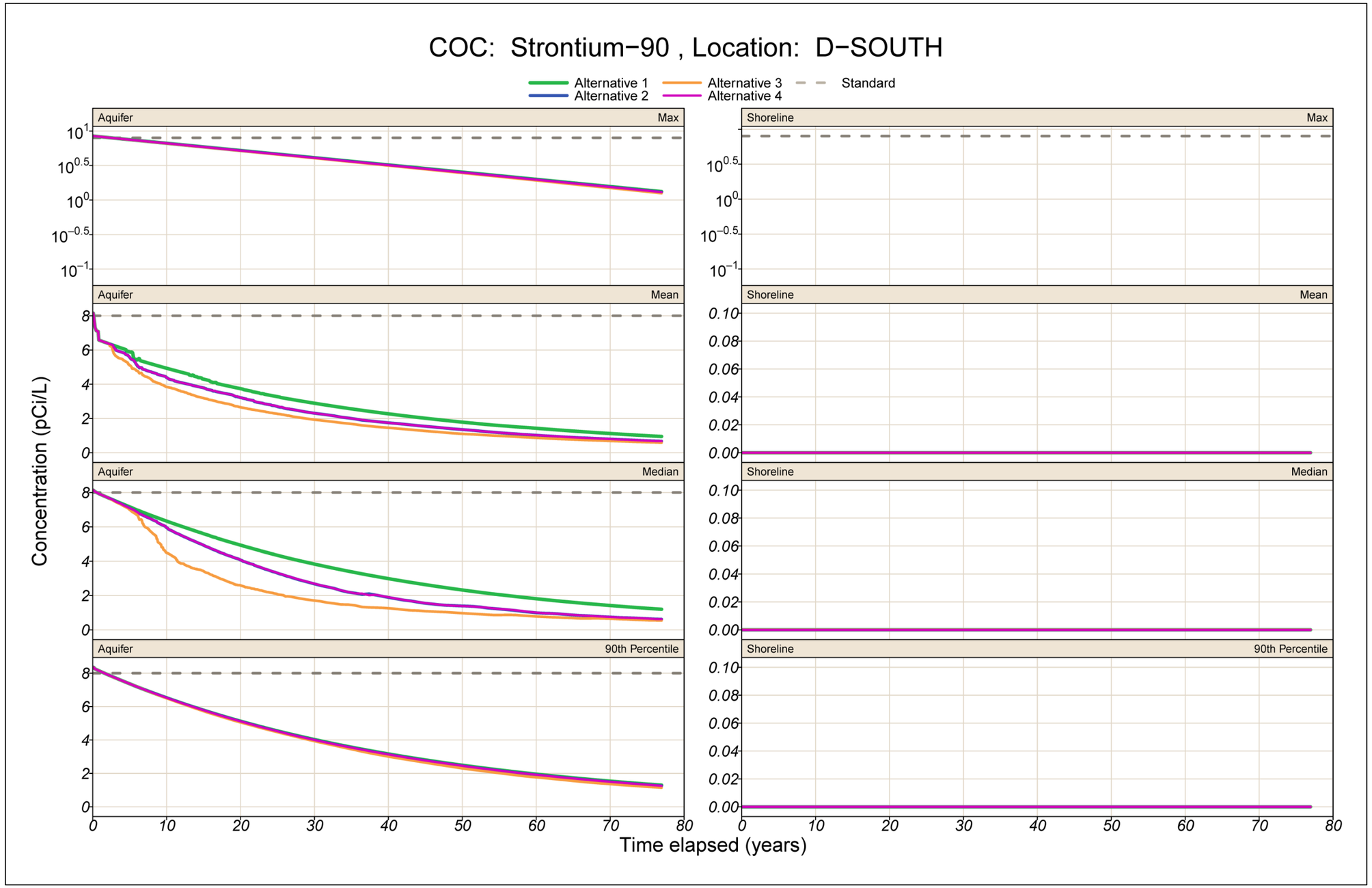

Figure 5-91. Strontium-90: Concentration Statistics – D-South (All Alternatives).

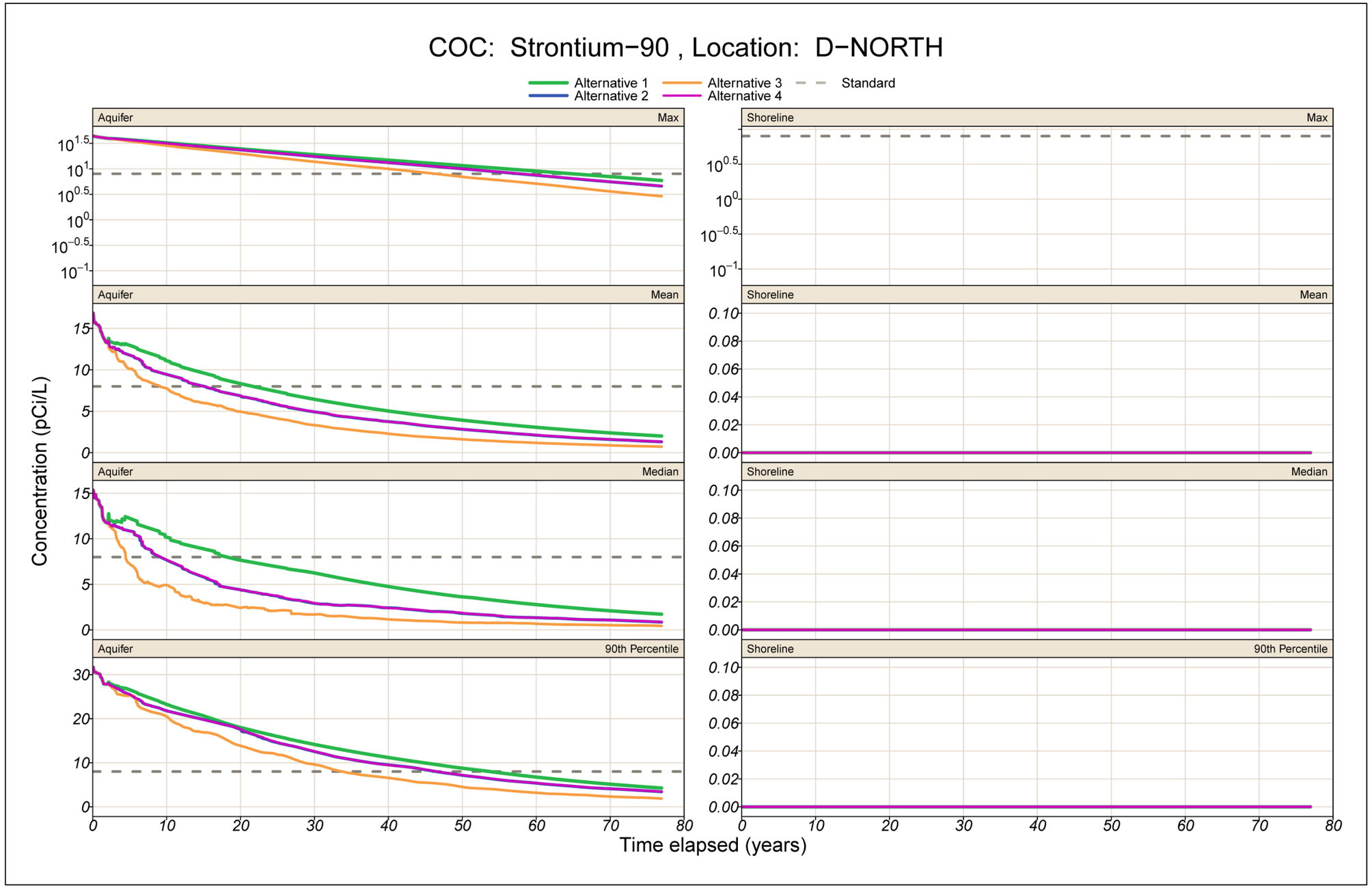

Figure 5-92. Strontium-90: Concentration Statistics – D-North (All Alternatives).

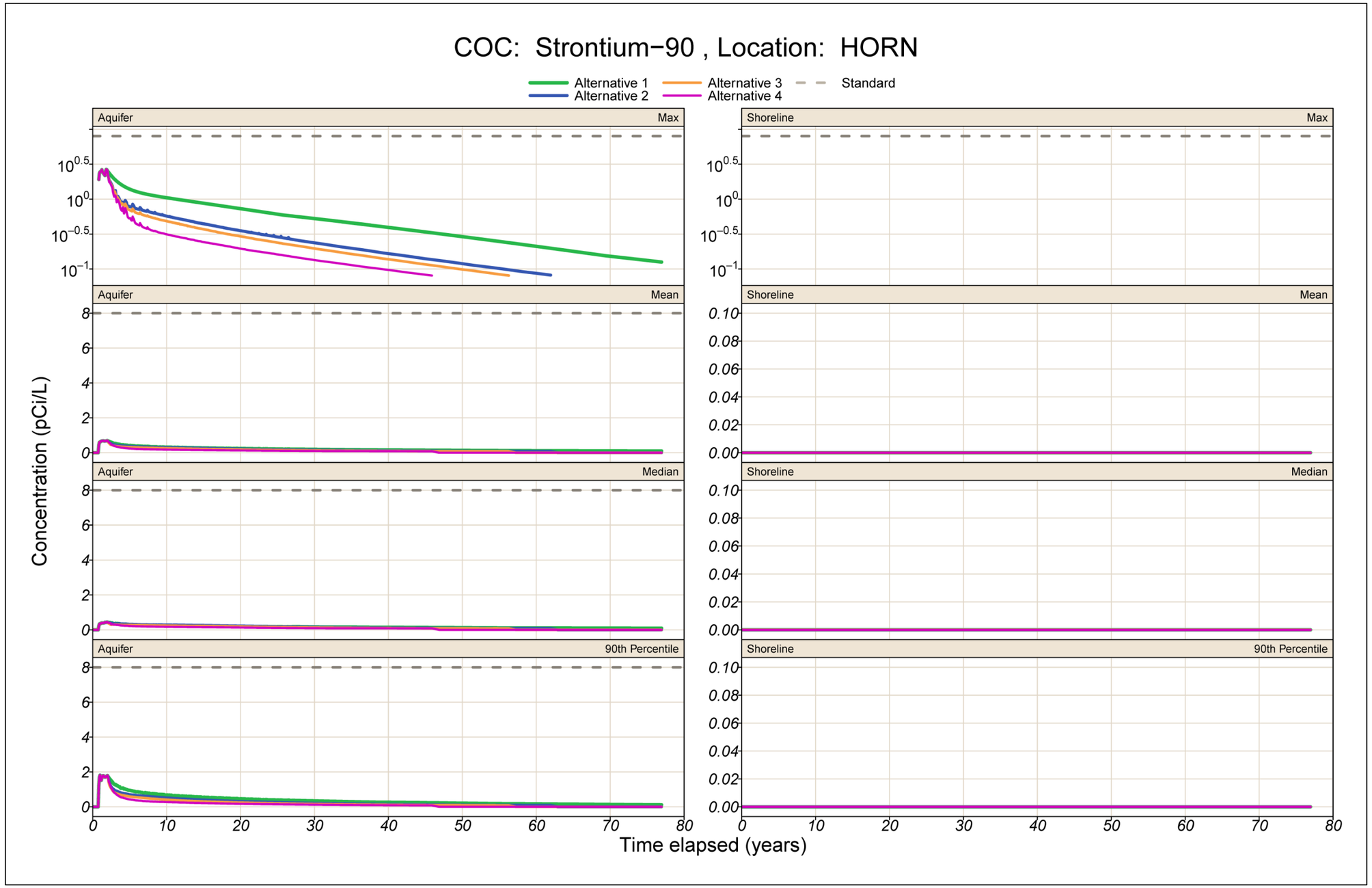

Figure 5-93. Strontium-90: Concentration Statistics – Horn (All Alternatives).

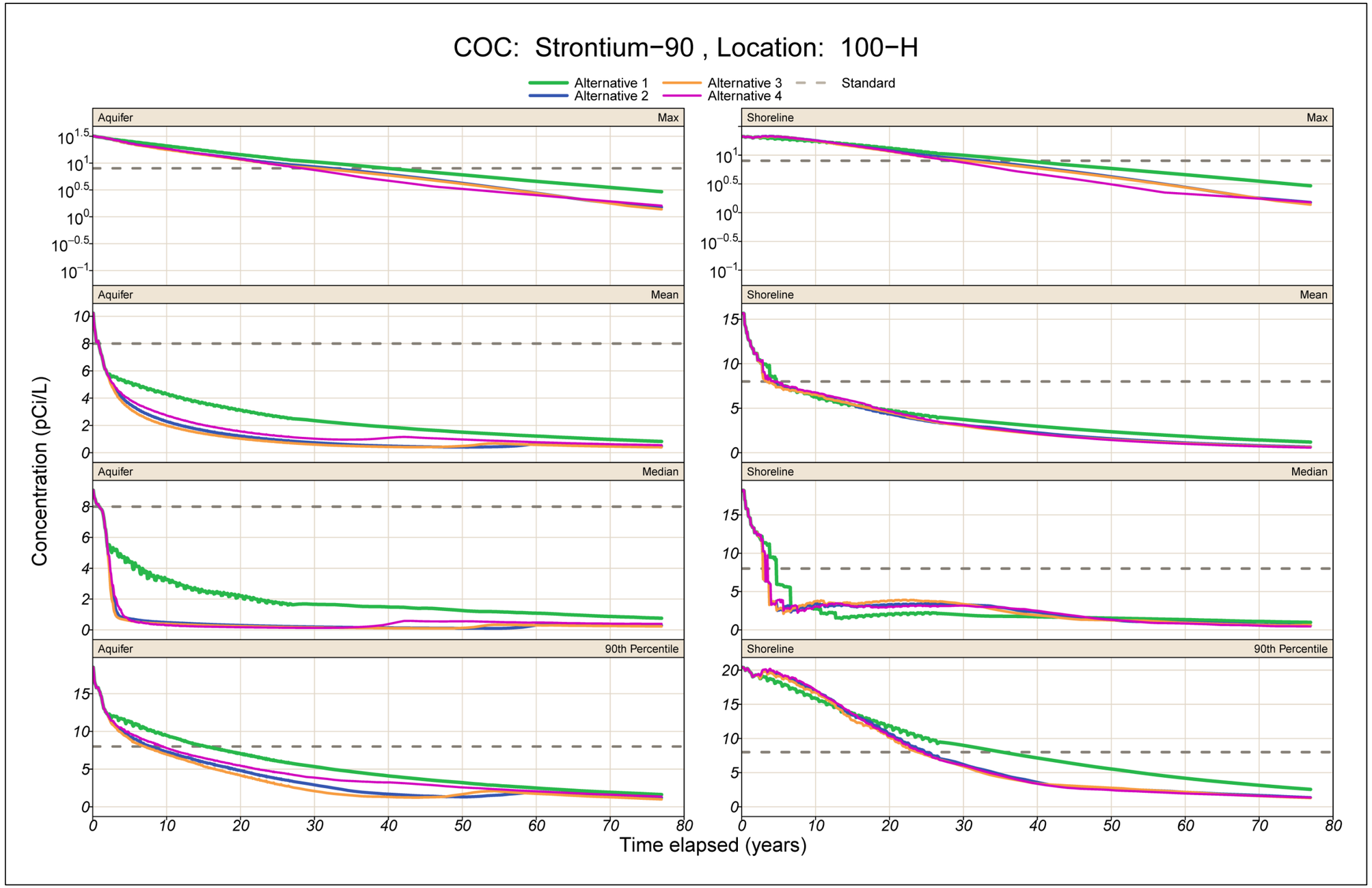

Figure 5-94. Strontium-90: Concentration Statistics – 100-H (All Alternatives).

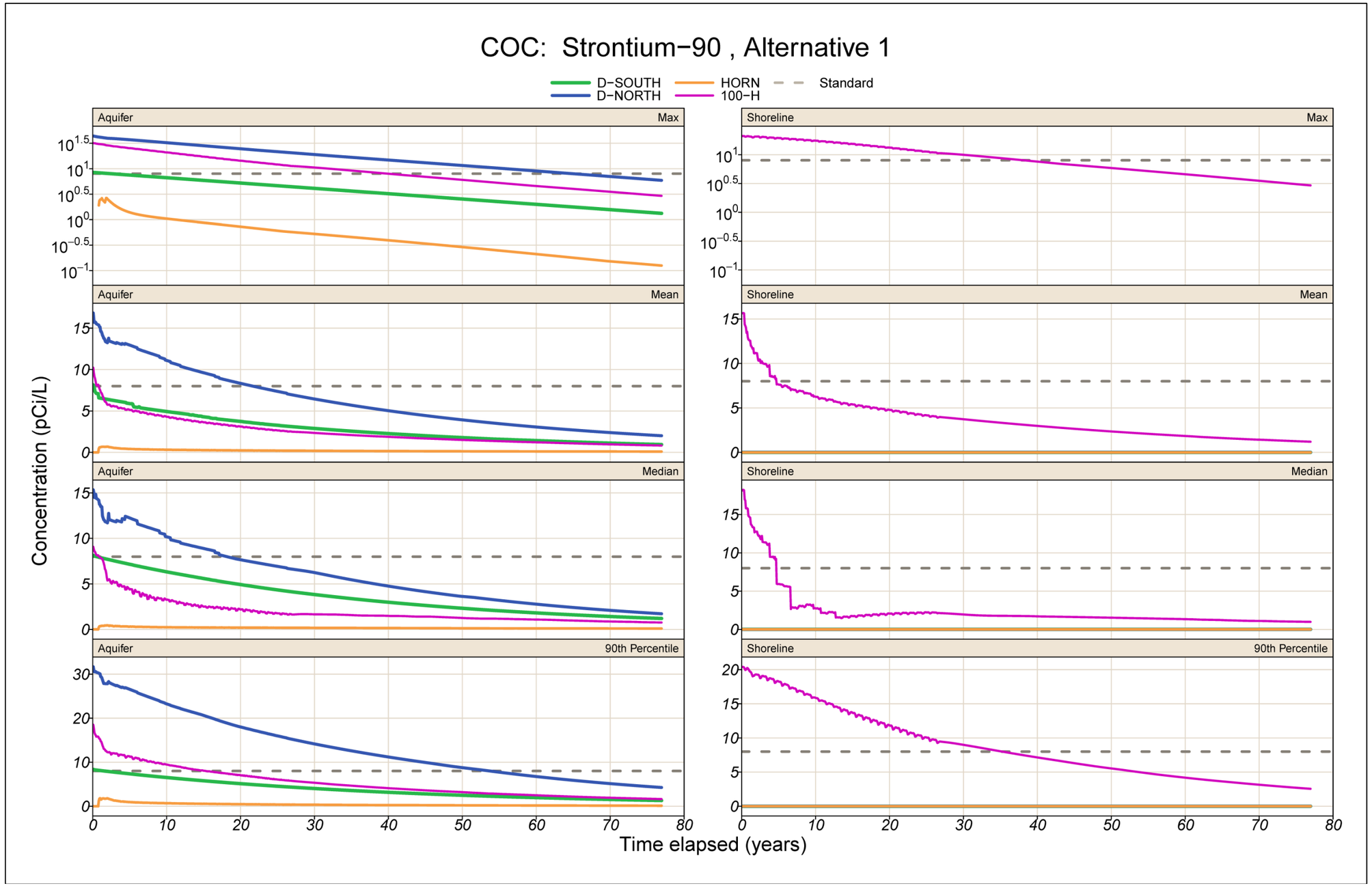

Figure 5-95. Strontium-90: Concentration Statistics – Alternative 1 (All Areas).

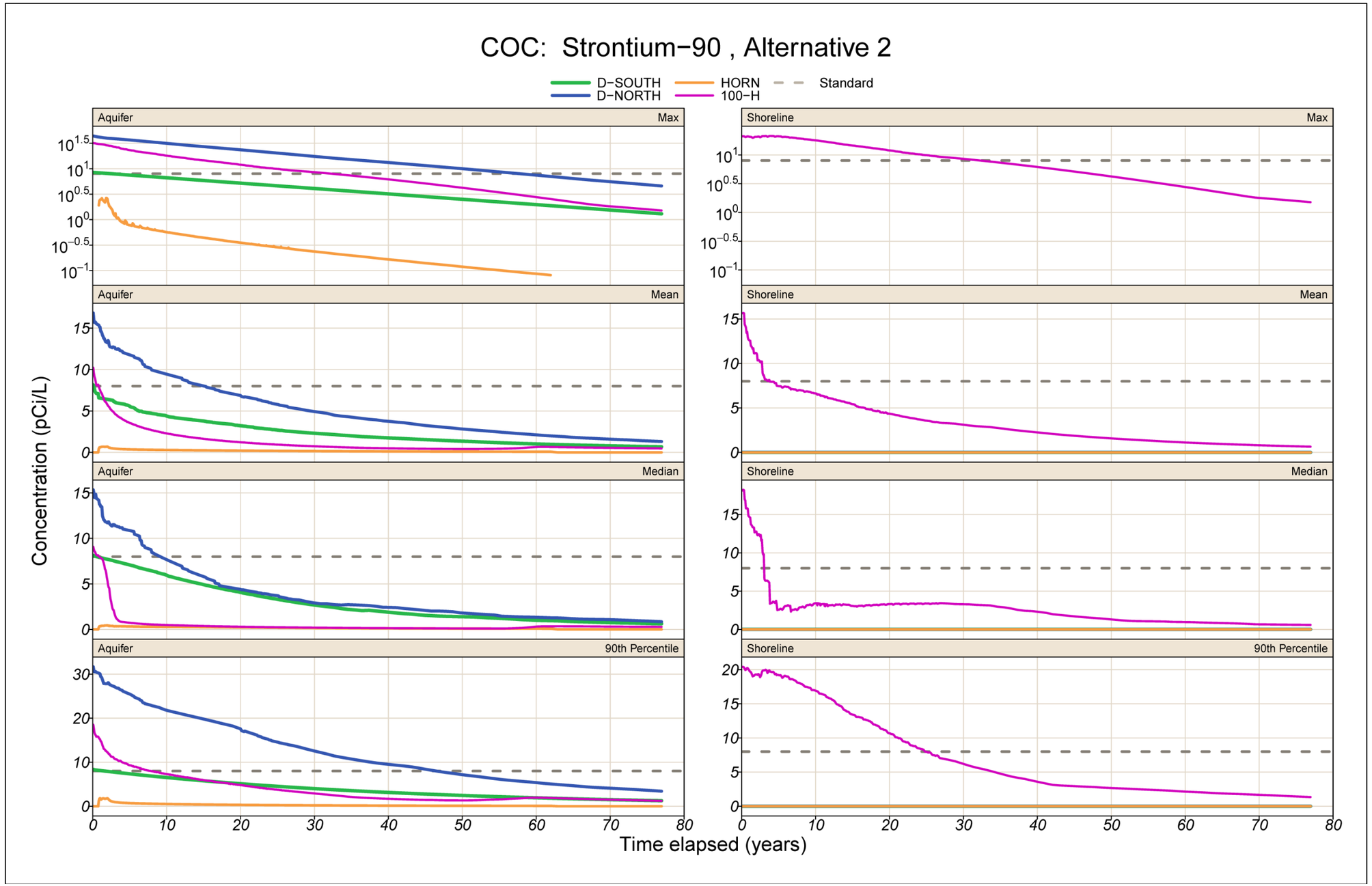

Figure 5-96. Strontium-90: Concentration Statistics – Alternative 2 (All Areas).

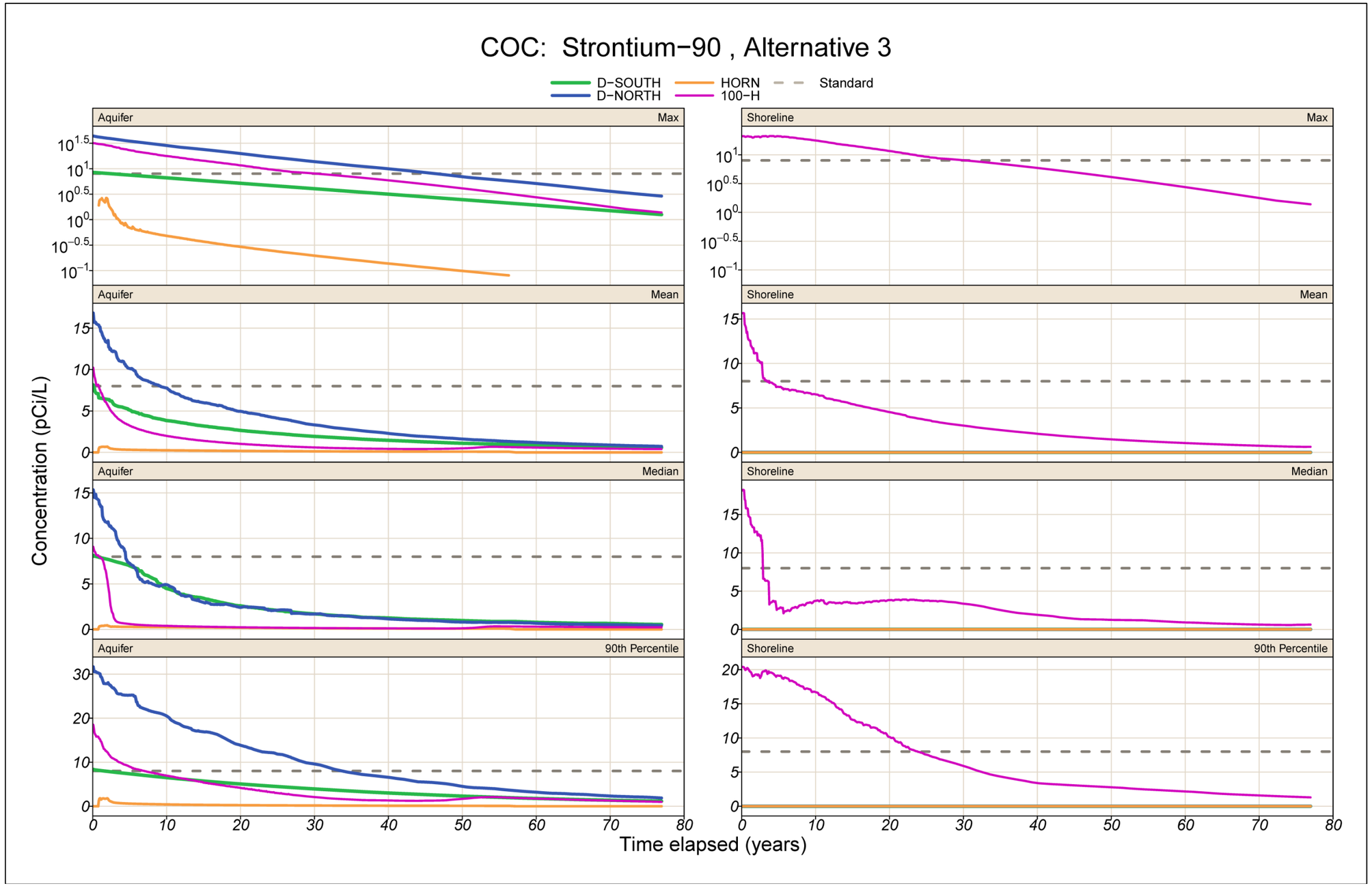

Figure 5-97. Strontium-90: Concentration Statistics – Alternative 3 (All Areas).

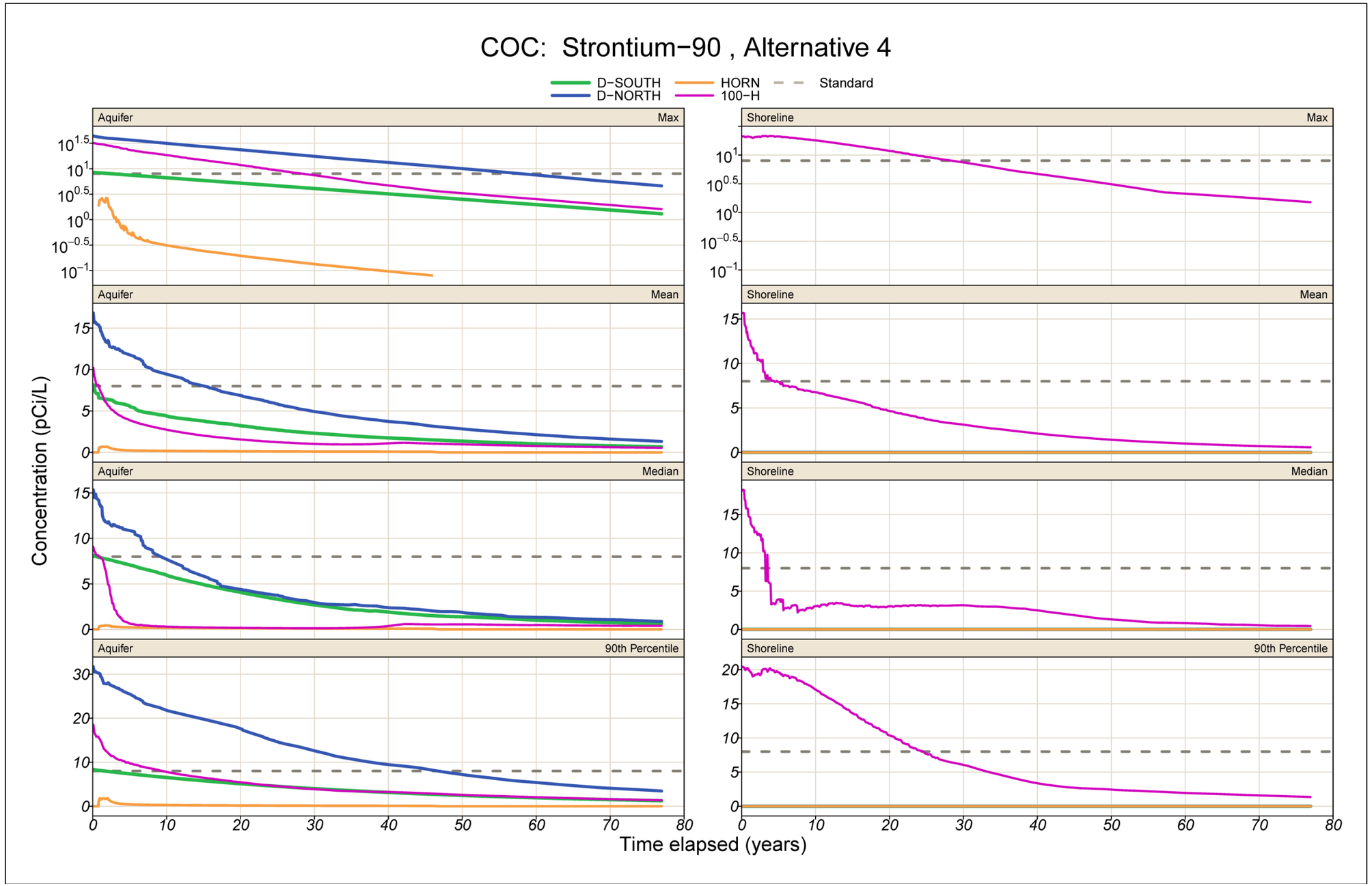

Figure 5-98. Strontium-90: Concentration Statistics – Alternative 4 (All Areas).

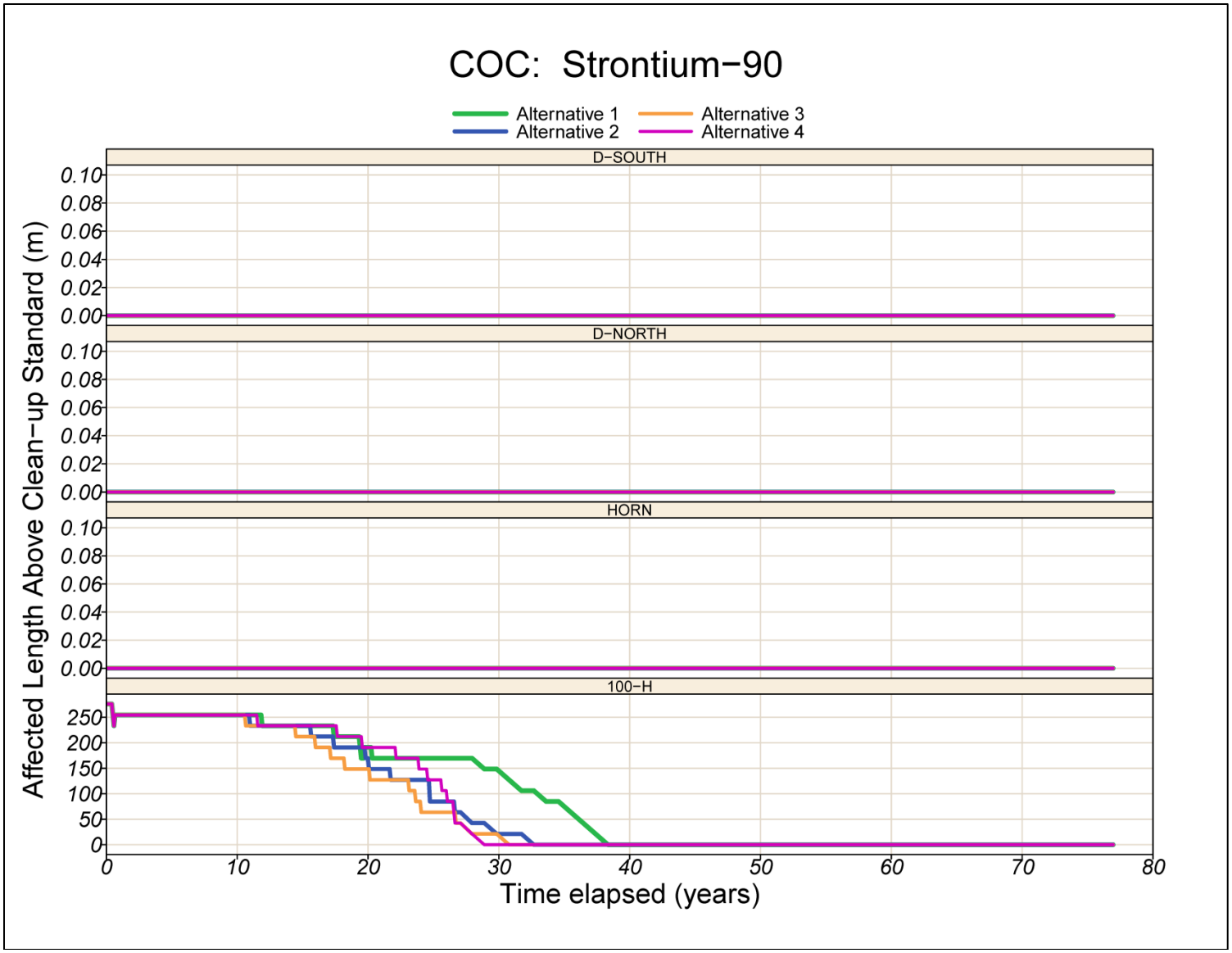

Figure 5-99. Strontium-90: Affected Shoreline Length Above Clean-Up Standard (All Areas-Alternatives).

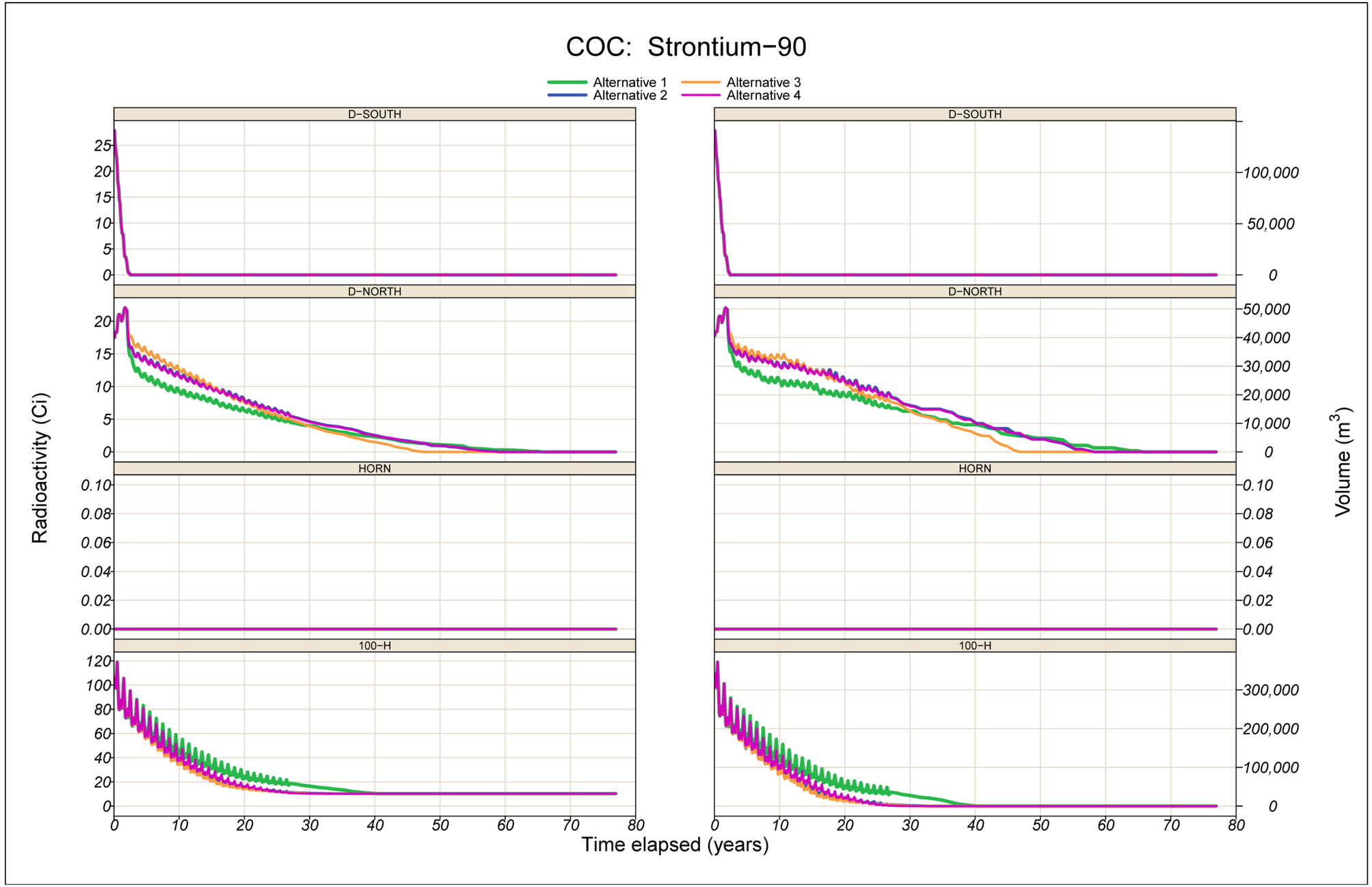

Figure 5-100. Strontium-90: Calculated Mass and Volume – (All Areas-Alternatives).

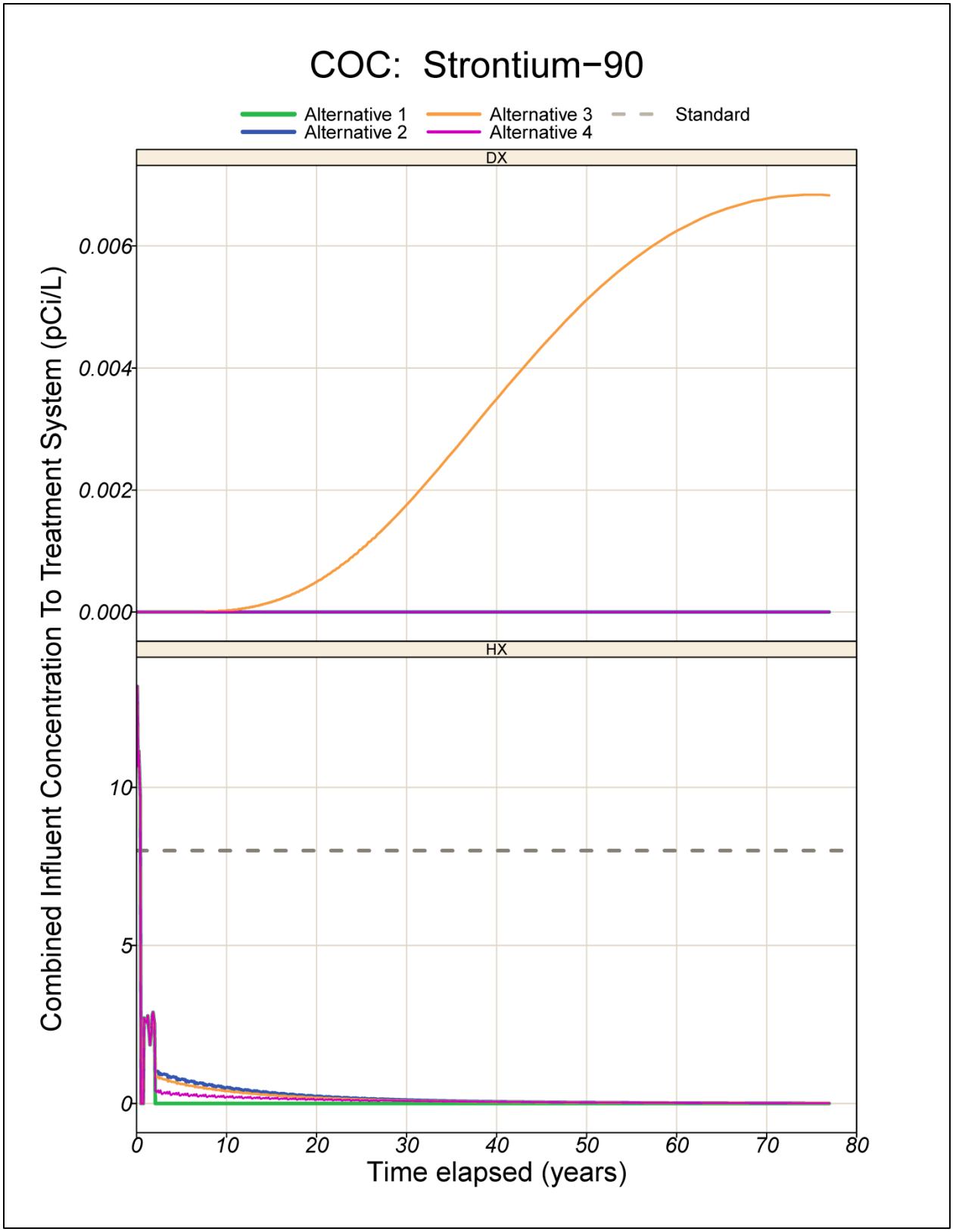

Figure 5-101. Strontium-90: Calculated Influent Concentration at P&T (All Areas-Alternatives)

Table 5-3: Strontium-90 Cleanup Times.

Alternative	Statistic	Strontium-90 Cleanup Time (MCL 8 pCi/L)
Alternative 1 - D-South	Max	3
	90th Percentile	2
	Mean	2
	Median	2
Alternative 1 - D-North	Max	65
	90th Percentile	54
	Mean	22
	Median	19
Alternative 1 - Horn	Max	A.B.S.[1]
	90th Percentile	A.B.S.
	Mean	A.B.S.
	Median	A.B.S.
Alternative 1 - 100 H	Max	40
	90th Percentile	16
	Mean	2
	Median	2
Alternative 2 - D-South	Max	3
	90th Percentile	2
	Mean	2
	Median	2
Alternative 2 - D-North	Max	58
	90th Percentile	46
	Mean	16
	Median	10
Alternative 2 - Horn	Max	A.B.S.
	90th Percentile	A.B.S.
	Mean	A.B.S.
	Median	A.B.S.
Alternative 2 - 100 H	Max	32

Table 5-3: Strontium-90 Cleanup Times.

Alternative	Statistic	Strontium-90 Cleanup Time (MCL 8 pCi/L)
	90th Percentile	8
	Mean	2
	Median	2
Alternative 3 - D-South	Max	3
	90th Percentile	2
	Mean	2
	Median	2
Alternative 3 - D-North	Max	46
	90th Percentile	34
	Mean	10
	Median	5
Alternative 3 - Horn	Max	A.B.S.
	90th Percentile	A.B.S.
	Mean	A.B.S.
	Median	A.B.S.
Alternative 3 - 100 H	Max	30
	90th Percentile	8
	Mean	2
	Median	2
Alternative 4 - D-South	Max	3
	90th Percentile	2
	Mean	2
	Median	2
Alternative 4 - D-North	Max	58
	90th Percentile	46
	Mean	16
	Median	10
Alternative 4 - Horn	Max	A.B.S.
	90th Percentile	A.B.S.

Table 5-3: Strontium-90 Cleanup Times.

Alternative	Statistic	Strontium-90 Cleanup Time (MCL 8 pCi/L)
	Mean	A.B.S.
	Median	A.B.S.
Alternative 4 - 100 H	Max	28
	90th Percentile	10
	Mean	2
	Median	2

[1] The calculated concentration is always lower than the corresponding standard.

5.2.3 Simulated Contaminant Distributions – Concentration Statistics: Nitrate

The model results for Nitrate are grouped in the following sets of figures:

1. Figures 5-102 to 5-125: simulated distributions for each alternative.
2. Figures 5-126 to 5-129: summary concentration statistics for each area (all alternatives).
3. Figures 5-130 to 5-133: summary concentration statistics for each alternative (all areas).
4. Figure 5-134: Affected shoreline length above clean-up standard (all areas and alternatives).
5. Figure 5-135: Calculated plume mass and volume (all areas and alternatives).
6. Figure 5-136: Calculated influent concentration at each P&T (all areas and alternatives).

Estimated cleanup times based on the calculated concentration statistics are summarized in Table 5-4.

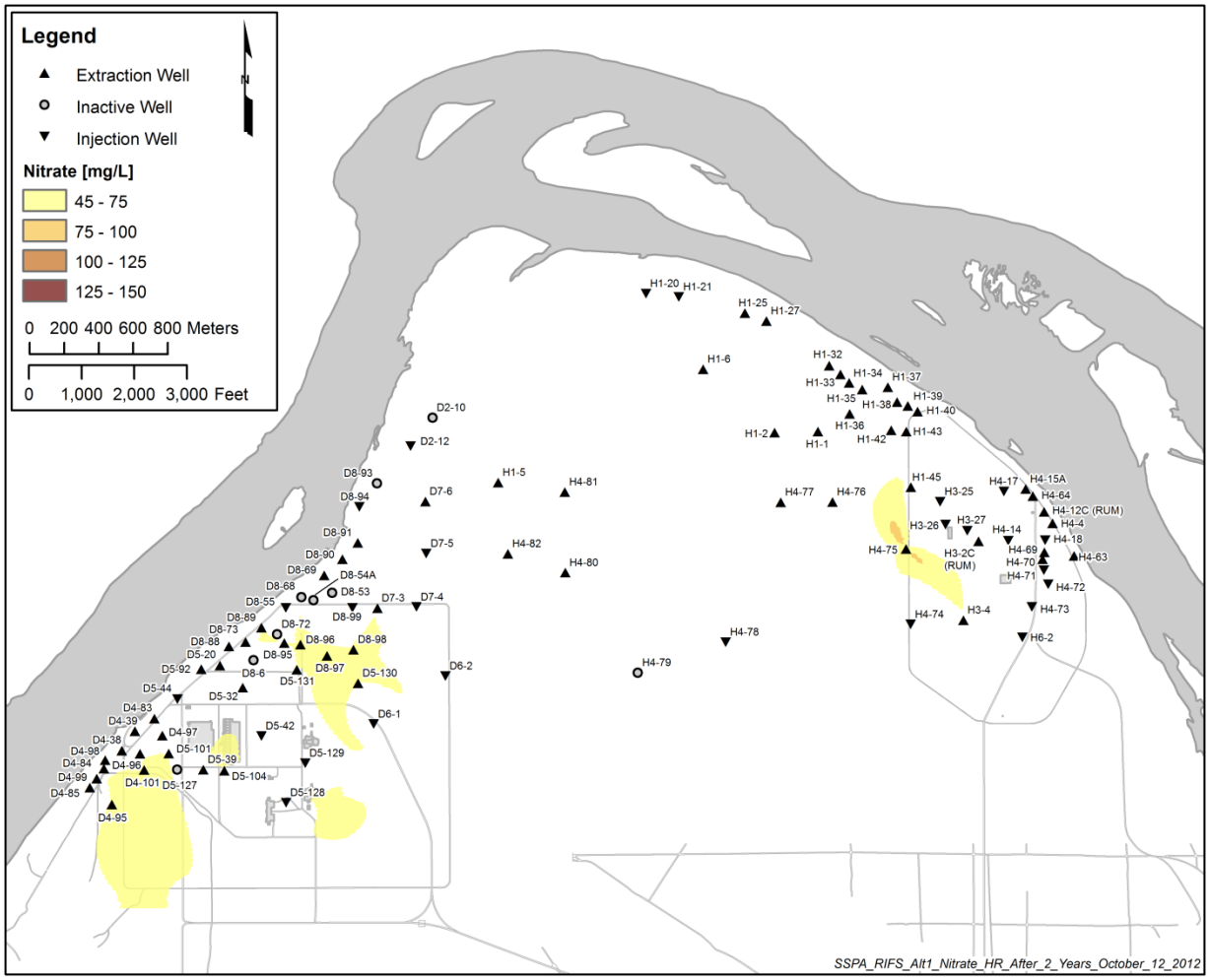

Figure 5-102. Simulated Distribution of Nitrate after 2 Years – Alternative 1.

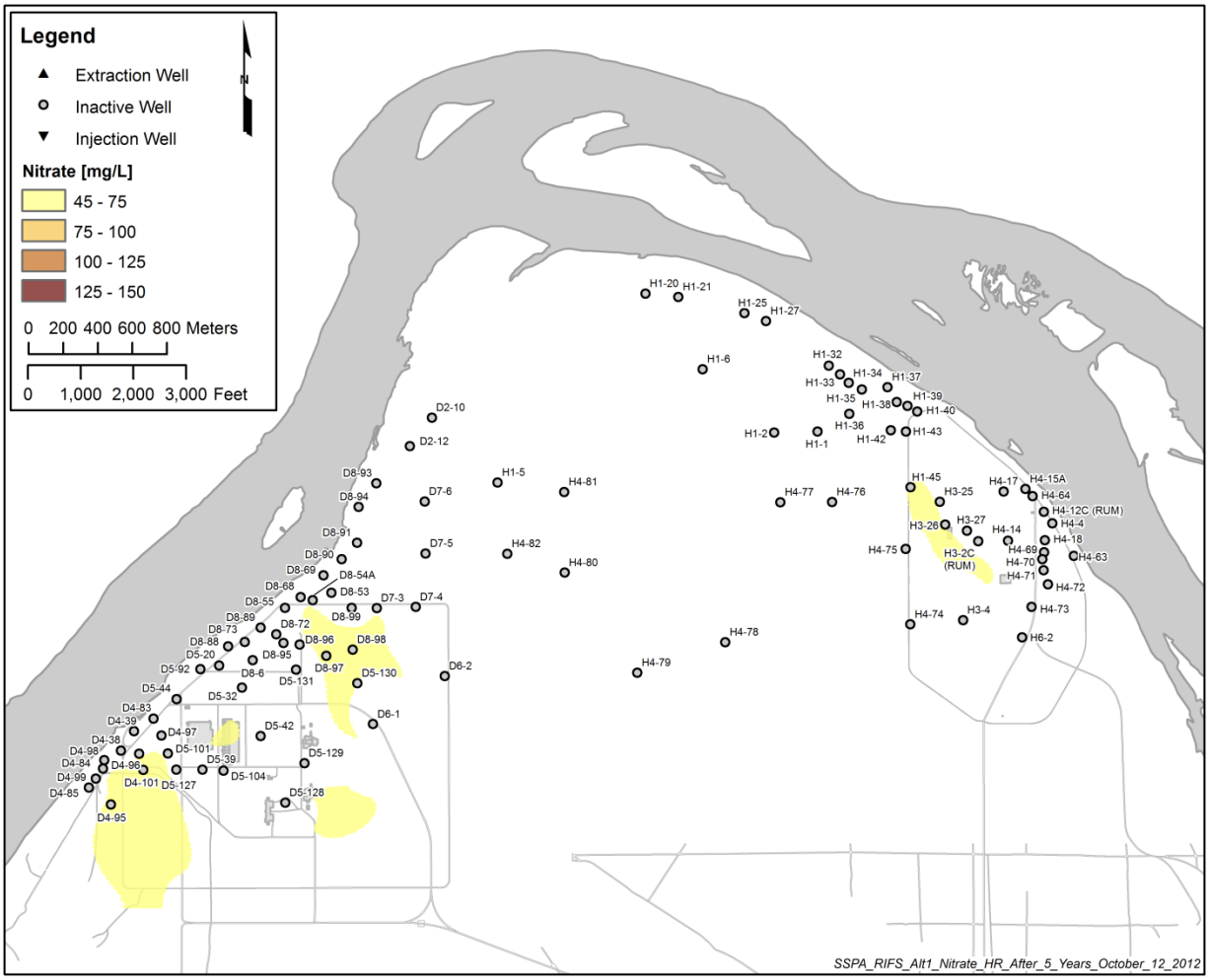

Figure 5-103. Simulated Distribution of Nitrate after 5 Years – Alternative 1.

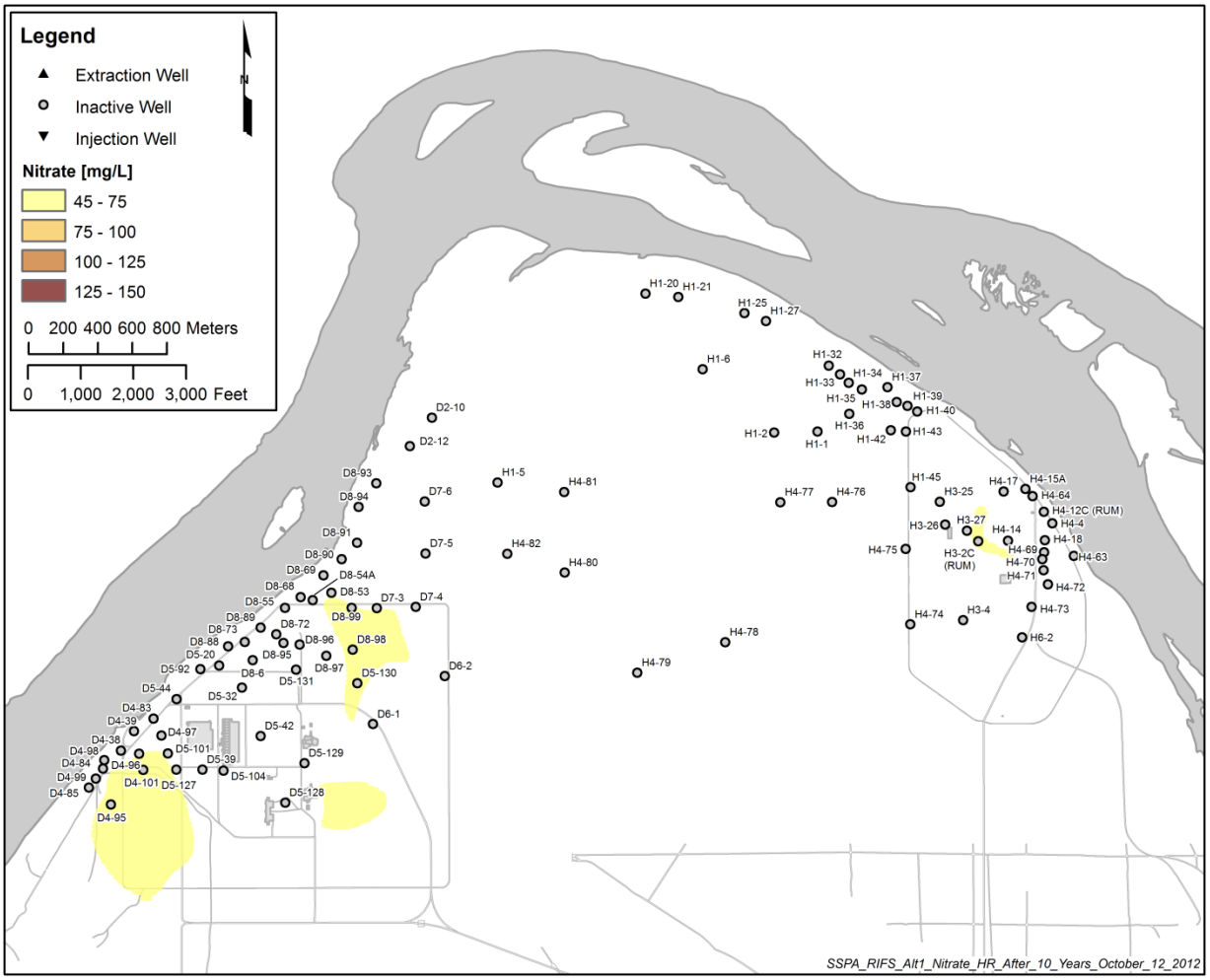

Figure 5-104. Simulated Distribution of Nitrate after 10 Years – Alternative 1.

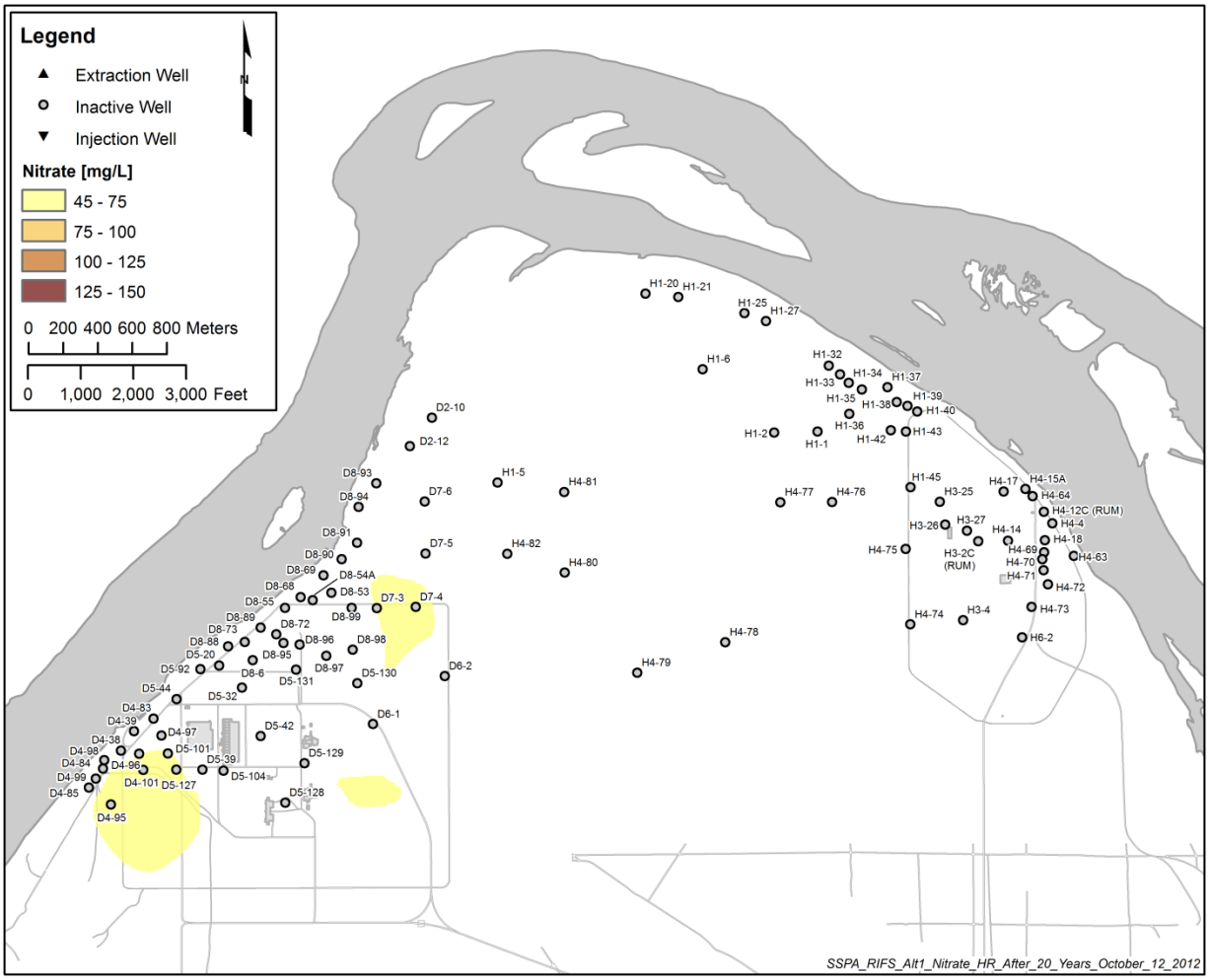

Figure 5-105. Simulated Distribution of Nitrate after 20 Years – Alternative 1.

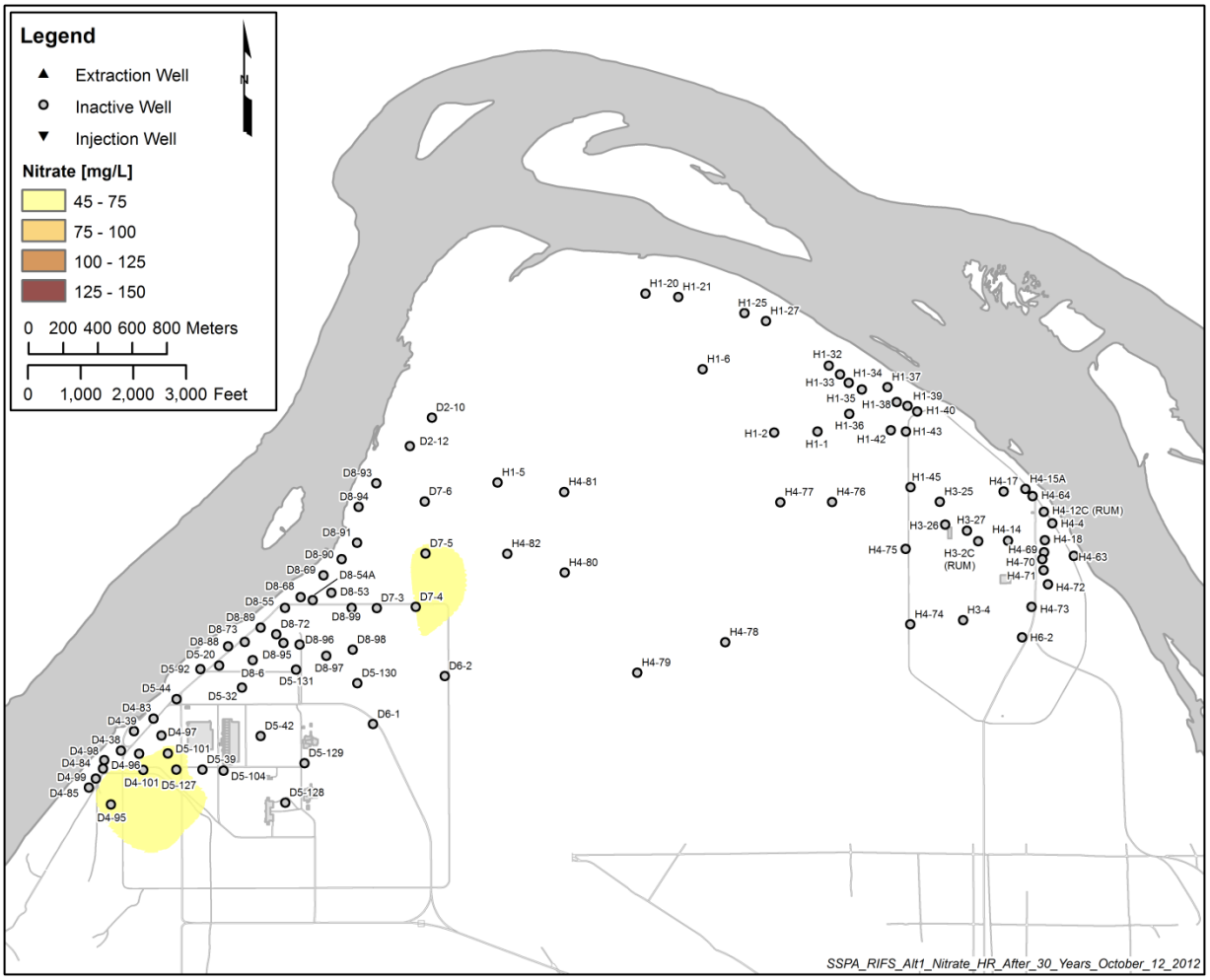

Figure 5-106. Simulated Distribution of Nitrate after 30 Years – Alternative 1.

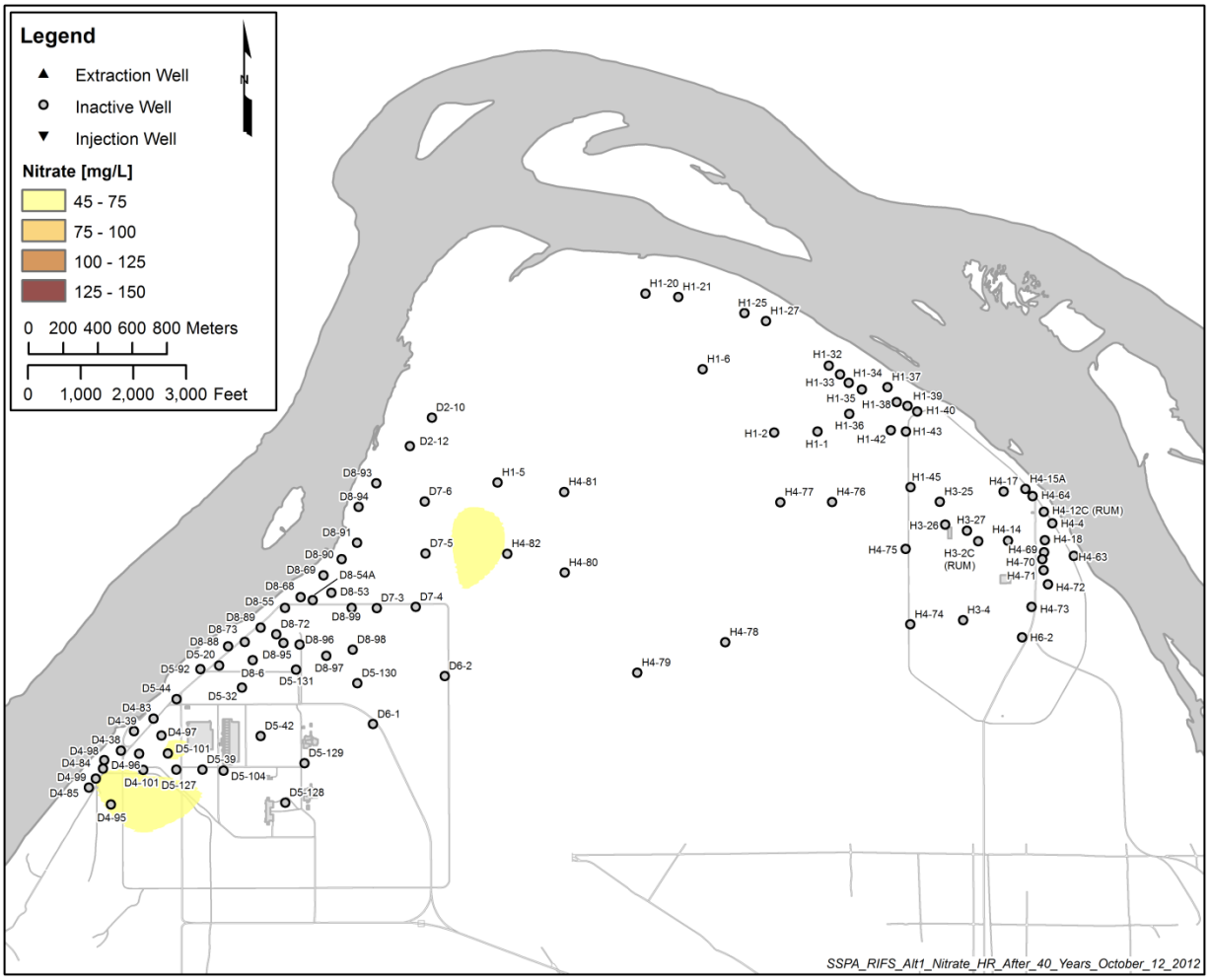

Figure 5-107. Simulated Distribution of Nitrate after 40 Years – Alternative 1.

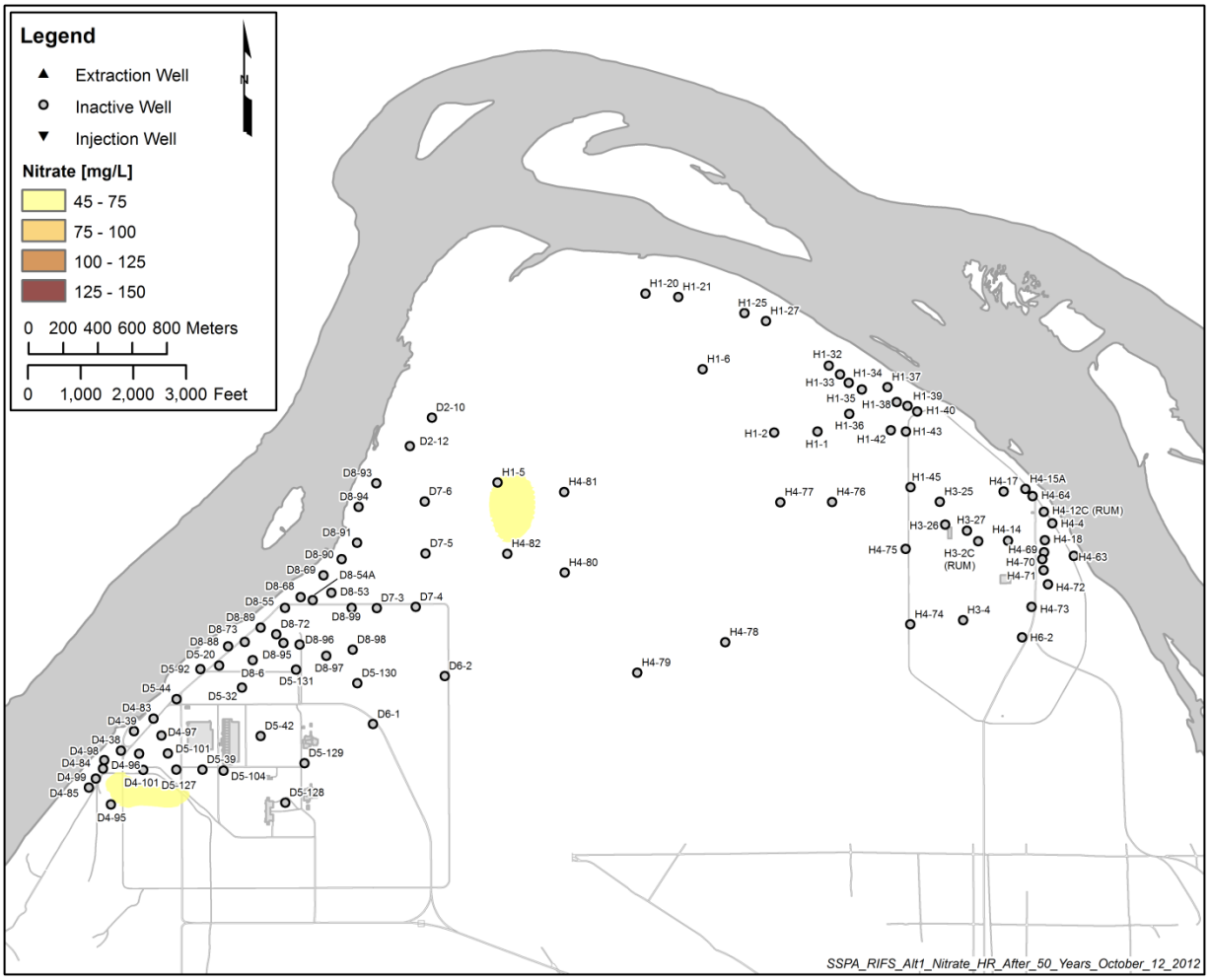

Figure 5-108. Simulated Distribution of Nitrate after 50 Years – Alternative 1.

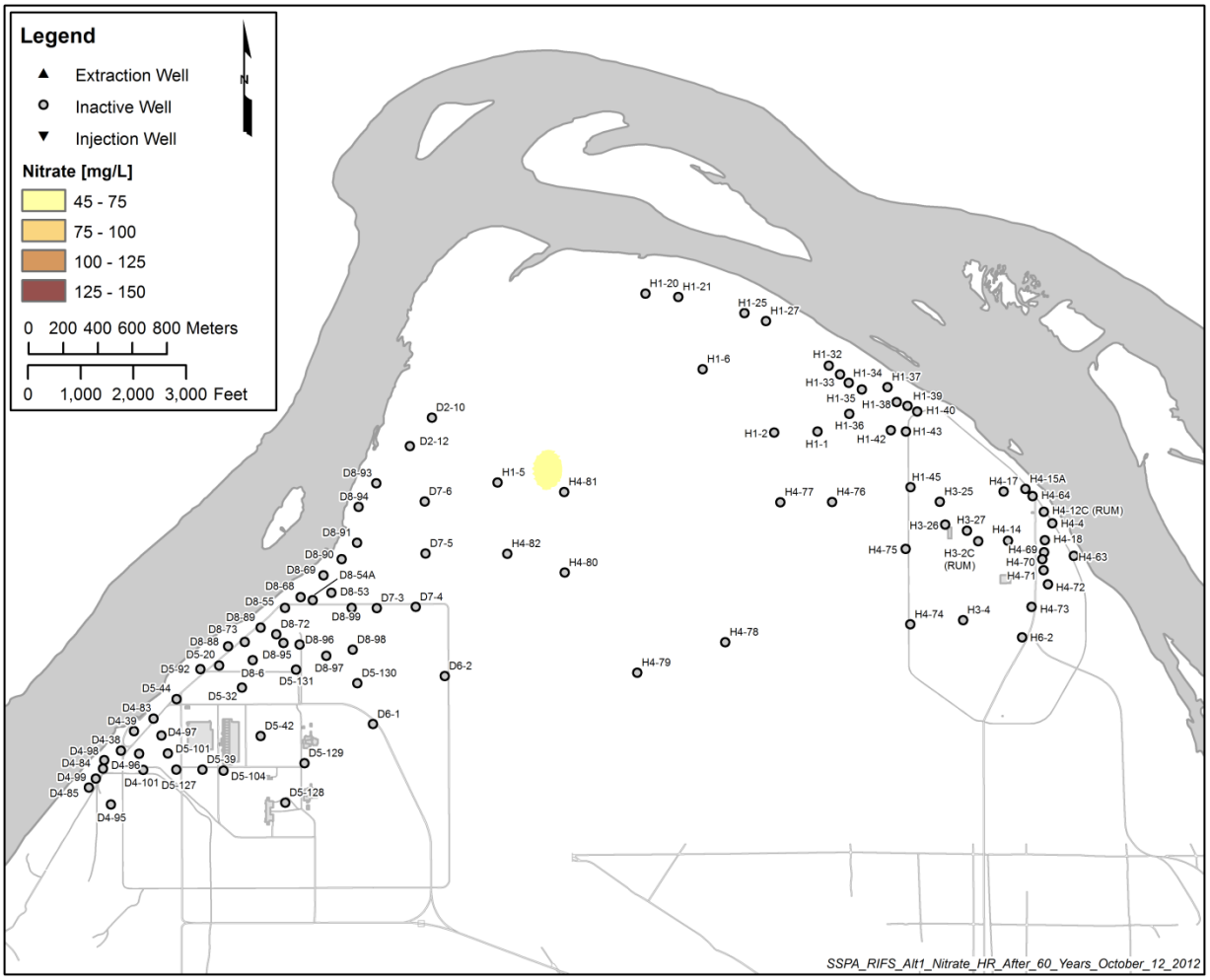

Figure 5-109. Simulated Distribution of Nitrate after 60 Years – Alternative 1.

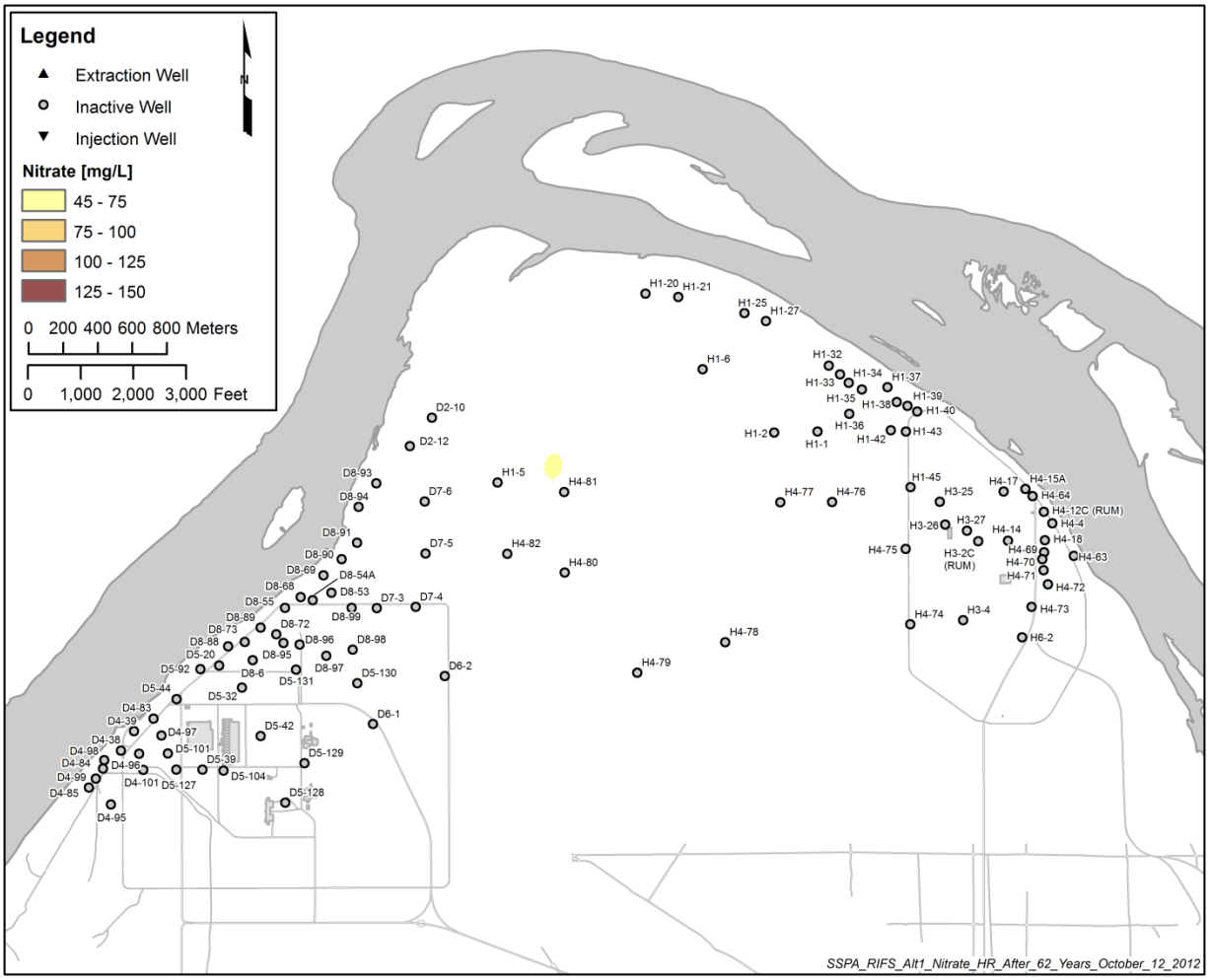

Figure 5-110. Simulated Distribution of Nitrate after 62 Years – Alternative 1.

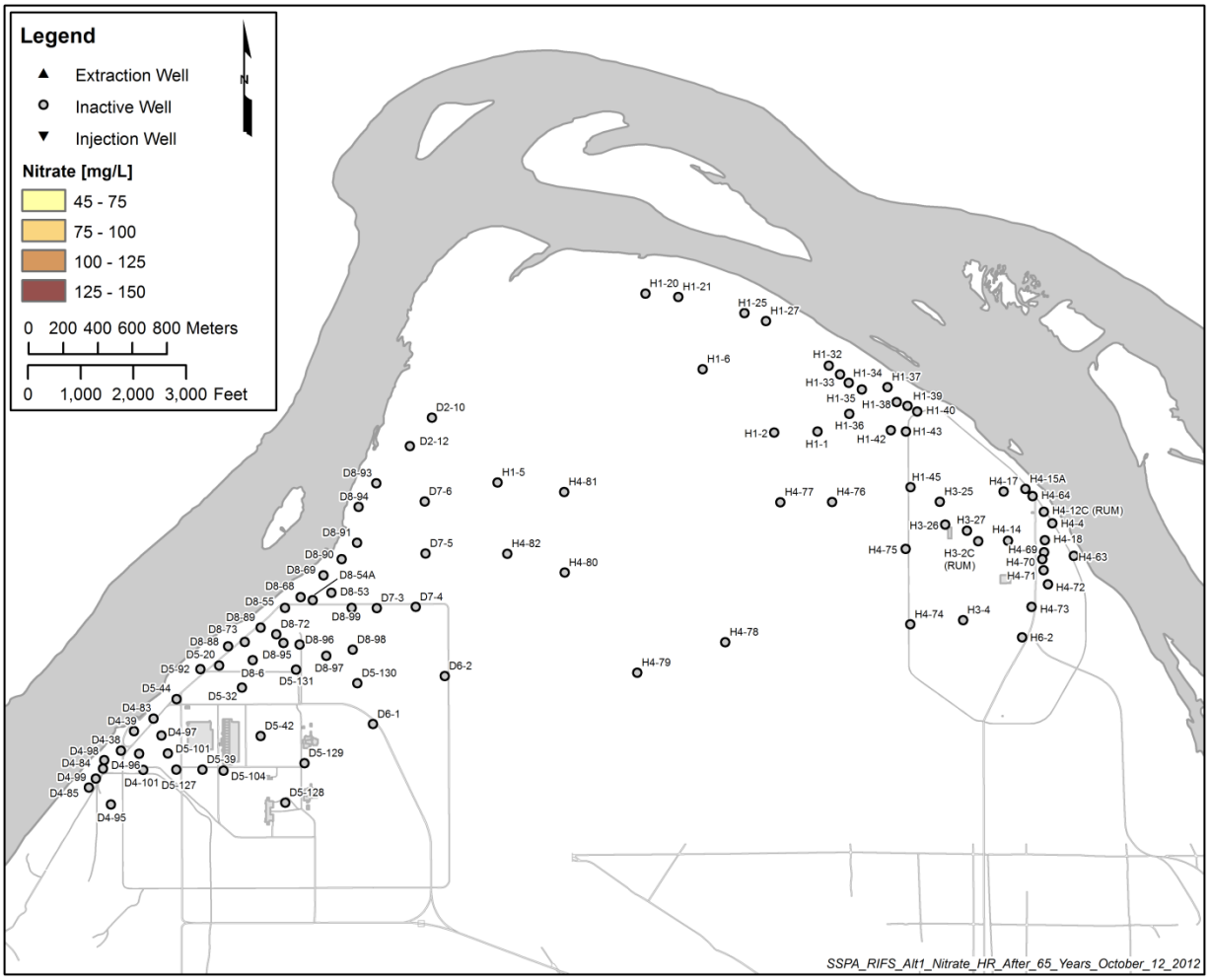

Figure 5-111. Simulated Distribution of Nitrate after 65 Years – Alternative 1.

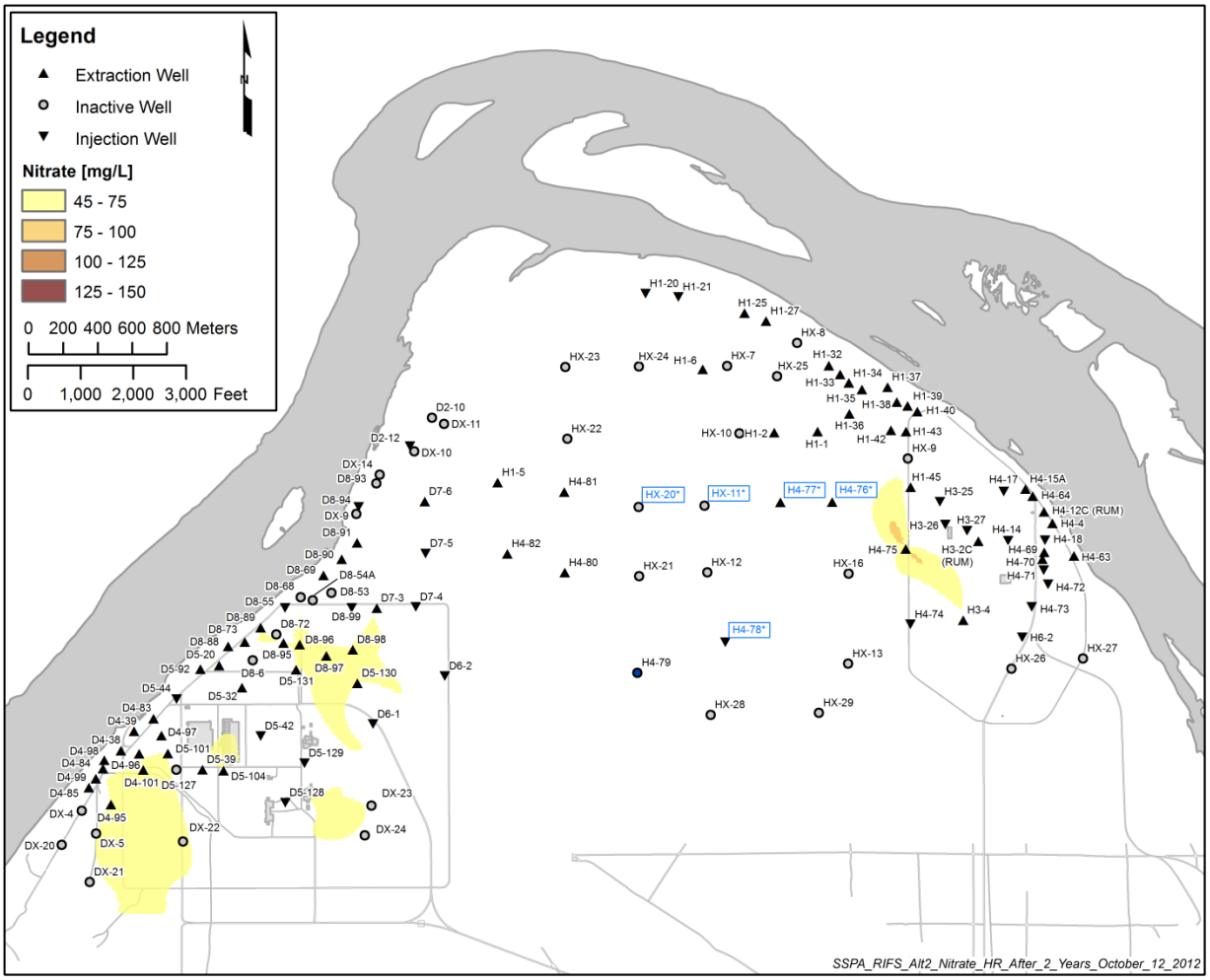

Figure 5-112. Simulated Distribution of Nitrate after 2 Years – Alternative 2.

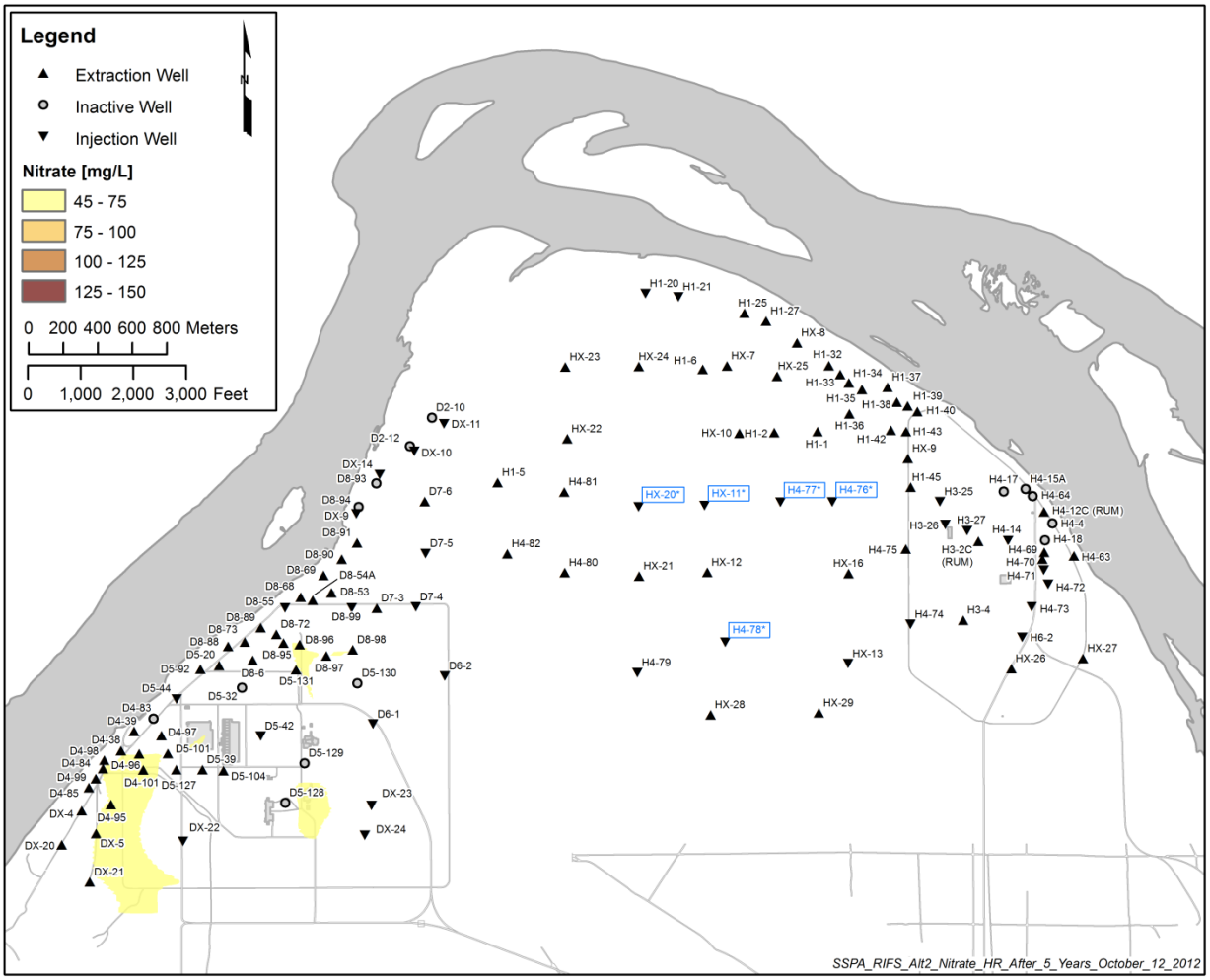

Figure 5-113. Simulated Distribution of Nitrate after 5 Years – Alternative 2.

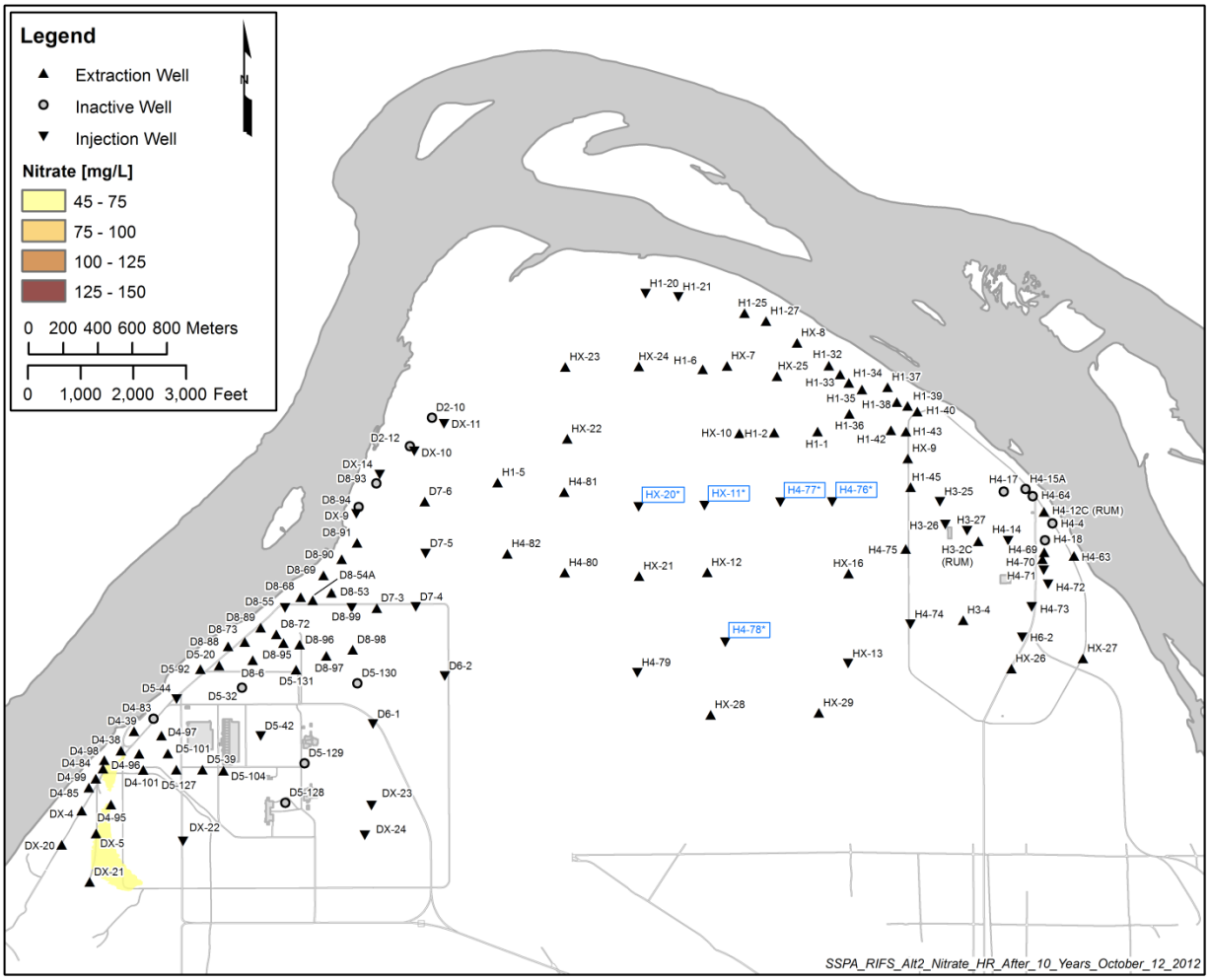

Figure 5-114. Simulated Distribution of Nitrate after 10 Years – Alternative 2.

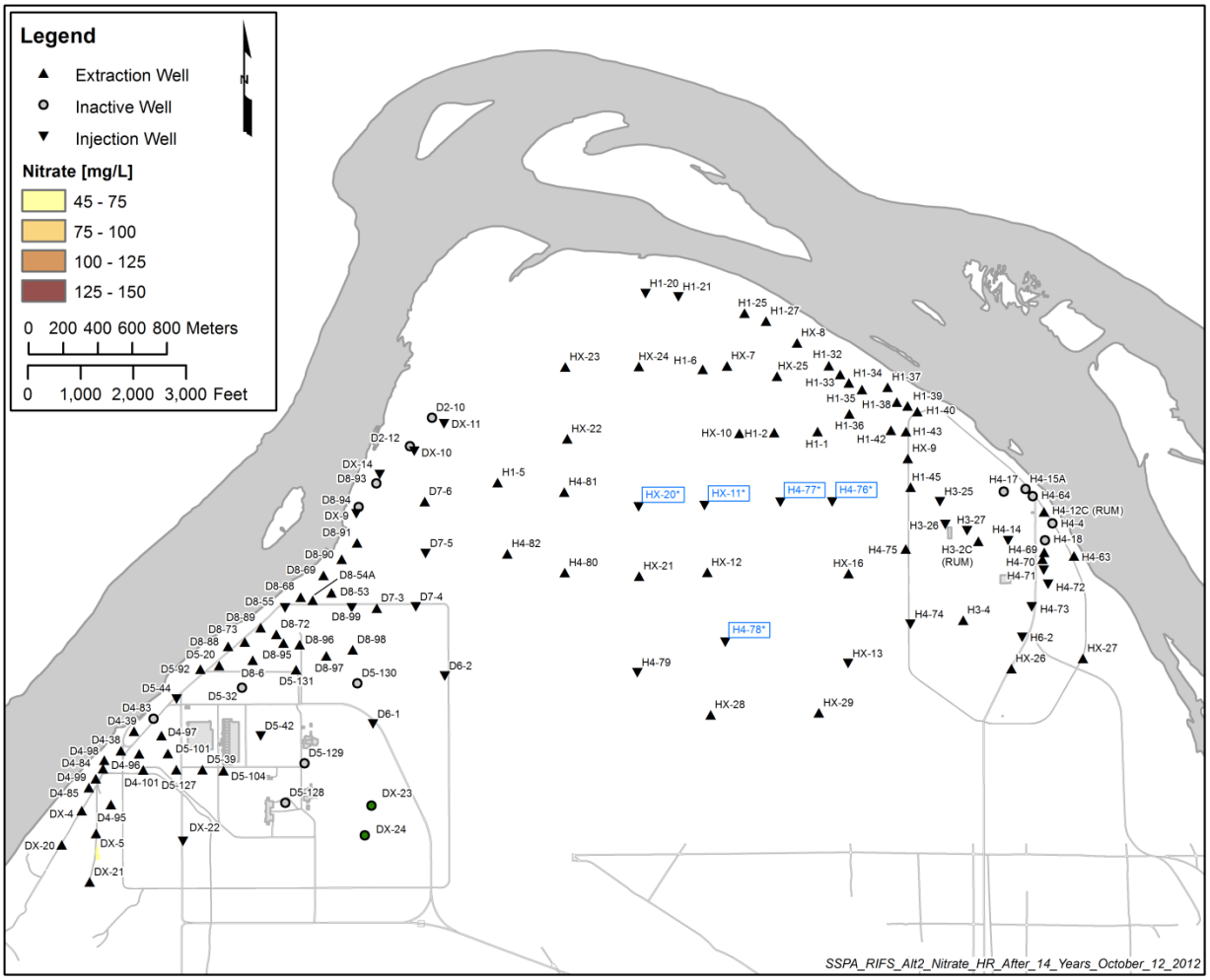

Figure 5-115. Simulated Distribution of Nitrate after 14 Years – Alternative 2.

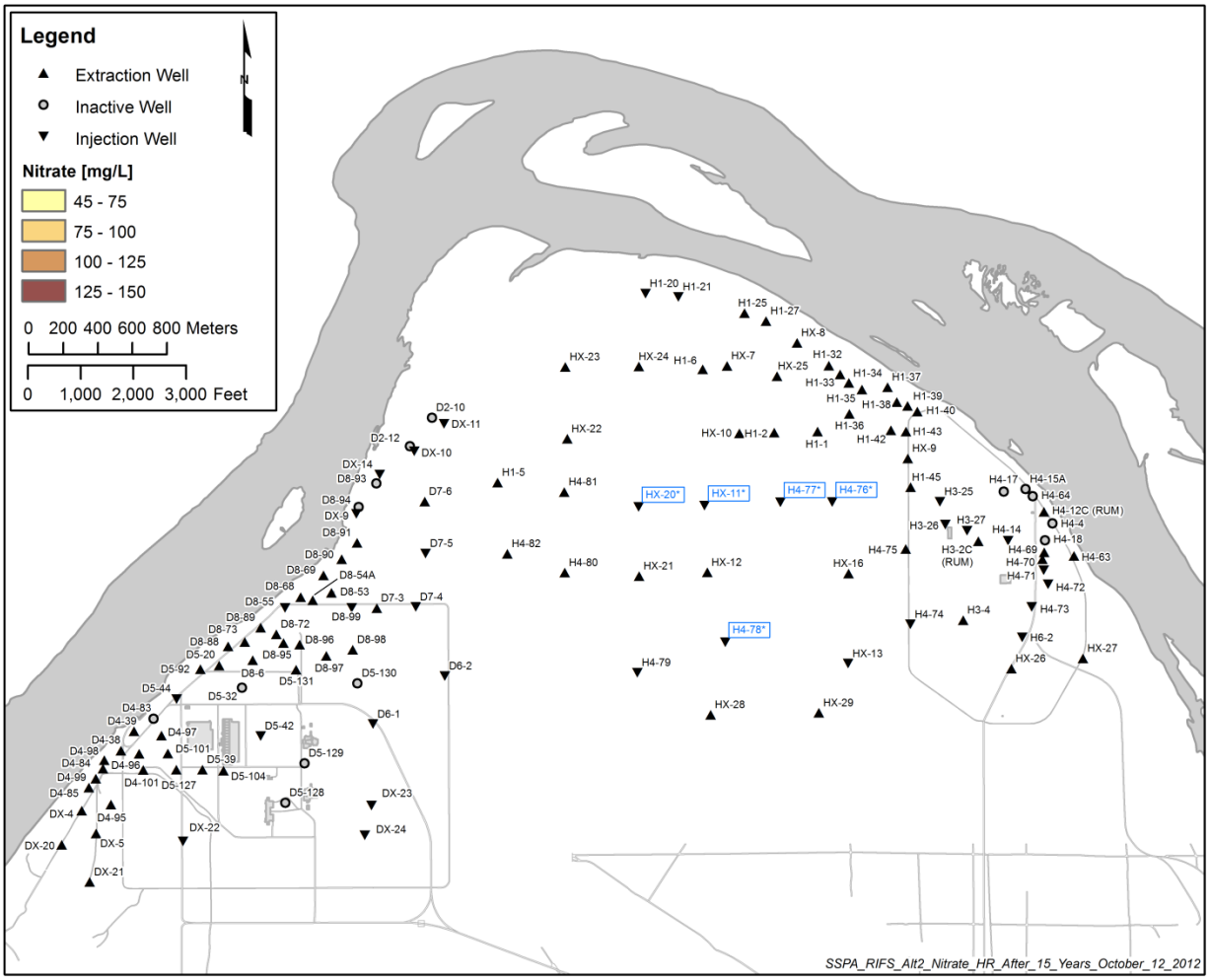

Figure 5-116. Simulated Distribution of Nitrate after 15 Years – Alternative 2.

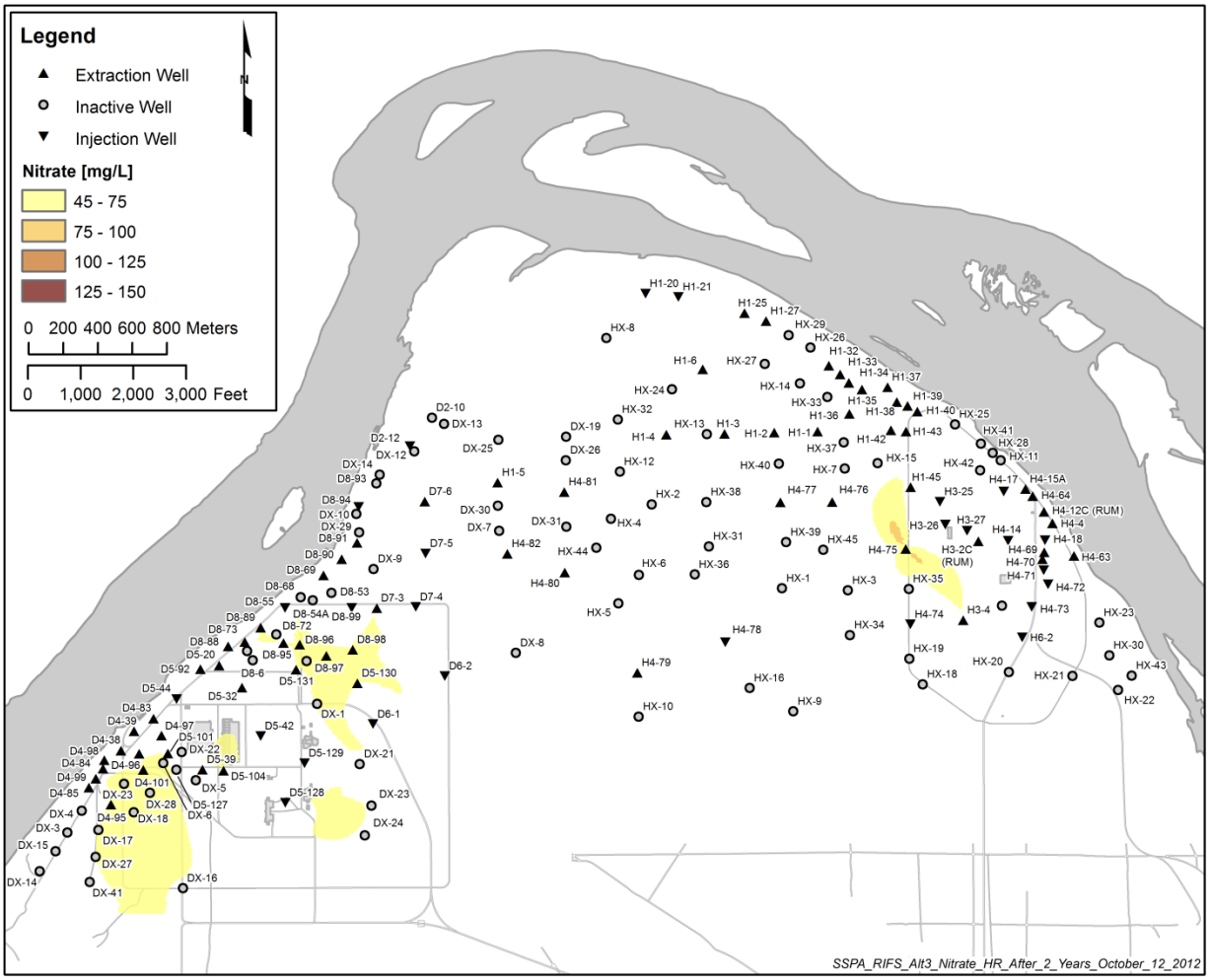

Figure 5-117. Simulated Distribution of Nitrate after 2 Years – Alternative 3.

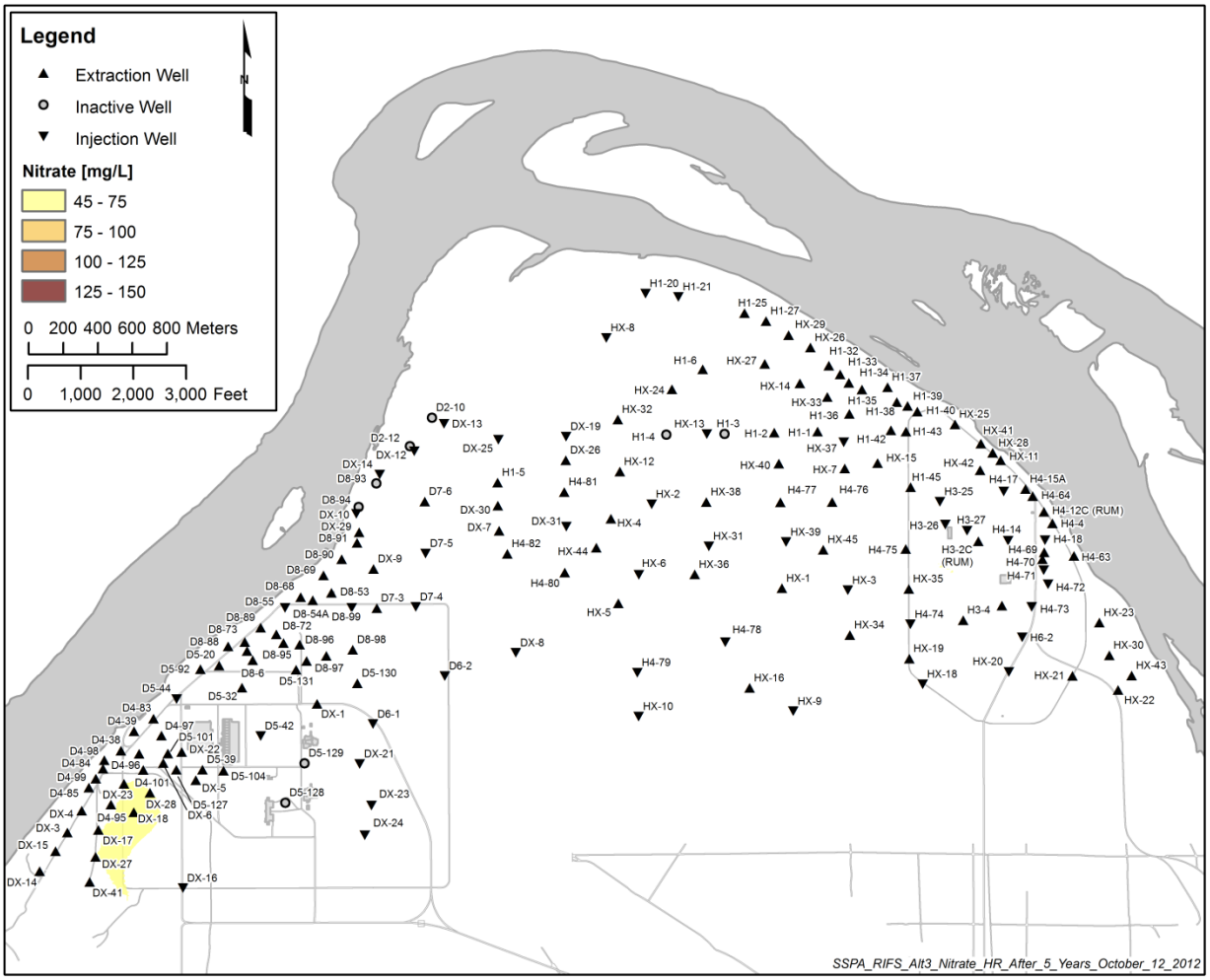

Figure 5-118. Simulated Distribution of Nitrate after 5 Years – Alternative 3.

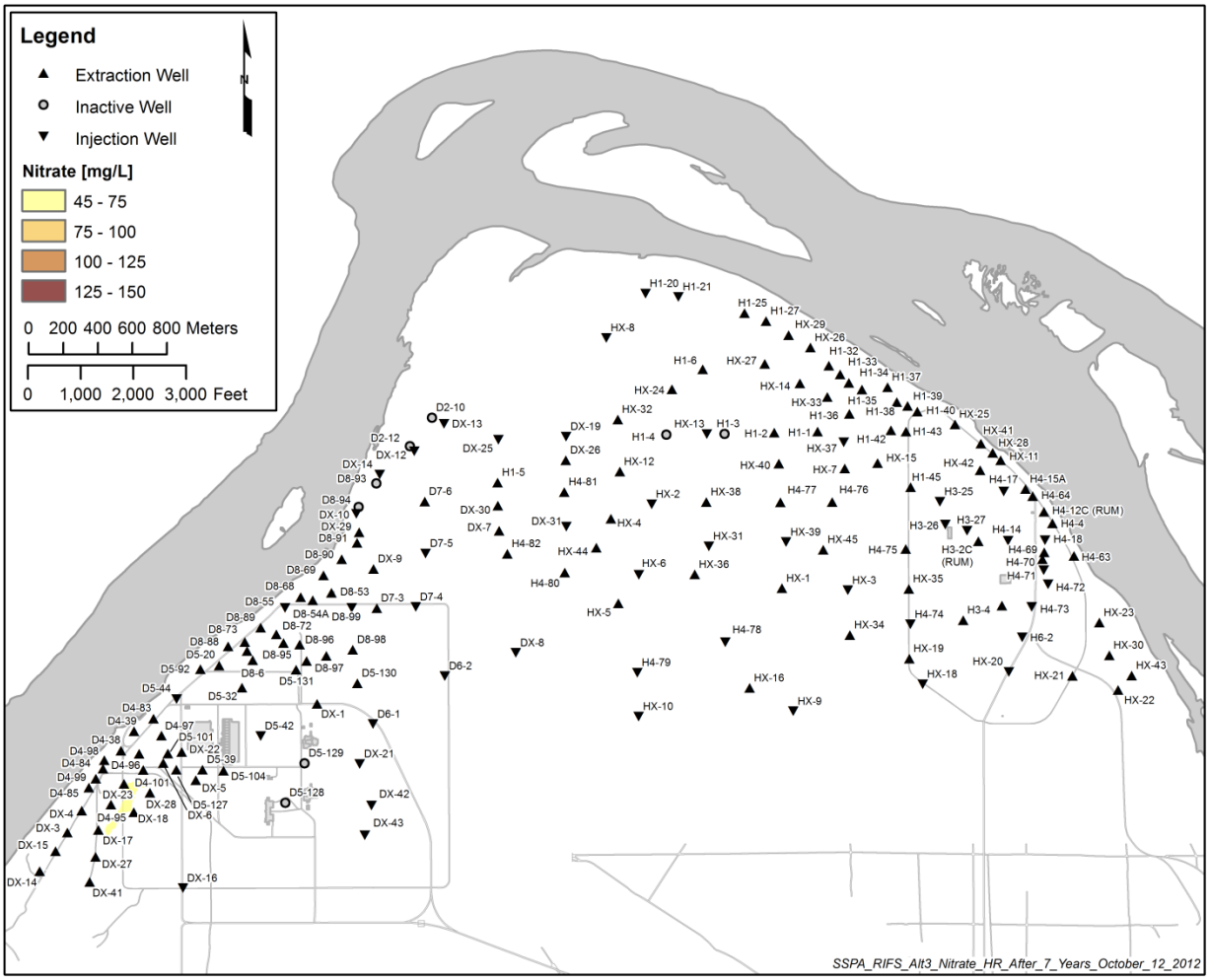

Figure 5-119. Simulated Distribution of Nitrate after 7 Years – Alternative 3.

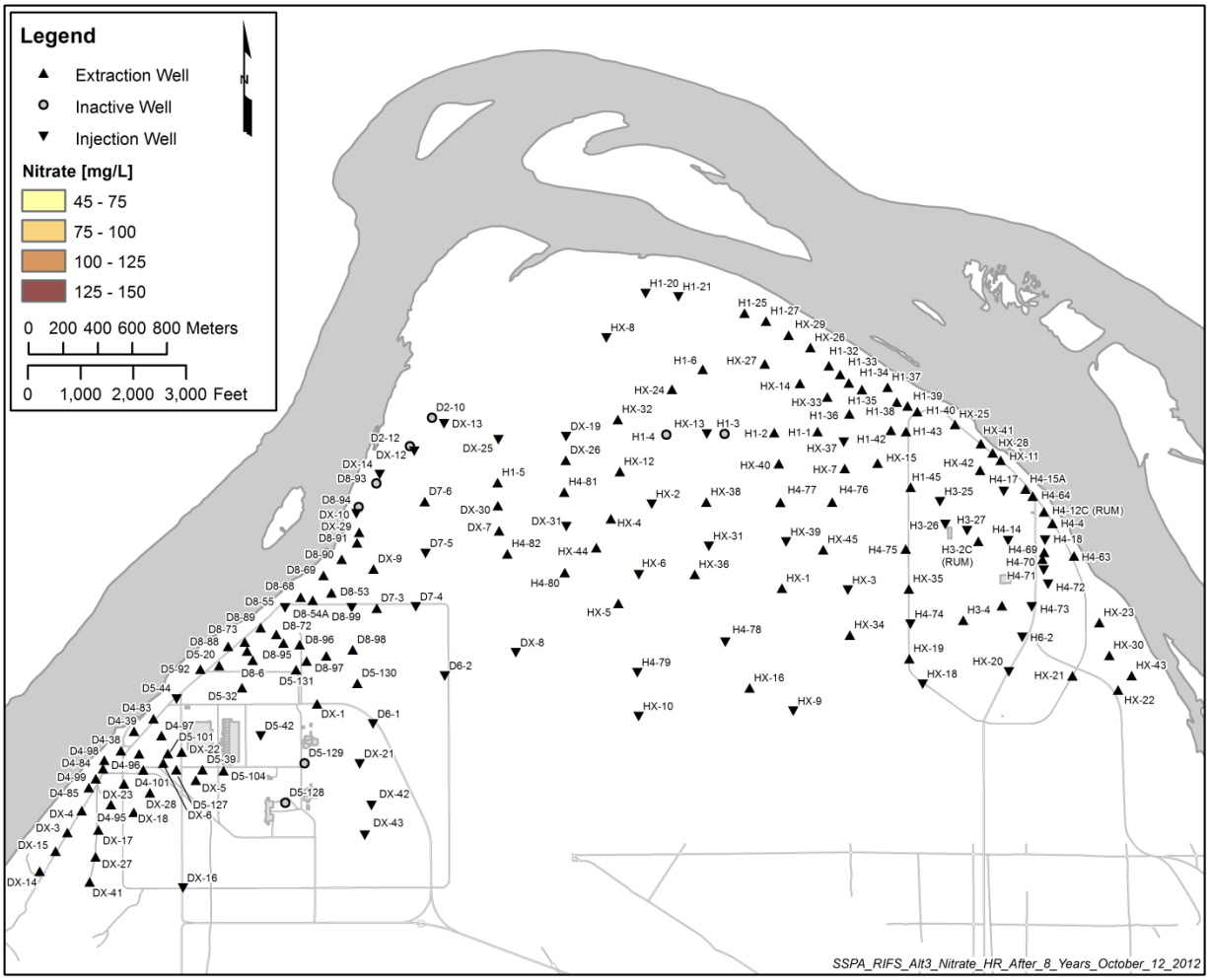

Figure 5-120. Simulated Distribution of Nitrate after 8 Years – Alternative 3.

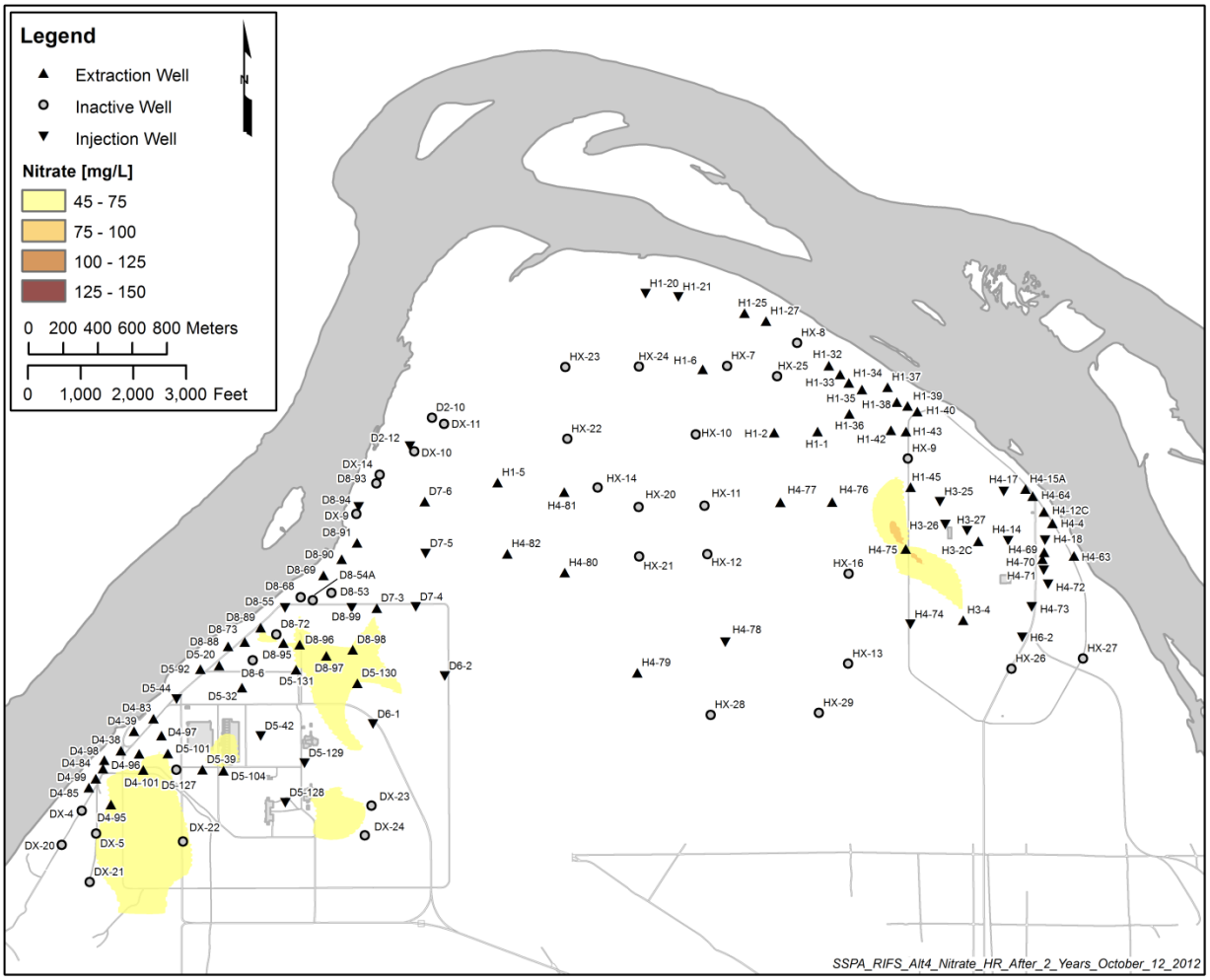

Figure 5-121. Simulated Distribution of Nitrate after 2 Years – Alternative 4.

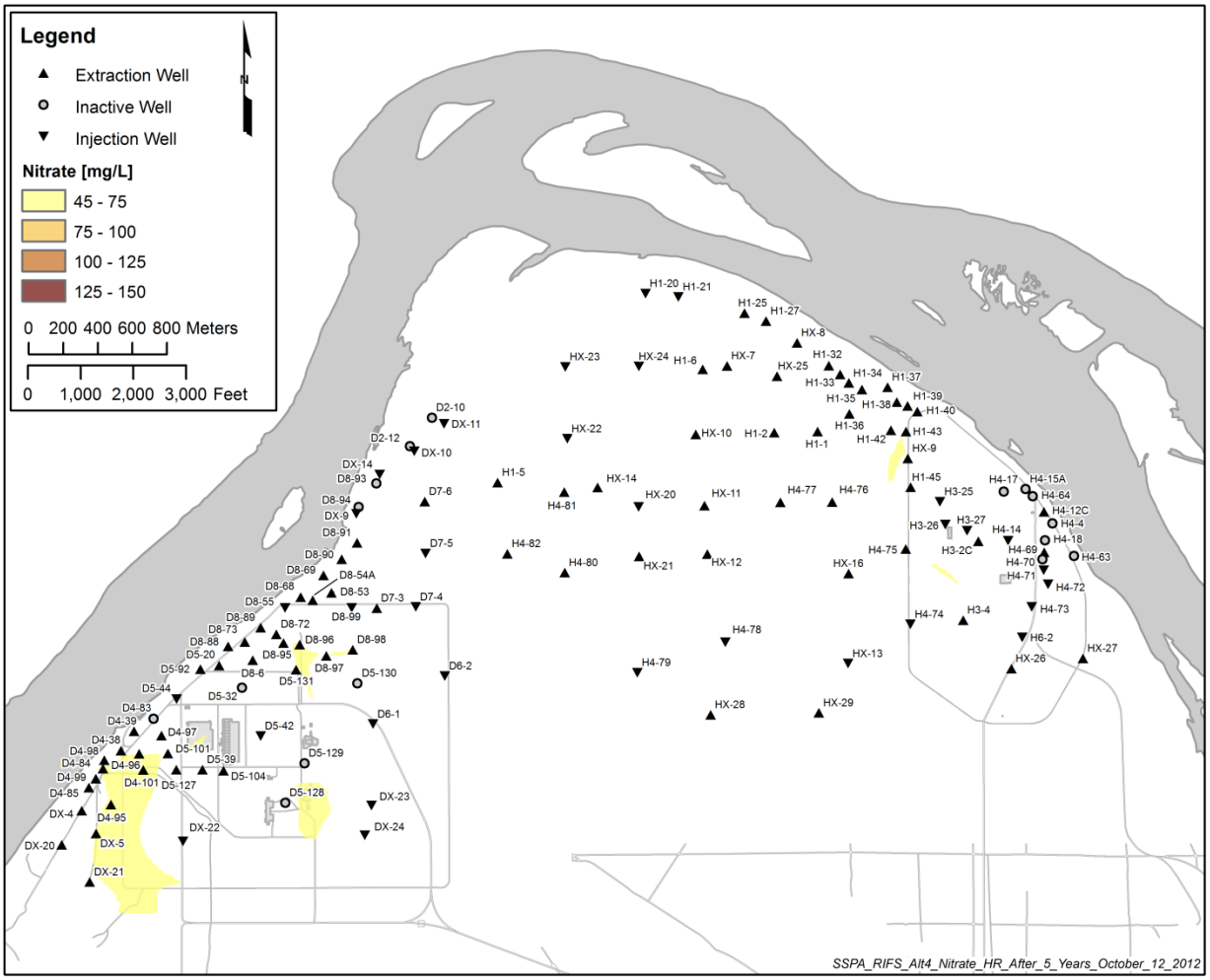

Figure 5-122. Simulated Distribution of Nitrate after 5 Years – Alternative 4.

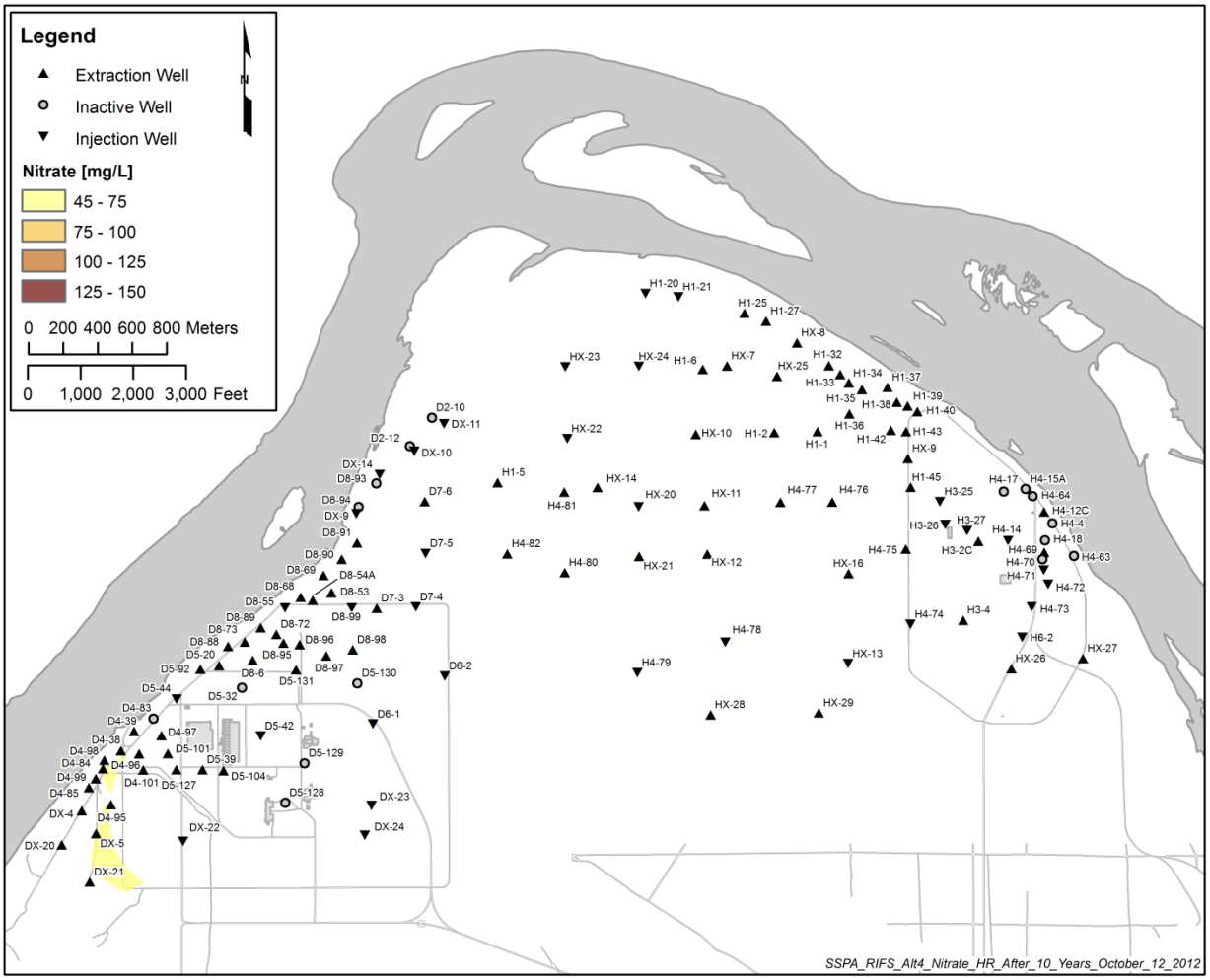

Figure 5-123. Simulated Distribution of Nitrate after 10 Years – Alternative 4.

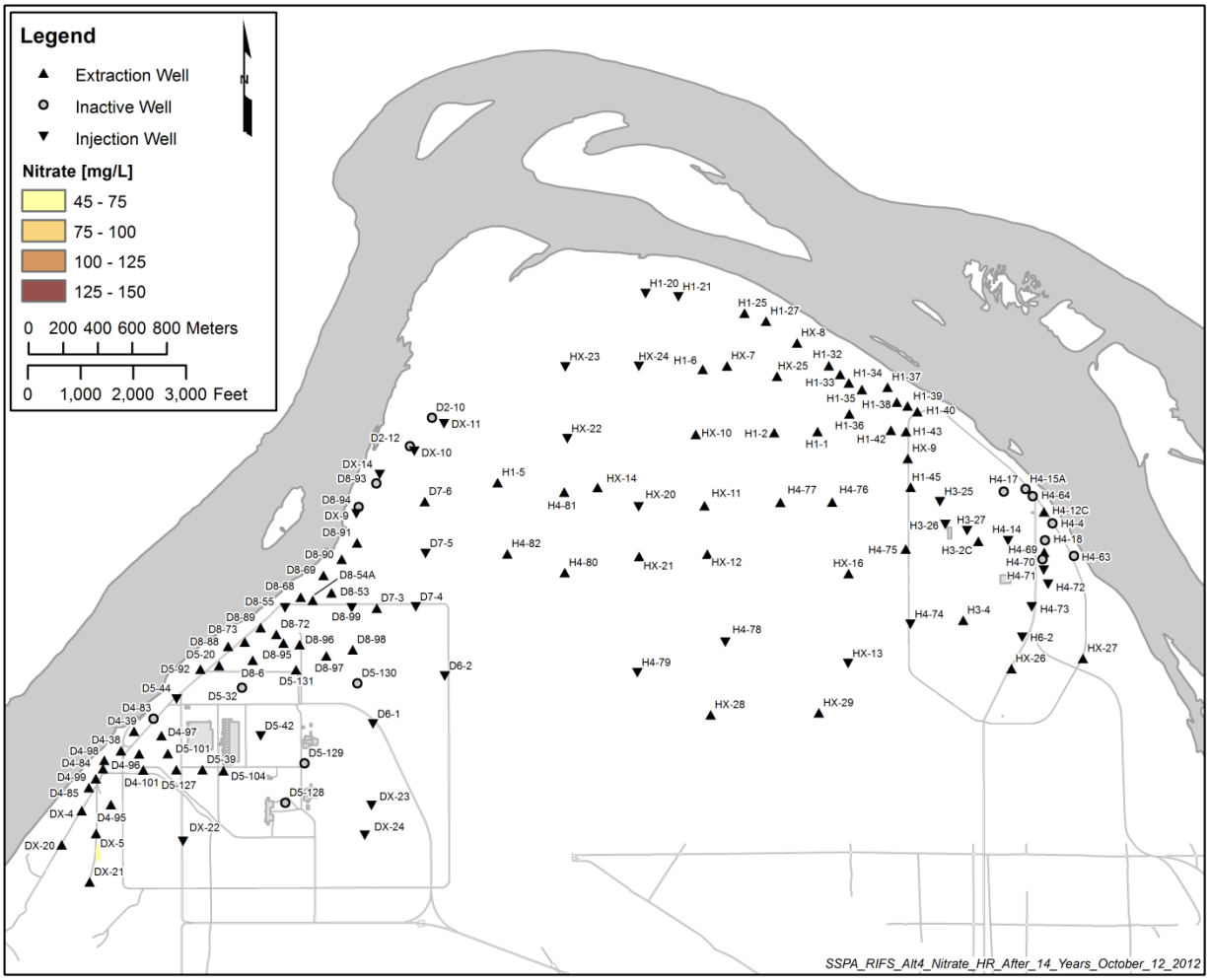

Figure 5-124. Simulated Distribution of Nitrate after 14 Years – Alternative 4.

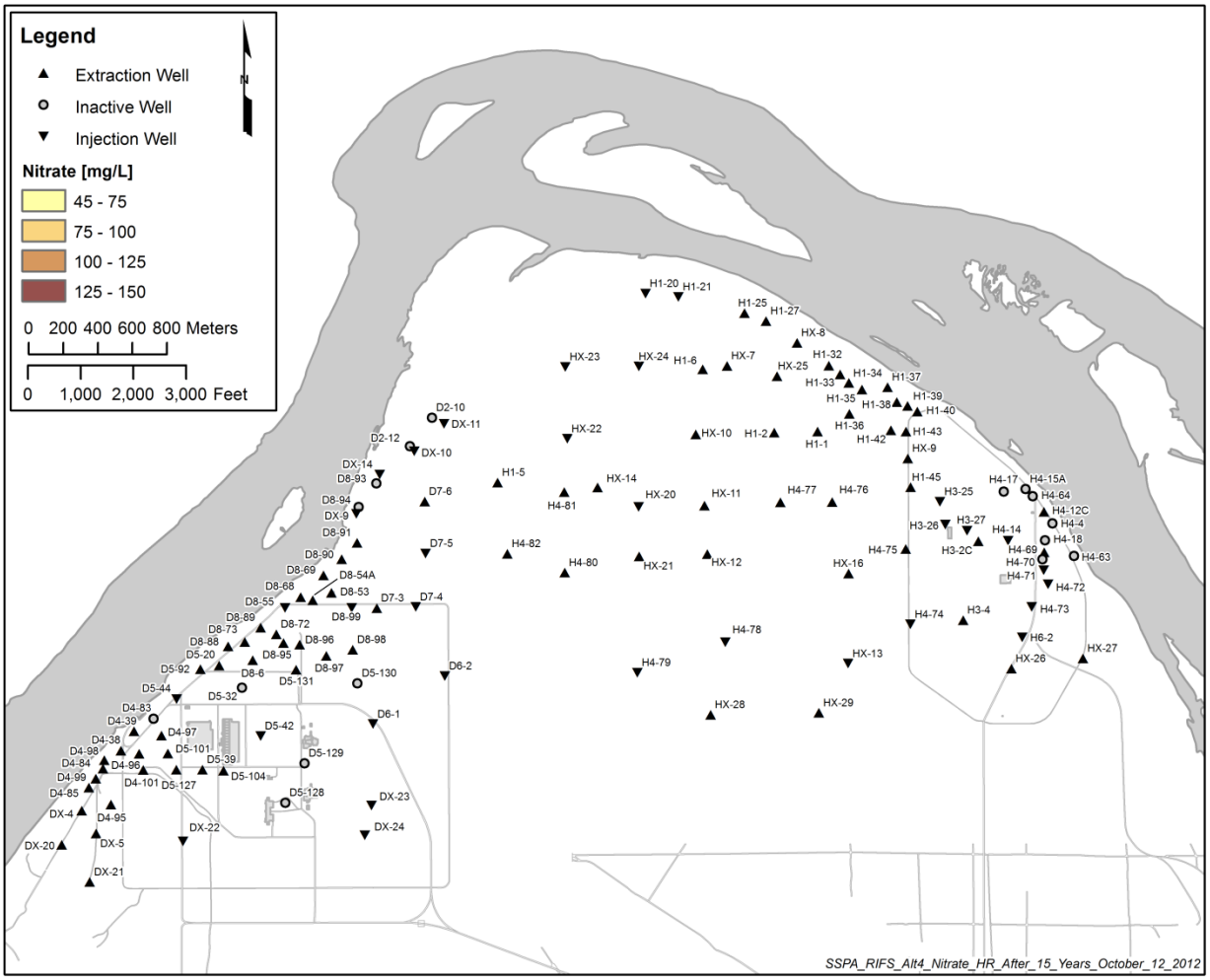

Figure 5-125. Simulated Distribution of Nitrate after 15 Years – Alternative 4.

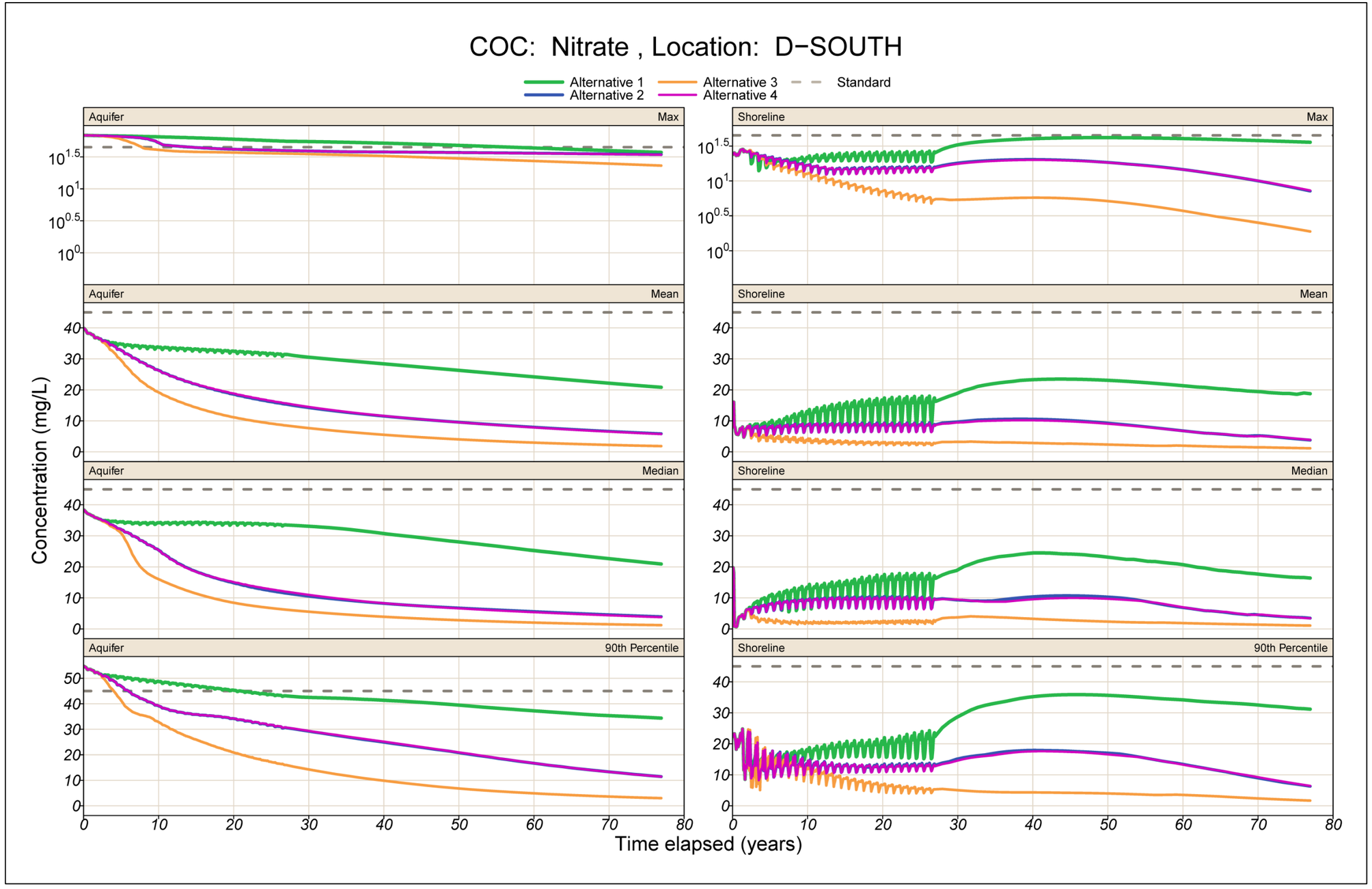

Figure 5-126. Nitrate: Concentration Statistics – D-South (All Alternatives).

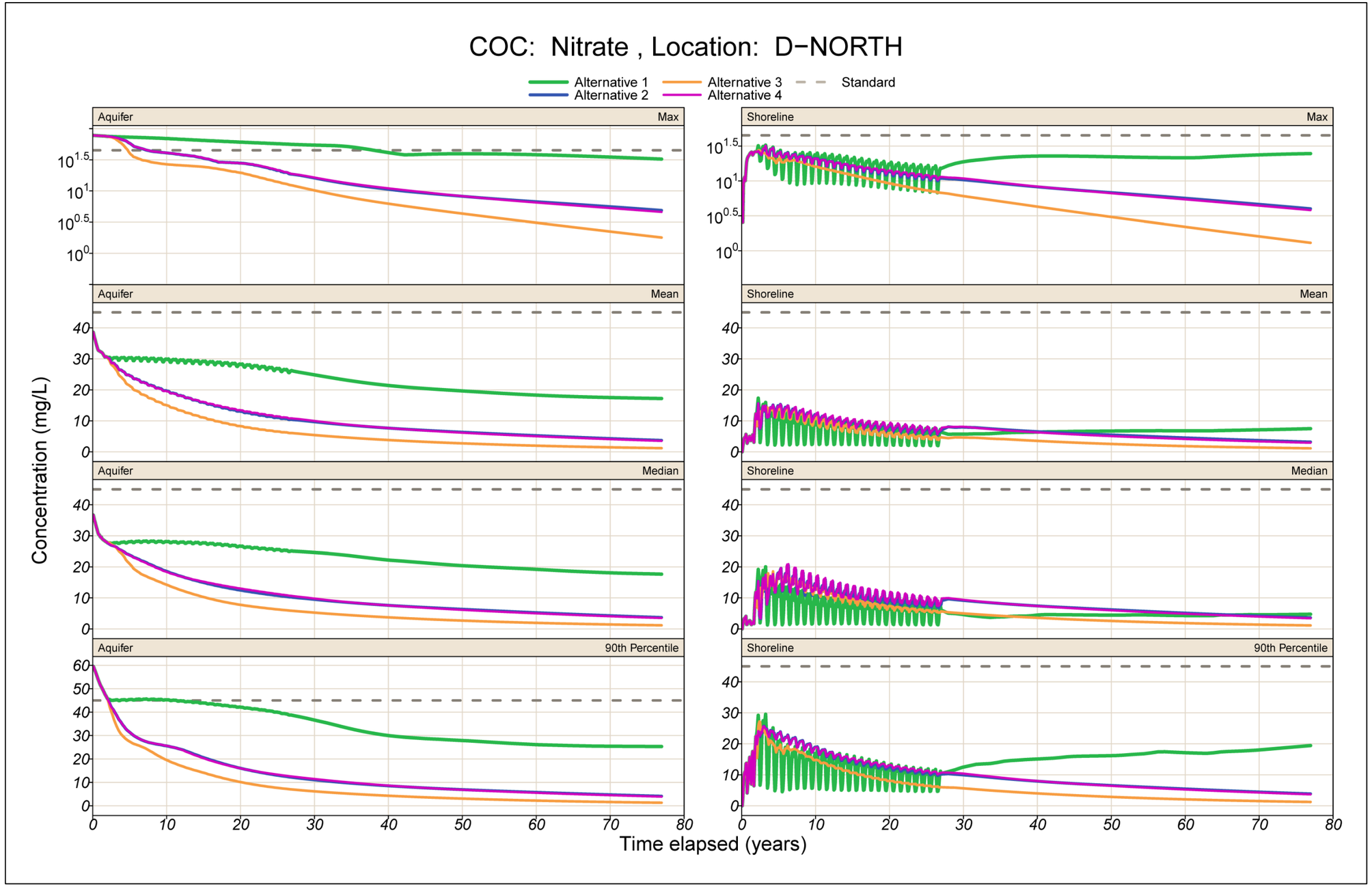

Figure 5-127. Nitrate: Concentration Statistics – D-North (All Alternatives).

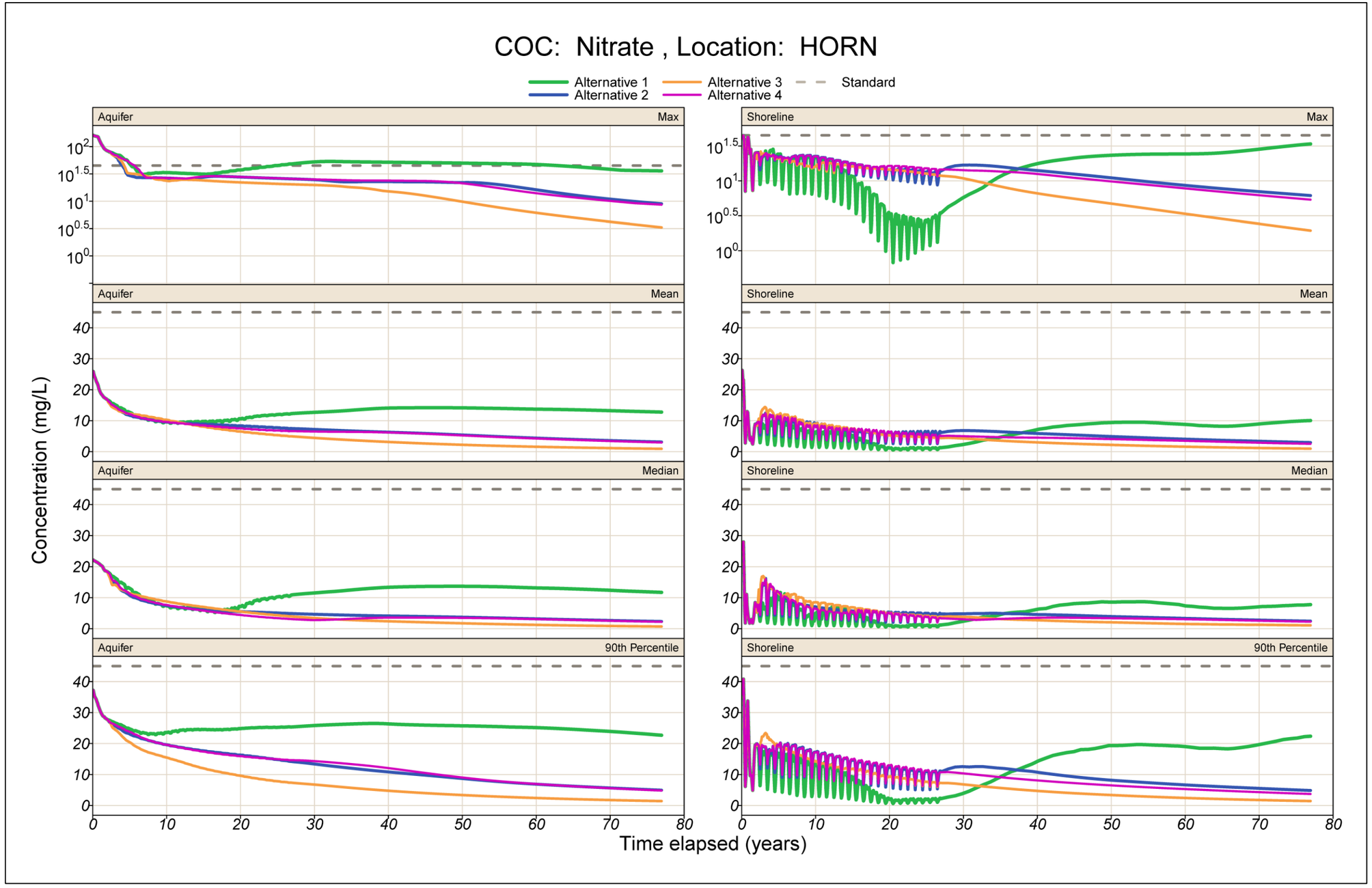

Figure 5-128. Nitrate: Concentration Statistics – Horn (All Alternatives).

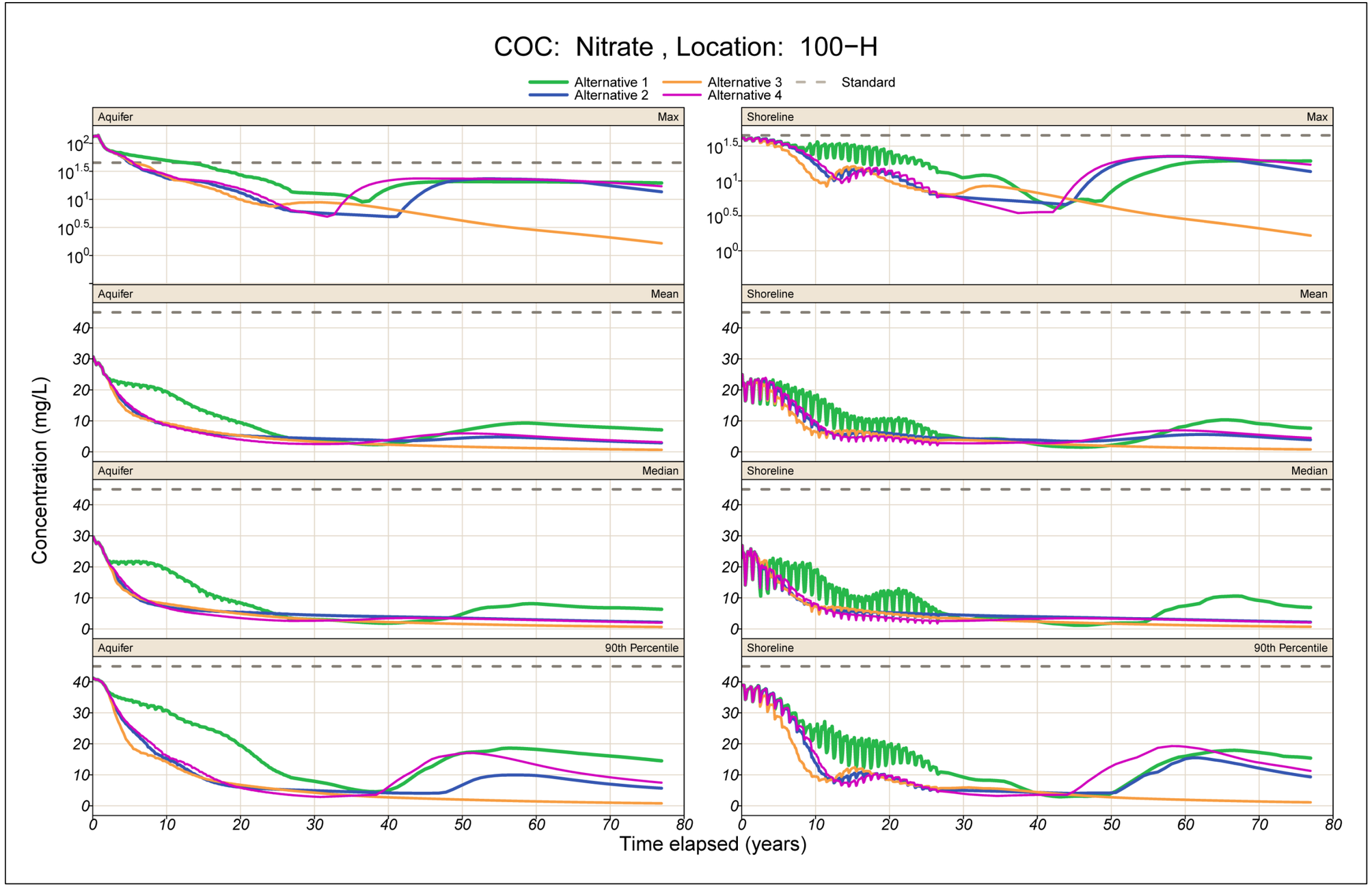

Figure 5-129. Nitrate: Concentration Statistics – 100-H (All Alternatives).

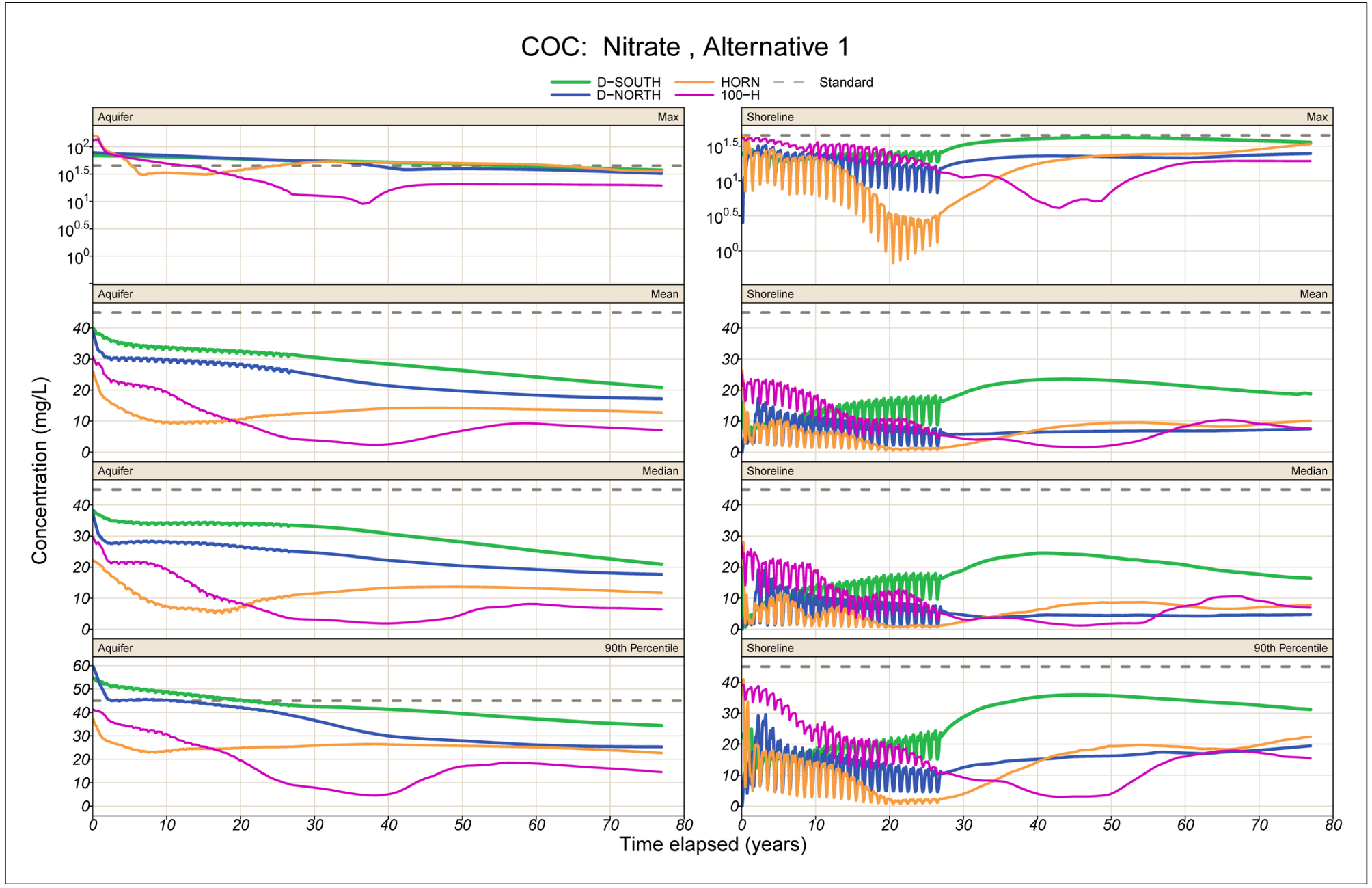

Figure 5-130. Nitrate: Concentration Statistics – Alternative 1 (All Areas).

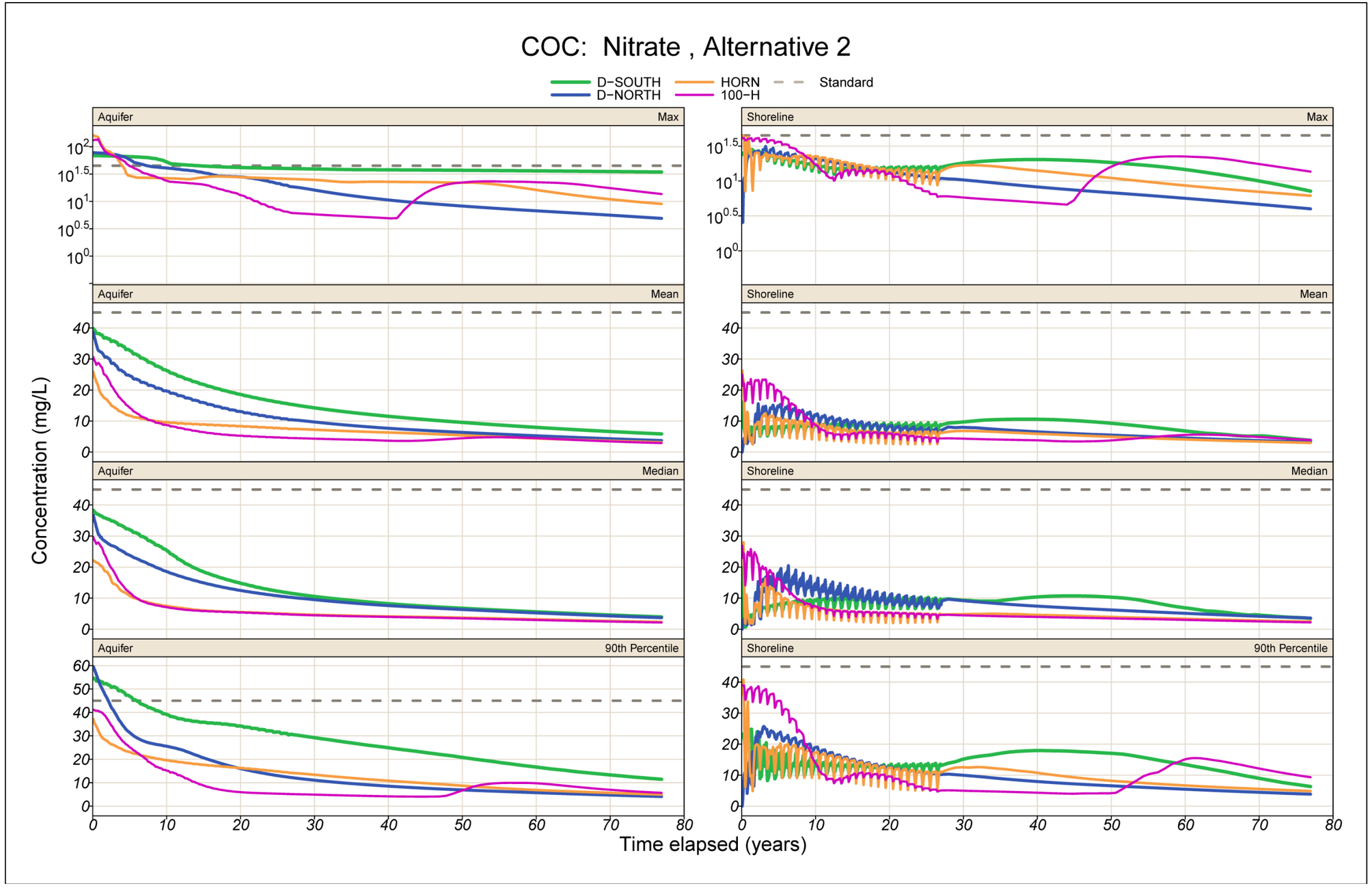

Figure 5-131. Nitrate: Concentration Statistics – Alternative 2 (All Areas).

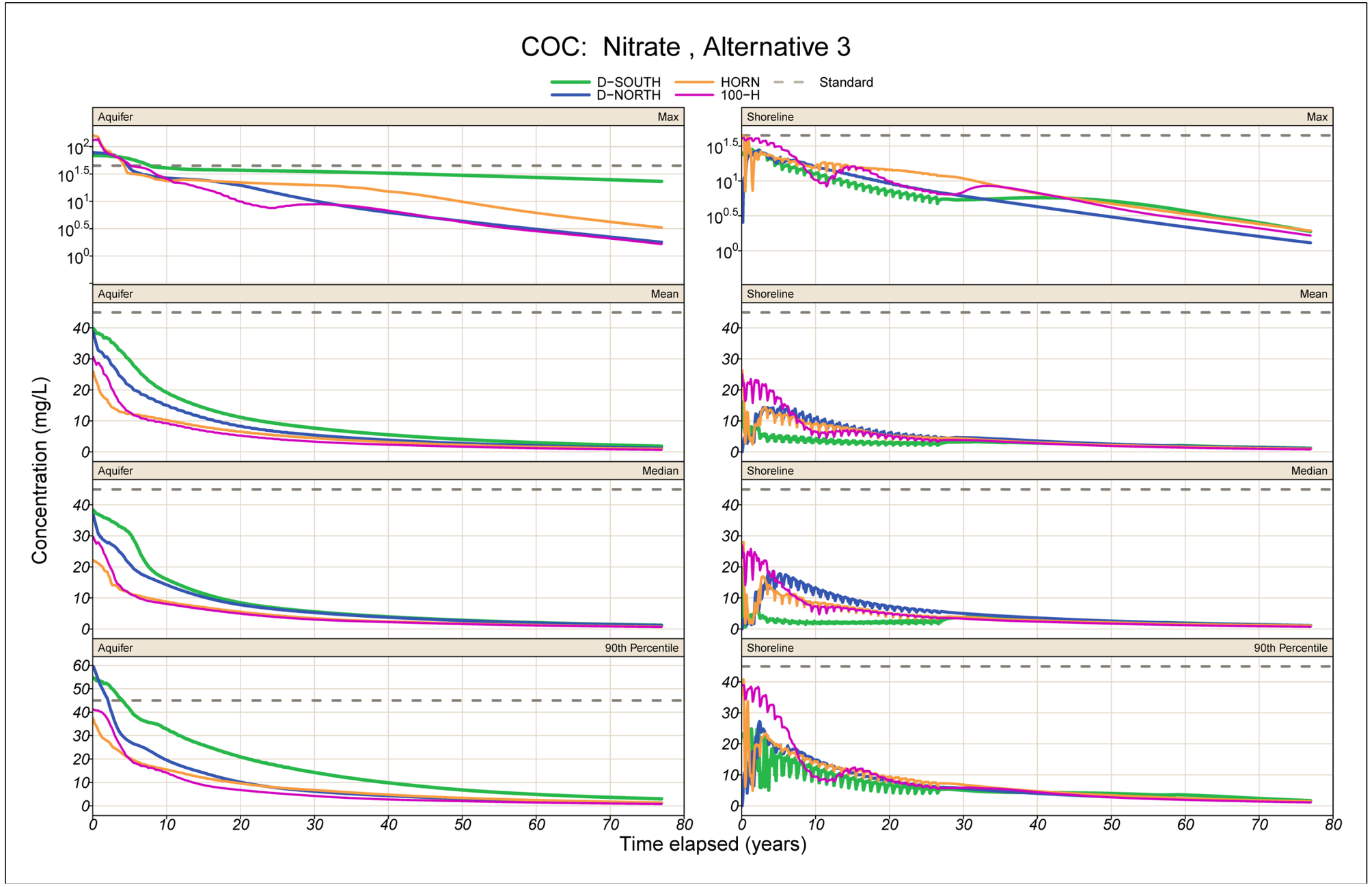

Figure 5-132. Nitrate: Concentration Statistics – Alternative 3 (All Areas).

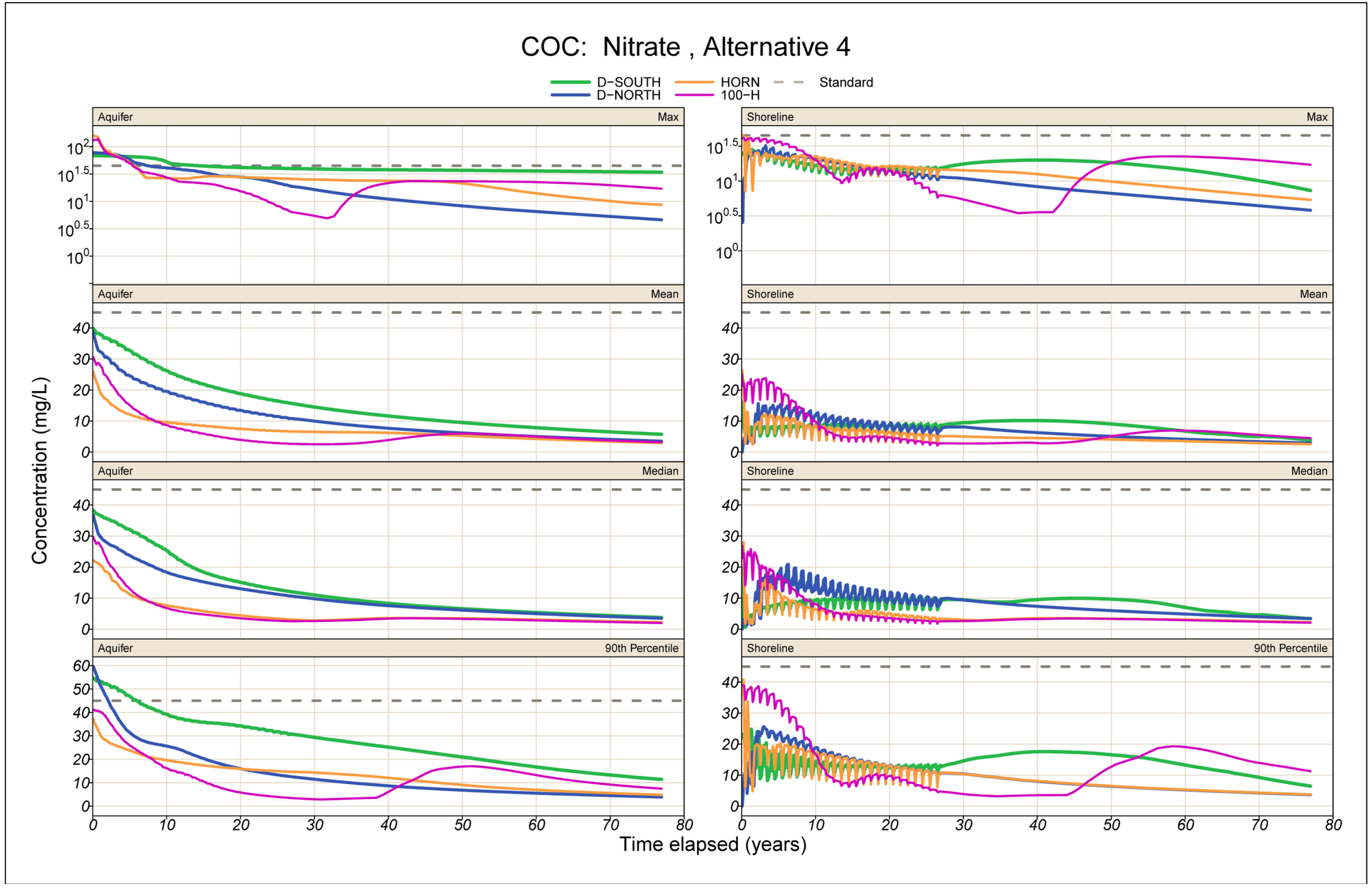

Figure 5-133. Nitrate: Concentration Statistics – Alternative 4 (All Areas).

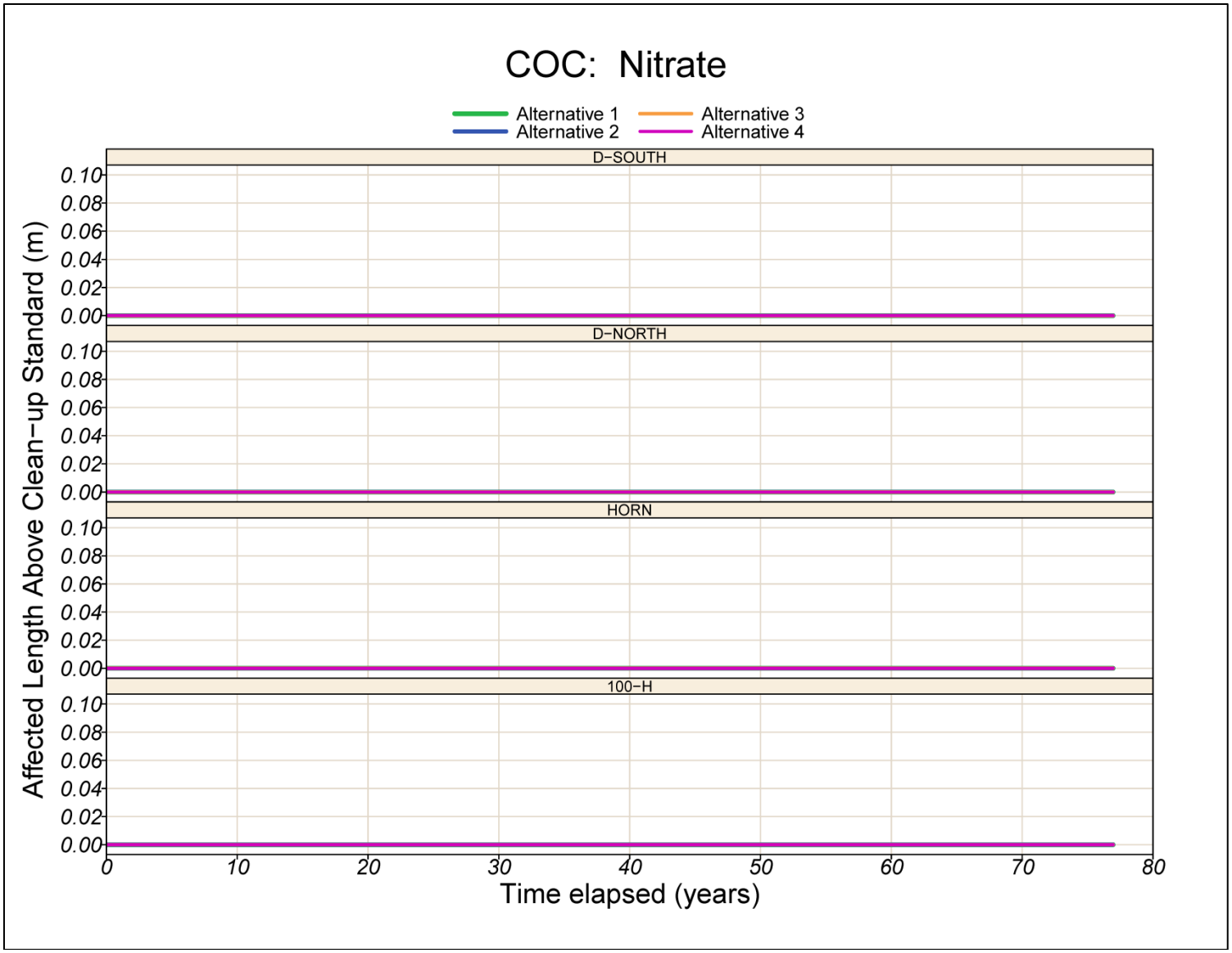

Figure 5-134. Nitrate: Affected Shoreline Length Above Clean-Up Standard (All Areas-Alternatives).

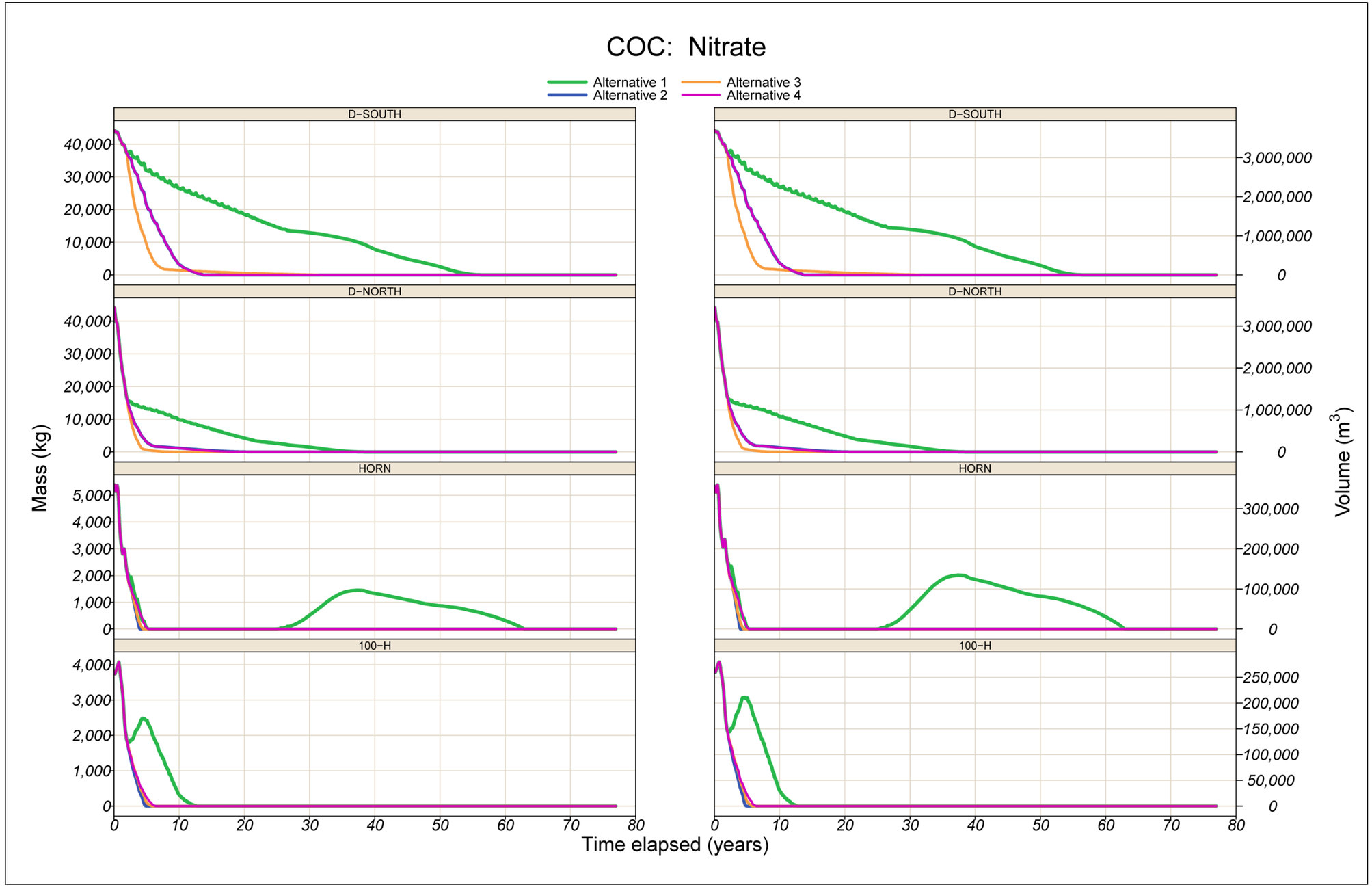

Figure 5-135. Nitrate: Calculated Mass and Volume – (All Areas-Alternatives).

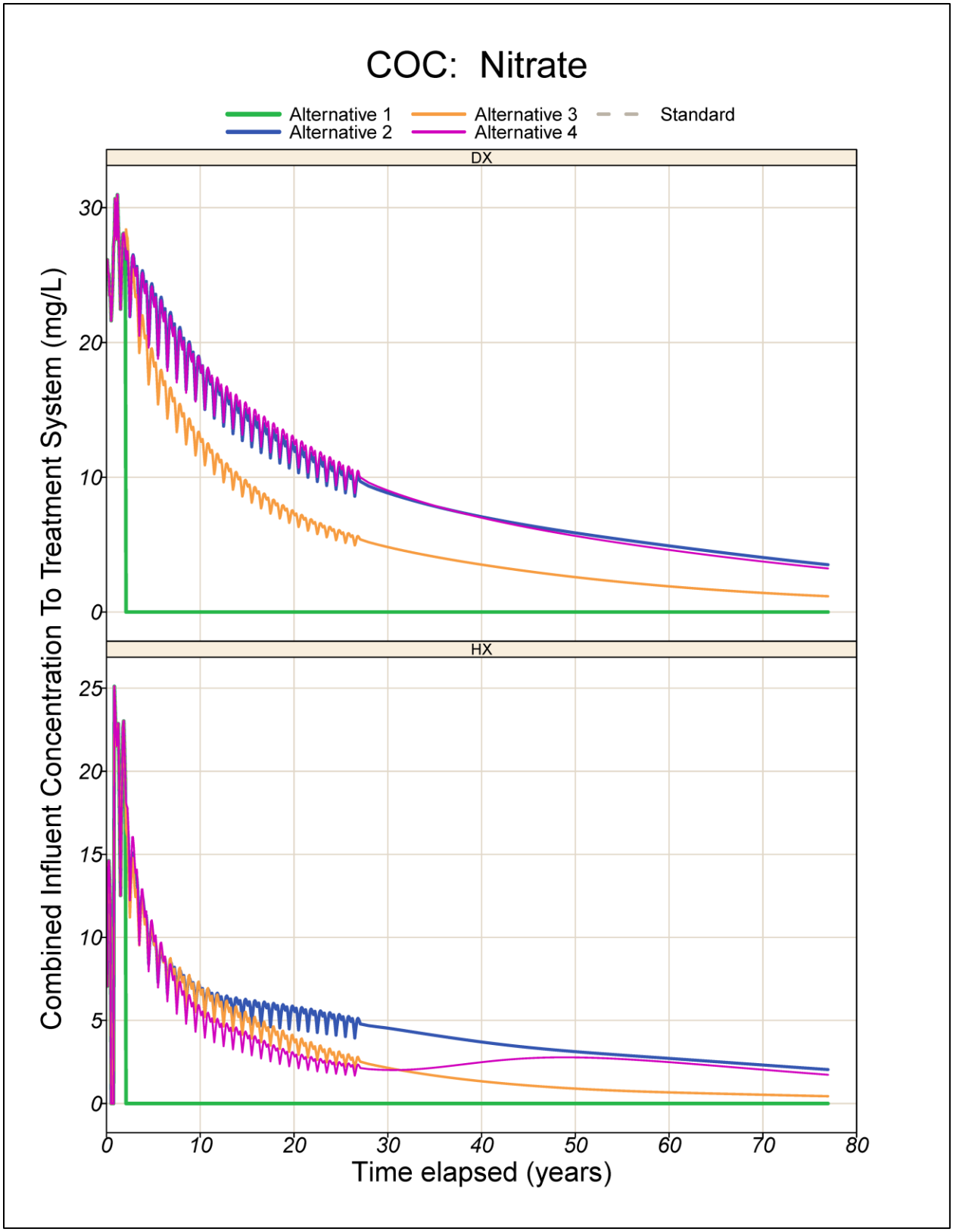

Figure 5-136. Nitrate: Calculated Influent Concentration at P&T (All Areas-Alternatives)

Table 5-4: Nitrate Cleanup Times.

Alternative	Statistic	Nitrate Cleanup Time (MCL 45 mg/L)
Alternative 1 - D-South	Max	57
	90th Percentile	21
	Mean	A.B.S.[1]
	Median	A.B.S.
Alternative 1 - D-North	Max	38
	90th Percentile	12
	Mean	A.B.S.
	Median	A.B.S.
Alternative 1 - Horn	Max	62
	90th Percentile	A.B.S.
	Mean	A.B.S.
	Median	A.B.S.
Alternative 1 - 100 H	Max	13
	90th Percentile	A.B.S.
	Mean	A.B.S.
	Median	A.B.S.
Alternative 2 - D-South	Max	15
	90th Percentile	6
	Mean	A.B.S.
	Median	A.B.S.
Alternative 2 - D-North	Max	8
	90th Percentile	3
	Mean	A.B.S.
	Median	A.B.S.
Alternative 2 - Horn	Max	5
	90th Percentile	A.B.S.
	Mean	A.B.S.
	Median	A.B.S.
Alternative 2 - 100 H	Max	5

Table 5-4: Nitrate Cleanup Times.

Alternative	Statistic	Nitrate Cleanup Time (MCL 45 mg/L)
	90th Percentile	A.B.S.
	Mean	A.B.S.
	Median	A.B.S.
Alternative 3 - D-South	Max	8
	90th Percentile	5
	Mean	A.B.S.
	Median	A.B.S.
Alternative 3 - D-North	Max	5
	90th Percentile	3
	Mean	A.B.S.
	Median	A.B.S.
Alternative 3 - Horn	Max	5
	90th Percentile	A.B.S.
	Mean	A.B.S.
	Median	A.B.S.
Alternative 3 - 100 H	Max	6
	90th Percentile	A.B.S.
	Mean	A.B.S.
	Median	A.B.S.
Alternative 4 - D-South	Max	15
	90th Percentile	6
	Mean	A.B.S.
	Median	A.B.S.
Alternative 4 - D-North	Max	8
	90th Percentile	3
	Mean	A.B.S.
	Median	A.B.S.
Alternative 4 - Horn	Max	6
	90th Percentile	A.B.S.

Table 5-4: Nitrate Cleanup Times.

Alternative	Statistic	Nitrate Cleanup Time (MCL 45 mg/L)
	Mean	A.B.S.
	Median	A.B.S.
Alternative 4 - 100 H	Max	6
	90th Percentile	A.B.S.
	Mean	A.B.S.
	Median	A.B.S.

[1] The calculated concentration is always lower than the corresponding standard.

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