# Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision

## Hanford Site
## Benton County, Washington

## August 2009

## SITE NAME AND LOCATION

U.S. Department of Energy 100 Area, EPA ID# WA3890090076
100-HR-3 and 100-KR-4 Operable Units
Hanford Site
Benton County, Washington

## INTRODUCTION TO THE SITE AND STATEMENT OF PURPOSE

The 100-HR-3 and 100-KR-4 groundwater Operable Units are part of the 100 Area Hanford NPL site in south central Washington State (Figures 1 and 2). Remediation is being conducted under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) in accordance with an interim action Record of Decision for the USDOE 100 Area 100-HR-3 and 100-KR-4 Operable Units (EPA, 1996) as amended (EPA, 1999), hereafter referred to as the ROD. The U.S. Department of Energy (DOE) is lead agency, the U.S. Environmental Protection Agency (EPA) is lead regulatory agency for 100-KR-4, and the Washington State Department of Ecology (Ecology) is lead regulatory agency for 100-HR-3. These three agencies, hereinafter referred to as the Tri-Parties, are issuing this Explanation of Significant Differences (ESD) to provide public notice on significant changes to the Interim Action ROD.

### Summary of circumstances that led to the need for an ESD

1. Costs for the pump-and-treat remedial actions at 100-HR-3 and 100-KR-4 have exceeded the cost range identified in the ROD, as amended.
2. The original 1996 ROD specified that treated water be re-injected to the aquifer upgradient of the hexavalent chromium plumes located in the 100-HR-3 and 100-KR-4 Operable Units in order to best treat the plumes. Since then, the hexavalent chromium plumes have expanded and migrated in different directions. Alternate re-injection locations are needed to help contain the plumes in both of these operable units and to prevent the hexavalent chromium plume in 100-KR-4 from reaching and mixing with the strontium-90 plume in 100-NR-2.

### Statutory Citation for an Explanation of Significant Difference

The Tri-Parties are issuing this ESD in accordance with Section 117(c) of CERCLA and Section 300.435(c)(2)(i) of the "National Oil and Hazardous Substances Pollution Contingency Plan" (NCP) (40 CFR 300). The purpose of this ESD is to provide public notice of the changes identified herein. This ESD will become part of the Administrative Record for the 100-HR-3 and 100-KR-4 operable unit Interim Action ROD in accordance with Section 300.825(a)(2) of the NCP. The Administrative Record is available for review at the following location:

U.S. Department of Energy, Richland Operations Office
Administrative Record
2440 Stevens Center Place, Room 1101
Richland, Washington 99354
Hours of operation: 7:00 am to 4:30 pm
Telephone: (509) 376-2530
Internet URL: http://www2.hanford.gov/arpir/

**SITE HISTORY, CONTAMINATION, AND SELECTED REMEDY**

The 100-HR-3 Operable Unit is located in the north-central part of the Hanford Site along the Columbia River. This operable unit includes the groundwater underlying the 100-D/DR and 100-H Reactor Areas and a portion of the 600 Area. The 100-D/DR Area is the site of two deactivated reactors: the 100-D Reactor, which operated from 1944 to 1967, and the 100-DR Reactor, which operated from 1950 to 1965. The 100-H reactor operated from 1949 to 1965.

The 100-KR-4 Operable Unit is also located in the north-central part of the Hanford Site, upriver of 100-HR-3. The 100-KR-4 Operable Unit includes the groundwater underlying the 100-KR-1 and 100-KR-2 Operable Units. The 100-K Area is the site of two deactivated reactors: the 100-K East Reactor, which operated from 1955 to 1971, and the 100-K West Reactor, which operated from 1955 to 1970.

During the years of reactor operations, large volumes of reactor coolant water containing chromium and radionuclides was discharged to retention basins for ultimate disposal in the Columbia River through outfall pipelines. Liquid wastes, containing significant quantities of chromium from reactor operations, were also discharged to the soil column at cribs, trenches, and french drains. Contaminant plumes in groundwater resulted from these former waste disposal practices. Groundwater contaminated with chromium is present beneath the 100-D/DR, 100-H, Horn Area (inter-area between 100-D and 100-H) and 100-K Reactor areas and is migrating toward, and discharging into, the Columbia River. The groundwater upwells into the river through the riverbed with contributions from riverbank seepage. The 1996 ROD selected the interim remedy of groundwater pump-and-treat to intercept the hexavalent chromium plume under the 100-H, 100-D and 100-K Areas and treat it using an ion-exchange treatment technology. Under the ROD, groundwater is to be extracted from wells primarily located along the Columbia River in each of the three reactor areas. The extracted groundwater must be treated to the maximum extent practicable. Treated effluent is then returned to the aquifer using injection wells located upgradient of the existing 100-H Area (for 100-H and 100-D) and 100-K Area chromium plumes. Treated groundwater exceeding 50 micrograms per liter chromium cannot be discharged to the aquifer. While 50 micrograms per liter chromium and below was selected for the reinjection threshold to groundwater upgradient of the plumes, a 20 micrograms per liter threshold at on-shore near-river monitoring locations was selected to achieve the Aquatic Water Quality Criteria (AWQC) of 10 micrograms per liter. Groundwater monitoring is conducted at on-shore near-river locations within the groundwater operable units to ensure protection of aquatic receptors in the river and to monitor remediation progress in groundwater. Since mixing of groundwater and river water occurs between the on-shore near-

river monitoring locations and the aquatic receptor exposure point of concern within the river substrate, a preliminary dilution factor of 1:1 was selected in the 1996 ROD, based on the available data. Institutional controls are required to prevent human exposure to groundwater, and are identified in the "Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions."

Between 1995 and 1997, high concentrations of hexavalent chromium were identified west of the 100-D/DR Reactor Area in groundwater well samples, local Columbia River pore water samples, and in near-river aquifer sampling tube groundwater samples. DOE and Ecology, as the lead regulatory agency, determined a different interim remedial action than that selected in the 1996 ROD was appropriate for this plume. The 1999 ROD amendment selected ISRM (In Situ Redox Manipulation) for remediation of this hexavalent chromium "hot spot" in the groundwater. An ESD in 2003 was issued due to cost increase for the ISRM remedy.

The interim action, which has a limited scope focused on hexavalent chromium within the groundwater in the near vicinity of the Columbia River, is one element of the overall site cleanup actions for these areas. Multiple remedial and removal decision documents for the contaminant source units have resulted in cleanup actions for these areas which includes excavation of source waste sites sufficient to protect unrestricted future surface use to a depth of 15 feet below ground surface, cleanup and removal of contaminated buildings, removal of stored waste, and cleanup adequate to protect groundwater from contaminants leaching through the vadose zone under natural and irrigation scenarios such that MCLs in the aquifer and surface water quality standards are met. Much of the contaminant source remediation work has been completed, but years of work remain. The large liquid waste disposal sites known to have caused the largest of the chromium plumes have been remediated. Other sources may exist which are the origin of additional chromium plumes. Efforts to locate and remediate these other sources are underway. During remediation under the existing interim RODs a large amount of additional site data is being collected and will be used in making the final remedial action decision for these areas. The final decisions will address co-contaminants not targeted by the current groundwater interim remedial action.

**BASIS FOR THE DOCUMENT**

There are two significant differences being made to the ROD by this ESD: (1) Projected cost for the pump-and-treat operations is being increased and the cost will be more than 50% of the estimate in the ROD; and (2) Re-injection location requirements for treated water are being revised to allow reinjection other than in upgradient locations to control migration of the plume and to prevent the 100-KR-4 chromium plume from converging with and interfering with remedial action of the strontium-90 plume at the 100-N area.

**1. Cost is more than the 50% of the estimate in the ROD**.

Cost for the pump and treat systems has increased because:

- **a.** The pump-and-treat systems at 100-HR-3 and 100-KR-4 have operated past the 5 year operational estimate identified in the 1996 ROD, and will continue to run for at least three more years.
- **b.** New pump-and-treat systems were added to meet ROD requirements at the Columbia River. Also, the pump-and-treat systems need to be expanded further.

The identified areas of the hexavalent chromium plumes in 100-HR-3 and 100-KR-4 (Figures 3, 4, 5 and 6) have persisted and expanded. The original 1996 ROD cost estimate was for a 5-year operations and maintenance period. The systems have been operating for more than twice that long, and are currently estimated to operate at least through 2012. Final RODs for the 100 Area Operable Units are expected to be issued in 2012, and will define final actions for groundwater remedial actions, including any additional or alternative actions that may be needed. In addition to the longer operation time, the increased size of the plumes requires expansion of the pump-and-treat systems.

Cost increase for 100-KR-4

The 100-KR-4 hexavalent chromium plume has expanded to the NE (Figure 5), and the hexavalent chromium concentrations in the groundwater have increased, which required expansion of the pump-and-treat system. The existing treatment system has been expanded to 900 gpm compared to the 220 gpm identified in the 1996 ROD. An expanding plume has developed in the area of the K West reactor. A separate pump-and-treat system was installed in 2007 to remediate that plume. The new 200 gpm treatment capacity for K West began operation in FY09 and will result in increased cost reflected in this ESD. In addition, system performance improvements were implemented, which also increased the cost of the total project.

Previous Costs – ROD issuance to FY 2008

For the 100-KR-4 Groundwater Operable Unit, the estimated costs contained in the ROD for the first five years of the project were:

- Capital Cost: $6,600,000
- Operation and Maintenance Cost (5-year period): $8,100,000

These costs were based on eleven extraction wells spaced approximately 240 m (786 ft) apart with a composite withdrawal rate of 220 gpm and with two re-injection wells.

The actual costs for the construction and operations of the interim remedial action for 100 KR 4 through FY2008 are $41,036,000. The cost breakdown by fiscal year is as follows:

| Cost Breakdown for 100-KR-4 Pump-and-Treat Construction and Operations | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Description** | **Actual Costs (Dollars x 1,000)** | | | | | | | | | | | |
| | **1996 - 1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** |
| Treatment system capital construction | 2,124 | 63 | -- | 109 | -- | 860 | 380 | 94 | 274 | 1,506 | 4,293 | 6,303 |
| Operations and maintenance | 3,048 | $1,261 | 875 | 1274 | 1353 | 1553 | 1836 | 2253 | 2566 | 2758 | 3,284 | 2,969 |
| **Totals** | **$5,172** | **$1,324** | **$875** | **$1,383** | **$1,353** | **$2,413** | **$2,216** | **$2,347** | **$2,840** | **$4,264** | **$7,577** | **$9,272** |

These costs exceed the CERCLA cost estimate criteria range of +50/-30%.

Future Costs – FY 2009 to FY 2012

Projected costs for the next four years, until the anticipated final ROD for the 100-K Area is in place, is $40,857,000 and are broken down as follows:

| Future Cost Breakdown for 100-KR-4 Pump-and-Treat Construction and Operations | | | | |
|---|---|---|---|---|
| Description | **Actual Costs (Dollars x 1,000)** | | | |
| | FY 2009 | FY 2010 | FY 2011 | FY 2012 |
| Estimated treatment system capital construction | 7,166 | 4,733 | 1,172 | 3,256 |
| Estimated operations and maintenance | 6,744 | 6,137 | 5,627 | 6,022 |
| **Totals** | **$13,910** | **$10,870** | **$6,799** | **$9,278** |

These costs include the continued operation and maintenance of the 100-KR-4 pump-and-treat systems in 100-K Areas and the planned pump-and-treat system expansions to increase total treatment system capacity in 100-KR-4 to 1,100 gpm.

Cost increases for 100-HR-3

The hexavalent chromium plumes in 100-HR-3 have increased in concentration at the 100-D Area (Figure 3), and have migrated across the Horn Area towards the 100-H Area (Figures 4 and 6). This has required expansion and additions to the pump-and-treat system at 100-HR-3. Process system performance improvements were also implemented in FY2004.

For the 100-H Area, the original pump-and-treat system has been effective at remediating the hexavalent chromium plume in the original target area. The hexavalent chromium plume that migrates east from the 100-D Area is now discharging north of the 100-H area pump-and-treat system. The expansion of the pump-and-treat system for 100-HR-3, identified in the future cost estimates and presented in this ESD, is driven by the need to remediate this plume as well as the plume at the 100-D reactor to meet ROD requirements. The RDR/RAWP for 100-HR-3 will identify the specific changes to the capture system for the 100-HR-3 plume.

The remedial response at 100-D was originally expected to be a 100 gpm pump-and-treat system. In 2004, a new stand-alone pump-and-treat system, 100-DR-5, was installed to capture a newly identified portion of the hexavalent chromium plume resulting from a source in the central portion of the 100-D Area. The RAO for protection of aquatic receptors in the river bottom substrate from contaminants in groundwater entering the Columbia River has not been met at the 100-D Area. An increase in the groundwater pump-and-treat facility capacity and groundwater extraction rate through expansion of the pump-and-treat system is required and the future cost increase is identified in this ESD.

Previous Costs – From ROD Issuance to FY 2008

For the 100-HR-3 Groundwater Operable Unit remedial action, the estimated costs as contained in the ROD for the first five years of the project were:

- Capitol Cost: $6,600,000
- Operation and Maintenance Cost (5-year period): $13,700,000

These costs were based on nine extraction wells spaced approximately 160 m (515 ft) apart with a composite withdrawal rate of 225 gallons per minute with three re-injection wells.

The actual costs for the construction and operations of the interim remedial action through FY 2008 are $37,561,000. The cost breakdown by fiscal year is as follows:

| **Cost Breakdown for 100-HR-3 Pump-and-Treat Construction and Operations** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Description** | **Actual Costs (Dollars x 1,000)** | | | | | | | | | | | |
| | **1995 - 1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** |
| Treatment system capital construction | 5,635 | -- | -- | 58 | -- | 750 | -- | 2,117 | 10 | 22 | -- | |
| Operations and maintenance | 1,941 | 1,799 | 1,916 | 2,144 | 1,671 | 1982 | 2,012 | 2,549 | 3,519 | 3,681 | 2,537 | 3,218 |
| **Totals** | **$7576** | **$1,799** | **$1,916** | **$2,202** | **$1,671** | **$2,732** | **$2,012** | **$4,666** | **$3,529** | **$3,703** | **$2,537** | **3,218** |

These costs exceed the CERCLA cost estimate criteria range of +50/-30% of the most recent ESD to this ROD.

Future Costs – FY 2009 to FY 2012

Projected costs for the next four years, until the anticipated final ROD for the 100-D and 100-H Areas is in place, is $60,298,000 and are broken down as follows:

| Future Cost Breakdown for 100-HR-3 Pump-and-Treat Construction and Operations | | | | |
|---|---|---|---|---|
| Description | Future Costs (Dollars x 1,000) | | | |
| | FY 2009 | FY 2010 | FY 2011 | FY 2012 |
| Estimated treatment system capital construction | 5,580 | 17,116 | 6,470 | 1,462 |
| Estimated Annual Operations and Maintenance Costs | 5,185 | 8,139 | 10,023 | 6,323 |
| **Totals** | **$10,765** | **$25,255** | **$16,493** | **$7,785** |

These costs include the continued operations and maintenance of the 100-HR-3 Groundwater OU pump and treatment systems at 100-H and 100-DR Areas.

**2. Revised re-injection of treated water.**

The original 1996 ROD specified that treated water be re-injected to the aquifer upgradient of the chromium plume. At the time, this was expected to push the chromium plume towards the extraction wells. This initially appeared to be working effectively. However, due to the up-gradient reinjection, the large 100-K Area chromium plume has migrated to the northeast and if allowed to continue would converge with the strontium-90 plume at the 100-N reactor and interfere with the remedial action for groundwater at 100-N Area. Re-injecting the treated water in other locations will prevent these two plumes from merging. The hexavalent chromium plume at 100-HR-3 is also expanding and being pushed away from the extraction wells. Revised reinjection well locations will help contain the plume and push the hexavalent chromium towards the extraction wells.

This ESD allows for reinjection of treated groundwater in locations other than upgradient of the extraction wells to help contain the hexavalent chromium plumes and prevent the plumes from expanding. The groundwater treatment and re-injection system shall be designed in accordance with the Remedial Design Report/Remedial Action Work Plan as approved by the lead regulatory agency. The treatment system still must reduce the effluent chromium concentrations to the maximum extent practicable. The ROD currently states that "The groundwater treatment systems will reduce the effluent chromium concentrations to the maximum extent practicable. However, groundwater above 50 μg/L chromium will not be discharged." Current effluent chromium concentrations re-injected into the aquifer are typically below the Aquatic Water Quality Criteria (AWQC) of 10 μg/L and treatment is expected to be maintained at or below this concentration. Since AWQC are required to be met at the river, injection of groundwater in wells that are not located upgradient of the extraction wells need to meet these criteria. Therefore, injection wells that are not located upgradient of the extraction wells must reduce the effluent chromium concentrations to the maximum extent practicable, and not to exceed 20 μg/L (i.e. two times the AWQC of 10 μg/L). As indicated in the ROD, a dilution factor of 1:1 is

expected before the injected treated groundwater would reach the aquatic receptor point of concern within the river substrate, ensuring that the AWQC of 10 μg/L in the river substrate will be met. As required by the ROD, monitoring of groundwater near the river will be conducted at a sufficient number of locations to determine system performance in meeting ROD requirements.

## DESCRIPTION OF SIGNIFICANT DIFFERENCES

1. The expected total operational cost of the pump-and-treat systems has increased in 100-KR-4 from $14,700,000 to $81,893,000, and in 100-HR-3 from $20,300,000 to $97,759,000. Costs for the ISRM have not changed since the 2003 ESD to the ROD.
2. The ROD Groundwater Treatment and Discharge Standards-Hexavalent Chromium are changed to state:

> The groundwater treatment systems will reduce chromium concentrations to the maximum extent practicable. However, groundwater above 50 μg/L chromium will not be discharged and groundwater above 20 μg/L chromium will not be discharged to injection wells that are not located upgradient of the extraction wells. The average chromium concentrations in the treated effluent are expected to be at or below 20 μg/L. Treatment will be performed using ion exchange resins. (underline signifies new text).

The first sentence of the Groundwater Reinjection section of the ROD is changed to read "After treatment, water will be reinjected into the upper aquifer in a manner that will help contain the hexavalent chromium plumes and prevent the plumes from expanding ~~using injection wells located upgradient of the existing chromium plume~~ in the 100-HR-3 and 100-KR-4 Operable Units, respectively".

The design, schedule and plans for implementing the 100 HR-3 and 100 KR-4 remedy, as revised by this ESD, will be described in an amended RDR/RAWP to be approved by the lead regulatory agency, and will include specific locations of the wells.

## NON-LEAD AGENCY COMMENTS

Ecology, as lead regulatory agency for 100-HR-3 and non-lead regulatory agency for 100-KR-4, concurs with this ESD to the 100-HR-3 and 100-KR-4 Operable Units Interim Action ROD. EPA, as lead regulatory agency for 100-KR-4 and non-lead regulatory agency for 100-HR-3, approves this ESD to the 100-HR-3 and 100-KR-4 Operable Units Interim Action ROD.

## STATUTORY DETERMINATIONS

This remedy satisfies the statutory requirements of CERCLA section 121 and, to the extent practicable, the NCP. The remedy selected in the 100-HR-3 and 100-KR-4 OU Interim Action ROD, as amended in 1999, and as modified by this ESD, remains protective of human health and the environment, complies with federal and state requirements identified in the ROD that are applicable or relevant and appropriate to remedial actions, is cost effective, and uses permanent solutions and alternative treatment technologies to the maximum extent practicable.

The response action, as modified by this ESD, is necessary to protect the public health, welfare, and/or environment from actual or threatened releases of hazardous substances into the environment. Such a release or threat of release may present an imminent and substantial endangerment to the public health, welfare, or the environment.

## PUBLIC PARTICIPATION COMPLIANCE

The public participation requirements set forth in Section 300.435(c)(2)(i) of the NCP will be met. The Tri-Parties will follow the processes described in the *Hanford Site Tri-Party Agreement Community Relations Plan* (DOE et al. 2002), as detailed below.

DOE will make the ESD and supporting information available to the public in the Administrative Record established under 40 CFR 300.815. The Parties will develop a fact sheet that briefly summarizes the ESD, including the reasons for such differences. The fact sheet will be sent out electronically to individuals on the Tri-Party Agreement listserv.

A notice of availability and brief description of the ESD will be published by DOE in the Tri-City Herald, which is a major local newspaper of general circulation.

## REFERENCES


DOE, 2008. *Hanford Site Groundwater Monitoring for Fiscal Year 2007, DOE/RL-2008-01, Revision 0.* March 2008. U.S. Department of Energy, Richland, WA [http://www2.hanford.gov/arpir/?content=findpage&AKey=00098824]

DOE, 2008. *Calendar Year 2007 Annual Summary Report for the 100-HR-3, 100-KR-4, and 100-NR-2 Operable Unit Pump-and-Treat Operation, DOE/RL-2008-05, Revision 0.* June 2008. U.S. Department of Energy, Richland, WA. [http://www2.hanford.gov/arpir/?content=findpage&AKey=0807090160]

DOE, EPA, Ecology 2002. *Hanford Site Tri-Party Agreement Community Relations Plan*, January 2002, U.S. Department of Energy, U.S. Environmental Protection Agency, Washington State Department of Ecology, Richland, WA. [http://www2.hanford.gov/arpir/?content=findpage&AKey=D8989711]

DOE, 2001. *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions, DOE/RL-2001-41*, U.S. Department of Energy, Richland, WA. [http://www2.hanford.gov/arpir/?content=findpage&AKey=D8993419]

EPA, 2003, *Explanation of Significant Difference for the 100-HR-3 Operable Unit Record of Decision, Hanford Site*, U.S. Environmental Protection Agency, Region 10, Seattle, WA. [http://www2.hanford.gov/arpir/?content=findpage&AKey=D1499872]

EPA, 2002, *Explanation of Significant Difference for the 100-HR-3 Operable Unit Record of Decision, Hanford Site*, U.S. Environmental Protection Agency, Region 10, Seattle, WA. [http://www2.hanford.gov/arpir/?content=findpage&AKey=D9192299]

EPA, 1999. *Amended Record of Decision; Decision Summary and Responsiveness Summary for the 100-HR-3 Operable Unit, Hanford Site*, U.S. Environmental Protection Agency, Region 10, Seattle, WA. [http://www2.hanford.gov/arpir/?content=findpage&AKey=D199159580]

EPA, 1996. *Declaration of the Interim Action Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units, Hanford Site*, U.S. Environmental Protection Agency, Region 10, Seattle, WA. [http://www2.hanford.gov/arpir/?content=findpage&AKey=D196097243]

**Figure 1. 100-HR-3 Operable Unit.**

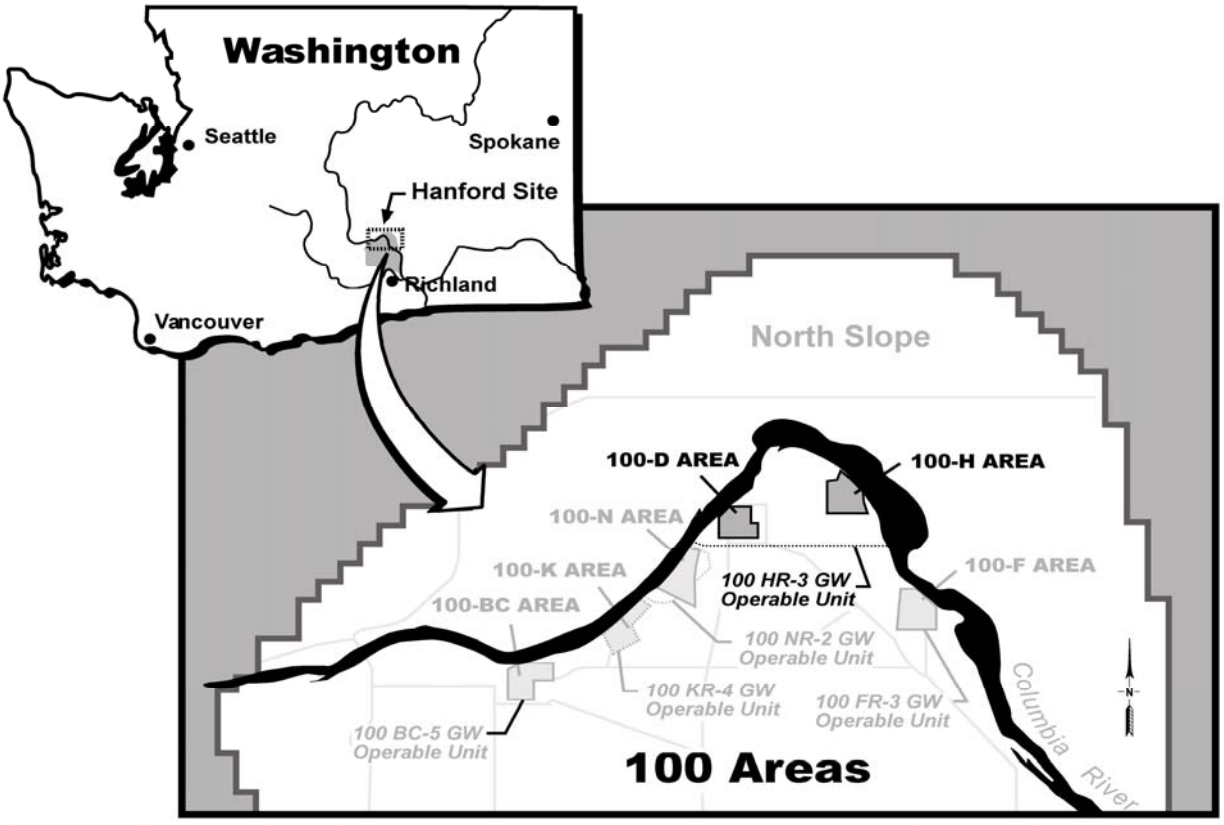


**Figure 2. 100-KR-4 Operable Unit.**

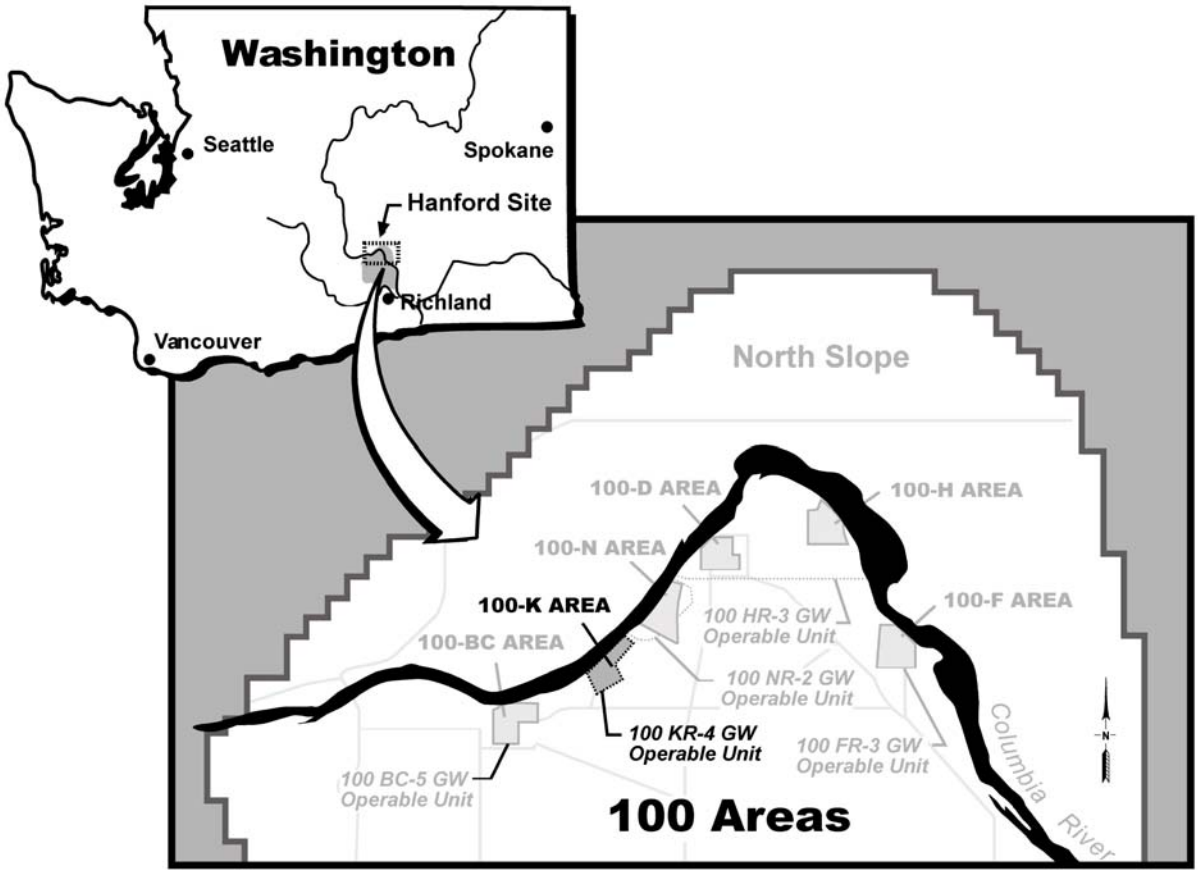


**Figure 3. 100-D Area Chromium Plume Conceptual Site Model 1995-2007**

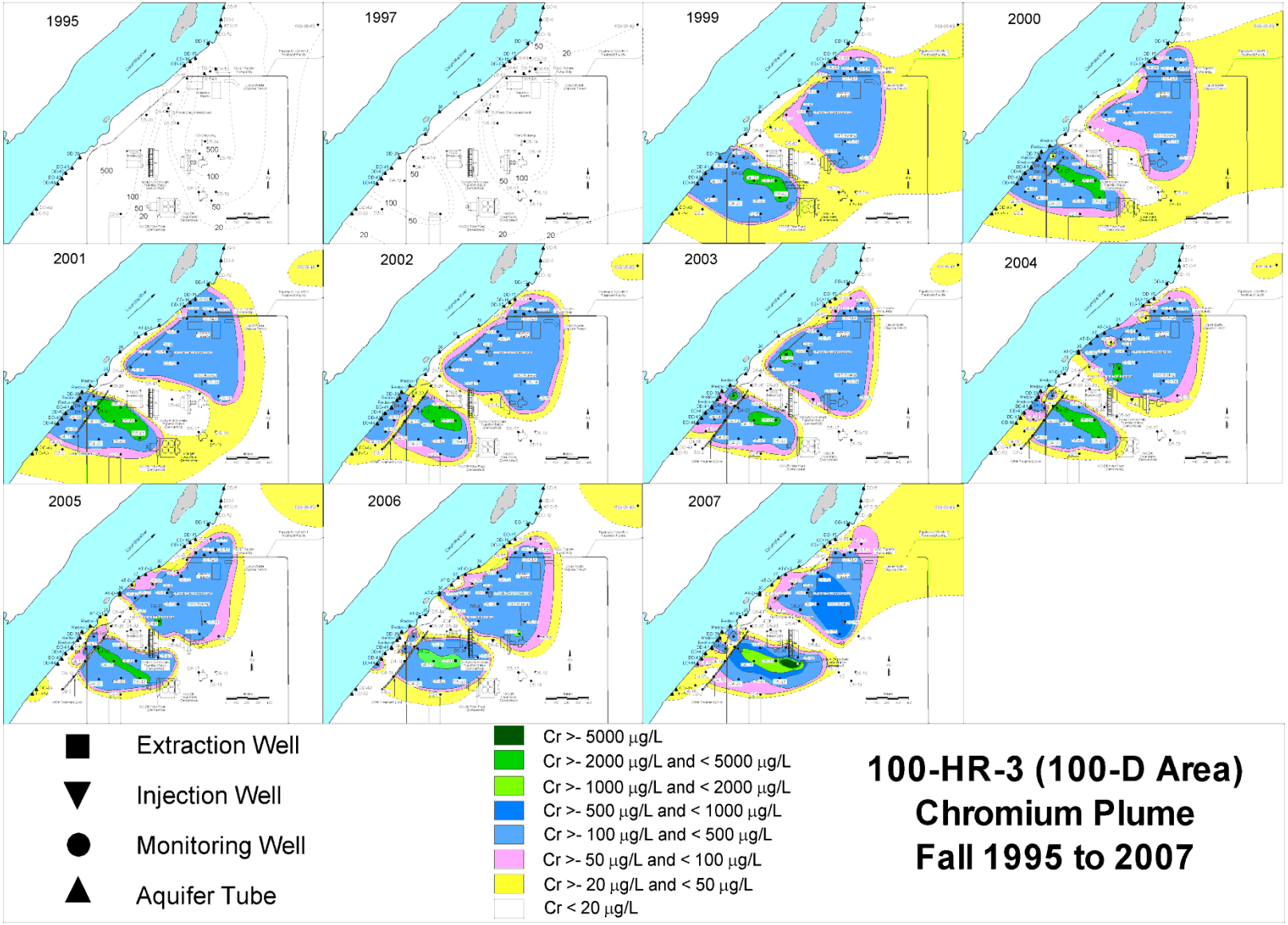


**Figure 4. 100-H Area Chromium Plume Conceptual Site Model 1995-2007**

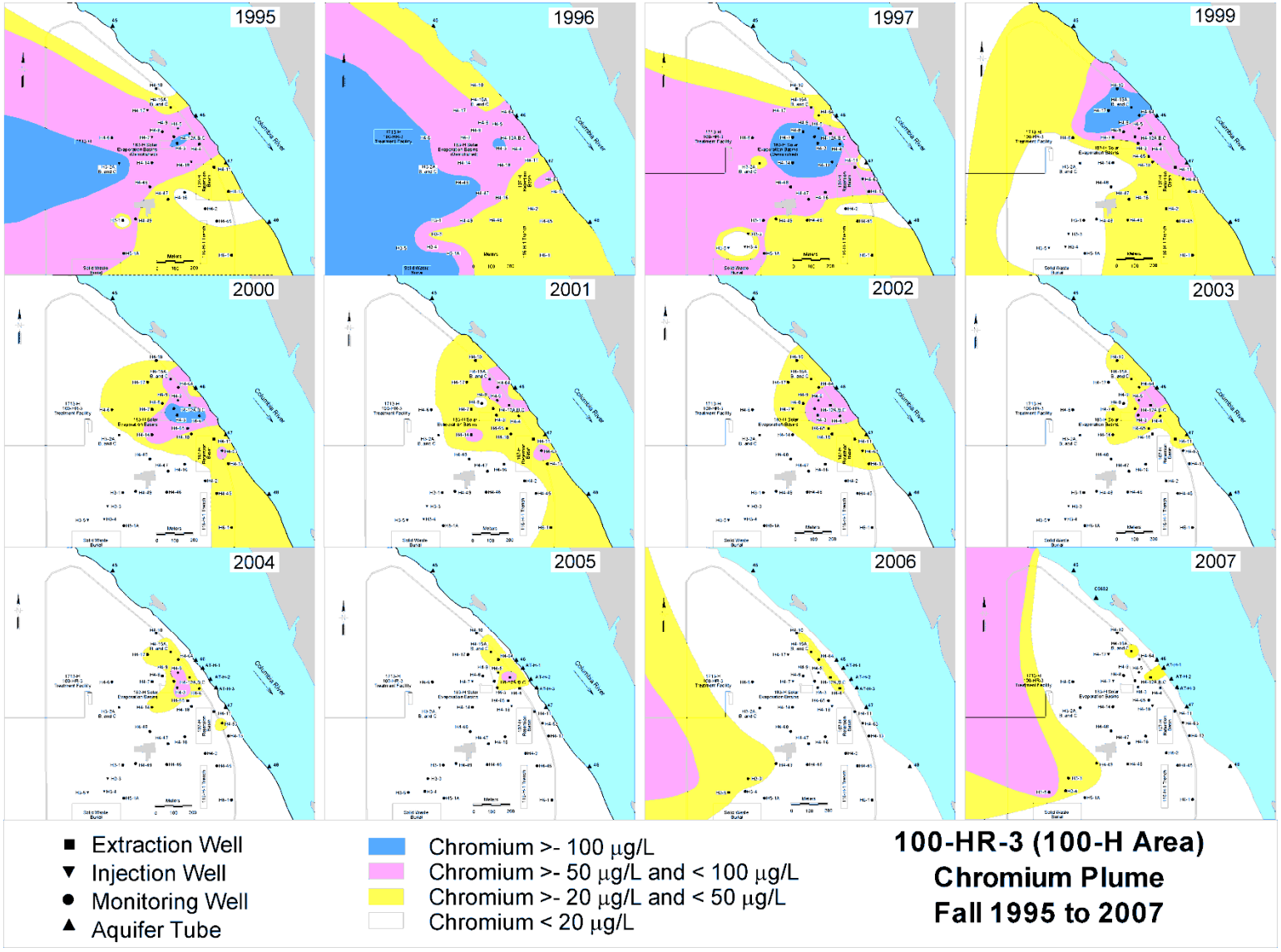


**Figure 5. 100-K Area Chromium Plume Conceptual Site Model 1997-2007**

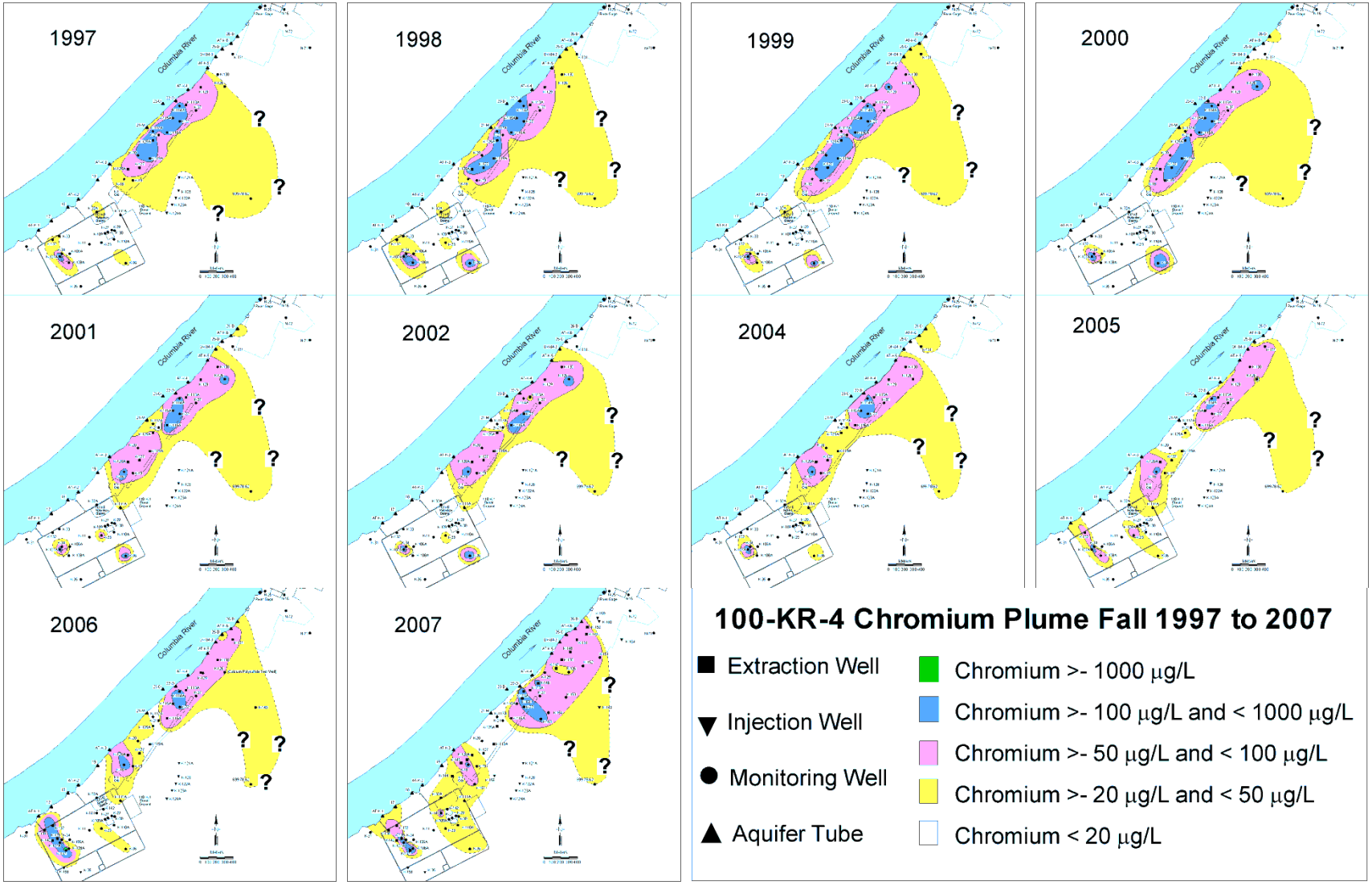
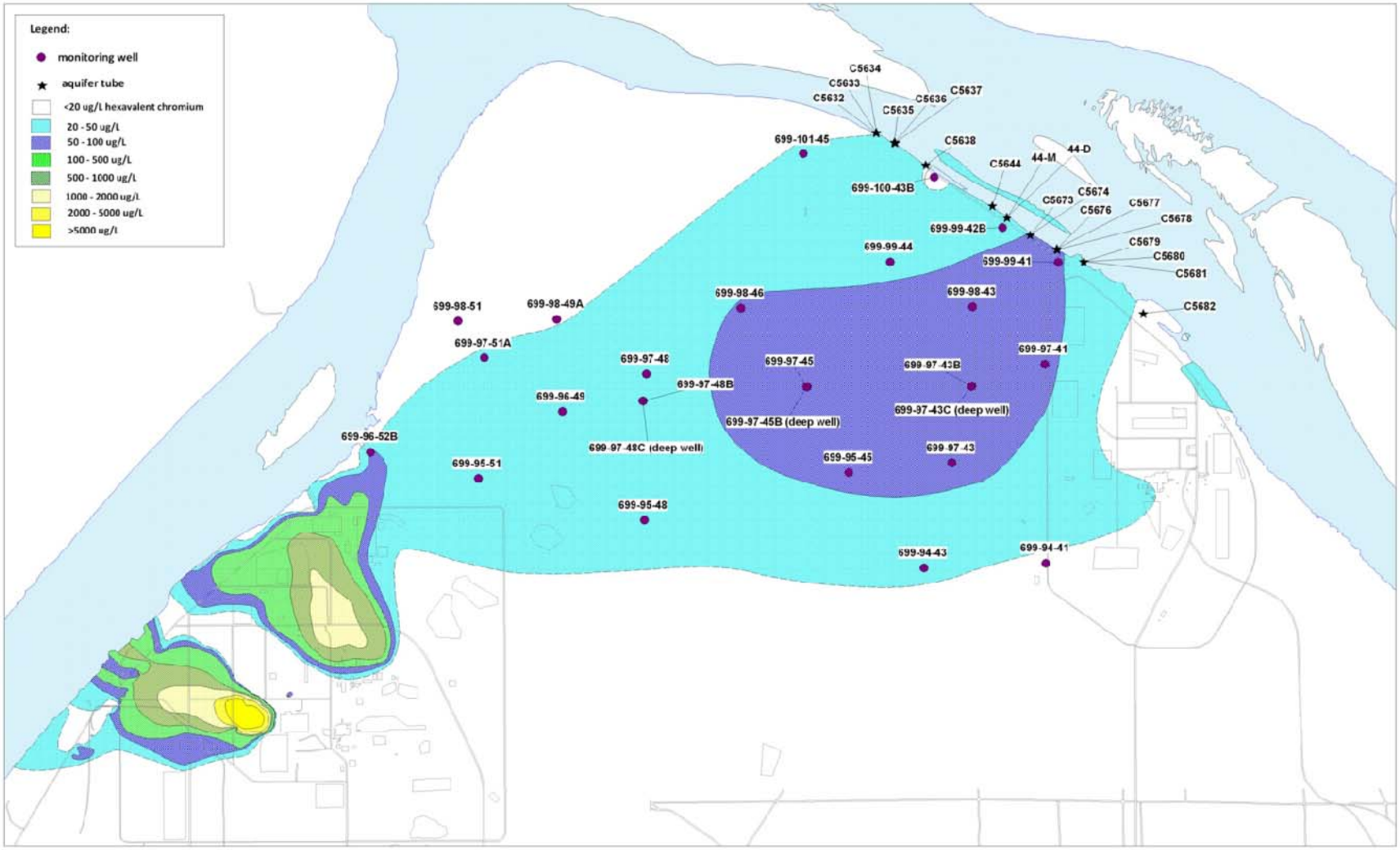


**Figure 6. Chromium contamination in the Horn area as of 2008.**



*Signature sheet for the*
*100-HR-3 and 100-KR-4 Operable Units Explanation of Significant Differences*

Daniel D. Opalski, Director
Office of Environmental Cleanup
U.S. Environmental Protection Agency, Region 10

11 August 2009
Date

Signature sheet for the
*100-HR-3 and 100-KR-4 Operable Units Explanation of Significant Differences*

David A. Brockman
Manager, Richland Operations
U.S. Department of Energy

8/10/09
Date

Signature sheet for the
*100-HR-3 and 100-KR-4 Operable Units Explanation of Significant Differences*

Jane A. Hedges
Program Manager, Nuclear Waste Program
Washington State Department of Ecology

8/11/09
Date