

2.5 100-HR-3-D Operable Unit

M. J. Hartman

The scope of this section is the 100-HR-3-D groundwater interest area, which occupies the west half of the 100-HR-3 Operable Unit (see Figure 1.0-1 in Section 1.0). The “groundwater interest areas” are informal designations to facilitate scheduling, data review, and interpretation. Figures 2.5-1 and 2.5-2 show facilities, wells, and shoreline monitoring sites in this region. Hexavalent chromium is the primary contaminant of concern in groundwater. DOE monitors groundwater to assess the performance of three *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) interim actions for chromium: two pump-and-treat systems and an in situ reduction-oxidation (redox) manipulation system. Groundwater monitoring also tracks the nature and extent of other contaminants.

Groundwater flows primarily to the north and west, toward the Columbia River (Figure 2.5-3). Near the Columbia River, including the redox site, the average flow direction is toward the northwest. Farther inland, average flow is northward. Leakage from the 182-D reservoir (see Section 2.5.2.3) and injection of treated groundwater into well 199-D5-42 form a broad groundwater mound in the central region of the 100-D Area.

The remainder of this section describes contaminant plumes and concentration trends for the constituents of interest under CERCLA and *Atomic Energy Act* (AEA) monitoring.

Hexavalent chromium is the primary contaminant of concern in the 100-D Area.

2.5.1 Groundwater Contaminants

This section describes the distribution and trends of chromium, strontium-90, tritium, nitrate, sulfate, and gross beta in groundwater in the 100-D Area.

2.5.1.1 Chromium

Hexavalent chromium is a contaminant of concern for interim actions in the 100-HR-3 Operable Unit (ROD 1996a, 1999a). The remedial action goal for the pump-and-treat systems is 22 µg/L and for the in situ redox system is 20 µg/L.

Groundwater monitoring in the 100-HR-3-D groundwater interest area includes the following monitoring activities:

CERCLA and AEA Monitoring (Appendix A)

- *Eight wells are sampled monthly to annually for the pump-and-treat systems; one monthly sample was missed in FY 2007.*
- *Twenty-nine wells are sampled monthly to quarterly for the redox system. One well was sampled less frequently than planned in FY 2007.*
- *Thirty-one wells throughout the 100-D Area are sampled monthly to biennially.*
- *Eleven wells are sampled annually to biennially in the “horn” area between 100-D and 100-H Areas.*
- *Six new wells were installed in the “horn” in FY 2007.*

At 100-D Area, three remediation systems help reduce the amount of chromium reaching the Columbia River: two pump-and-treat systems in the north and an in situ remediation system in the southwest.

Chromium contamination underlies most of the 100-D Area in two plumes. The north plume likely originated from cribs and trenches in the central 100-D Area and the south plume has sources near the former chromate transfer station (Figure 2.5-1).

Figure 2.5-4 shows chromium in the entire “horn” of the Hanford Site, which includes the 100-D and 100-H Areas and the 600 Area between. In fiscal year (FY) 2007 and early FY 2008, DOE installed 21 monitoring wells in the 600 Area to help define the plume in the horn. Chromium concentrations in most of these wells were above 20 µg/L,^(a) confirming that the plume extends from 100-D Area to 100-H Area. A small portion of the plume west of 100-H Area had concentrations >100 µg/L. The contamination is believed to have migrated eastward from the 100-D Area when there was a groundwater mound beneath the retention basins. DOE also installed new aquifer tubes north of the 100-H Area in early FY 2008. Section 2.5.2.4 discusses the horn chromium investigation.

Figure 2.5-5 shows detail of chromium distribution at the redox site in southwest 100-D Area. The remediation has reduced chromium concentrations in this region. However, chromium concentrations remained elevated above 100 µg/L in several wells within and downgradient of the redox barrier. Section 2.5.2 discusses this “breakthrough” of chromium and describes the planned activities to mitigate it.

Aquifer tubes provide additional monitoring points along the 100-D Area shoreline (Figure 2.5-6). The highest concentration in FY 2007 was 199 µg/L at tube site AT-36, in the central portion of the shoreline. Figure 2.5-7 illustrates the depths of the aquifer tubes and screened intervals of wells near the shoreline. Chromium concentrations greater than 100 µg/L are detected in tubes from 1 to 8 meters below land surface near the shoreline. Concentrations in the shallowest tubes generally are lower than in deeper tubes because of mixing with river water, as indicated by specific conductance.

North Plume. The 100-µg/L contour of the north chromium plume extends from cribs, trenches, and pipelines near the former reactor building toward the north and west. At levels between 20 and 100 µg/L, the plume extends eastward to the 100-H Area.

Wells 199-D5-15 and 199-D5-16 are monitored near the sources of the north plume. Concentrations have increased dramatically in well 199-D5-15 over the past several years, reaching a maximum of 2,450 µg/L in May 2007 (Figure 2.5-8). The low chromium concentrations in 1999 to 2003 were caused by dilution from nearby leaking water lines. During this time, specific conductance was often low (<300 µS/cm), indicating that groundwater was being diluted with fresh water. Since 2003, the specific conductance has stabilized at ~600 µS/cm, suggesting the dilution has ceased. The cause of the continuing increase in chromium concentrations is unknown. Chromium concentrations in nearby well 199-D5-16 increased modestly in FY 2007 to just above the drinking water standard.

In the north 100-D Area near the original pump-and-treat system, compliance wells continued to show variable chromium concentrations, with the lowest concentrations in the early summer when river stage was high

Plume areas (square kilometers) at the 100-HR-3-D Operable Unit:

Chromium, 100 µg/L — 0.84

Chromium, 20 µg/L* — 3.2

Nitrate, 45 mg/L — 0.81

Tritium, 20,000 pCi/L — 0.03

****Includes chromium plume east to boundary with 100-HR-3-H interest area.***

(a) The plume map of Figure 2.5-4 includes results of samples collected from the new horn wells during well development. Results may not be representative and are considered preliminary. Continued monitoring will further delineate the plume.

(Figure 2.5-9). The concentrations were below the 22 µg/L remedial action goal from April through September in well 199-D8-69, and from May through August in well 199-D8-70 (these are compliance wells for the remedial action). The seasonal concentration peaks (fall and winter of each year) have declined since 2000. Section 2.5.2 contains more information about the pump-and-treat systems.

Chromium concentrations in wells on the southwest side of the north plume decreased from their peak values observed in 2004 (Figure 2.5-10). Wells 199-D5-20 and 199-D5-32 were converted to extraction wells in July 2004. Chromium concentrations in monitoring well 199-D5-41 dropped from ~2,000 µg/L in August 2006 to 225 µg/L in August 2007.

Well 199-D8-54B in the north 100-D Area monitors a silty sand unit within the Ringold Formation upper mud. In this deeper, confined unit, chromium is near the detection limit while an adjacent shallow well has concentrations above the drinking water standard.

South Plume. This chromium plume lies south and southwest of the 182-D reservoir and west of the 183-DR filter plant, extending to the Columbia River (Figures 2.5-4 and 2.5-5). The core of the chromium plume, with concentrations >1,000 µg/L, is oriented west-northwest. The redox barrier intersects the south chromium plume and terminates the highest-concentration portion of the plume.

In FY 2007, DOE installed new wells to investigate chromium sources in the south 100-D Area. New wells are 199-D2-11, 199-D5-97, 199-D5-98, 199-D5-99, 199-D5-102, 199-D5-103, and 199-D5-104 (see Figure 2.5-1). The wells were drilled in areas that were suspected sources of chromium contamination. The highest levels of chromium in groundwater in the new wells were in wells 199-D5-99 and 199-D5-104 (Figure 2.5-11). Section 2.5.2.7 discusses this investigation further.

Compliance monitoring wells downgradient of the redox barrier show inconsistent chromium trends (Figure 2.5-12). The northernmost well, 199-D4-83, shows variable chromium concentrations with decreasing peaks. Concentrations were below the 20-µg/L remedial action goal in February and May 2007. Well 199-D4-39, near the north end of the barrier, shows high variability since 2000. Concentrations in FY 2007 were about the same as FY 2006, with a maximum value of 651 µg/L in November 2006. Chromium concentrations were below the remedial action goal part of the year in wells 199-D4-23, 199-D4-85, and 199-D4-86. Concentrations in wells 199-D4-38 and 199-D4-84 remained above the remedial action goal, with FY 2007 maxima of 369 and 74 µg/L, respectively.

Chromium concentrations downgradient of the redox site have decreased since monitoring began in most of the aquifer tubes (Figure 2.5-13). The highest concentration in this region in FY 2007 was 171 µg/L in tube DD-43-3.

Chromium concentrations in the central 100-D Area (e.g., wells 199-D5-33 and 199-D5-44) are very low, separating the south and north chromium plumes. The low concentrations were probably caused by infiltration of clean water from the 182-D reservoir. Repairs and operational changes have reduced the amount of infiltration (see Section 2.5.2.3). In response, chromium concentrations increased sharply in well 199-D5-34 in FY 2006 (Figure 2.5-14). This well is located near the southeast corner of the reservoir. Specific conductance increased concurrently. This change may reflect decreased dilution from the 182-D reservoir. However, well 199-D5-33 continues to show no detectable chromium.

New wells in the south 100-D Area will help characterize chromium sources there. Some of the new wells have the highest chromium concentrations on the Hanford Site.

2.5.1.2 Strontium-90

Two locations in the 100-D Area have a history of strontium-90 detections in groundwater, i.e., near the former retention basins in the north and near the D Reactor building in central 100-D Area. All FY 2007 results were below the 8-pCi/L drinking water standard.

Well 199-D8-68, near the former retention basins, had the highest strontium-90 concentration in FY 2007. Duplicate samples in November 2006 had results of 7.8 and 4.9 pCi/L. Concentrations ranged from 2 to 14 pCi/L in this well over the past 6 to 8 years. Strontium-90 was also detected in wells 199-D8-53, 199-D8-54A, 199-D8-69, and 199-D8-70 in FY 2007.

Near the former D Reactor, strontium-90 continued to be detected in well 199-D5-15 at ~2 pCi/L. Nearby well 199-D5-16 continued to have no detectable strontium-90.

2.5.1.3 Tritium

Tritium concentrations remained below the 20,000-pCi/L drinking water standard in most wells in the 100-D Area, but continued to exceed the standard in three wells and one aquifer tube near the south part of the redox barrier (Figure 2.5-15). The tritium contamination is believed to have originated as part of the 100-N Area tritium plume to the south. A peak of contamination moved past well 199-D3-2 in the late 1990s. Concentrations in this well have increased again since 2004.

The tritium concentration declined below the drinking water standard in FY 2007 in well 199-D5-17, located near waste sites associated with the former DR Reactor. Since 1996, concentrations have ranged from 12,000 to 26,400 pCi/L with no obvious increasing or decreasing trend. Concentrations in nearby wells remained below the standard.

2.5.1.4 Nitrate and Nitrite

Nitrate distribution is generally similar to chromium in the 100-D Area; both constituents form two plumes (Figure 2.5-16). Nitrate concentrations continued to exceed the drinking water standard (45 mg/L) in both plumes, with a FY 2007 maximum concentration of 89 mg/L in well 199-D5-13 southeast of the former 120-D-1 pond.

The redox barrier intersects the south nitrate plume and converts nitrate to nitrite. Nitrate concentrations declined in wells downgradient of the barrier between 2000 and 2004 or 2005, but have increased in the past several years (Figure 2.5-17). The concentration in downgradient well 199-D4-38 increased to a level above the drinking water standard in FY 2007. These changes may relate to a reduction in the effectiveness of the redox barrier (see Section 2.5.3).

Nitrite was detected in many of the wells monitoring the redox barrier in FY 2007. Only one result exceeded the 3.3 mg/L drinking water standard: 5.58 mg/L in well 199-D4-62. The result was flagged as being associated with out-of-limits laboratory quality control samples, but is within the range of previous results.

2.5.1.5 Sulfate

Sulfate concentrations remained >100 mg/L beneath much of the 100-D Area. Excluding wells influenced by the redox system, concentrations all were below the

*Tritium
contamination in the
south 100-D Area
may have originated
in the 100-N Area.*

secondary drinking water standard (250 mg/L) in FY 2007. Past injections of sodium dithionite solution at the redox site increased sulfate concentrations to levels above the standard in the barrier and in some downgradient wells and aquifer tubes.

2.5.1.6 Gross Beta

Samples from several of the wells in the redox barrier are analyzed for gross beta, and a few of these exceed the 50-pCi/L drinking water standard. Analysis of previous samples show that the beta is caused by potassium-40 naturally present in the injected solution.

2.5.2 Operable Unit Activities

This section summarizes CERCLA activities in the 100-D Area. Remedial actions include two pump-and-treat systems and the in situ redox manipulation system, all of which treat chromium contamination. DOE also began work on several Environmental Management Technology (EM-22) proposals in the 100-D Area. DOE also began characterizing a chromium plume between the 100-D and 100-H Areas.

2.5.2.1 Status of CERCLA Five-Year Review Action Items

The second CERCLA five-year review was published in November 2006 (DOE/RL-2006-20). The review identified six actions pertaining to the 100-D Area.

- **Action 8-1.** Complete a field investigation to investigate additional sources of chromium groundwater contamination within the 100-D Area. Additional geologic and geochemical investigations of the vadose zone in the 100-D Area (March 2009). Section 2.5.2.7 provides more information on this investigation.
- **Action 9-1.** Perform additional characterization of the aquifer in the horn and evaluate the need to perform remedial action to meet the remedial action objectives of the 100-D record of decision for interim action (September 2009). Section 2.5.2.4 discusses the status of this investigation. Figure 2.5-4 illustrates chromium distribution across the horn.
- **Action 9-2.** Incorporate the horn into the 100-HR-3 interim ROD if Action 9-1 indicates the horn contains a plume that needs immediate remediation (September 2009). This action depends on the outcome of Action 9-1.
- **Action 10-1.** Direct the operating contractor to further minimize leakage from the 182-D reservoir (previously completed; see Section 2.5.2.3).
- **Action 11-1.** Initiate limited iron amendments to evaluate whether this enhances redox barrier performance (September 2007). Section 2.5.2.5 discusses the status of this action.
- **Action 11-2.** Expand groundwater pump-and-treat extraction within the 100-D Area by 378.5 liters/minute to enhance remediation of the chromium plume (no due date). DOE and the lead regulatory agency have agreed that this action will be resolved through continuing improvements to the pump-and-treat system. Currently, optimization of the pump-and-treat system and new technologies (electrocoagulation) for the treatment of extracted water are being evaluated.

*During FY 2007,
two pump-and-
treat systems in the
100-D Area removed
75.9 kilograms
of hexavalent
chromium from
the aquifer.*

2.5.2.2 Pump-and-Treat Systems

R. F. Raidl

A pump-and-treat system in the north 100-D Area includes four extraction wells located near the former 116-D-7 and 116-DR-9 retention basins. The system began operating in July 1997 with two extraction wells (199-D8-53 and 199-D8-54A). In May 2002, wells 199-D8-68 and 199-D8-72 were converted to additional extraction wells.

The remedial action objectives of the 100-HR-3 Operable Unit (ROD 1996a, 1999a) are:

- *Protect aquatic receptors in the river bottom from contaminants in groundwater entering the Columbia River.*
- *Protect human health by preventing exposure to contaminant in the groundwater.*
- *Provide information that will lead to the final remedy.*

The contaminant of concern is hexavalent chromium. The records of decision set the cleanup goal at compliance wells as 22 µg/L for the pump-and-treat system and 20 µg/L for the redox system.

Extracted groundwater is transferred via pipeline to the 100-H Area where it is treated and injected into the aquifer. Monitoring requirements for this system are included in DOE/RL-96-90, as modified by DOE/RL-96-84. Long-term monitoring requirements in the 100-D Area were derived from Change Control Form 107. Appendix A lists wells, constituents, and sampling frequencies for interim action monitoring.

A second pump-and-treat system (DR-5 system) began operating at the end of July 2004

to treat increasing hexavalent chromium concentrations in the wells southwest of the original pump-and-treat system. The system was modified in FY 2005 to increase the rate of remediation and widen the capture zone. From August 2005 to present, the extraction wells have been 199-D5-20, 199-D5-32, 199-D5-39, and 199-D5-92. The extracted water is treated in the 100-D Area using a metal chelating medium and injected into well 199-D5-42.

The 100-D Area pump-and-treat systems have removed over 450 kilograms of hexavalent chromium from groundwater. The table below lists the volume of water treated and the mass of chromium removed by each system.

	Original Pump-and-Treat		DR-5 Pump-and-Treat		Pilot Scale Pump-and-Treat	Total	
	FY 2007	Since 1997	FY 2007	Since 2004	1992-1994	FY 2007	Since 1992
Mass of chromium removed (kg)	21.2	263.7	54.7	160.1	30	75.9	453.8

In FY 2007, chromium concentrations remained elevated in the 100-D Area, although the trend over the last 4 years is clearly decreasing in compliance wells 199-D8-69 and 199-D8-70 (Figure 2.5-9). Chromium concentrations vary inversely with river stage, and have remained above the 22-µg/L remedial action goal except for occasional readings during summer months when river stage is high and dilution occurs. Chromium in the vadose zone appears to be a continuing source of contamination on the inland portion of the plume.

DOE/RL-2006-76 presents results of operational monitoring and additional details about the pump-and-treat systems for calendar year 2006. Results for calendar year 2007 will be included in an upcoming report on the 100 Areas pump-and-treat systems.

2.5.2.3 In Situ Redox Manipulation System

R. O. Mahood

This treatment system uses a change in redox potential to reduce dissolved hexavalent chromium in groundwater to trivalent chromium, a much less soluble and less toxic species. Objectives of the redox interim action are the same as for the 100-D Area pump-and-treat system except that the remedial action goal for chromium at the redox site is 20 µg/L. Remedial action monitoring is described in DOE/RL-99-51.

The redox treatment zone is ~680 meters long, aligned parallel to the Columbia River and ~100 to 200 meters inland. The treatment zone is designed to reduce the concentration of hexavalent chromium in groundwater to ≤20 µg/L at seven compliance wells situated between the treatment zone and Columbia River. The system has lowered chromium concentrations in the aquifer near the Columbia River, as shown in the chromium plume maps of Figures 2.5-4 and 2.5-5. In FY 2007 the 20-µg/L goal was met^(b) at two of the seven compliance wells: 199-D4-85 and 199-D4-86. Chromium trends in the other compliance wells were generally decreasing (Figure 2.5-12).

During FY 2007, as well as in recent years, chromium concentrations increased in redox barrier wells beyond what was expected based on the design. At the end of FY 2007, concentrations in barrier wells ranged from below detection limits to 880 µg/L, with concentrations in ~69% of the wells below the remedial action goal of 20 µg/L. Concentrations in 77% of the wells were <50 µg/L, 4% were between 50 and 100 µg/L, and 19% were greater than 100 µg/L. Most of the elevated concentrations are in the northeast half of the barrier. DOE is investigating methods to mitigate the chromium breakthrough (Section 2.5.2.5).

Results of water-level monitoring within the 182-D reservoir showed that ~6 million liters of water leaked to the ground between November 1, 2006 and December 8, 2006.^(c) This was lower than the ~31 million liters that leaked in FY 2006. The leakage rate in FY 2007 was 106 liters/minute. The water table below the reservoir rose temporarily in response. The leakage occurred during a period of standby condition at the 182-D reservoir. The reservoir does not appear to have leaked during the rest of the fiscal year. Leakage from the 182-D reservoir was identified as an issue in the CERCLA five-year review (see Section 2.5.2.1). The operating contractor maintains the water level at 0.6 to 1.8 meters during pumping operations and 0.3 to 0.9 meter during standby conditions. Maintaining low water levels helps minimize leakage. Water is only pumped from the 182-D reservoir during emergency conditions, i.e., if unable to pump from the 182-B reservoir. There were three periods of emergency operations at the 182-D reservoir in FY 2007: September 24 to October 4, 2006; September 5 to 10, 2007; and September 17 to 25, 2007. At all other times, the 182-D reservoir is maintained in a standby condition. DOE/RL-2007-19 presents more information on the redox site for FY 2006. Results for FY 2007 will be presented in an upcoming report.

The redox system has reduced chromium concentrations in the aquifer near the Columbia River.

(b) FY 2007 average of filtered, total chromium and filtered, hexavalent chromium.

(c) The volume of leakage from the 182-D reservoir is estimated using the water level monitoring data for the reservoir and dimensions of the reservoir. The method is described in WMP-26568.

In FY 2007 DOE began to investigate chromium contamination across the “horn” of the Hanford Site. New wells show that contamination extends from the 100-D Area to the 100-H Area.

2.5.2.4 Chromium Investigation in the Horn

D. Weekes

DOE initiated a field study to characterize the extent, concentration, and movement of hexavalent chromium in groundwater underlying the area between 100-D and 100-H Areas (commonly called the “horn”). SGW-33224 provides the sampling and analysis instructions for the study.

By the end of September 2007, DOE had installed six wells in the horn area: 699-94-41, 699-94-43, 699-95-45, 699-95-48, 699-97-41, and 699-97-48C. Fifteen more wells and eighteen aquifer tubes were completed in early FY 2008.

Preliminary hexavalent chromium analyses from the new wells indicate continuous contamination across the horn between 100-D and 100-H Areas at levels above the 22- $\mu\text{g/L}$ remedial action goal (see Section 2.5.1.1 and Figure 2.5-4). Water samples collected from the semi-confined aquifer within the Ringold upper mud also show hexavalent chromium contamination above the goal.

Results of the investigation will be published in an upcoming report in FY 2008.

2.5.2.5 Micron-Size Iron Injection

S. W. Petersen

In this project, micron-size iron will be tested for its ability to be injected into the redox wells and react with groundwater to reduce chromium. This is a unique application that has never been tested at Hanford.

During FY 2007, a contractor tested various iron compounds in the laboratory for their ability to be injected into Ringold Formation sediments and reduce chromium in groundwater. Laboratory tests will be completed by April 2008, with the goal of injecting one or two of the most suitable compounds during spring or summer of 2008.

2.5.2.6 Electrocoagulation Tests

S. W. Petersen

This project, conducted during the summer of 2007, tested electrocoagulation as an alternative to ion exchange for treating chromium-contaminated groundwater. Electrocoagulation is a water treatment process that has been used to remove a variety of suspended solids and dissolved pollutants from water by applying an electric field to steel plates. The electric field liberates iron and causes the pollutants to precipitate, forming a solid that can be removed and disposed. The test ran at ~190 liters/minute for several months. Water was extracted from wells 199-D5-13 and 199-D5-41. The treated water was injected into well 199-D5-106, upgradient of the northern chromium plume. A treatability test report is scheduled to be released in spring 2008.

2.5.2.7 Chromium Source Area Refinement

S. W. Petersen

Chromium concentrations in both 100-D Area plumes have not declined significantly, which strongly suggests that chromate is still present in the vadose

zone. Chromium concentrations are above 1,500 µg/L in both plumes and have been above 12,000 µg/L in some areas, which confirms that the source is not historic reactor cooling water but a considerably more concentrated solution.

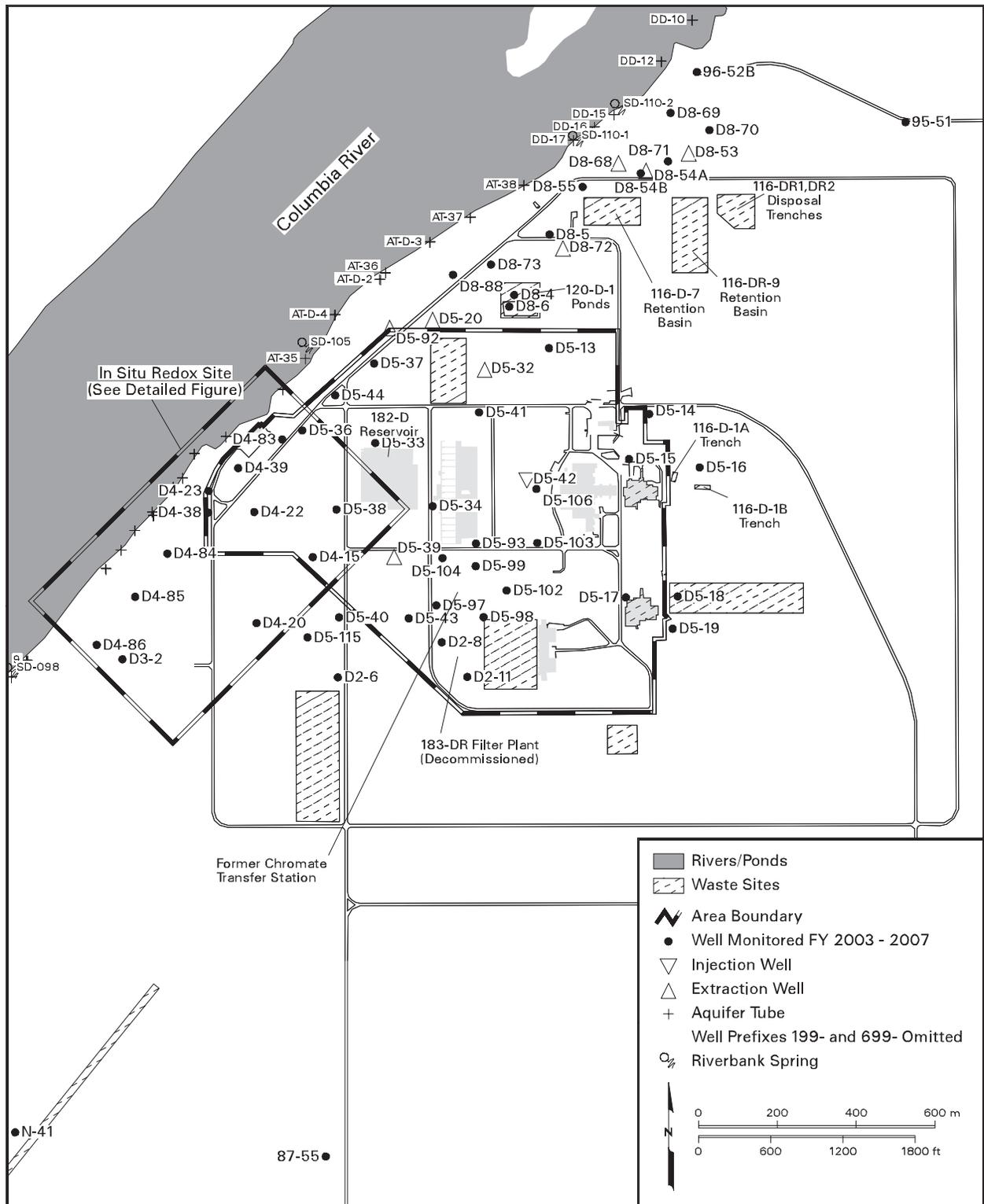
Two EM-22 projects have been funded to refine the area of the source for each plume. DOE/RL-2006-74 presents the field investigation plan for this study. The objectives of this work are to obtain soil samples from the suspected source areas, and refine the source location by collecting groundwater samples for several months. The groundwater samples will be used to refine the location of the proximal portion of each of the plumes in the 100-D Area. DOE installed seven wells in the southern plume in February and March 2007 and has been sampling the wells bi-weekly since then. The wells have been instrumented to automatically measure the groundwater levels, which will aid in locating the source area. Plans for the northern plume include approximately fifteen vadose zone pushes to collect soil samples using a hydraulic hammer rig developed specifically for Hanford, and installing three groundwater monitoring wells. This work will be performed at the beginning of calendar year 2008.

2.5.2.8 Chromium Vadose Zone Characterization and Geochemistry

J. S. Fruchter, R. B. Rowley, S. W. Petersen, and K. M. Thompson

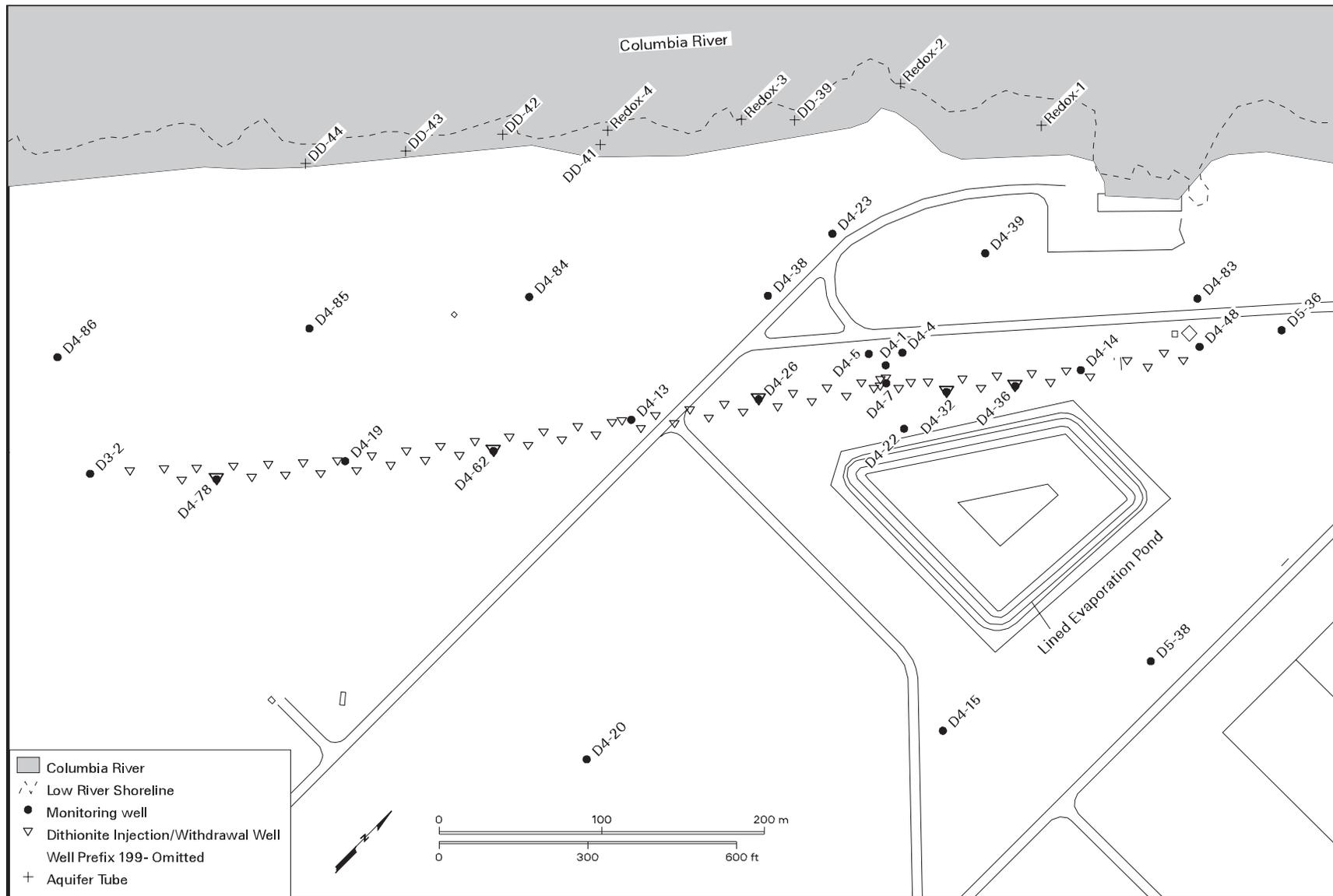
Pacific Northwest National Laboratory is conducting a study of chromium geochemistry as part of DOE's Environmental Management (EM-22) program (<http://www.hanford.gov/cp/gpp/science/em21.cfm>). The primary objectives of the study are to (1) determine the leaching characteristics of hexavalent chromium from contaminated sediments collected from 100 Area spill sites; (2) clarify possible mineral or chemical associations that may be responsible for chromium retention, through the use of solubility studies and characterization of contaminated sediments; and (3) from these data, construct a conceptual model of hexavalent chromium geochemistry in the 100 Area vadose zone.

During FY 2007, hexavalent chromium-contaminated sediments were collected from the 100-B/C and 100-D Areas. Some sediments in the cores were freshly contaminated from pipeline leaks. Other sediments were contaminated up to 40 years ago, and represented aged contamination. Various column-leaching experiments were completed on the core sediments. In all column-leaching studies, the majority of hexavalent chromium was released in the first pore volume, indicating that it remains highly soluble and mobile. However, at least some tailing was observed in all of the columns. The leaching behavior from sediments of common origin sometimes exhibited different behavior, and the amount of tailing did not correlate well with the age of the spill. Column experiments also were conducted in which fresh hexavalent chromium solution was introduced. In all cases, the retardation coefficient was close to one, showing that fresh hexavalent chromium acts as a conservative tracer. This behavior was independent of the influent concentration of chromium on the solutions. The next step in this project is to characterize the form of the hexavalent chromium in the various sediments.



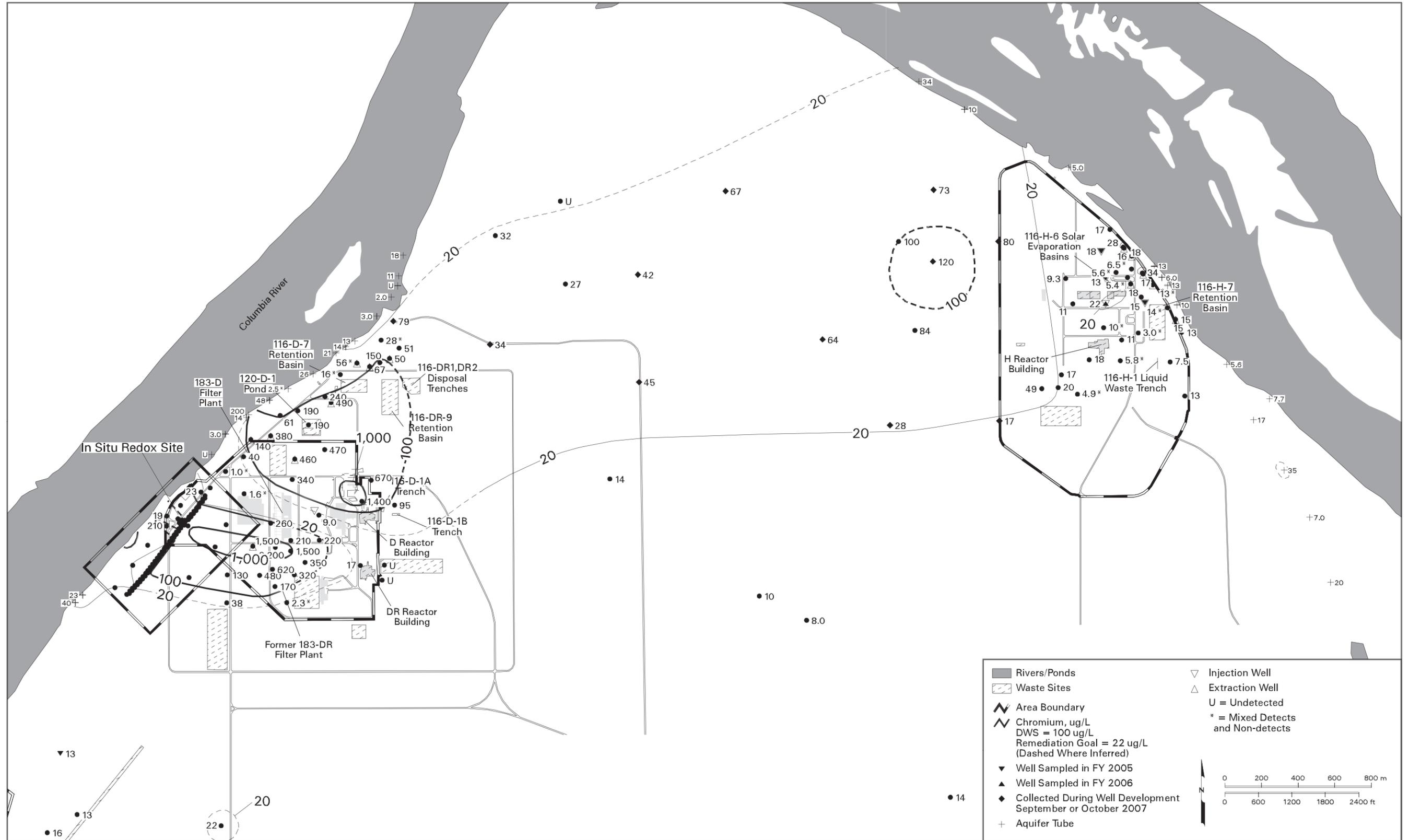
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Figure 2.5-1. Groundwater Monitoring Wells in 100-D Area



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Figure 2.5-2. Groundwater Monitoring Wells Near Redox Site in 100-D Area



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Figure 2.5-4. Average Chromium Concentrations in 100-D and 100-H Areas, Upper Part of Unconfined Aquifer

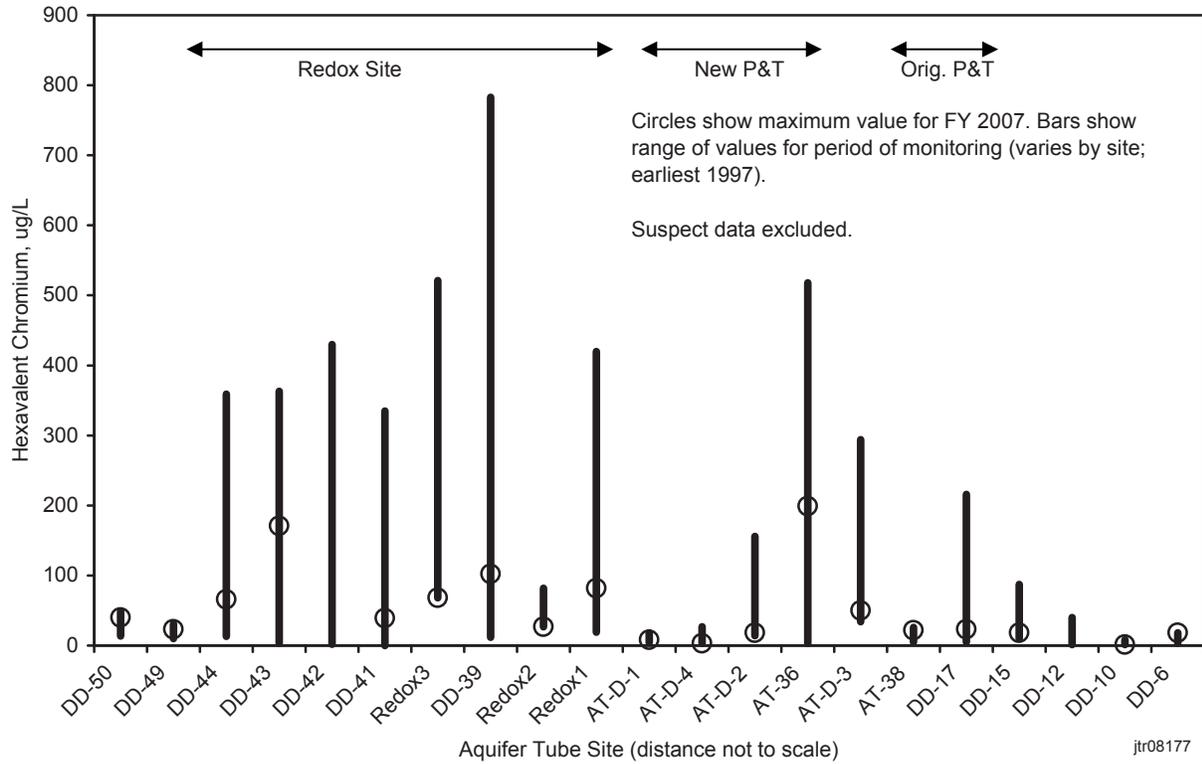
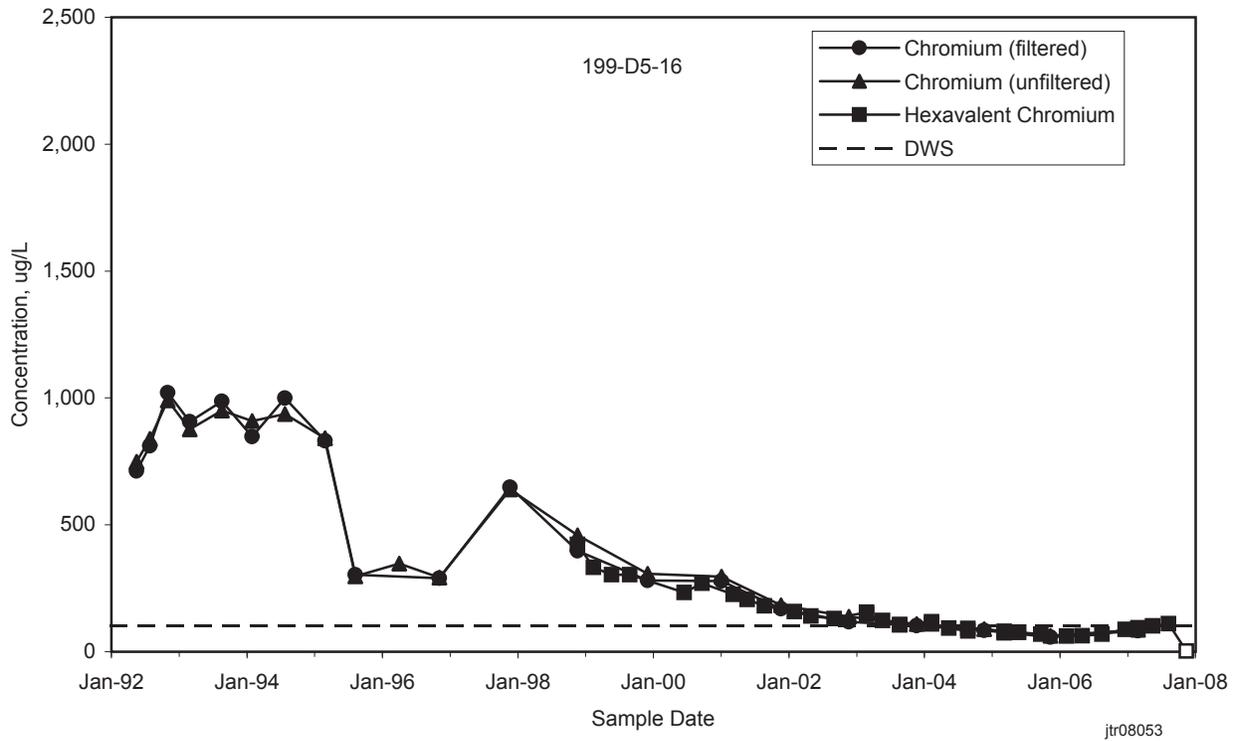
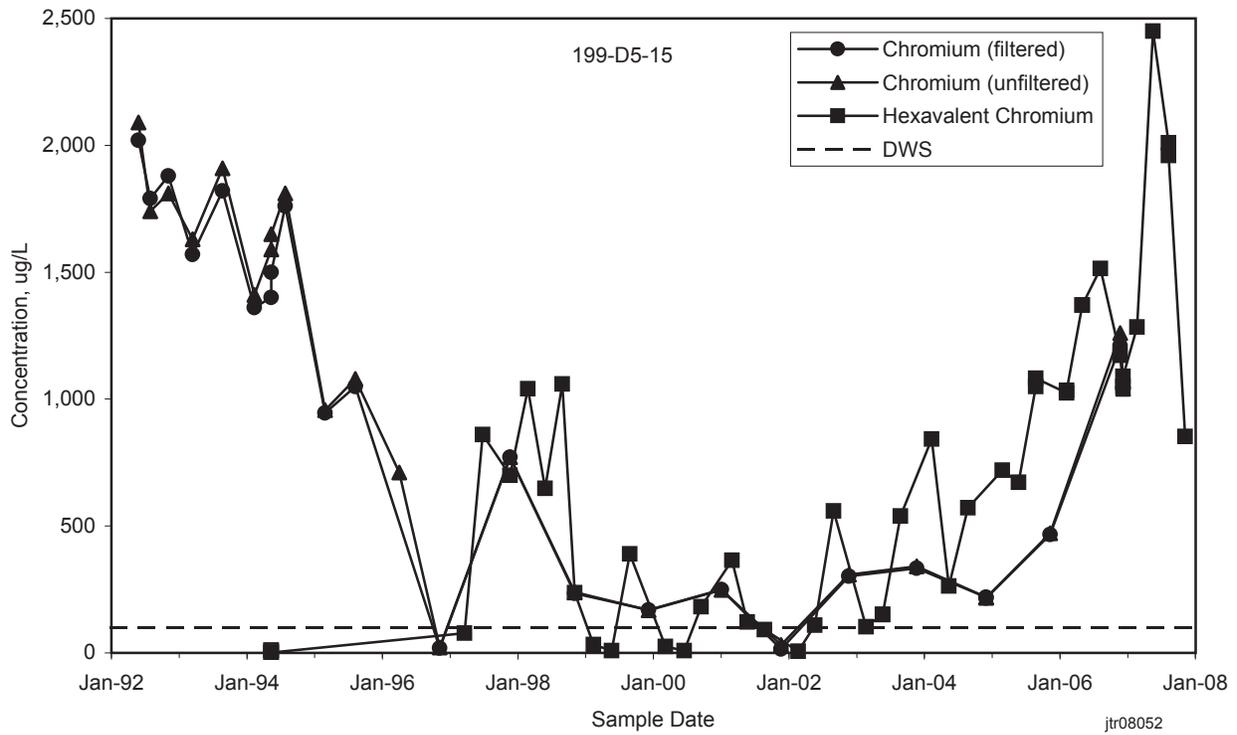


Figure 2.5-6. Hexavalent Chromium Concentrations at Selected Aquifer Tube Sites at 100-D Area



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Figure 2.5-8. Chromium Concentrations in Wells Near Former D Reactor

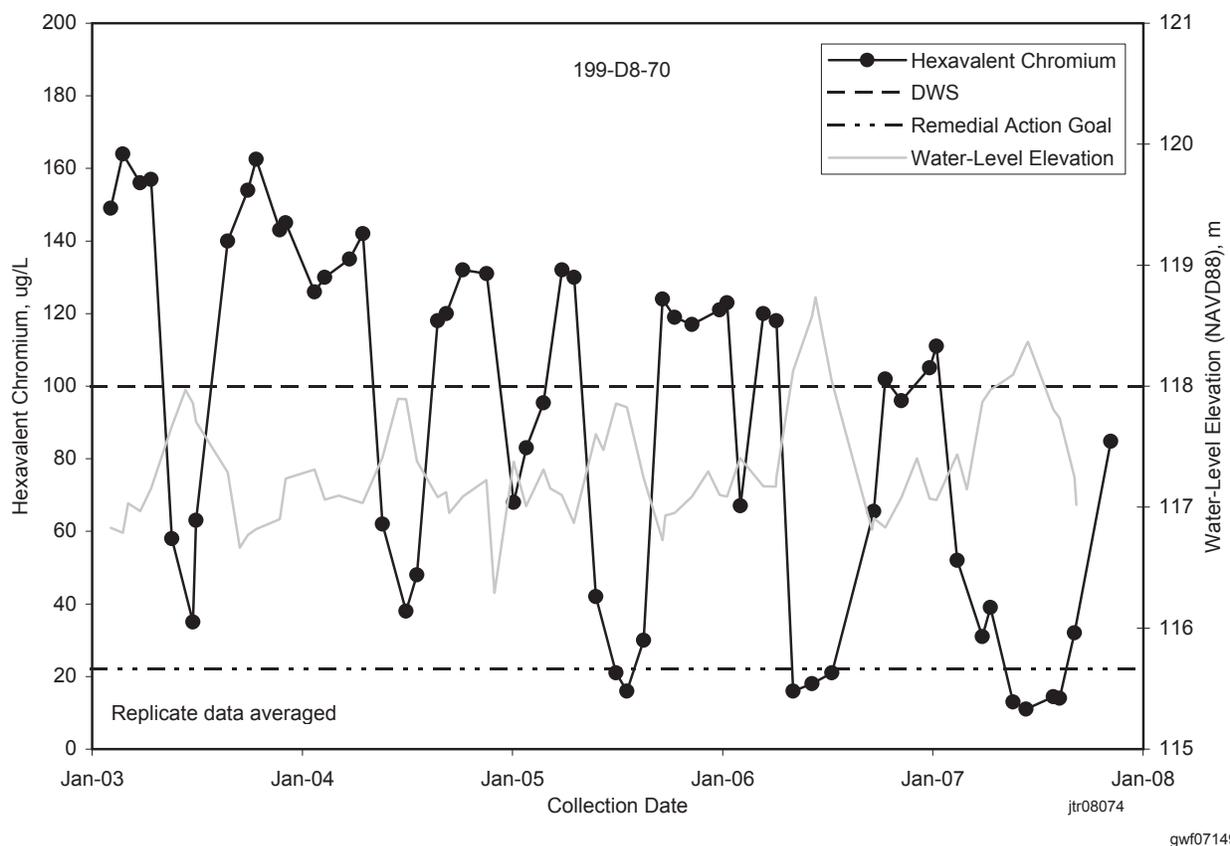
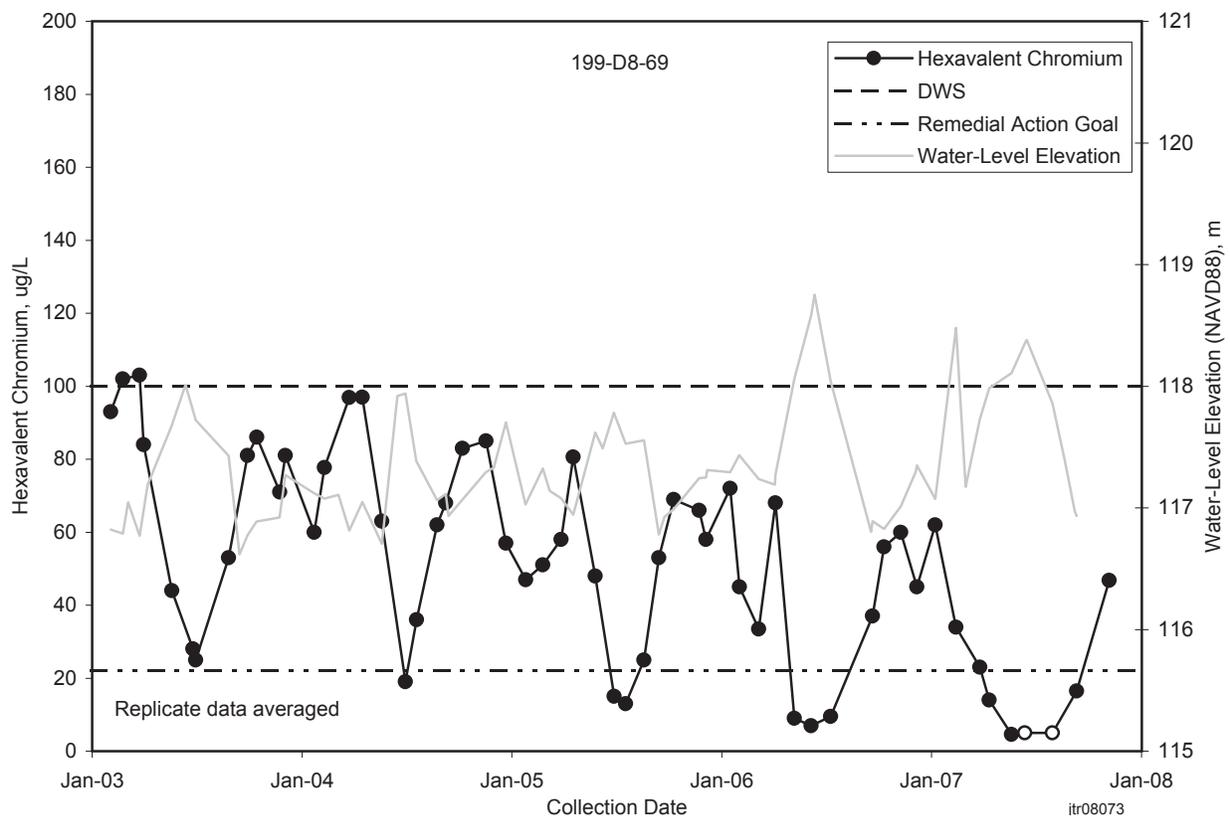


Figure 2.5-9. Hexavalent Chromium Concentrations and Water Levels in Compliance Wells for 100-HR-3 Pump-and-Treat System at 100-D Area

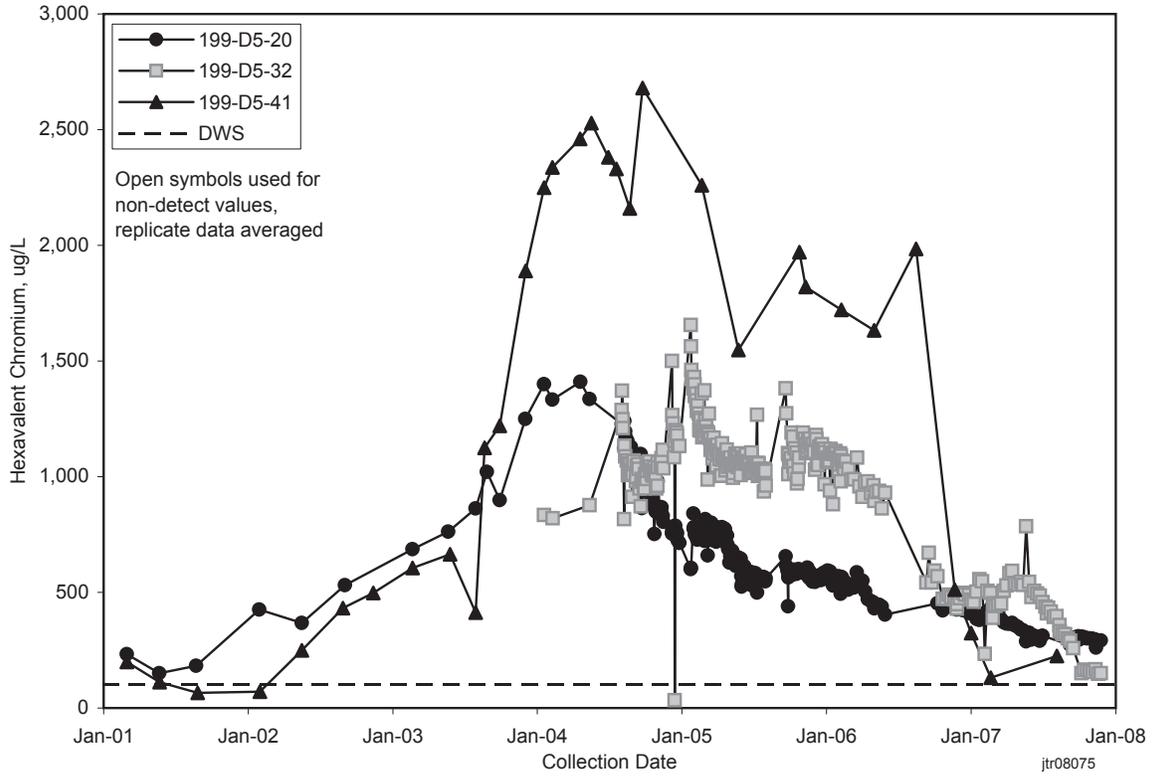


Figure 2.5-10. Hexavalent Chromium Concentrations in Central 100-D Area

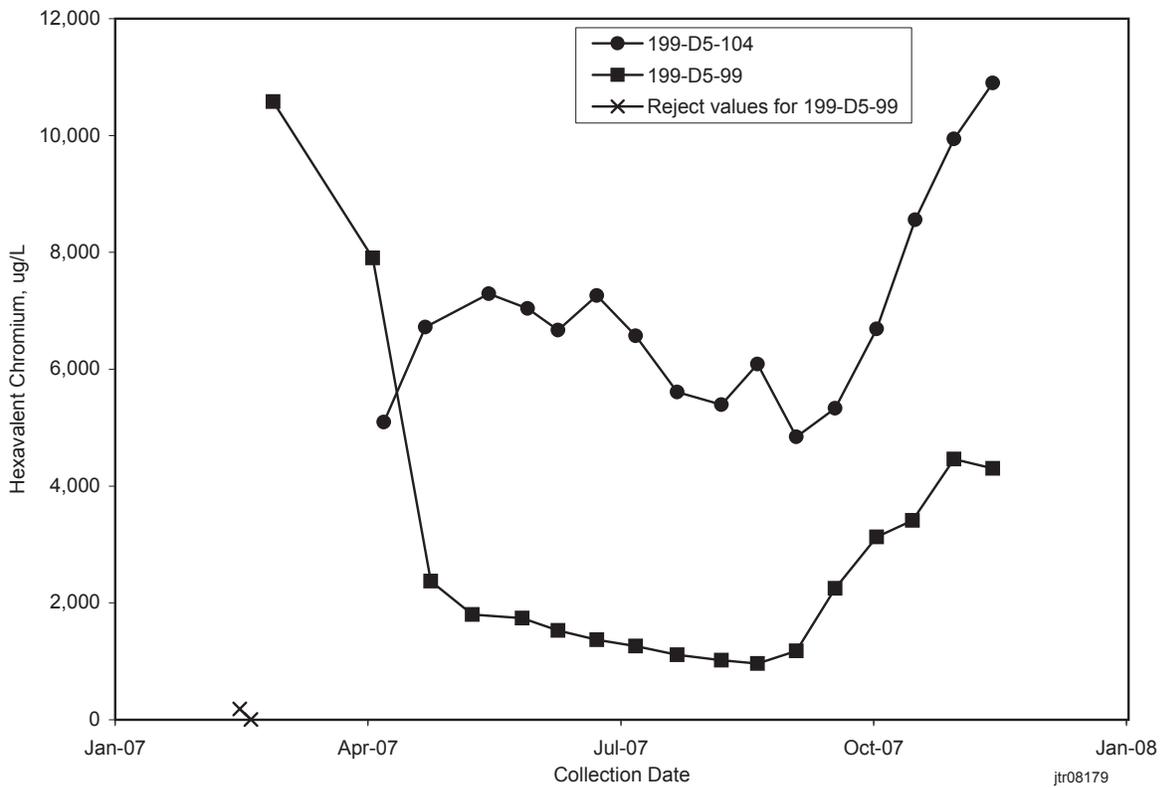


Figure 2.5-11. Hexavalent Chromium Concentrations in South Central 100-D Area

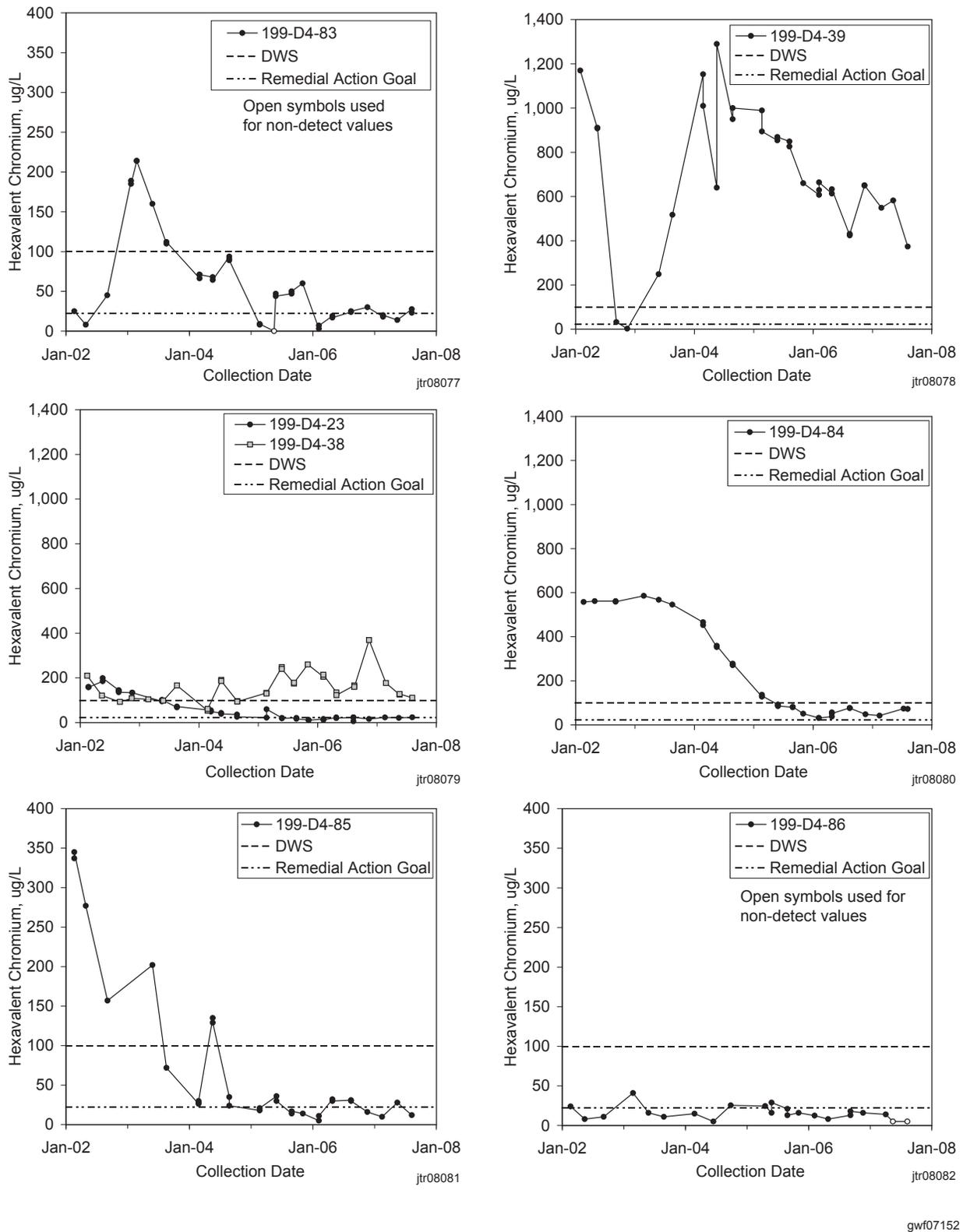


Figure 2.5-12. Hexavalent Chromium Concentrations in Compliance Wells Downgradient of Redox Barrier

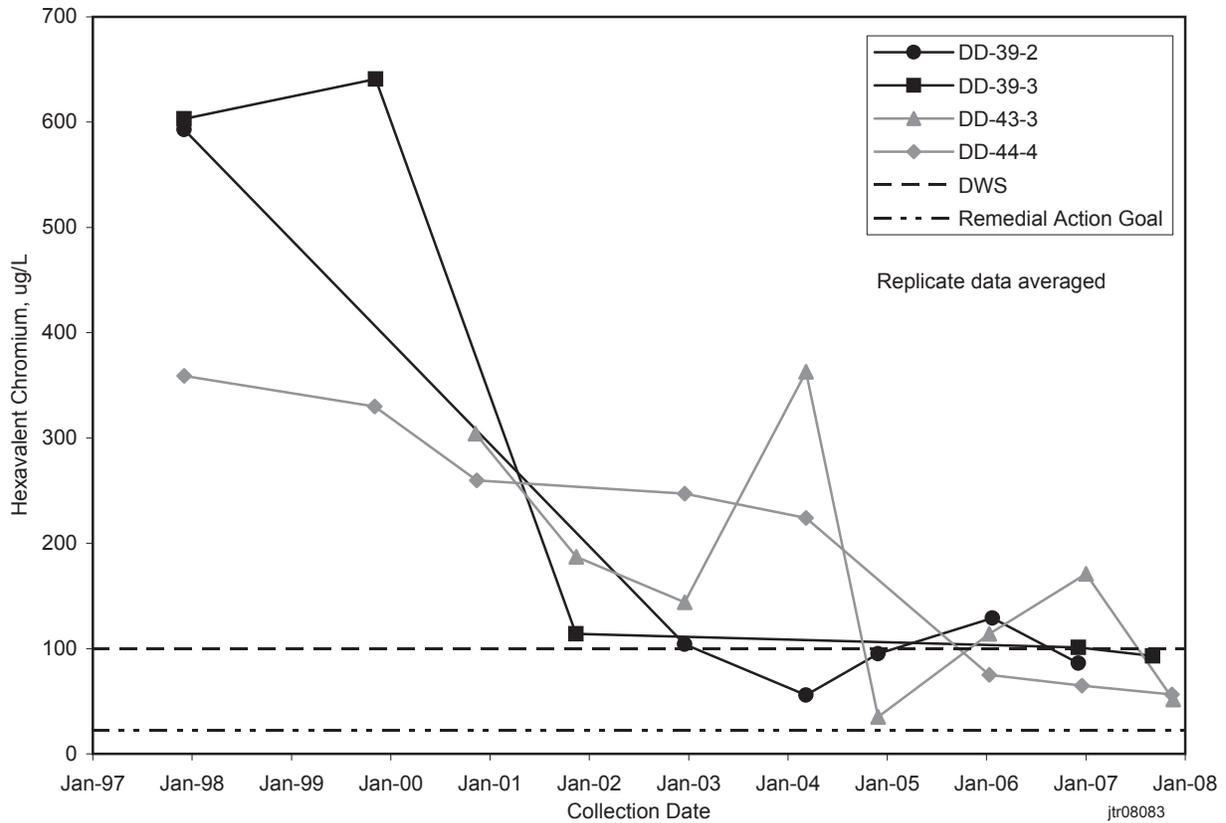


Figure 2.5-13. Hexavalent Chromium Concentrations in Aquifer Tubes Downgradient of Redox Barrier

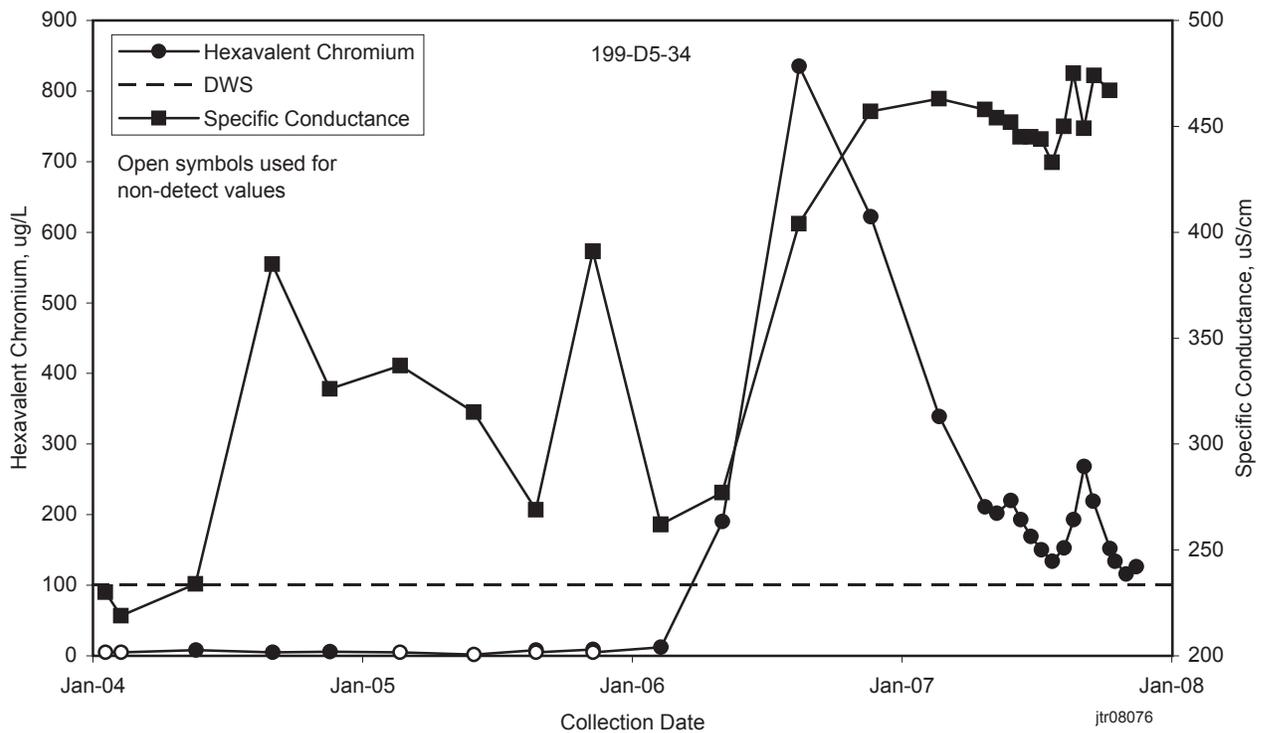


Figure 2.5-14. Hexavalent Chromium Concentrations and Specific Conductance Southeast of 182-D Reservoir

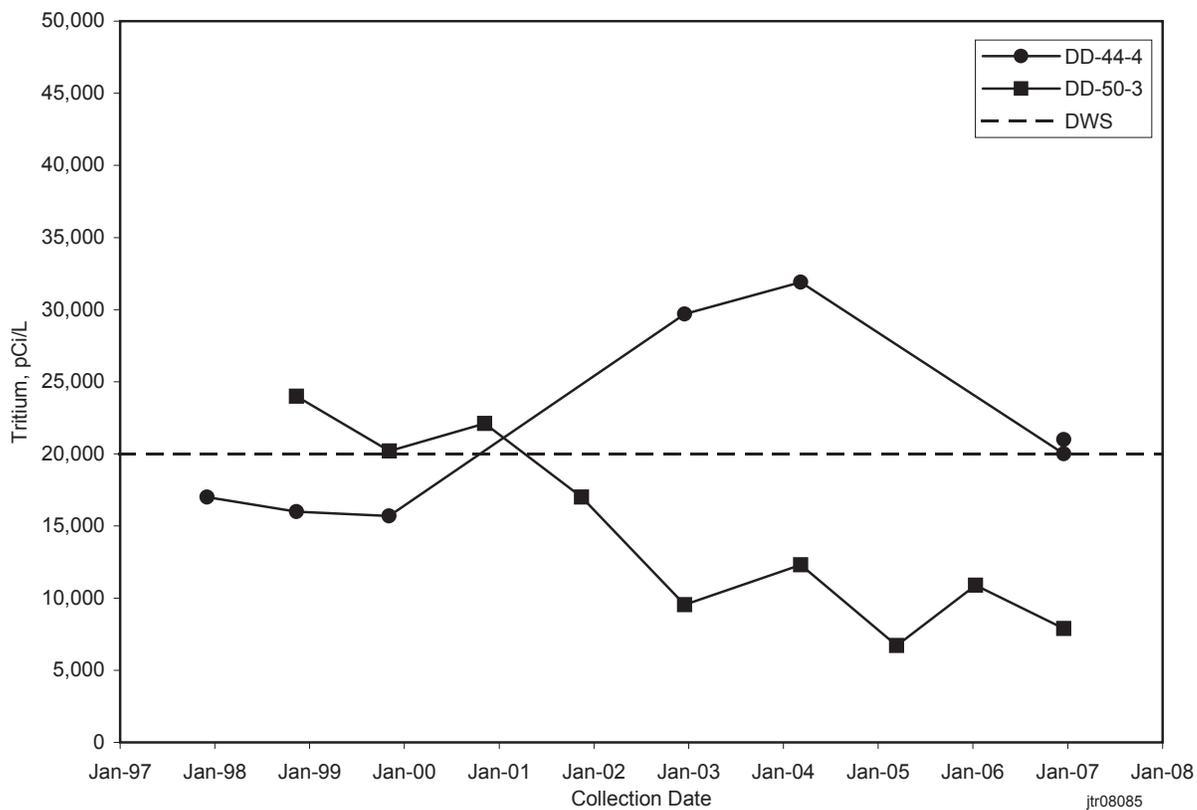
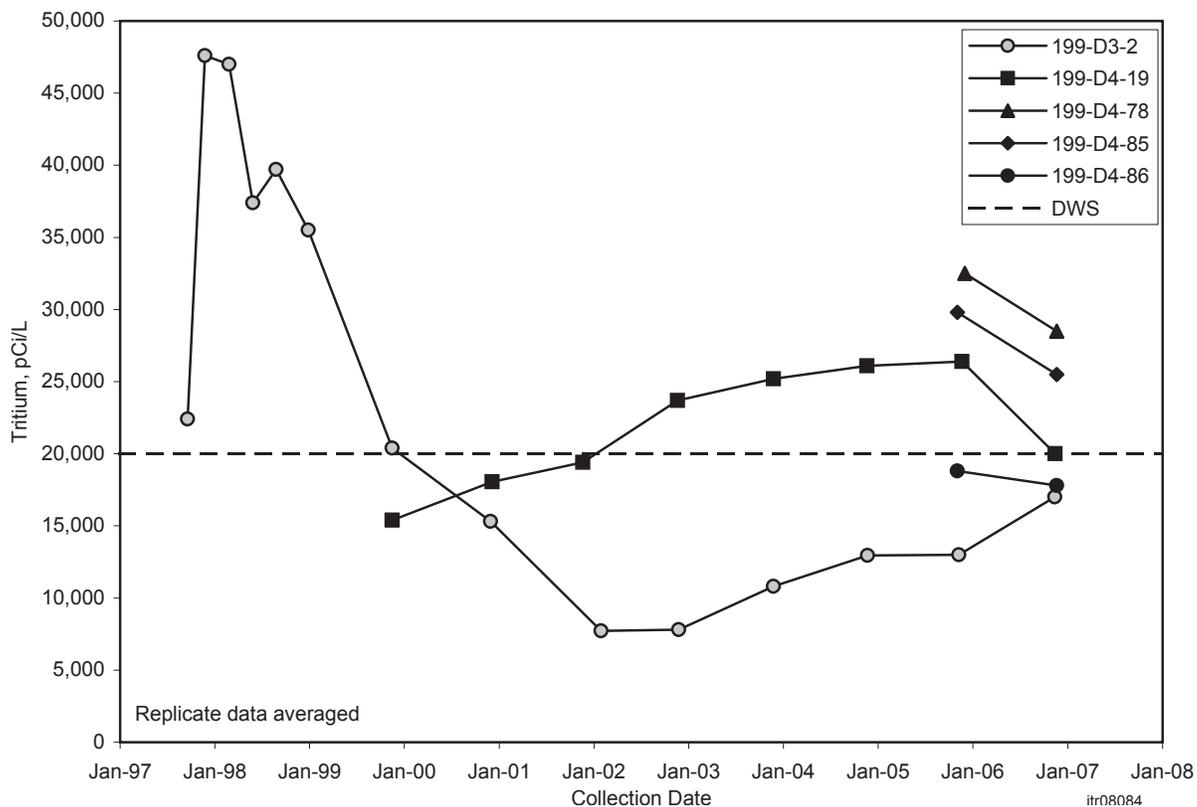
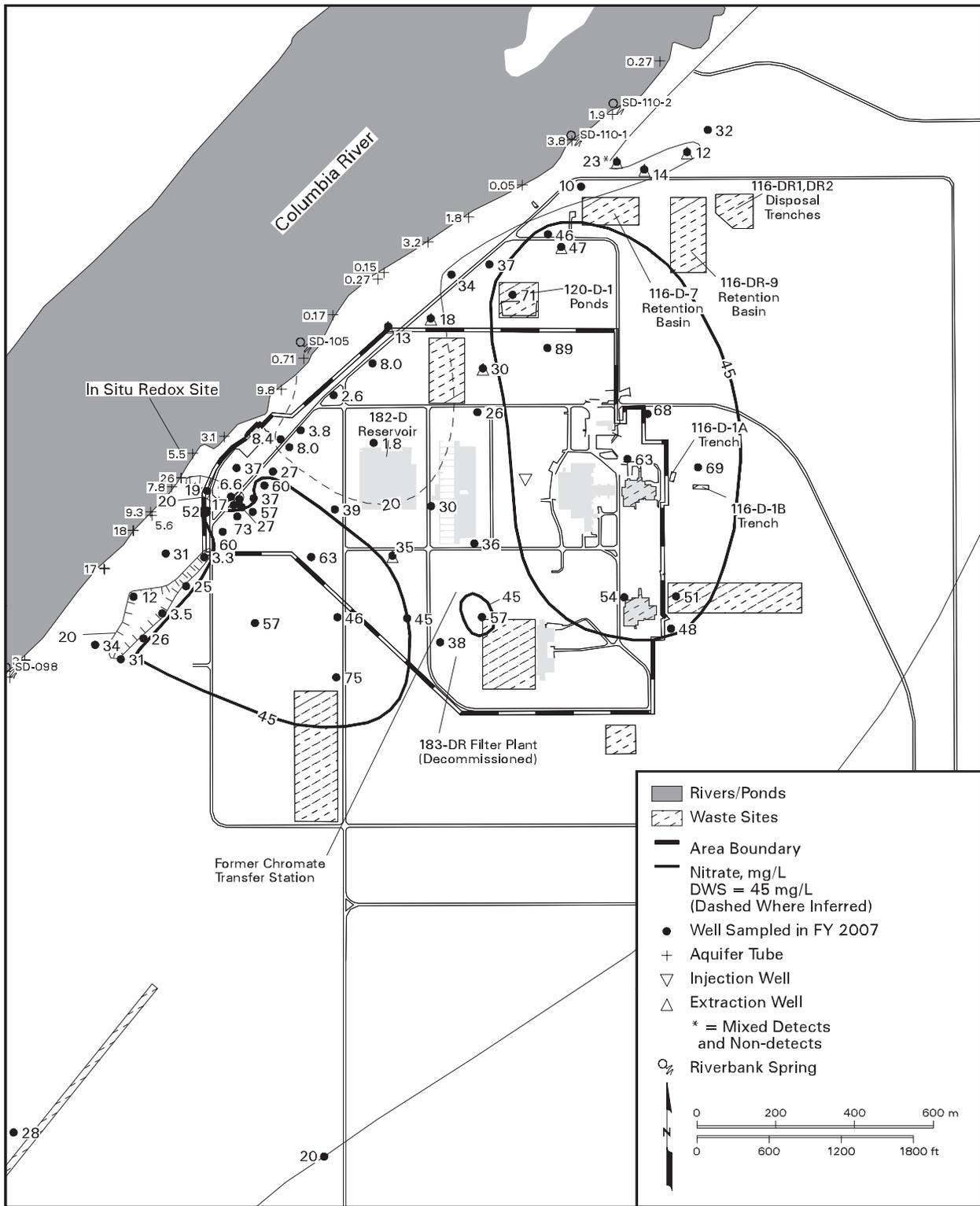


Figure 2.5-15. Tritium Concentrations in South 100-D Area



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Figure 2.5-16. Average Nitrate Concentrations in 100-D Area, Upper Part of Unconfined Aquifer

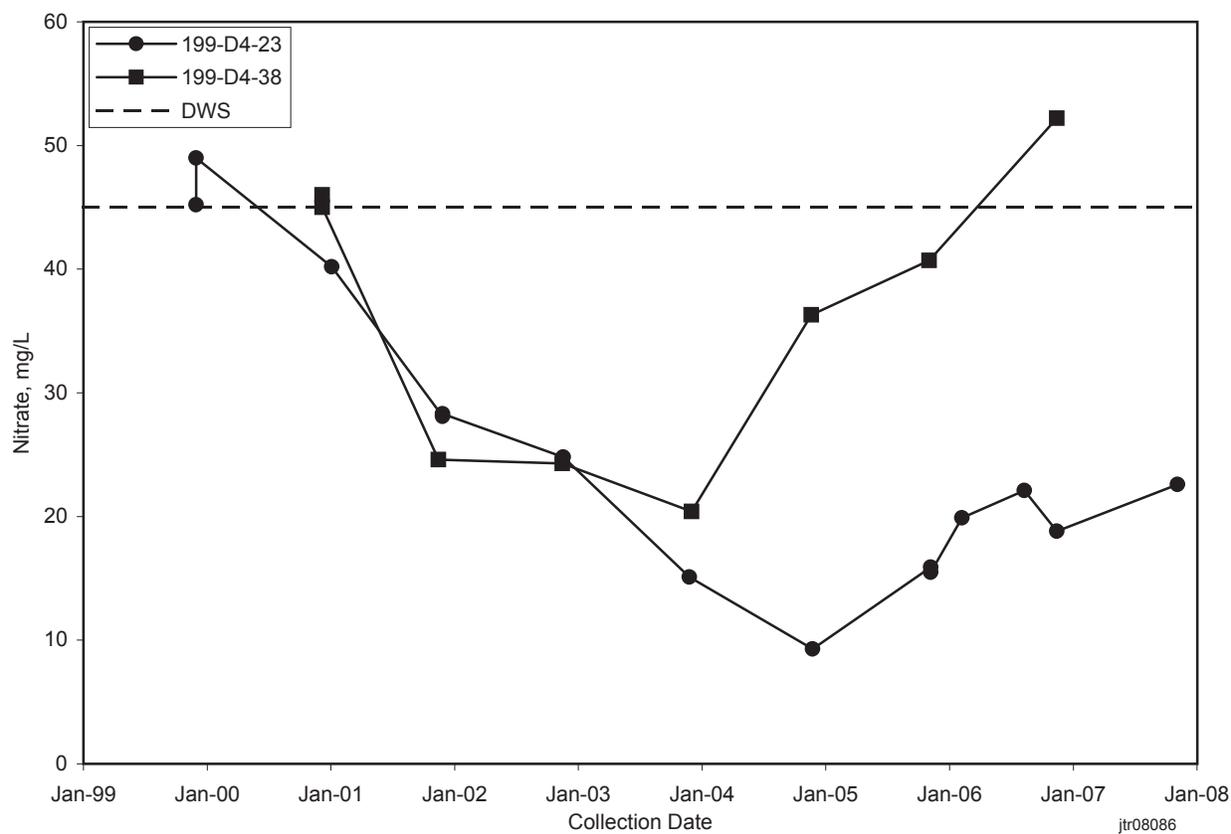


Figure 2.5-17. Nitrate Concentrations Downgradient of Redox Barrier