2.11 200-PO-1 Operable Unit

J. W. Lindberg

This section describes groundwater flow and contaminant plumes within the 200-PO-1 groundwater interest area, which includes the 200-PO-1 Operable Unit (Figure 1.0-1). The area is roughly defined by the large tritium plume emanating from the southeastern portion of the 200 East Area and includes the southern portion of the 200 East Area and a large triangle-shaped portion of the Hanford Site extending to the Hanford townsite (to the east) and to the 300-FF-5 groundwater interest area (to the southeast). Although the 216-B-3 Pond (B Pond) straddles the northern boundary with the 200-BP-5 Operable Unit, it is considered part of the 200-PO-1 groundwater interest area. The BC Cribs and Trenches are completely outside of the 200-PO-1 Operable Unit, but potential groundwater contamination there is discussed in this section because of proximity to the 200-PO-1 Operable Unit.

Wells located in the 200 East Area near the major sources for groundwater contamination are in the near-field area; whereas wells located in the 600 Area to the east and southeast are considered far-field wells. Figure 2.11-1 shows the location of local facilities and wells used in near-field monitoring. Figures 2.11-1 and 2.11-2 provide the locations of wells used in the remainder of the 200-PO-1 Operable Unit far-field area and Columbia River shoreline monitoring sites within the 600 Area.

Groundwater in the unconfined aquifer flows primarily to the southeast in the west portion of the operable unit (200 East Area) in response to higher heads to the west and the large paleochannel incised in the top of the underlying Ringold Formation that trends the same direction. In the central to eastern portion of the operable unit, groundwater flow fans outward and flows northeast, east, and southeast as it approaches the Columbia River. Vertical head differences in the 200-PO-1 Operable Unit are generally increasing with depth forming an upward gradient. In the 200 East Area, the difference between the aquifers below the Ringold Formation lower mud unit and the unconfined aquifer ranges from a few centimeters to about one meter. Along the Columbia River near well 699-20-E12 the vertical head difference is about 10 m with the 600 Area between the two areas having intermediate head differences. The exception to the general upward gradient is near B Pond where the heads decrease with depth, possibly a condition remaining from the time that the B Pond System was in operation. Section 2.14 contains additional information about the hydraulic head values and vertical gradients in the confined aquifers. PNNL-12261 provides a detailed discussion of 200 East Area hydrogeology and groundwater flow characteristics.

Tritium, nitrate, and iodine-129 are the contaminants with the largest groundwater plumes and are largely the result of the two periods of PUREX (Plutonium-Uranium Extraction Plant) operation. Other contaminants of concern in more localized areas include strontium-90 near the 216-A-36B Crib (a PUREX crib) and technetium-99 in Waste Management Area (WMA) A-AX. Contaminants of potential concern include arsenic, chromium, manganese, vanadium, cobalt-60, cyanide, and uranium.

Groundwater monitoring in the 200-PO-1 groundwater interest area is designed to meet requirements for the *Atomic Energy Act of 1954* (AEA), *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), *Resource Conservation and Recovery Act of 1976* (RCRA), and *Washington*

Administrative Code, as directed in U.S. Department of Energy (DOE) Orders. The immediate goal for the 200-PO-1 Operable Unit is to monitor the contaminants of concern (and potential concern) under the CERCLA remedial investigation/feasibility study process until final cleanup decisions are made. The operable unit has six RCRA units that are monitored under separate groundwater monitoring plans. The RCRA units include Integrated Disposal Facility, the PUREX Cribs (or RCRA PUREX Cribs[1]), WMA A-AX (single-shell tanks), 216-A-29 Ditch, 216-B-3 Pond Facility (B Pond), and the Nonradioactive Dangerous Waste Landfill. Although not regulated under RCRA, the Solid Waste Landfill and 200 Area Treated Effluent Disposal Facility are subject to *Washington Administrative Code*, requirements. Water supply wells in the 400 Area are monitored for tritium under AEA.

Some of the main concepts associated with the 200-PO-1 Operable Unit include the following.

- Principal sources of groundwater contamination included cribs, ponds, and single-shell tanks that formerly leaked. These facilities are currently inactive, and pumpable liquids have been removed from the tanks. However, the waste sites have not yet been remediated and contamination remains in the vadose zone.
- Characterization of vadose zone contamination continued during fiscal year (FY) 2008 with the drilling of exploratory boreholes. Groundwater samples were collected from each of these boreholes and results were consistent with surrounding groundwater monitoring wells.
- Tritium, nitrate, and iodine-129 are the principal groundwater contaminants of concern because of their widespread plumes. The area of the iodine-129 plume is stable and the tritium and nitrate plumes are shrinking.
- Small plumes of strontium-90 and technetium-99 exceed their respective drinking water standards, but concentrations are stable to decreasing.
- There is no active groundwater remediation in the 200-PO-1 Operable Unit. A record of decision has not yet been established.
- The 200-PO-1 Operable Unit is in the characterization phase of a CERCLA remedial investigation and feasibility study. During FY 2008, DOE released a work plan that identifies a 2-year process for collecting additional characterization data.
- Six RCRA sites are located in the 200-PO-1 Operable Unit. At the Nonradioactive Dangerous Waste Landfill, total organic carbon concentrations in one downgradient well exceeded the critical mean value. The site will begin an assessment monitoring program in FY 2009. The other RCRA sites continued to be monitored under previously-established monitoring programs.
- One new well was installed at WMA A-AX as required by the RCRA groundwater monitoring plan.
- Groundwater flow directions in the 200 East Area are difficult to interpret from water-table maps because of the low hydraulic gradient. Preliminary efforts to refine the water-table map were partially successful, and efforts will continue during FY 2009.

1 The term "PUREX Cribs" refers to all the cribs in the southeast part of the 200 East Area and east of the 200 East Area where PUREX wastewater was discharged. Three of these cribs are monitored under RCRA and termed the "RCRA PUREX Cribs" (Section 2.11.3.2).

- Most of the monitoring wells are screened at the top of the unconfined aquifer. No groundwater constituents exceed drinking water standards in 26 deeper wells.

The following sections provide details about groundwater monitoring in the 200-PO-1 groundwater interest are during FY 2008. Section 2.11.1 describes contaminant plumes and concentration trends. Section 2.11.2 summarizes operable unit activities. Section 2.11.3 describes monitoring of the RCRA-regulated facilities and facilities monitored to meet *Washington Administrative Code* requirements.

2.11.1 Groundwater Contaminants

This section describes the major contaminants of concern within the 200-PO-1 Operable Unit: tritium, iodine-129, nitrate, strontium-90, technetium-90, and other contaminants of potential concern.

Plume areas (square kilometers) in the 200-PO-1 Operable Unit:

Iodine-129, 1 pCi/L — 53.80
Nitrate, 45 mg/L — 0.66
Strontium-90, 8 pCi/L — 0.01
Technetium-99, 900 pCi/L — <0.01
Tritium, 20,000 pCi/L — 117.48
Tritium, 80,000 pCi/L — 17.69
Uranium, 30 µg/L — 0.09

The cribs, ponds, and ditches surrounding the PUREX Plant are responsible for most of the groundwater contamination in the 200-PO-1 Operable Unit. The PUREX Plant started operation in 1956, eventually replacing the Reduction-Oxidation (REDOX) Plant as the plutonium separations facility. The first PUREX operational campaign was from 1956 to 1972. Following an 11-year shutdown, the PUREX Plant operation restarted in 1983 and shut down in December 1988 when the weapons production mission ended. Plant operation briefly restarted in December 1989 to stabilize material in the system. The plumes primarily contain those species associated with process condensates, including tritium, iodine-129, and nitrate. Some strontium-90 and technetium-99 also are associated with PUREX waste disposal, though technetium-99 is not found above the 900 pCi/L drinking water standard in contaminant plumes from PUREX Cribs. Technetium-99 exceeds the drinking water standard beneath WMA A-AX.

2.11.1.1 Tritium

The principal source for the large tritium plume extending from the southeastern portion of the 200 East Area to the Columbia River (Figures 1.0-2 and 2.11-3) is in the vicinity of the PUREX Cribs. The highest concentrations of tritium (drinking water standard 20,000 pCi/L) in this plume remain near these cribs (Figure 2.11-4). The highest reported level of tritium during FY 2008 was 650,000 pCi/L for samples collected in April 2008 at well 299-E17-14 near the 216-A-36B Crib.

Tritium, nitrate, and iodine-129 are the contaminants of greatest significance in this operable unit.

Concentrations of tritium generally continue to decline in the far-field area as the plume attenuates naturally due to radioactive decay and dispersion, along with the generally decreasing source that resulted from the termination of PUREX Plant operations. Wells in the eastern portion of the 200-PO-1 Operable Unit have tritium concentrations above 80,000 pCi/L (Figure 2.11-3) from an early period of discharge to the PUREX Cribs (PNNL-11141, *Hanford Site Ground-Water Monitoring for 1995*). The area of the tritium plume with concentrations above the 80,000 pCi/L in the eastern portion of the Hanford Site is ~18 km^2. In FY 1997, this portion of the plume was over ~60 km^2. The concentrations in wells within this portion of the plume are expected to continue decreasing as areas with higher concentrations (representing the two periods of PUREX Plant operations) move beyond the wells into the river or decay and disperse. Groundwater at this location likely will continue

to be contaminated with tritium at levels greater than the drinking water standard for 40 to 50 years. Wells more distant from the source are sampled once every three years (most were sampled during FY 2007). Wells in the south of the 200-PO-1 Operable Unit (immediately north of the 300 Area) also have decreasing tritium concentrations indicating that the southward migration of the plume has slowed or stopped because of the effects of dispersion and radioactive decay (Section 2.12.1.3).

Concentrations of tritium continue to generally decline in the far-field area as the plume attenuates naturally.

Tritium concentrations in the aquifer tubes are similar to nearby groundwater monitoring wells. The aquifer tubes with the highest concentrations of tritium (35,000 pCi/L in C6353 and 24,000 pCi/L in C6383) are located southeast of the Hanford townsite corresponding to the tritium plume with concentrations greater than 80,000 pCi/L (Figure 2.11-3).

Wells in the near-field area show steady to rising tritium trends.

Because they are closer to the source of the tritium, wells in the near-field area have higher tritium concentrations than wells in the far-field area and have shown steady to rising trends since FY 2005 (Figure 2.11-5). Well 299-E17-14 (near the 216-A-36B Crib) had a decreasing trend until FY 2005, then concentrations began to rise. Well 299-E24-16 (near the 216-A-10 Crib) had a decreasing trend until FY 2002, then concentrations began to rise. Tritium concentrations at well 299-E25-19 (near the 216-A-37-1 Crib) have been stable since FY 1998. It is possible that the vadose zone near the 216-A-10 and 216-A-36B Cribs is still contributing tritium to the unconfined aquifer. However, another potential scenario for the changing tritium concentrations in these near-field wells is changing groundwater flow directions after the cessation of wastewater discharges at B Pond. Determining a precise groundwater flow direction in the vicinity of the PUREX Cribs is difficult because of the extremely flat water table. Section 2.11.2.2 provides information about refining the water-table map near the PUREX Cribs.

The zone of lower tritium concentrations near the Energy Northwest Complex (Figure 2.11-3) likely is the result of the effect of a zone of lower hydraulic conductivity in the unconfined aquifer. In this area, the water table is within the upper portion of the Ringold Formation that may have a greater degree of local cementation. Section 2.12.1.3 discusses tritium at the 618-11 Burial Grounds, located just west of the Energy Northwest Complex.

The 200-PO-1 Operable Unit wells screened in the middle or lower portions of the unconfined aquifer (or deeper in confined aquifers) generally show very little tritium groundwater contamination. Tritium was either not detected or detected at very low concentrations (10 pCi/L) at the 200 Area Treated Effluent Disposal Facility during FY 2008. The wells are screened at the first occurrence of groundwater below the Ringold Formation lower mud unit where the aquifer is locally confined (i.e., potentiometric surface is within the lower mud unit). Well 499-S1-8J (a water-supply well in the 400 Area) is screened in the lower portion of the Ringold Formation (but not confined) and during FY 2008 had tritium levels ranging from 2,100 to 2,500 pCi/L. Nearby well 499-S0-7, screened at the water table had tritium values that ranged from 7,900 to 9,700 pCi/L during FY 2008. Tritium was not detected in the Laser Interferometer Gravitational Wave Observatory well (699-S2-34B), which is screened in basalt-confined aquifer system. Similarly, five other deep 200-PO-1 Operable Unit wells screened in basalt-confined aquifer system (and sampled once every three years) showed no detectable tritium during FY 2006, the last time they were sampled. Section 2.14 provides more information of the upper basalt-confined aquifer system results.

2.11.1.2 Iodine-129

The iodine-129 plume has changed very little in 14 years.

The iodine-129 plume (Figure 1.0-4 and 2.11-6) extends southeast into the 600 Area from the 200 East Area and appears to coincide with the northern portions of the tritium and nitrate plumes (Figures 1.0-2, 1.0-3, 2.11-3, and 2.11-7). The plume has changed very little over the last 14 years (PNL-10698, *Hanford Site Ground-Water Monitoring For 1994*, Figure 5.3). The unusual geometry of the plume where the 1.0 pCi/L isopleth appears to turn 90° northward may be a result of the lower than expected iodine-129 concentration (less than 0.31 pCi/L) at well 699-31-31 and the lack of any wells in the area immediately north of well 699-31-31.

During FY 2008, the highest concentrations of the iodine-129 plume were near the sources of the plume in the southeastern portion of the 200 East Area. The concentrations in this area ranged from undetected to 10.4 pCi/L in well 299-E17-14 (near the 216-A-36B Crib). The generally decreasing to stable trend for iodine-129 at well 299-E17-14 (Figure 2.11-8) is typical of the gradually decreasing trend for iodine-129 in the vicinity of the PUREX Cribs. The contribution of iodine-129 from the vadose zone near the PUREX Cribs is most likely similar to the amount dispersed on the eastern edges of the plume, based on the high mobility of iodine-129, the continued detection of iodine-129 near the PUREX Cribs, and the long half-life of the iodine-129 isotope. During FY 2008, iodine-129 was not detected in the wells sampled deeper in the unconfined aquifer or in the 200-PO-1 Operable Unit aquifer tubes.

2.11.1.3 Nitrate

The extent of the nitrate plume originating in the 200 East Area (Figures 1.1-3 and 2.11-7) is nearly identical to the tritium plume. However, the area with concentrations above the 45 mg/L nitrate drinking water standard is smaller than the area with concentrations above the 20,000 pCi/L tritium drinking water standard. Nitrate at levels above the drinking water standard north of the 400 Area and at the Energy Northwest Complex (within the area impacted by the PUREX Cribs) can be attributed to wastewater disposal activities in those areas. In FY 2008, the highest nitrate concentration (127 mg/L) within the 200-PO-1 Operable Unit was at well 299-E17-14 (Figure 2.11-9). The nitrate plume (Figure 2.11-7), with sources in the 200 Area, appears to have receded slightly over previous years, except in the immediate vicinity of the PUREX Cribs (PNNL-15670; DOE/RL-2008-01) and WMA A-AX. Another nitrate plume, with offsite sources, exists near the 300 Area (Section 2.12.1.4). The highest nitrate concentration in the aquifer tubes was 33 mg/L in C6353 near the Hanford townsite.

The overall nitrate plume has receded slightly, except for portions near the PUREX Cribs and WMA A-AX.

Wells near the PUREX Cribs in the southeastern portion of the 200 East Area had increasing nitrate concentrations in recent years. The trend at well 299-E24-16 (near the 216-A-10 Crib) is typical of the increasing trend (Figure 2.11-10). Increasing nitrate concentrations also were observed at WMA A-AX (Section 2.11.3.3). The cause of the increase in nitrate at some of the wells in the southeastern portion of the 200 East Area is unknown, but it may be a result of shifting groundwater flow directions related to the cessation of wastewater discharges at B Pond or to groundwater contamination from PUREX Cribs and WMA A-AX.

Nitrate was detected in wells deeper in the Ringold Formation unconfined aquifer or lower confined aquifer. However, none of the deeper wells had reported nitrate concentrations exceeding the drinking water standard (45 mg/L). At the

Nonradioactive Dangerous Waste Landfill, nitrate concentrations were as high as 19.4 mg/L in well 699-26-35C and 11.1 mg/L in well 699-25-33A. These wells are screened at the top of the low permeability unit (bottom of the unconfined aquifer) in the Ringold Formation. Beneath the Ringold Formation lower mud unit at B Pond and the 200 Area Treated Effluent Disposal Facility (the uppermost aquifer), nitrate concentrations continue to be lower (less than 6.9 mg/L). In the lower portions of the unconfined aquifer beneath the 216-A-29 Ditch (well 299-E25-28) the nitrate level was 2.1 mg/L. Nitrate was not detected (i.e., less than 0.044 mg/L) in water supply well 499-S1-8J in the 400 Area (screened in the lower portion of the Ringold Formation). Nitrate remains undetected in well 699-S2-34B (at the Laser Interferometer Gravitational Wave Observatory) and in three other wells screened in the basalt-confined aquifer system beneath the 200-PO1-1 Operable Unit.

The strontium-90 plume near the 216-A-36 Crib is very localized.

2.11.1.4 Strontium-90

A localized area of strontium-90 (a beta-emitter) contamination exists near the 216-A-36B Crib (a PUREX Crib). Well 299-E171-14 was the only well with strontium-90 concentrations above the 8 pCi/L drinking water standard during FY 2008, with a maximum concentration of 20.2 pCi/L. The trend for strontium-90 in well 299-E17-14 shows an increasing trend from 1997 to 2001, and then a fluctuating trend that is neither overall increasing nor decreasing. Results since FY 2006 have ranged from 14 to 21 pCi/L. The contaminant impact is localized because of the low mobility of strontium-90 compared to tritium, nitrate, or iodine-129.

Technetium-99 exceeds the 900 pCi/L drinking water standard at one upgradient and one downgradient well.

2.11.1.5 Technetium-99

Technetium-99 (a beta-emitter) continues to be detected at WMA A-AX at levels far above the drinking water standard (900 pCi/L) and was detected indirectly (from gross beta measurements) at the PUREX Cribs. It also was detected in four aquifer tubes with a maximum concentration of 77 pCi/L. Although most wells at WMA A-AX had technetium-99 levels below the drinking water standard, groundwater samples from downgradient well 299-E25-93 had technetium-99 concentrations ranging from 6,200 to 8,000 pCi/L during FY 2008. Upgradient well 299-E24-33 had technetium-99 concentrations ranging from 1,000 to 1,100 pCi/L. Concentrations for technetium-99 at these two wells have been steady since FY 2006 (Figure 2.11-11). Section 2.11.3.3 provides more information about technetium-99 at WMA A-AX.

2.11.1.6 Other Constituents

Other constituents (i.e., arsenic, chromium, manganese, vanadium, and uranium) are contaminants of concern or potential concern at various facilities within the 200-PO-1 Operable Unit (DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*). Chromium, cobalt-60, cyanide, and uranium are contaminants of potential concern at the BC Cribs and Trenches. Arsenic was detected at nearly every well analyzed in the 200-PO-1 Operable Unit, in concentrations ranging from 1.9 (the method detection limit) to 10.5 μg/L (unfiltered sample at well 299-E25-42) during FY 2008. However, these concentrations are not significantly different from Hanford Site groundwater background values (less than 11.8 μg/L at the 95% confidence level; DOE/RL-96-61).

During FY 2008, the highest chromium concentration in the 200-PO-1 Operable Unit was 113 μg/L (for an unfiltered sample) at well 299-E18-1, (located near the former 2101-M Pond on the west side of the operable unit). A filtered sample collected at the same time from this well was 9.7 μg/L. The primary drinking water standard

for chromium is 100 μg/L. Chromium concentrations in wells on the western side of the 200-PO-1 Operable Unit may be influenced by a plume of chromium entering the area from the west or southwest (Section 2.9).

Well 299-E25-19 near the 216-A-37-1 Crib had manganese concentrations that exceeded the 50 μg/L secondary drinking water standard during FY 2008. The source of the manganese is unknown. It may be related to wastewater discharged to the 216-A-37-1 Crib or to the deterioration of the well screen or casing. The trend for manganese in this well has been stable to increasing since FY 2005. Seven of the new aquifer tubes had elevated manganese concentrations (with a maximum concentration of 743 μg/L at C6378), but these elevated values are most likely related to the drilling process.

Vanadium concentrations ranged in the 200-PO-1 Operable Unit from 7 (the method detection limit) to 45 μg/L (unfiltered sample from well 299-E25-28) and 55 μg/L (filtered sample from well 699-43-45) during FY 2008. Both wells are located at the 216-A-29 Ditch. Except for the elevated vanadium results in early FY 2008, the trends for vanadium at these wells are stable (ranging from ~30 to 34 μg/L). There is no drinking water standard for vanadium.

In recent years, uranium has been increasing in concentration near the PUREX Cribs.

In recent years, uranium concentrations have reached the drinking water standard (30 μg/L) near the PUREX Cribs. The highest concentration during FY 2008 was 30 μg/L at well 299-E17-14. Overall, the trend for uranium in this well has increased since the well was first monitored for uranium in 2005 (Figure 2.11-12). Because the uranium concentration increases (or the indicator parameter gross alpha) are observed only in the wells near the PUREX Cribs, the PUREX Cribs are the most likely source.

Groundwater monitoring routinely occurs at two wells in the BC Cribs and Trenches (299-E13-5 and 299-E13-14). Results from these well showed that the contaminants of potential concern (chromium, cobalt-60, cyanide, and uranium), as well as the 200-PO-1 Operable Unit contaminants of concern, were either not detected or were similar to background (upgradient) concentrations in the BC Cribs and Trenches.

During FY 2008, contaminants of potential concern at the BC Cribs and Trenches were either undetected or similar to background concentrations.

Although not a contaminant of concern in the 200-PO-1 Operable Unit, the fluoride concentration (9.09 mg/L) in well 699-S2-34B (at the Laser Interferometer Gravitational-Wave Observatory) was above the 4 mg/L primary drinking water standard. The result is typical of the historical trend for this well. Well 699-S2-34B is screened in the upper basalt-confined aquifer system known to have elevated concentrations of fluoride.

2.11.2 Operable Unit Activities

The 200-PO-1 Operable Unit contains a large portion of the Hanford Site (Figures 1.0-1 and 2.11-2). The operable unit boundaries generally are defined by tritium, the largest contaminant plume of the operable unit. Although outside the 200-PO-1 Operable Unit boundary, wells at the BC Cribs and Trenches, (Figures 2.11-1 and 2.11-2) are included in the 200-PO-1 Operable Unit.

In FY 2008, the remedial investigation/ feasibility study work plan for the 200-PO-1 Operable Unit was released.

2.11.2.1 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 one issue and an associated action pertaining to the 200-PO-1 Operable Unit.

- **Issue 15.** Soil resistivity measurements have detected large regions of anomalously high soil conductivity in the area south of the PUREX Plant around the 216-A-4 Crib and near the BC Cribs and Trenches.
- **Action 15-1.** Complete data quality objective process and sampling plan to further characterize the high soil conductivity measurements detected at the BC Cribs and Trenches (December 2007).

In FY 2007, the data quality objective process was completed and the report was released (SGW-34011, *Data Quality Objectives Summary report Supporting the 200-PO-1 Groundwater Operable Unit*).

In FY 2008, DOE/RL-2007-31, *RI/FS Work Plan for the 200-PO-1 Groundwater Operable Unit*, was released. Appendix A of the work plan includes a characterization sampling and analysis plan, a portion of which contains plans to further characterize the high soil conductivity measurements detected at the BC Cribs and Trenches.

The remedial investigation/ feasibility study work plan contains two sampling and analysis plans, one for routine groundwater monitoring, and another for characterization activities.

2.11.2.2 Remedial Investigation/Feasibility Study

Groundwater monitoring at the 200-PO-1 Operable Unit supports the remedial investigation/feasibility study process for the 200-PO-1 Groundwater Operable Unit. During FY 2008, the remedial investigation/feasibility study process generated a work plan (DOE/RL-2007-31) containing two sampling and analysis plans (one for routine groundwater monitoring of wells within the 200-PO-1 Groundwater Operable, and another for groundwater characterization within the 200-PO-1 Operable Unit). The routine sampling and analysis plan (also released earlier as DOE/RL-2003-04) contains plans for general groundwater monitoring in the 200-PO-1 Operable Unit to track the extent, movement, and concentration of groundwater contamination. Groundwater monitoring under this plan is a continuation of earlier groundwater monitoring plans in the operable unit for CERCLA, AEA, and *Washington Administrative Code*, compliance. The characterization sampling and analysis plan identifies a two-year process specifically for collecting additional data for the remedial investigation (including groundwater data) that are not already covered under the routine sampling and analysis plan.

Wells sampled under the characterization sampling and analysis plan are analyzed for a comprehensive list of 44 analytes.

The work plan (DOE/RL-2007-31) was released too late in FY 2008 to schedule and collect groundwater samples (with a few exceptions) to address the new characterization sampling and analysis plan or any changes identified in the routine sampling and analysis plan. By the time the work plan was released, many of the wells had been sampled for FY 2008. Groundwater samples collected for the new characterization sampling and analysis plan included existing well 299-E17-14 (at the 216-A-36B Crib) and grab samples from exploratory boreholes C6552, C5941, and C5923. These exploratory boreholes are located at the 216-A-5 Crib, 216-A-30 Crib, and the BC Cribs and Trenches (respectively) (Figure 2.11-1). Exploratory borehole C5923 was completed as a groundwater monitoring well with the number 299-E13-62. The groundwater samples collected at well 299-E17-14 and exploratory boreholes were analyzed for a larger list of analytes (Table 2.11-1), compared to the shorter list of required analytes in the routine sampling and analysis plan (Appendix A). Sections 2.11.2.1 and 2.11.2.3 include the results of groundwater sampling at well 299-E17-14 and the exploratory boreholes.

Included in the characterization sampling and analysis plan is an effort to refine the water-table map in the southeastern 200 East Area. Refinement of the water-table map for this area would help determine groundwater flow directions and flow rate because of the low water-table gradient. The gradient is so low that errors in measuring the depth to water can be larger than the differences in water-table elevations between wells. Refining the water-table map for the southeastern portion of the 200 East Area also will assist in determining groundwater flow directions at RCRA sites at the Integrated Disposal Facility (Section 2.11.3.1) and PUREX Cribs (Section 2.11.3.2). The solution is to decrease the amount of measurement error in determining water-table elevations at wells. Other than measurement variation caused by barometric effects, the two potential sources of significant error are the surveys that provided well locations and elevations and the deviation of the wells from vertical. When a 100 m deep well is deviated ~2.6º from vertical, the depth to water measurement will have an error of 0.1 m. An error of 0.1 m is greater than the relief on the water table across the southeastern portion of the 200 East Area.

Revising the water-table map of the southeastern portion of the 200 East Area and interpreting groundwater flow directions was attempted using a three-step process.

Producing a corrected water-table map of the southeastern portion of the 200 East Area and interpreting groundwater flow directions was attempted using the following three steps.

- Twelve wells in the southeastern portion of the 200 East Area were resurveyed to a known datum. The vertical error was reduced to approximately +/- 1 mm.
- The depth to water measurements were corrected for borehole deviation in the 12 wells to +/-0.003 m using a down-hole gyroscope.
- Trend surface analyses were conducted of resulting water-table maps to separate local from regional variability and determine any regional trends on the water-table surface (Davis, 2002, *Statistics and Data Analysis in Geology*).

Efforts to refine the water-table map in the southeastern portion of the 200 East Area were not definitive. Results of flow direction ranged from northeast to south.

Results to refine the water-table map were not definitive. The expectation was that by increasing the precision of known surface elevations and correction factor for the degree of tilting (from perfectly vertical) at each of the 12 well locations that trend surface analyses of the resulting water-table surfaces would provide definitive groundwater flow directions. Four new sets of water-level measurements were collected during the summer months, after the wells were resurveyed for location, elevation, and degree of tilting from vertical. The new data sets resulted in directions ranging from northeast to south (61 to 173º of azimuth), and water-table gradients ranged from 1.7×10^{-5} to 2.9×10^{-5}. Each trend surface analysis was run several times. Each run removed the well with the highest residual (deviation from the trend surface) from the analysis, until all the residuals were less than 1 cm, the trend surface fit was statistically significant, and the direction changed by less than 10º. The variability in results could be caused by barometric pressure fluctuations. Automated water-level data will be collected at the site during FY 2009 to help resolve barometric effects. Monthly depth-to-water measurements will continue to be collected for additional trend surface analyses.

Aquifer tubes were installed at an additional 11 sites along the Columbia River between the Hanford town site and the 300 Area.

The characterization sampling and analysis plan required the installation of aquifer tubes at 11 locations along the Columbia River between the Hanford townsite and the 300 Area. A shallow, medium, and deep aquifer tube were planned at each of the locations. Installation was difficult because partially cemented Ringold Formation

impeded the drilling operations. With the installation difficulties, only the shallow tubes were installed at most of the locations. The medium depth aquifer tube was installed at only two of the 11 sites. Figure 2.11-13 shows the locations of the new aquifer tubes along the Columbia River. Ten of the sites were sampled during FY 2008.

The characterization sampling and analysis plan also required geophysical surveys to support geologic structure and stratigraphy characterization at the 200-PO-1 Operable Unit. Fifteen line miles of seismic reflection and airborne magnetic surveys over 336.7 km^2 were conducted in FY 2008. Data analysis will occur in FY 2009 to identify possible preferential groundwater flow paths from the 200 East Area to the Columbia River.

2.11.2.3 Results of Operable Unit Monitoring for FY 2008

The only constituents exceeding drinking water standards at the southeast transect during FY 2008 were iodine-129, iron, and tritium.

The 200-PO-1 Operable Unit routine sampling and analysis plan (DOE/RL-2003-04) specifies annual sampling of two lines of guard wells to screen for a comprehensive list of analytes. One of these lines of guard wells (the Southeast Transect) is located southeast of the 200 East Area (Figure 2.11-2) and ensures that unexpected contaminants do not migrate from the 200 East Area undetected. The other line (the River Transect) is located along the Columbia River to assess the concentration of any groundwater contamination that may reach the river. The comprehensive list of analytes for both transects includes iodine-129, tritium, anions (including nitrate), gross alpha and beta, gamma scan, metals, strontium-90, and volatile organic compounds.

At the southeast transect, the following 24 groundwater constituents were detected in groundwater samples during FY 2008:

Barium	Iron	Silver
Calcium	Magnesium	Sodium
Chloride	Manganese	Strontium
Chromium	Methylene chloride	Sulfate
Cobalt	Nickel	Tetrachloroethene
Copper	Nitrate	Tritium
Fluoride	Potassium	Vanadium
Iodine-129	Potassium-40	Zinc.

Tritium, iron, and pH exceeded drinking water standards at the River Transect during FY 2008.

Many of these groundwater constituents occur naturally (e.g., potassium-40) or are consistent with background values. Iodine-129, iron, and tritium are the only groundwater constituents exceeding drinking water standards. The tritium and iodine-129 concentrations are consistent with their respective plumes (Figures 2.11-3 and 2.11-6) along the Southeast Transect. Unfiltered and filtered iron in wells 699-41-23 and 699-24-46 and unfiltered iron in well 699-26-33 exceeded the 300 µg/L secondary drinking water standard. All three of these wells have carbon steel casings that are likely responsible for the elevated iron. Two volatile organic compounds (methylene chloride and tetrachloroethene) were detected in well 699-26-33 at the Nonradioactive Dangerous Waste Landfill, where low levels of volatile organic compounds previously have been detected. The recent detections in this well are estimated and questionable because the results were close to the method detection limit. Section 2.11.3.6 provides more information about volatile organic compounds at the Nonradioactive Dangerous Waste Landfill.

At the River Transect, 18 of the same groundwater constituents were detected (excluding iodine-129, magnesium, manganese, methylene chloride, potassium-40, and tetrachloroethene) and a high pH was recorded for one well. Like the Southeast Transect, most of these either are naturally occurring constituents or are groundwater contaminants with concentrations consistent with upgradient wells or typical of their respective plumes. The unfiltered iron concentration and pH exceeded drinking water standards (300 µg/L and 8.5, respectively) in well 699-20-E12O (1,010 µg/L and 9.1, respectively). The filtered iron result was 230 µg/L. Wells 699-41-1A and 699-46-4 had tritium concentrations exceeding the 20,000 pCi/L drinking water standard (60,000 and 53,000 pCi/L, respectively). Both wells are located near the Hanford townsite where the known concentration of the tritium plume is similar (Section 2.11.1.1). The elevated pH at well 699-20-E12O is anomalous for the region, and the reason for the elevated concentration is unknown.

Manganese and tritium were detected at levels above their respective drinking water standards in the new aquifer tubes installed along the Columbia River in the 200-PO-1 Operable Unit.

Sampling of 10 of the new aquifer tubes (Figure 2.11-13) between the Hanford townsite and the 300 Area was accomplished late in FY 2008. Only part of the results were received at the time this report was written. Results to date indicate that fluoride, manganese, neptunium-237, nitrate, pH, protactinium-231, strontium-90, technetium-99, tritium, uranium, and zinc were detected in the aquifer tube samples collected. Manganese and tritium were detected at levels above their respective drinking water standards, and pH was lower than the 6.5 drinking water standard at one aquifer tube. The remainder of the results were either at natural background levels for naturally occurring constituents or very low levels. Manganese (both filtered and non-filtered) exceeded the 50 µg/L drinking water standard in almost all the tubes sampled, indicating the elevated levels were related to the tube installation process. The highest level reported was 743 µg/L at C6378. Tritium at aquifer tubes C6353 and C6383 had concentrations exceeding the 20,000 pCi/L drinking water (35,000 and 24,000 pCi/L, respectively). These tritium results are similar to wells in the area (considering partial dilution by river water). The single occurrence of pH below the 6.5 drinking water standard was 6.45 at tube C6368. A pH value this low is not typical of the river or nearby wells and is under review.

The highest tritium and nitrate concentrations in the existing aquifer tubes (original) were 7,000 pCi/L and 8.5 mb/L, respectively.

Two of the original six aquifer tube locations near the Hanford townsite (Figure 2.11-2) were sampled as scheduled during FY 2008. Samples were collected from location AT-82-M and AT-86-D. Aquifer tubes at locations 81 and 83 were not found at the time of sampling. Aquifer tubes at locations 84 and 85 had specific conductance values too low to consider that the samples would have enough groundwater mixed with them to be meaningful. As the river portion of river-groundwater mixtures increases, the specific conductance decreases. Columbia River water typically has specific conductance ranging from 120 to 150 µS/cm. Groundwater in the unconfined aquifer near the river generally has specific conductance values ranging from 350 to 500 µS/cm. Aquifer tube samples are retained only when the specific conductance is clearly above the normal range for river water. Even so, the samples collected at locations 82 and 86 had relatively low specific conductance values (217 and 298 µS/cm, respectively). Detected groundwater constituents included chloride, fluoride, hexavalent chromium nitrate, sulfate, and tritium. None of these detected constituents had concentrations exceeding drinking water standards. The highest tritium and nitrate concentrations were 7,000 pCi/L and 8.5 mg/L, respectively.

During FY 2008, grab samples of groundwater were collected from three exploratory boreholes (C6552, C4951, and C5923[2]) as the boreholes reached the water table. The exploratory boreholes were at the 216-A-5 Crib, 216-A-30 Crib, and at the BC Cribs and Trenches (Figure 2.11-1). Because collecting groundwater from an exploratory borehole lacks the benefit of well development, the technique produces groundwater samples of high turbidity that must be filtered at the collection site. Therefore, the groundwater aliquots for all the analyses methods were filtered from these three boreholes. The 200-PO-1 Operable Unit characterization samples also were collected from well 299-E17-14 (located near the 216-A-36B Crib). The constituents analyzed in the groundwater samples from the exploratory borehole and well 299-E17-14 included an extensive list of 44 constituents (Table 2.11-1), and currently some of the results for the more unusual analysis methods (pesticides) had not been received from the laboratories.

Manganese and tritium were detected at levels above drinking water standards in grab samples taken from three exploratory boreholes near the 216-A-5 Crib, 216-A-30 Crib, and at the BC Cribs and Trenches.

Results from the exploratory boreholes at the 216-A-5 Crib, 216-A-30 Crib, and the BC Cribs have similar results. Nothing unusual was discovered with the increased number of groundwater constituents analyzed in these exploratory boreholes, and results were typical of nearby wells. About 20 constituents were detected with most being natural-occurring constituents or constituents with concentrations similar to background or upgradient areas. Constituents exceeding drinking water standards at the exploratory boreholes near the 216-A-5 and 216-A-30 Cribs included manganese and tritium. The tritium concentration at those two boreholes was (250,000 and 47,000 pCi/L, respectively). Manganese at the BC Cribs borehole also exceeded the 50 µg/L drinking water standard, but tritium was not detected. Manganese concentrations are typically elevated in the first few samples collected from new wells or boreholes.

Well 299-E17-14 (at the 216-A-36B Crib) had results that were similar to those at the exploratory boreholes. Nothing unusual was discovered with the increased number of groundwater constituents analyzed in this existing well, and results of detected analytes were typical of historical trends. Along with elevated tritium, gross beta (drinking water standard of 50 pCi/L), iodine-129 (drinking water standard of 1.0 pCi/L), nitrate (drinking water standard of 45 mg/L), and strontium-90 (drinking water standard of 8 pCi/L) exceeded their respective drinking water standards. Results for these constituents were as follows: tritium, 590,000 pCi/L; gross beta, 63 pCi/L: iodine-129, 9.5 pCi/L; nitrate, 124 mg/L; and strontium-90, 14 pCi/L. Because technetium-99 was discovered at low concentrations, the constituent responsible for the elevated gross beta is most likely strontium-90.

2.11.3 Facility Monitoring

This section describes results of monitoring at individual units (i.e., treatment, storage, and disposal units or tank farms). Some of these facilities are monitored under the requirements of RCRA for hazardous waste constituents and AEA for source, special nuclear, and by-product materials. Data from facility-specific monitoring also are integrated into the CERCLA groundwater investigations. Hazardous constituents and radionuclides are discussed jointly in this section to provide comprehensive interpretations of groundwater contamination for each facility. Pursuant to RCRA,

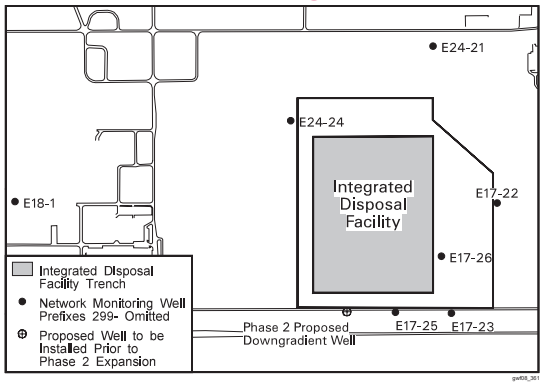
2 Exploratory borehole C5923 was converted to a vadose zone vapor injection well named 299-E13-62 after groundwater samples were collected at the water table. The borehole was backfilled up to a level of 20 m of depth before setting the screens for vapor injection. Groundwater sample analysis results are identified in HEIS as 299-E13-62, rather than C5923.

the source, special nuclear, and by-product material components of radioactive mixed waste are not regulated under RCRA and are regulated by the DOE, acting pursuant to its AEA authority. Therefore, while this report may satisfy RCRA reporting requirements, the inclusion of information on radionuclides in such a context is for information only and may not be used to create conditions or other restrictions set forth in any RCRA permit.

The 200-PO-1 Operable Unit contains six RCRA sites with groundwater monitoring requirements: Integrated Disposal Facility, RCRA PUREX Cribs, WMA A-AX, 216-A-29 Ditch, 216-B-3 Pond Facility, and the Nonradioactive Dangerous Waste Landfill. Also included in the 200-PO-1 Operable Unit are the Solid Waste Landfill (regulated by Washington State Department of Ecology [Ecology] under WAC 173-304), the 200 Area Treated Effluent Disposal Facility (monitored under waste discharge permit WAC 173-216), and three 400 Area water supply wells monitored for the AEA. This section summarizes results of statistical comparisons, assessment studies, and other developments for FY 2008. Groundwater data are available in the Hanford Environmental Information System database and on the data files accompanying this report. Appendix B provides additional information (including well and constituent lists, maps, flow rates, and statistical tables).

2.11.3.1 Integrated Disposal Facility

D. G. Horton



Construction of the Integrated Disposal Facility began in September 2004 and was completed in April 2006. The DOE submitted a Part B RCRA permit application to the Ecology, and it was incorporated into the Hanford Facility RCRA Permit (WA7890008967) on April 9, 2006. The future start date for operations at the Integrated Disposal Facility has not been determined.

The objective of RCRA and operational monitoring at the Integrated Disposal Facility is to determine whether the facility has impacted groundwater quality. The facility is not yet operational, and the current monitoring is directed at obtaining background values for monitored constituents. The current groundwater-monitoring network consists of seven wells (Appendix B). Another well remains to be installed at a future date when required by facility expansion.

Current monitoring at the Integrated Disposal Facility is directed at obtaining background values for monitoring constituents.

The Integrated Disposal Facility consists of an expandable, double-lined landfill with ~7 ha of liner. The facility is located in the south-central part of the 200 East Area (Figure 2.11-1). Appendix B lists the network wells, their locations, and groundwater constituents monitored. The landfill is divided lengthwise (north/south) into two distinct cells: the east cell for the disposal of low-level radioactive waste and the west cell for the disposal of mixed waste. The facility is a RCRA-compliant landfill (i.e., a double high-density polyethylene-lined trench with leachate collection and leak detection system). The constructed liner is ~442 m wide by 160 m long and up to 15 m deep. The landfill will have four layers of waste containers separated vertically by 0.9 m of soil. The current waste disposal capacity is ~163,000 m^3. The waste will be segregated into a RCRA-permitted side and a non-RCRA-permitted side.

The delineation of groundwater flow directions and water-table gradients are difficult to estimate for the 200 East Area from water-level data because of a flat water table. Based on the geometry of existing contaminant plumes and on regional

water-level measurements, the groundwater flow direction is estimated to be toward the east to southeast at rates between 0.002 and 0.0075 m/day (Appendix B).

Work began in FY 2008 to better understand the groundwater flow direction beneath the Integrated Disposal Facility. Gyroscope surveys were completed on four of the monitoring wells and well 299-E17-21 (wells 299-E17-26 and 299-E24-24 had gyroscope surveys completed in FY 2005). A gyroscope survey could not be completed in well 299-E18-1 because the well has a bent section preventing tool access. Also, new vertical elevation surveys were done on all seven wells in the network. Several sets of water level measurements were made and trend surface analyses were applied to the measurements. The results to date were inconclusive (Sections 2.1.3 and 2.11.2.2). To determine water levels, pressure transducers have been installed in two of the Integrated Disposal Facility monitoring wells to determine the response of each well to changes in barometric pressure. This detailed work will continue in FY 2009 and will allow better definition of the water table in the area.

Groundwater monitoring at the Integrated Disposal Facility during FY 2008 included semiannual sampling (four independent sampling events each 6-month period).

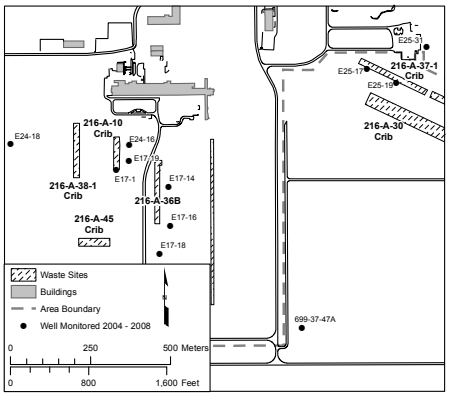
The Integrated Disposal Facility operational monitoring plan was published in FY 2005 (RPP-PLAN-26534, *Integrated Disposal facility Operational Monitoring Plan to Meet DOE Order 435.1*). That plan called for analyses of gross alpha, gross beta, technetium-99, and iodine-129 in groundwater. Therefore, these constituents were added to the list of RCRA indicator parameters (specific conductance, pH, total organic carbon, and total organic halides) and supplemental groundwater quality parameters (alkalinity, anions, metals, temperature, and turbidity) for analysis. Appendix B includes the complete sampling schedule of constituents and sampling frequency.

All groundwater monitoring wells in the Integrated Disposal Facility monitoring network initially were sampled twice quarterly for one year (June 2005 through May 2006) to determine baseline conditions. This was followed by collection of semiannual samples (four independent sampling events each 6-month period) and semiannual sampling continued throughout FY 2008.

Only nitrate exceeded drinking water standards at the Integrated Disposal Facility during FY 2008.

Only nitrate exceeded the drinking water standard (45 mg/L) during FY 2008 in wells at the Integrated Disposal Facility. The average annual nitrate concentration was 45 mg/L in well 299-E24-21, with the highest concentration of 46 mg/L. The average annual nitrate concentration was 64 mg/L in well 299-E24-24, and the highest concentration was 66 mg/L. These wells are in the regional 200 East nitrate plume that is presumed to originate from the RCRA PUREX Cribs east of the Integrated Disposal Facility (Section 2.11.3.2).

2.11.3.2 RCRA PUREX Cribs



The RCRA PUREX Cribs are located in the southeastern part of the 200 East Area and include the 216-A-10, 216-A-36B, and 216-A-37-1 Cribs (Figure 2.11-1) monitored under RCRA interim status to assess groundwater quality. Other nearby cribs also received PUREX waste (e.g., 216-A-45 Crib) but are not regulated as RCRA treatment, storage, or disposal units. They are monitored collectively under the 200-PO-1 Operable Unit.

The objective of RCRA monitoring at these cribs is to assess the nature and extent of groundwater contamination with hazardous constituents and determine their rate of movement in the aquifer (40 CFR 265.93(d) as referenced by WAC 173-303-400). Groundwater monitoring under AEA tracks radionuclides at the cribs and surrounding vicinity, and is reported

under the 200-PO-1 Operable Unit (Section 2.11.1). Appendix B lists the wells, their locations, and groundwater constituents monitored for the RCRA PUREX Cribs. The RCRA PUREX Cribs groundwater-monitoring plan is PNNL-11523, *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*. The 11 RCRA wells near the PUREX Cribs (Appendix B) monitor contaminant plumes in the near-field area close to the cribs. More distant portions (or the far-field area) of the contaminant plumes are monitored by the 200-PO-1 Operable Unit (Appendix A). Section 2.11.1 provides concentrations of the major plumes in both the near- and far-field areas.

Groundwater flow direction in the vicinity of the 216-A-10 and 216-A-36B Cribs (west cribs) is most likely toward the southeast; in the vicinity of the 216-A-37-1 Crib, it is estimated to be to the south or southwest. These flow directions are supported mainly by the distribution of the tritium, nitrate, and iodine-129 plumes emanating from the vicinity of these cribs. Appendix B provides more information on flow direction and rate and Section 2.11.2.2 includes information on efforts to refine the water-table map in the southeastern portion of the 200 East Area. The RCRA PUREX cribs are located in a region where several groundwater contamination plumes contain constituents that exceed drinking water standards. The similarities in effluent constituents disposed to these cribs and the 216-A-45 Crib make determining the contribution of the RCRA PUREX Cribs difficult.

The objective of RCRA monitoring at the PUREX Cribs is to assess the nature and extent of groundwater contamination with hazardous constituents and determine their rate of movement in the aquifer.

During FY 2008, all groundwater samples were collected as scheduled. Nitrate, non-filtered iron, and non-filtered manganese were the only hazardous waste constituents exceeding drinking water standards (for the metals, secondary drinking water standards). The nitrate drinking water standard (45 mg/L) was exceeded at seven near-field monitoring wells during FY 2008, including upgradient well 299-E24-18 to the west of the 216-A-10 Crib. The highest concentration of nitrate in the RCRA PUREX Cribs near-field monitoring network (and of the entire 200-PO-1 Operable Unit) was 127 mg/L at well 299-E17-14, located near the 216-A-36B Crib.

Nitrate trends vary depending on location. At wells near the 216-A-36B Crib (Figure 2.11-14), nitrate appears to be relatively stable at wells 299-E17-14 and 299-E17-16, but at well 299-E17-18 the trend has been rising slightly since FY 2004. At the 216-A-10 Crib, nitrate trends have been rising in earlier years, but during FY 2008 were relatively steady (Figure 2.11-15). Nitrate trends near the 216-A-37-1 Crib have been rising slightly since FY 2005, with a pulse of higher nitrate concentration passing through the site around October 2007 (Figure 2.11-16). This same higher-concentration pulse was not detected in upgradient well 299-E25-31 or in wells near the other two cribs, possibly indicating a local source near the 216-A-37-1 Crib. After flowing away from the immediate vicinity of the RCRA PUREX Cribs, the nitrate plume blends with the larger nitrate plume emanating generally from the southeast portion of the 200 East Area. Figure 2.11-9 shows the nitrate plume in the southeast portion of the 200 East Area and Figure 2.11-7 shows the plume for the entire 200-PO-1 Operable Unit.

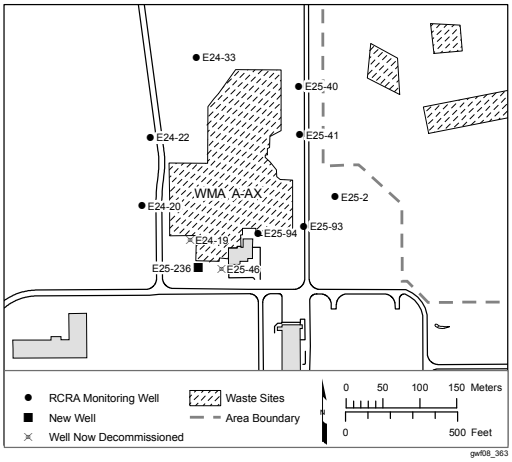
Nitrate, iron, and manganese were the only hazardous waste constituents to exceed drinking water standards at the PUREX Cribs during FY 2008.

The secondary drinking water standards for iron (300 μg/L) and manganese (50 μg/L) were exceeded in non-filtered samples from wells 299-E25-17 and 299-E25-19 located near the 216-A-37-1 Crib. The highest iron concentration (661 μg/L) and the highest manganese concentration (55.9 μg/L) were in well 299-E25-19. Filtered results for iron and manganese from well 299-E25-19 were 153 and 47.9 μg/L, respectively. These wells are not compliant with WAC 173-160,

and the exceedances likely were caused by unfiltered particulates from the corroded or rusted carbon-steel casings.

Groundwater quality constituents required by WAC 173-303-400 (chloride, iron, manganese, phenols, sodium, and sulfate) continued to be lower than their respective drinking water standards during FY 2008, except for the anomalously elevated iron and manganese values in wells 299-E25-17 and 299-E25-19 at the 216-A-37-1 Crib. Phenols were not detected.

2.11.3.3 Waste Management Area A-AX



WMA A-AX is located on the east-central border of the 200 East Area (Figure 2.11-1) and consists of the A and AX Tank Farms, the 244-AR Vault and ancillary equipment (seven diversion boxes and waste transfer lines). The tank farms contain ten 3.79 million-liter tanks constructed from 1954 to 1964. Some of the tanks are suspected to have leaked. Appendix B provides a well location map and a table of wells and analytes for this WMA.

WMA A-AX was placed in RCRA assessment monitoring (40 CFR 265.93(d) as referenced by WAC 173-303-400) because of elevated specific conductance in downgradient well 299-E25-93 during June 2005. The objective of the current groundwater assessment plan (PNNL-15315, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area A-AX at the Hanford Site*) is to determine whether dangerous waste or dangerous waste constituents from the tank farms have compromised groundwater quality (40 CFR 265.93(d)(5)) beneath WMA A-AX. During FY 2008, all groundwater samples were collected as scheduled.

The objective of the current groundwater monitoring plan at WMA A-AX is to determine whether dangerous waste constituents from the facility have effected groundwater quality.

A new well (299-E25-236) was installed in FY 2008, as required by the groundwater assessment plan, near the southwestern corner of the site. Well 299-E25-236 replaced two wells that were damaged by corrosion, and is compliant with WAC 173-160. Sampling of the new well will start in FY 2009. This new well was required by the RCRA assessment plan (PNNL-15315) to complete the monitoring network.

The groundwater-monitoring network for WMA A-AX consists of eight wells that are compliant with WAC 173-160 and one well that is not compliant (well 299-E25-2). All are screened or perforated at the water table. Aquifer thickness is ~27 m, while the saturated screened intervals range from 1.5 to 10.4 m in compliant wells. Based on projections of water-table decline, replacement of older wells will not be required for at least 14 years. During FY 2008, groundwater flow direction did not change. Estimated flow rate was reduced slightly from FY 2007, based on a more recent estimate of water-table gradient (Appendix B). The flow direction, determined mainly from plume tracking, is most likely toward the southeast. Determining flow direction from water-table maps is difficult because of the extremely low gradient (estimated 0.00002).

The only RCRA-regulated contaminant exceeding its drinking water standard (45mg/L) was nitrate, and that exceedance was at well 299-E25-93.

Nitrate, sodium, sulfate, total organic carbon, chromium, and lead are the principal site-specific constituents analyzed in groundwater samples at WMA A-AX (PNNL-15315). Technetium-99, as well as other anions and metals are supporting constituents. Technetium-99 is not a RCRA constituent, but is helpful to track potential groundwater contamination sources within the WMA A-AX. Only nitrate and technetium-99 exceeded their drinking water standards (45 mg/L and 900 pCi/L, respectively) during FY 2008.

Figure 2.11-9 shows the nitrate plume near the WMA A-AX and southeast 200 East Area. Only downgradient well 299-E25-93 exceeded the nitrate drinking standard (Figure 2.11-17) with a concentration of 54.4 mg/L. This higher concentration indicates a nitrate source within the WMA A-AX, although there is a nitrate contribution from the upgradient groundwater flow direction (northwest). The nitrate trend for well 299-E25-93 has been stable since FY 2006. The trend at upgradient well 299-E24-33 is similar. Downgradient well 299-E25-94 and upgradient well 299-E24-20 show generally decreasing trends. Downgradient wells 299-E25-40, 299-E25-41, and 299-E25-2 have generally increasing trends. The wells with stable to increasing trends are to the north and east of the WMA A-AX, whereas wells with declining trends are to the southwest and south.

Like nitrate, technetium-99 is more concentrated at downgradient well 299-E25-93 than any other well at WMA A-AX, suggesting a local source (Figure 2.11-18). During FY 2008, the technetium-99 drinking water standard (900 pCi/L) was exceeded in two wells (upgradient well 299-E24-33 and downgradient well 299-E25-93). Downgradient well 299-E25-93 had the highest concentrations ranging from 6,200 to 8,000 pCi/L, and a relatively stable concentration since FY 2006 (Figure 2.11-11). During FY 2008, upgradient well 299-E24-33 had a concentration range of 1,000 to 1,100 pCi/L. The elevated concentrations indicate that an upgradient source of technetium-99 (e.g., WMA C) is likely.

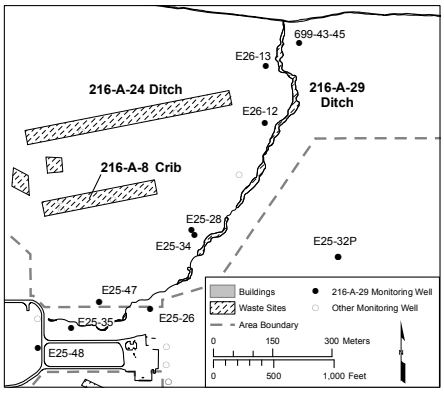
Elevated levels of nitrate and technetium-99 at downgradient well 299-E25-93 may indicate a local source of groundwater contamination.

The sulfate secondary drinking water standard (250 mg/L) was not exceeded at WMA A-AX during FY 2008, with the highest concentrations in wells 299-E24-33 and 299-E25-93. Both upgradient well 299-E24-33 and downgradient well 299-E25-93 had similar sulfate values (121 to 137 mg/L) and similar overall increasing trends (Figure 2.11-19). Upgradient well 299-E24-20 (in the western portion of WMA A-AX) had lower levels of sulfate concentration ranging from 60.6 to 70.5 mg/L. Figure 2.10-9 indicates that the increasing trend for sulfate at WMA A-AX may be from upgradient areas to the northwest or north.

Sodium and chromium also were detected at WMA A-AX wells, but neither exceeded their respective drinking water standards. Upgradient and downgradient concentrations were comparable. Lead in unfiltered samples was detected at low concentrations in two upgradient wells and three downgradient wells. Concentrations ranged from 0.1 to 0.5 µg/L. Filtered lead was not detected. Detected total organic carbon results during FY 2008 ranged from 300 to 1,100 µg/L in WMA A-AX wells. Upgradient wells were responsible for all the reported values above 500 µg/L, indicating there are probably no local sources of groundwater contamination that would raise total organic carbon results at WMA A-AX.

2.11.3.4 216-A-29 Ditch

C. J. Martin



The groundwater beneath the 216-A-29 Ditch is monitored under RCRA (40 CFR 265.93(d), as referenced by WAC 173-303-400) for detection of hazardous waste/hazardous waste constituent impact to groundwater. The nine wells of the groundwater-monitoring network are sampled semiannually for contamination indicator parameters and annually for groundwater quality parameters and site-specific constituents (PNNL-13047, *Groundwater Monitoring Plan for the 216-A-29 Ditch*). Appendix B lists the network wells, their locations, and groundwater constituents monitored. The well

network is adequate for the current groundwater flow direction. During FY 2008, all groundwater samples were collected as scheduled.

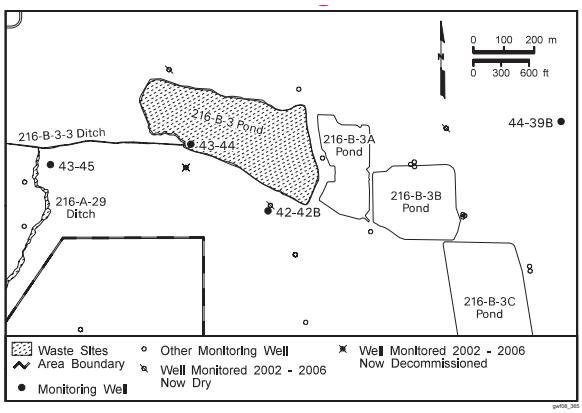
Specific conductance continues to remain above the critical mean in downgradient wells 299-E25-35, 299-E25-48, and 299-E26-13 during both semiannual sampling events (Appendix B). The continued increasing trend in specific conductance coincides with similar increases in sulfate, nitrate, chloride, and the major soil cations (i.e., calcium) in these wells. Wells 299-E25-28 (deep completion) and 299-E25-34 appear to be least affected by these trends. The cause of this rise is unknown, but appears to coincide with a general, multi-year increase in ionic strength throughout much of the 200 East Area and adjacent areas, and cannot be attributed solely to discharge practices at the 216-A-29 Ditch. None of the increasing constituents exceed drinking water standards. The remaining three contamination-indicator parameters (pH, total organic carbon, and total organic halides) were below critical means for all wells in the 216-A-29 Ditch network during FY 2008.

Specific conductance continued to remain above the critical mean in downgradient wells at the 216-A-29 Ditch during FY 2008.

Based on a general interpretation of the water-table map in the 200 East Area and measured head differences between network wells, the direction of groundwater flow near the 216-A-29 Ditch is estimated to be to the south or southeast. The water-table gradient at the 216-A-29 Ditch is estimated at 7.35×10^{-4} and yields a groundwater flow velocity of 0.053 m/d. Because of a variety of potential measurement errors that could exceed the head differences between wells and the very flat gradient, confidence in the estimates of flow direction and rate is low.

2.11.3.5 216-B-3 Pond Facility (B Pond)

C. J. Martin



The original B Pond System included the main pond and three expansion ponds (Figure 2.11-1). The main pond and an adjacent portion of the 216-B-3-3 Ditch are now regulated under RCRA and require groundwater monitoring under the interim status RCRA regulations (40 CFR 265.93(d), as referenced by WAC 173-303-400). These features are the regulated remnants of the more expansive system of ponds and ditches, which have been clean closed. The B Pond System continued in an interim status, indicator parameter evaluation program during FY 2008. The monitoring plan (including the well network, constituents of concern, sampling and analysis procedure, and a conceptual model) is detailed in PNNL-15479, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*.

As required under RCRA and *Washington Administrative Code*, procedures for interim status facility indicator parameter monitoring the required indicator parameters (pH, specific conductance, total organic carbon, and total organic halides) are compared between upgradient and downgradient wells using the most recent data. The current network wells and hydraulic gradient configuration allow for adequate determination of groundwater flow directions and allow the specified upgradient/downgradient comparisons to be made. Figure 2.11-1 shows the locations of the four wells (699-44-39B, 699-42-42B, 699-43-44, and 699-43-45) in the groundwater monitoring well network for the B Pond System. Well 699-44-39B is upgradient, and the other three wells are downgradient. The wells are sampled semiannually for the required indicator parameters, with four samples collected during each event.

In addition, general groundwater quality parameters, metals, phenols, and anions are collected annually. During FY 2008, all groundwater samples were collected as scheduled.

During FY 2008, critical mean values for the indicator parameters were not exceeded except for total organic carbon at well 699-43-44. The well was resampled, and concentrations were less than the critical mean.

During FY 2008, none of the indicator parameters exceeded their critical means at the 216-B-3 Pond Facility.

Nitrate, which had been rising in well 699-42-42B since 1998, declined from 7.04 to 6.82 mg/L. Sulfate continued a steady increasing trend in all wells at B Pond during FY 2008, with the highest concentration of 32.1 mg/L in well 699-42-39B. Levels of both nitrate and sulfate remain below estimates of site-wide groundwater background concentrations. The cause of the low-levels for nitrate and sulfate may be the large volume of wastewater discharged to the B Pond, which may have caused dilution of these constituents. During FY 2008, well 699-44-39B had the largest changes in concentration for chloride, nitrate, and sulfate, with increases of 20 percent, 44 percent, and 24 percent, respectively. Similar double-digit increases were seen in common soil cations in this well.

Gross beta in well 699-43-45 increased abruptly to 15.1 pCi/L in April 2007 before declining to 11.0 pCi/L in July 2007. Gross beta concentrations in this well continued to decrease during FY 2008, falling to below the detection level of 4 pCi/L in April 2008. Upgradient well 699-44-39B also is displaying an upward trend in low levels of gross beta that began in early FY 2005. In FY 2008, gross beta concentration increased from 10.0 pCi/L (July 2007) to 13 pCi/L. The reason for these small departures from historical trends is unknown. However, other wells in the B Pond network, which have since gone dry or were part of the closed expansion ponds network, have displayed brief, intermittent gross beta excursions of the same magnitude or higher.

Based on a gradient of 0.00154 (calculated between wells 699-44-39B, 699-43-44, and 699-42-42B), an average hydraulic conductivity of 1.0 m/day, and an estimated effective porosity of 0.25, the average linear flow velocity of groundwater is estimated at 0.0062 m/day (Appendix B) in a southwest direction.

2.11.3.6 Nonradioactive Dangerous Waste Landfill

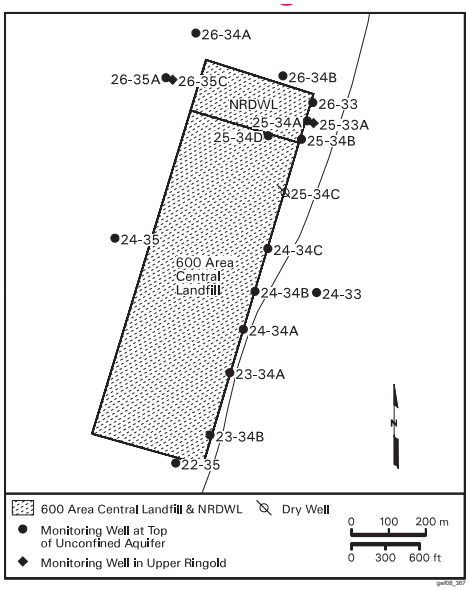
The Nonradioactive Dangerous Waste Landfill is located southeast of the 200 East Area (Figure 2.11-2) next to the Solid Waste Landfill. The objective of RCRA monitoring at the Nonradioactive Dangerous Waste Landfill is to determine if hazardous waste constituents from the landfill have contaminated groundwater (40 CFR 265.93(b) as referenced by WAC 173-303-400). Appendix B lists the wells, their locations, and groundwater constituents monitored. Groundwater flow direction is southeast as determined from the general direction of movement of major 200 East Area plumes.

The objective of RCRA monitoring at the Nonradioactive Dangerous Waste Landfill is to determine if hazardous waste constituents from the landfill have contaminated groundwater.

Monitoring of the Nonradioactive Dangerous Waste Landfill focuses on the RCRA interim status indicator parameters (pH, specific conductance, total organic carbon, and total organic halides), volatile organic compounds, nitrate, and the groundwater quality parameters (chloride, iron, manganese, phenols, sodium, and sulfate) (Appendix B; PNNL-12227, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*). Wells at the Nonradioactive Dangerous Waste Landfill are sampled semiannually, usually in February and August. During FY 2008, all groundwater samples were collected as scheduled.

Total organic carbon exceeded its critical mean at the Nonradioactive Dangerous Waste Landfill.

Three of the indicator parameters (pH, specific conductance, and total organic halides) were below their critical means. Concentrations for total organic carbon at three downgradient wells exceeded the 1,020 µg/L critical mean in August 2008 (1,020 µg/L). One of these wells (well 699-25-33A) is a deep well screened at the top of the Ringold Formation low permeability unit at the base of the unconfined aquifer. Upgradient/downgradient statistical comparisons are not made with this well. The other two wells (699-25-34A and 699-25-34B) are screened at the water table. The quadruplicate results averaged 1,525 µg/L for well 699-25-34A and 1,803 µg/L for well 699-25-34B. The wells were resampled in October 2008. The new averaged concentration for well 699-25-34A was below the laboratory detection level of 200 µg/L, but the concentration for well 699-25-34B averaged 2,035 µg/L. Verification sampling results for well 699-25-34B confirmed the initial results, and indicate the Nonradioactive Dangerous Waste Landfill may be impacting groundwater quality. Ecology was notified of the verified exceedance, and work began on a groundwater quality assessment plan for the Nonradioactive Dangerous Waste Landfill. Activities conducted after the initial exceedances of total organic carbon at the two downgradient wells were in FY 2009, and are presented here for completeness. Further developments will be reported in the FY 2009 report.



Drinking water standards of volatile organic compounds were not exceeded at the Nonradioactive Dangerous Waste Landfill during FY 2008. However, concentration levels of five volatile organic compounds were estimated at levels between their respective method detection levels and the analytical laboratory's practical quantitation limits (required detection limits). Those volatile organic compounds were 1,1,1-trichloroethane, chloroform, methylene chloride (dichloromethane), tetrachloroethene, and trichloroethene.

During FY 2008, the only groundwater quality parameter exceeding drinking water standards was unfiltered iron (382 µg/L). The corresponding filtered sample had a concentration of 19.7 µg/L for iron. The other results for groundwater quality parameters during FY 2008 were either not detected (e.g., phenols) or were reported in concentrations below their respective drinking water standards.

2.11.3.7 Solid Waste Landfill (600 Area Central Landfill)

Compliance at the Solid Waste Landfill is determined by comparing results from monitoring downgradient wells with statistically derived background threshold values from upgradient wells.

The Solid Waste Landfill is located south of the Nonradioactive Dangerous Waste Landfill (Figure 2.11-2). The landfill is regulated by Ecology under WAC 173-304. WAC 173-304 constituents and site-specific constituents (including volatile organic compounds and filtered arsenic) are analyzed on groundwater samples collected quarterly (PNNL-13014, *Groundwater Monitoring Plan for the Solid Waste Landfill*). Compliance is determined by comparing results from monitoring downgradient wells with statistically derived background threshold values from upgradient wells. Groundwater flow direction is southeast, as inferred from the general direction of movement of major 200 East Area plumes. The well network for the Solid Waste Landfill includes two upgradient and seven downgradient wells Appendix B lists the network wells, their locations, and groundwater constituents monitored. During FY 2008, all scheduled samples were collected at the Solid Waste Landfill.

A leachate collection system underlying one set of double trenches within the landfill has detected contamination from the landfill in past years. Arsenic and

1,4-dioxane were detected in the leachate, but were not analyzed in groundwater samples. They have been added to the list of constituents analyzed in groundwater samples from the network wells. Ammonium ion, dissolved iron, dissolved manganese, dissolved zinc, arsenic, barium, chloride, copper, fluoride, nickel, selenium, sulfate, 1,4-dioxane, and 1,4-dichlorobenzene were detected in the leachate (09-AMCP-0010, "Hanford Site Solid Waste Landfill Annual Monitoring Report, July 2007 Through June 2008") between July 2007 and June 2008. All of these constituents detected in the leachate collection system (except for selenium) were analyzed in groundwater samples collected from Solid Waste Landfill network wells. Section 3.2 provides more detail about vadose zone contamination and results of analyses in the Solid Waste Landfill leachate collection system.

All constituents detected in the leachate collection system (except for selenium) were analyzed in groundwater samples collected from Solid Waste Landfill network wells during FY 2008.

WAC 173-304 Parameters. Each WAC 173-304 parameter is discussed separately in the following paragraphs. A complete list of results for required constituents at the Solid Waste Landfill during FY 2008 and background threshold values are in Appendix B. The increased amount of detail in the discussions of individual groundwater constituents (compared to other sections of this report) is provided to meet the annual reporting requirements of the groundwater-monitoring plan (PNNL-13014).

Ammonium – Results for ammonium ion (background threshold value 90 μg/L) in Solid Waste Landfill wells during FY 2008 ranged from less than the method detection limit (12 μg/L) to 33.9 μg/L (from February 2008) at well 699-24-35. Ammonium ion was detected at the upgradient and downgradient wells. Detections of this groundwater constituent have been sporadic in previous years at the Solid Waste Landfill and continued in FY 2008.

Chemical Oxygen Demand – Chemical oxygen demand (background threshold value 10 mg/L) ranged from less than the method detection limit (10 mg/L) at upgradient wells and some downgradient wells to 23 mg/L at well 699-24-33. Historically, chemical oxygen demand values are sporadic at the Solid Waste Landfill. Elevated values of this constituent could be an indication of groundwater contamination by sewage, which was known to be discharged to Solid Waste Landfill trenches.

Downgradient wells at the Solid Waste Landfill showed elevated concentrations of chemical oxygen demand, coliform bacteria, specific conductance, sulfate, temperature, and total organic carbon, and low pH.

Chloride – Chloride ranged from 5.9 mg/L (at downgradient well 699-23-34A) to 7.6 mg/L (at downgradient well 699-24-34A). The background threshold value (7.8 mg/L) was not exceeded. Chloride slightly increased in concentration in most Solid Waste Landfill wells until about 2005, and stabilized thereafter.

Coliform Bacteria – The background threshold value (1 colony per 100 ml of groundwater) was exceeded at one well during FY 2008. That exceedance was 2 col./100 ml in background well 699-24-35. Like chemical oxygen demand, elevated levels of coliform bacteria have been detected sporadically at the Solid Waste Landfill in past years. Elevated levels of this constituent are expected with the known disposal of sewage at the Solid Waste Landfill.

Filtered Iron – None of the filtered iron results exceeded the 160 μg/L background threshold value during FY 2008. The reported values ranged from less than 9 to 109 μg/L. Elevated filtered iron results have been reported above the background threshold value occasionally at Solid Waste Landfill wells in recent years, but are not typical of the overall historical results.

Filtered Manganese – Filtered manganese was mostly undetected (above the method detection level of 4 μg/L) in Solid Waste Landfill wells during FY 2008.

The maximum level detected was 8.2 µg/L at downgradient well 699-24-34A. The background threshold value was 18 µg/L.

Nitrate – The Solid Waste Landfill is located on the western edge of the major nitrate plume emanating from the 200 East Area (Figure 2.11-7). Downgradient wells have similar levels of nitrate as the upgradient wells. During FY 2008, the highest level of nitrate at the Solid Waste Landfill was 19.2 mg/L at downgradient well 699-23-24A, which was significantly lower than the 29 mg/L background threshold value.

Nitrite – Although the background threshold value was 148 µg/L, the highest reported detected result of 88.4 µg/L was still below the analytical laboratory's required detection limit.

Field pH – Six wells at the Solid Waste Landfill during FY 2008, including upgradient well 699-24-35, had pH levels that were lower than the background threshold range (6.68 to 7.84). The downgradient wells that exceeded the background threshold range were 699-23-34A, 699-23-34B, 699-24-33, 699-24-34A, and 699-24-34B. The lowest pH value was 6.52 at well 699-23-34A. Trends of pH are relatively steady at Solid Waste Landfill wells.

Specific Conductance – Specific conductance values at all seven downgradient wells exceeded the 583 µS/cm background threshold value during FY 2008. At the two upgradient wells (699-24-35 and 699-26-35A), the values were lower. Six of the seven downgradient wells also had specific conductance values greater than the 700 µS/cm WAC 246-290-310 limit. The highest reported value during FY 2008 was 829 µS/cm at the downgradient well 699-22-35. Specific conductance values at the Solid Waste Landfill have remained relatively stable since 2001. Elevated specific conductance may caused by increased concentrations of sulfate and other anions in groundwater at the Solid Waste Landfill.

The only chlorinated hydrocarbons exceeding their WAC 173-200-40 limit during FY 2008 at the Solid Waste Landfill were tetrachloroethene (limit 0.8 µg/L) and carbon tetrachloride (limit 0.3 µg/L).

Sulfate – Reported results in downgradient wells ranged from 40.3 to 55.5 mg/L. Four of the seven downgradient wells had at least one result that exceeded the 47.2 mg/L background threshold value. The overall trend for sulfate at the Solid Waste Landfill is stable to slightly increasing in concentration.

Temperature – Two results at well 699-22-35 (24 and 25.9ºC) exceeded the 20.7ºC background threshold value during FY 2008. None of the other wells exceeded the limit. Both of the exceedances (one in May 2008 and one in August 2008) appear to be anomalous and not consistent with historical trends at this well. The elevated temperature measurements are under review.

Total Organic Carbon – Five of the downgradient wells and one of the upgradient wells had total organic carbon results that exceeded the 1,430 µg/L background threshold in the February 2008 sampling event. Results in the other three quarters were all below the background threshold value. The exceedances ranged from 2,910 µg/L at well 699-24-34B to 38,300 µg/L at well 699-24-33. Spurious elevated total organic carbon results have been reported previously at the Solid Waste Landfill. The total organic carbon exceedances are under review.

Filtered Zinc – Reported values for filtered zinc during FY 2008 at the Solid Waste Landfill ranged from less than 4 µg/L (the analytical method detection limit) to 25.9 µg/L at the upgradient well 699- 24-35. None of the Solid Waste Landfill wells had filtered zinc values exceeding the 43.2 µg/L background threshold value.

Site-Specific Parameters. Disposed waste at the Solid Waste Landfill has impacted groundwater with minor chlorinated hydrocarbon contamination. However,

the concentrations of chlorinated hydrocarbons at the Solid Waste Landfill have decreased over the years and were barely detectable during FY 2008. The only chlorinated hydrocarbons exceeding WAC 173-200-40 limits during FY 2008 were tetrachloroethene (limit 0.8 µg/L) and carbon tetrachloride (limit 0.3 µg/L). The highest reported tetrachloroethene result was 2.6 µg/L at the downgradient well 699-24-33; and the only detected carbon tetrachloride result was 1.0 µg/L at downgradient well 699-22-35. These results were below the analytical laboratory's practical quantitation limit (required detection limit). Four chlorinated hydrocarbons (1,1,1-trichloroethane, chloroform, methylene chloride, and trichloroethene) were detected at low concentrations in Solid Waste Landfill wells during FY 2008. Like the tetrachloroethene and carbon tetrachloride results, the results for these chlorinated hydrocarbons were below the analytical laboratory's practical quantitation limits (required detection limits). The two volatile organic compounds (1,4-dioxane and 1,4-dichlorobenzene) were undetected in groundwater samples.

A potential cause of the widespread, low-level chlorinated hydrocarbon contamination at the Solid Waste Landfill, including the upgradient wells and the adjacent Nonradioactive Dangerous Waste Landfill wells, is the dissolution of vadose zone vapors into groundwater. However, the vapor source is uncertain. Potential sources are the chlorinated hydrocarbons dissolved in the liquid sewage or the catch tank liquid from the 1100 Area heavy equipment garage and bus shop that were disposed to the Solid Waste Landfill (PNNL-13014).

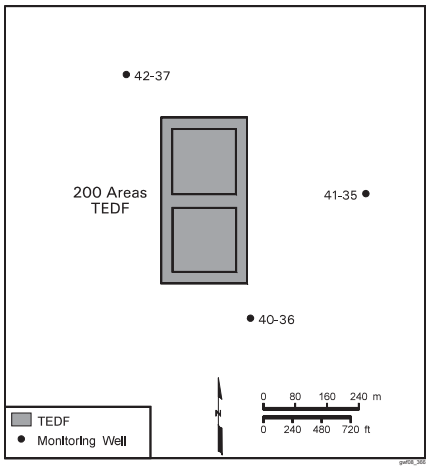
The other constituents discovered in the leachate collection system at the Solid Waste Landfill (barium, copper, fluoride, nickel, and arsenic) were all detected in groundwater but had results lower than primary drinking water standards (or secondary drinking water standards, if appropriate) or WAC 173-200-40 limits, except for arsenic. Although the drinking water standard for arsenic is 10 µg/L, the WAC 173-200-40 limit is 0.05 µg/L. Results for filtered arsenic ranged from 1.1 to 5.8 µg/L, all exceeding the WAC 173-200-40 limit. However, results from downgradient wells were not significantly different than results from upgradient wells.

Some downgradient wells continue to show higher chemical oxygen demand, coliform bacteria, specific conductance, sulfate, and lower pH. The lower pH apparently is a result of high concentrations of carbon dioxide in the vadose zone resulting from the degradation of sewage material disposed to the Solid Waste Landfill (DOE/RL-93-88, Section 5.3; PNL-7147; WHC-SD-EN-TI-199). The elevated chemical oxygen demand, coliform bacteria, and specific conductance also may be related to the disposed sewage.

2.11.3.8 200 Area Treated Effluent Disposal Facility

The 200 Area Treated Effluent Disposal Facility is located southeast of the B Pond RCRA facility and has received effluent since June 1995. Groundwater beneath the facility is monitored under a Washington State waste discharge permit (WAC 173-216; PNNL-13032). Wells 699-40-36, 699-41-35, and 699-42-37 monitor groundwater beneath the facility.

Prior to the 200 Area Treated Effluent Disposal Facility, there was no continuous unconfined aquifer above the Ringold Formation lower mud unit at that location. Therefore, the three groundwater monitoring wells installed at the facility were installed in the locally confined aquifer below the lower



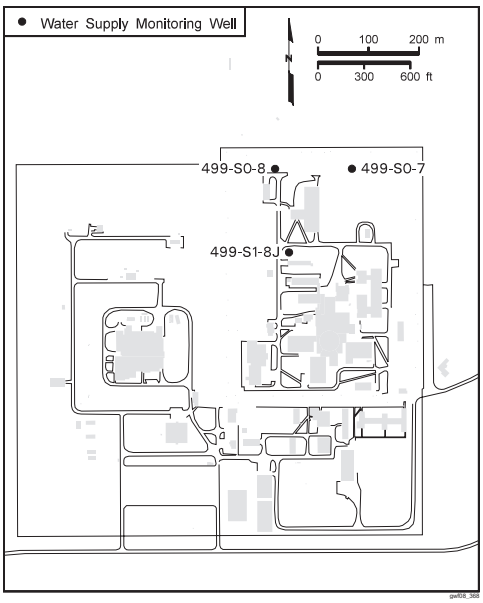
mud unit (Section 2.14) and are isolated from the effects of the effluent from the disposal facility by the relatively impermeable silts and clays of the lower mud unit (PNNL-14098; PNNL-15479). When the wells were installed, a minor amount of perched water was encountered above the lower mud unit, and recent discharges to the ground at the facility have most likely increased the amount of perched water. The quarterly analytical results from the three wells are used to demonstrate continuation of the isolation of discharges from the locally confined aquifer below the lower mud unit.

Based on hydraulic head measurements in FY 2008, and estimates of effective porosity and hydraulic conductivity, groundwater flow potential in the confined aquifer beneath the 200 Area Treated Effluent Disposal Facility is directed southwest (220º azimuth) at 0.0006 m/day. Historically, major ionic composition and extremely low tritium concentration have indicated that groundwater in the Ringold Formation confined aquifer beneath this facility is isolated from groundwater in the adjacent unconfined aquifer, and its water quality is largely unaffected by Hanford Site operations. Results of annual low-level tritium analyses confirm this interpretation. Hydraulic head continues to decline in the wells at the 200 Area Treated Effluent Disposal Facility as a result of the dissipating pressure effect of historical discharges at the nearby B Pond facility.

Enforcement limits for groundwater constituents were not exceeded at the 200 Areas TEDF during FY 2008.

Groundwater samples are collected quarterly from wells for a list of constituents required by the state waste-discharge permit ST-4502 (Ecology, 2000, *State Waste Discharge Permit ST 4500*). Three of the constituents (cadmium, lead, and pH) are compared with specific enforcement limits set by the permit. During FY 2008, all groundwater samples were collected as scheduled and no enforcement limits were exceeded. Most concentrations for anions, metals, and radionuclide indicators have been below Hanford Site groundwater background levels (e.g., WHC-EP-0595; DOE/RL-96-61) since monitoring began at the site.

2.11.3.9 400 Area Water Supply Wells



Primary groundwater monitoring activities in the 400 Area involve monitoring of the 400 Area water supply wells. Monitoring is conducted to provide information needed to describe the nature and extent of site-wide contamination (primarily tritium, nitrate, and iodine-129). This section discusses the monitoring of the 400 Area water supply wells (specifically tritium) and general aspects of groundwater chemistry in the 400 Area. The water supply wells were sampled quarterly as scheduled in FY 2008.

The Hanford Site water-table map (Figure 2.1-2) indicates that flow in the unconfined aquifer is generally to the east-southeast across the 400 Area. The water table is located near the contact of the Ringold Formation and Hanford formation, which is ~49 m below ground surface (WHC-EP-0587, *Groundwater Impact Assessment Report for the 400 Area Ponds*). Hanford formation sediment dominates groundwater flow in the 400 Area because of its relatively high permeability compared to that of the sediments in the underlying Ringold Formation.

Elevated levels of tritium associated with the groundwater plume originating from the PUREX Cribs in the 200 Area were identified in the 400 Area wells (Figures 1.0-2 and 2.11-3). Groundwater tritium levels are relevant to the water supply wells, which provide drinking water and emergency

supply water for the 400 Area. Well 499-S1-8J serves as the main water supply well, while wells 499-S0-7 and 499-S0-8 are backup supply wells. Well 499-S1-8J has lower tritium concentrations because it is screened at a greater depth than the other two water supply wells. Figure 2.11-20 compares the tritium concentrations in wells 499-S0-7, 499-S0-8, and 499-S1-8J to that of the 400 Area drinking water supply. Tritium was measured at levels below the drinking water standard (20,000 pCi/L) in all three of the water supply wells in FY 2008. Tritium levels in well 499-S1-8J (the main water supply well) ranged from 2,100 to 2,500 pCi/L.

Tritium was measured at levels below the drinking water standard (20,000 pCi/L) in all three of the water supply wells in FY 2008.

Tritium remained below the drinking water standard and the 4-mrem/yr dose equivalent in the drinking water supply (sampled at a tap) for all sampling events in FY 2008 (Figure 2.11-20). Nitrate remained below the 45 mg/L drinking water standard for the water supply wells. Data from these wells indicate no other constituents are present at levels above their drinking water standards.

Groundwater monitoring in the 200-PO-1 groundwater interest area includes the following monitoring activities.

CERCLA Monitoring (Appendix A)

- ***Forty-one near-field wells and eighty far-field wells are scheduled for annual to triennial sampling. The wells were sampled as planned in FY 2008.***
- ***One new well was installed in FY 2008 and will be sampled beginning in FY 2009.***
- ***Thirteen new aquifer tubes were installed and most were sampled in FY 2008.***

Facility Monitoring (Appendix B)

- ***Seven wells are scheduled for semiannual sampling at the Integrated Disposal Facility.***
- ***Eleven near-field wells are scheduled for quarterly to semiannual sampling at the RCRA PUREX Cribs. Far-field well sampling is coordinated with the 200-PO-1 Operable Unit.***
- ***Eight wells are scheduled for quarterly sampling at the single-shell tank Waste Management Area A-AX. One new well was installed in FY 2008 and will be sampled beginning in FY 2009.***
- ***Nine wells are scheduled for semiannual sampling at the 216-A-29 Ditch.***
- ***Four wells are scheduled for semiannual sampling at the B Pond.***
- ***Nine wells are scheduled for semiannual sampling at the Nonradioactive Dangerous Waste Landfill for RCRA monitoring.***
- ***Nine wells are scheduled for quarterly sampling at the Solid Waste Landfill under a Washington State permit (WAC 173-304).***
- ***Three wells are scheduled for quarterly sampling at the 200 Area Treated Effluent Disposal Facility under a Washington State waste discharge permit (WAC 173-216).***
- ***Three water supply wells are scheduled for quarterly to annual sampling at the 400 Area for AEA.***
- ***All wells were sampled as planned.***

Table 2.11-1. Analytes and Analytical Methods for the 200-PO-1 Operable Unit.

Characterization Sampling and Analysis Plan.	Analytical Method
1,1,2,2-Tetrachloroethane	8260B
1,2-Dichloroethane	8260B
1,4-Dioxane	8260/8270*
2,4-Dinitrophenol	8270
Antimony	6010B
Arsenic	6010B
Benzene	8260B
Bis(2-ethylhexyl)phthalate	8270
Bromodichloromethane	8260B
Cadmium	6010B/200.8
Carbon tetrachloride	8260B
Chromium	6010B/200.8
Dieldrin	8081
Dimethoate	8270/8081*
Dibromochloromethane	8260B
Fluoride	300
Gross alpha	9310_ALPHABETA_GPA
Hexane	8260B*
Heptachlor	8081
Heptachlor epoxide	8081
Iodine-129	GEA/GPC
Lead	6010B/200.8
Manganese	6010B/200.8
Methylene chloride	8260B
Neptunium-237	GEA/GPC
Nickel	6010B/200.8
Nitrate	300
Nitrite	300
Nitrobenzene	8270
Pentachlorophenol	8270
Protactinium-231	AEA
Selenium-79	LSC
Strontium-90	GPC
Technetium-99	LSC
Thallium	6010B/200.8
Tritium	LSC
Tetrachloroethene	8260B
Trichloroethene	8260B
Uranium	6010B/200.8
Uranium-234	AEA/AS
Uranium-238	AEA/AS
Vanadium	6010B/200.8
Vinyl chloride	8260B
Zinc	6010 B/200.8

* Constituents can be requested to add to the regular list of analytes analyzed with this method.
LSC = liquid scintillation counting.
AEA = alpha energy analysis.
AS = alpha spectroscopy.
GEA = gamma energy analysis.
GPC = gas proportional counting.

Figure 2.11-1. Facilities and Groundwater Monitoring Wells in Northern 200-PO-1 Operable Unit.

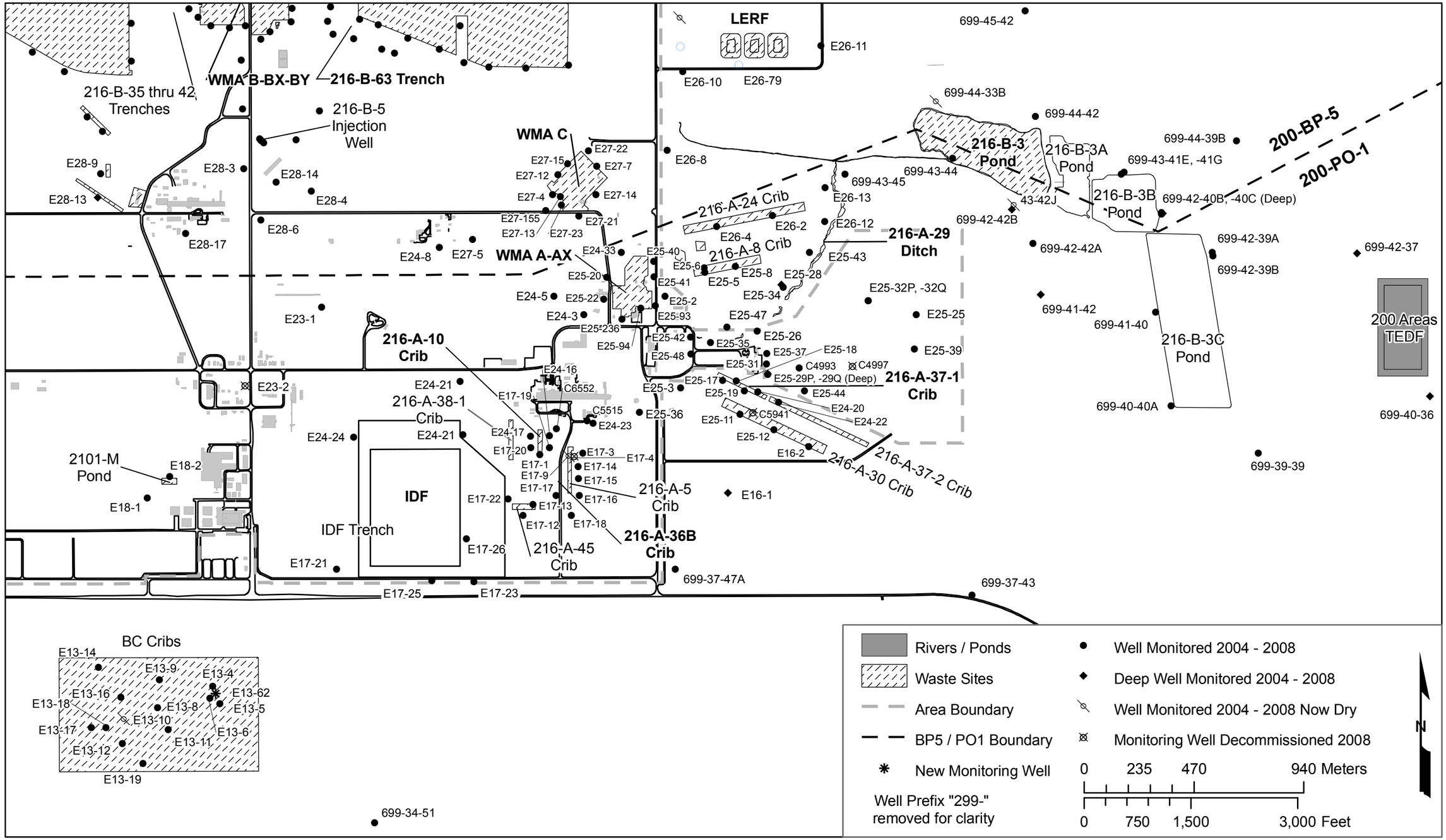


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Figure 2.11-2. 200-PO-1 Operable Unit Boundaries, Far-Field Monitoring Wells, And Transects.

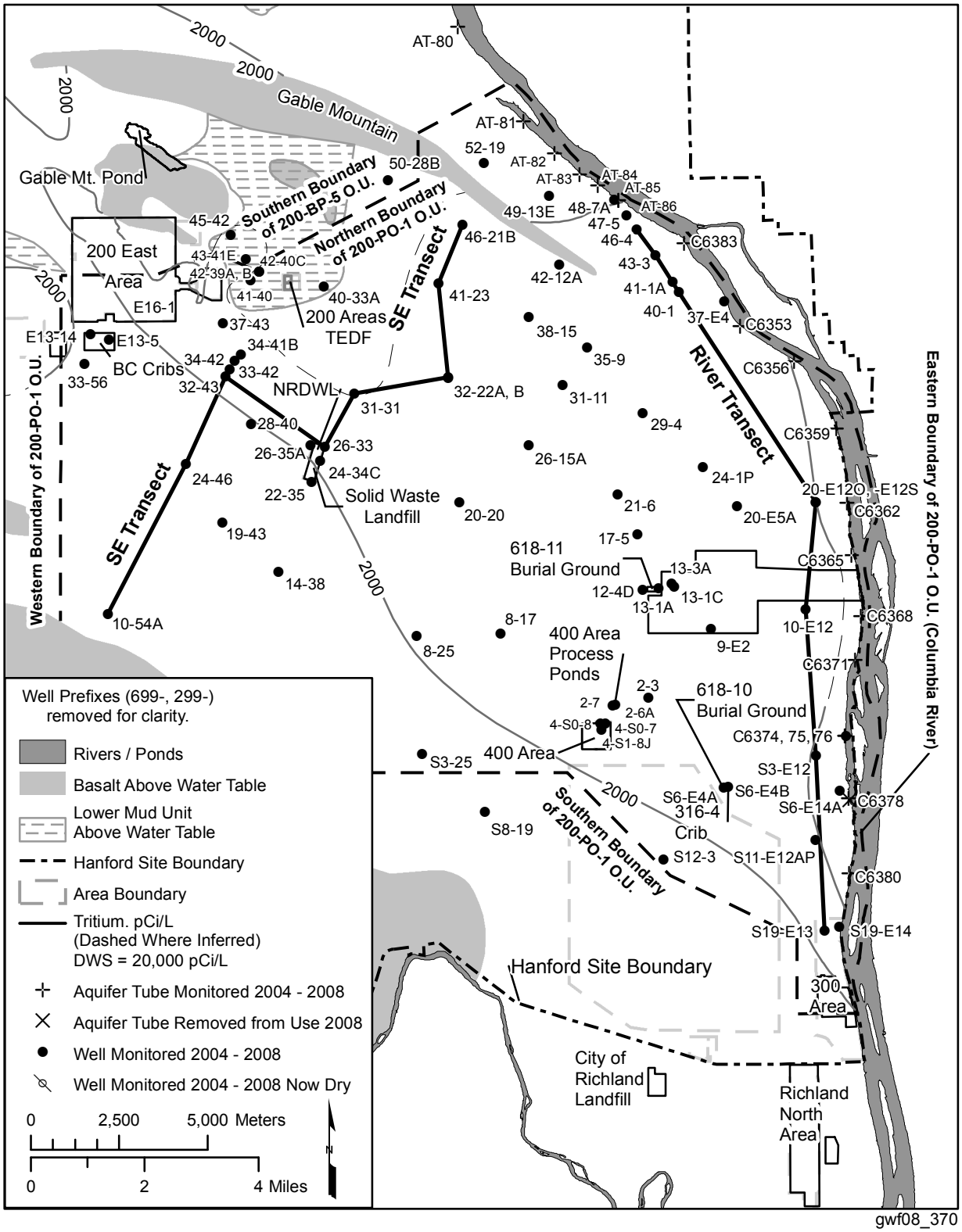

Figure 2.11-3. Tritium Concentrations in the 200-PO-1 Operable Unit, Upper Part of Unconfined Aquifer.

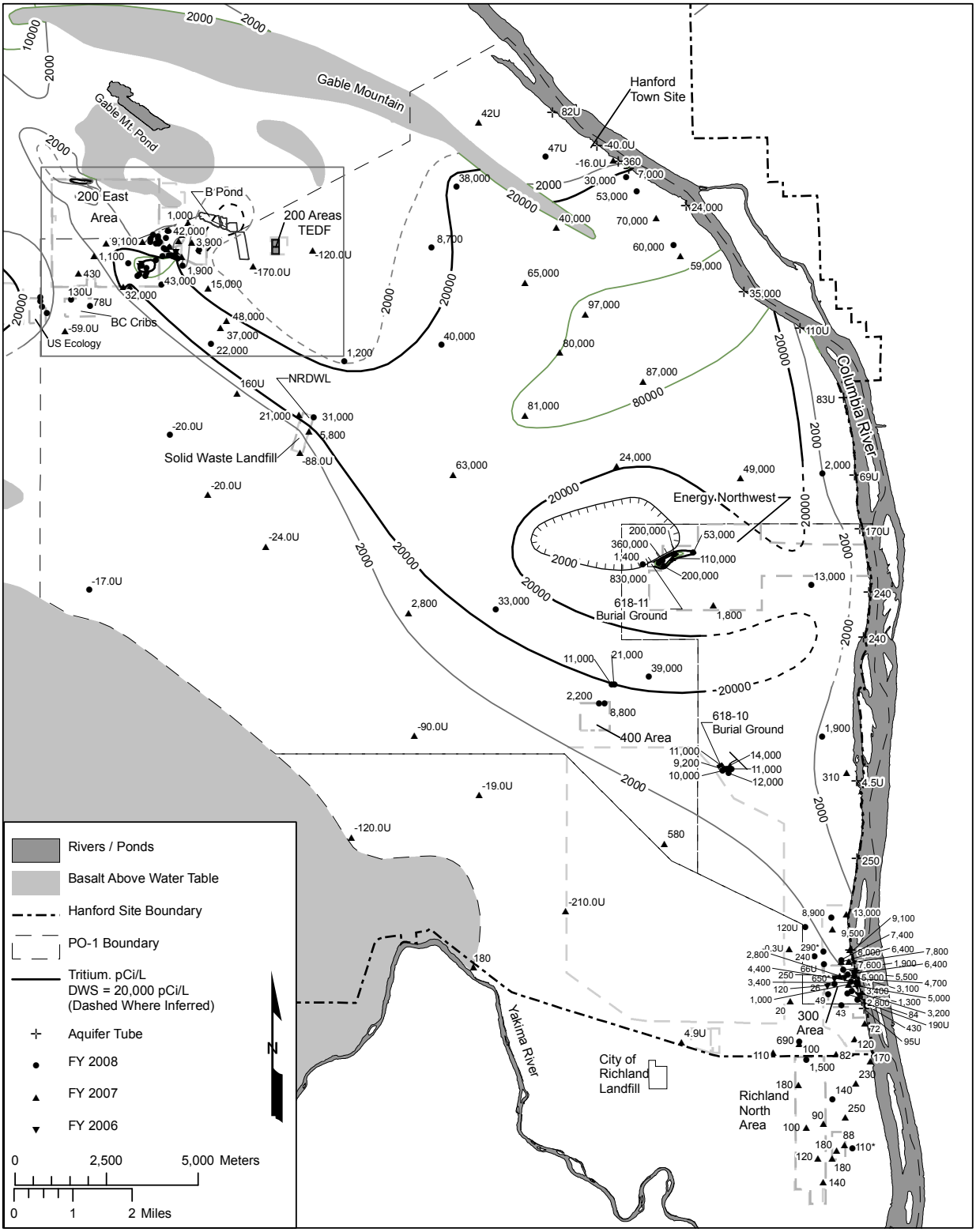

Figure 2.11-4. Average Tritium Concentrations in the Near-Field Area, Upper Part Of Unconfined Aquifer.

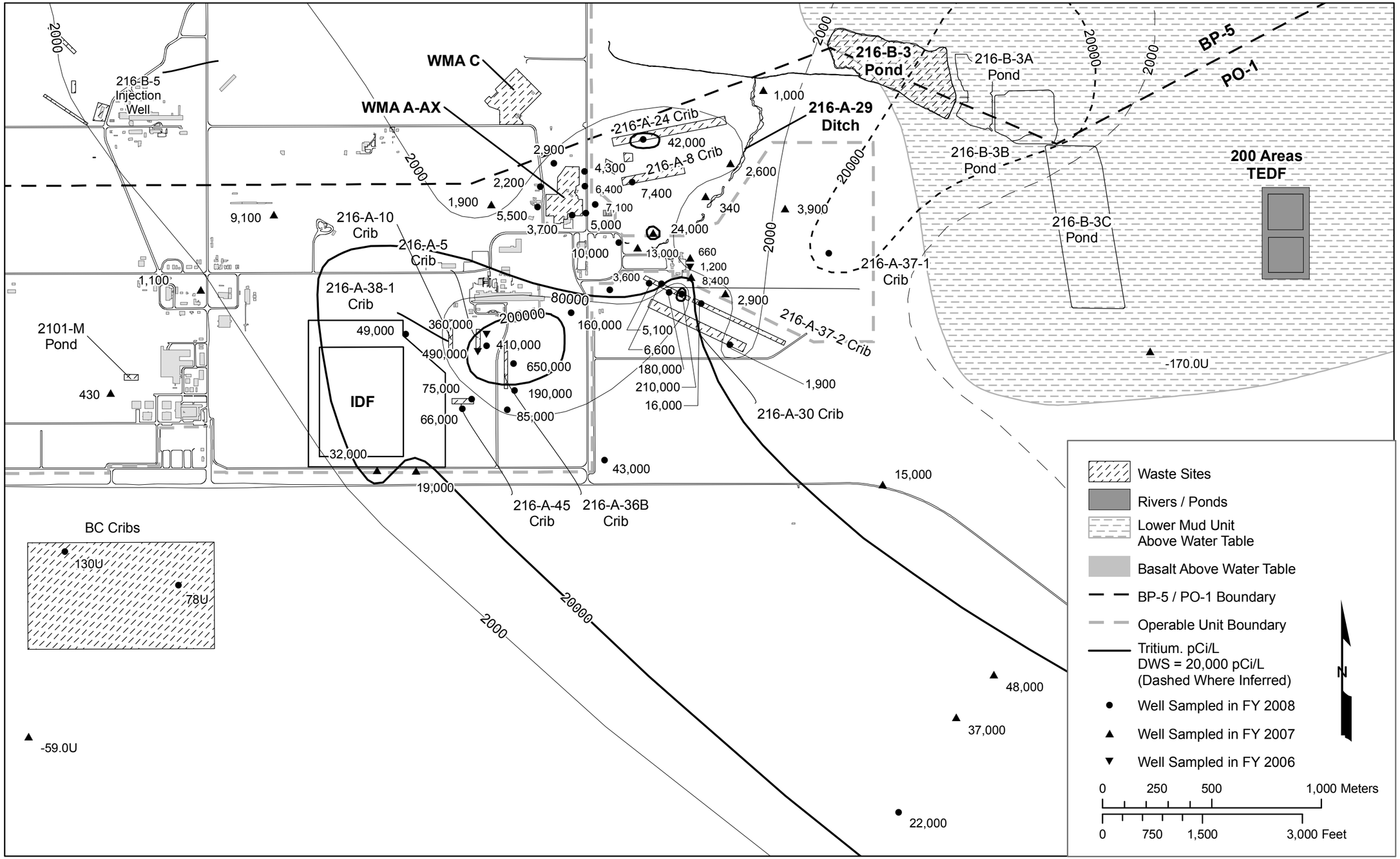

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Figure 2.11-5. Tritium Concentrations in RCRA PUREX Cribs Wells.

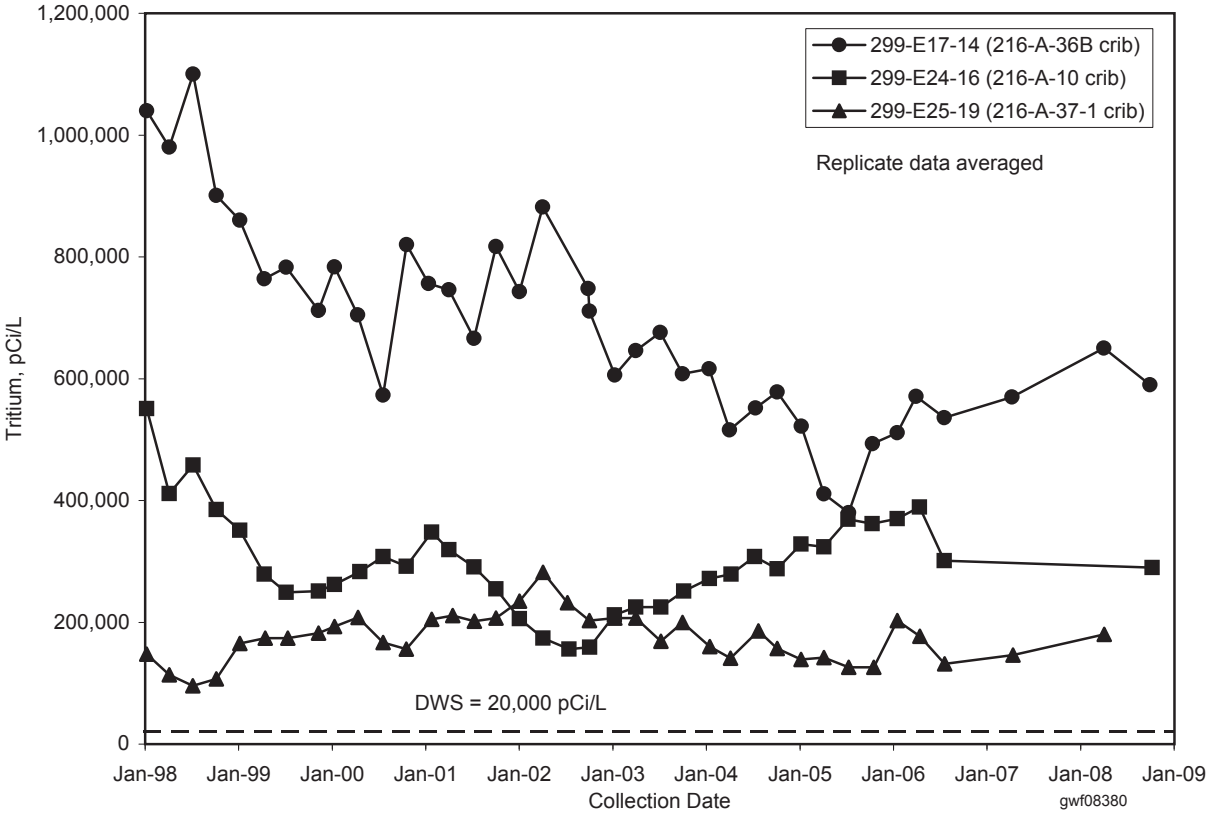

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Figure 2.11-6. Iodine-129 Plume for the 200-PO-1 Operable Unit, Upper Part of Unconfined Aquifer.

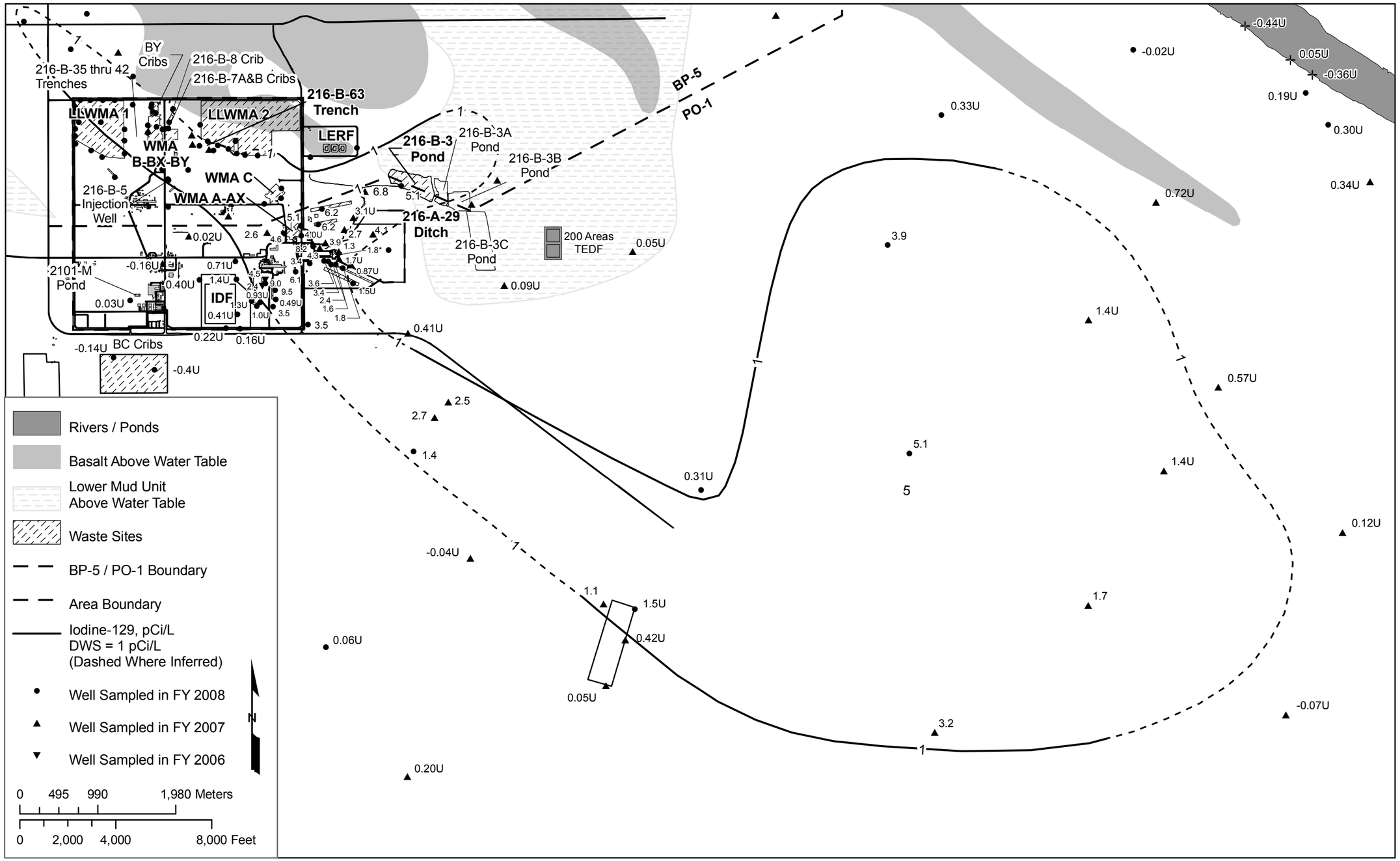

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Figure 2.11-7. Nitrate Concentrations in the 200-PO-1 Operable Unit, Upper Part of Unconfined Aquifer.

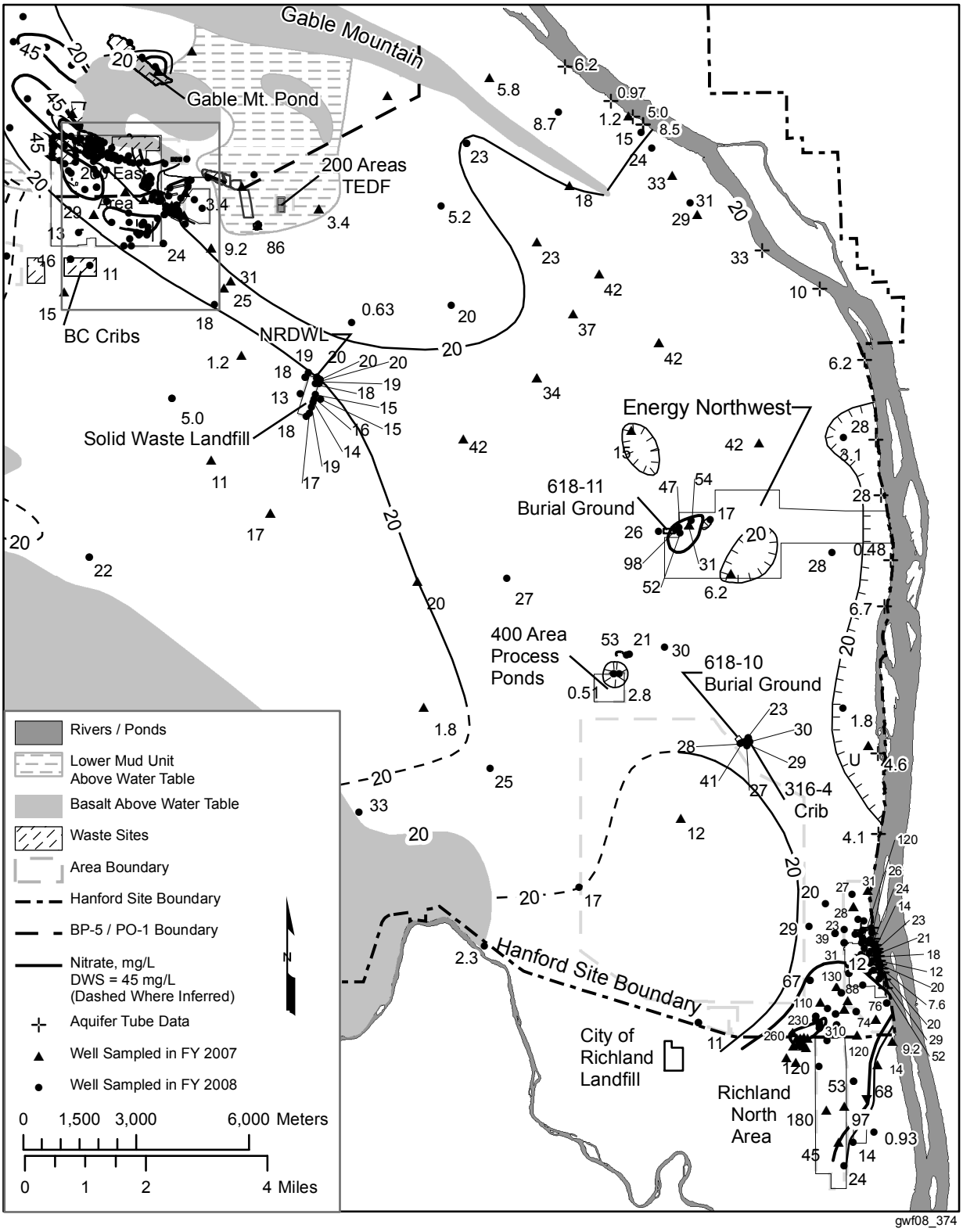

Figure 2.11-8. Iodine-129 Concentrations in Well 299-E17-14 at the 216-A-36B Crib.

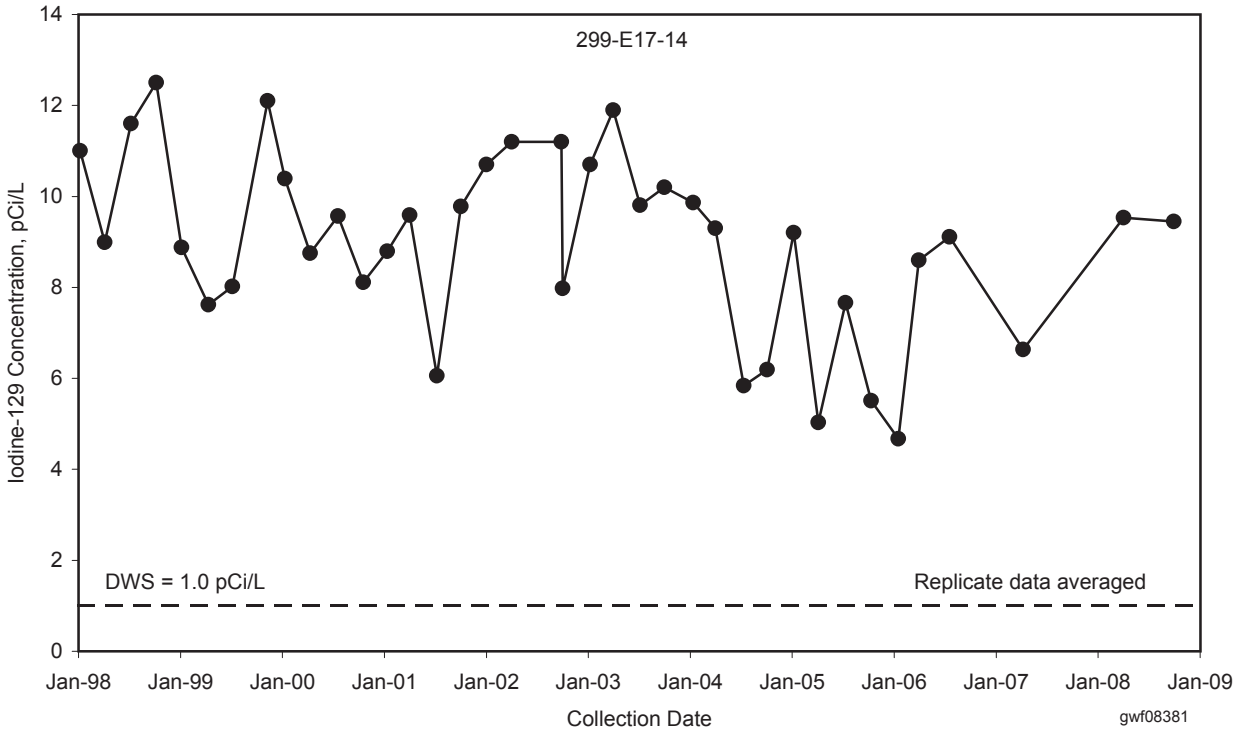

Figure 2.11-9. Nitrate Concentrations in the Near-Field Area, Upper Part of The Unconfined Aquifer.

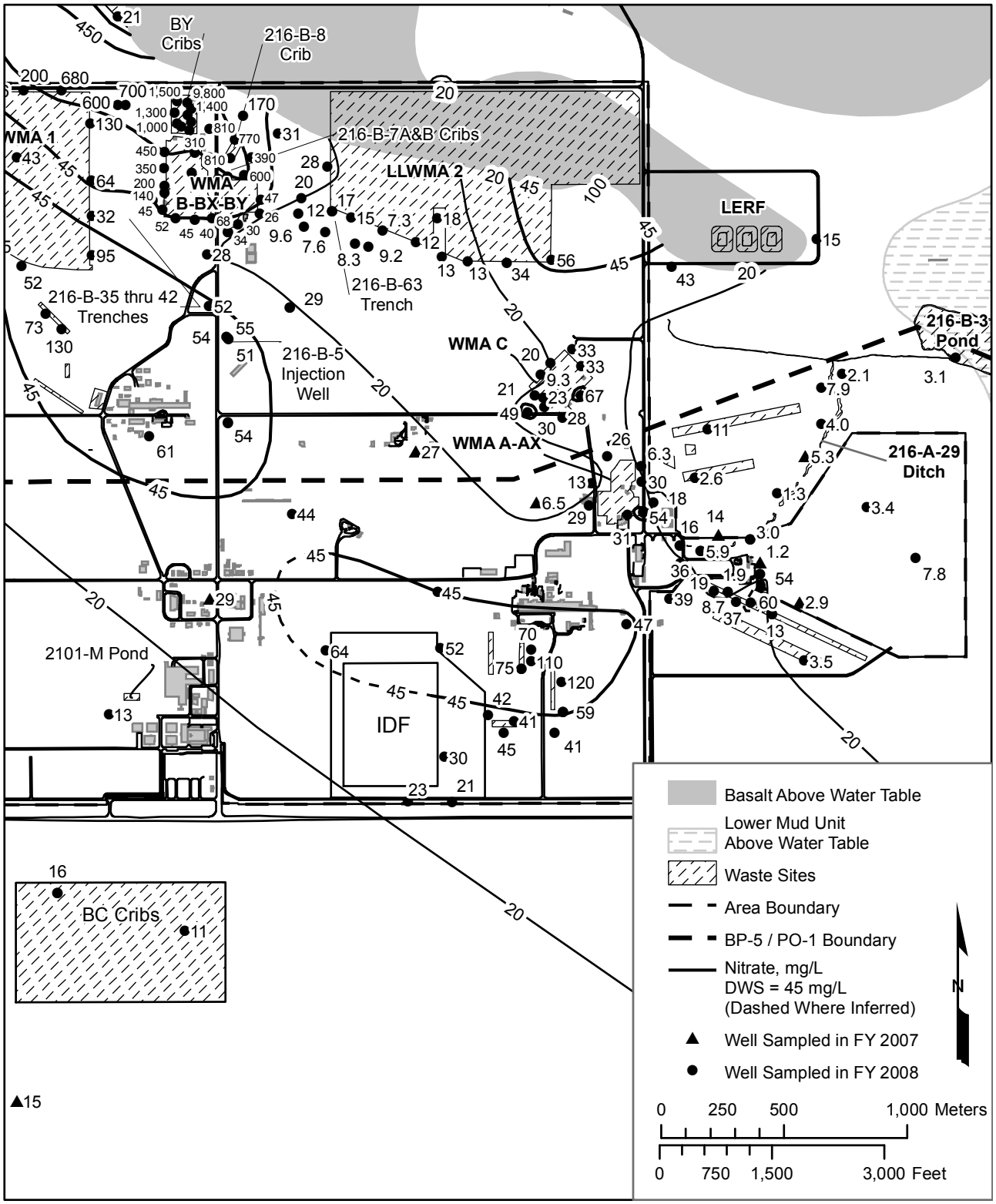

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Figure 2.11-10. Nitrate Concentrations in Well 299-E24-16 at the 216-A-10 Crib.

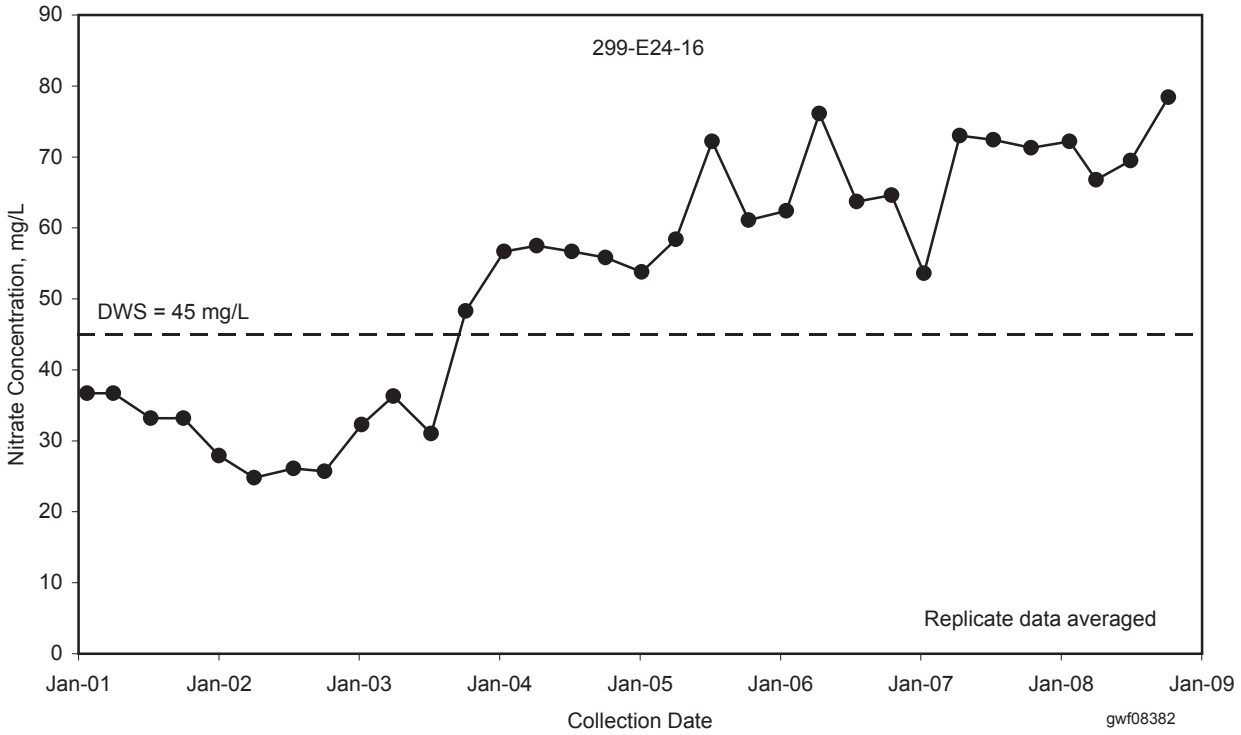

Figure 2.11-11. Technetium-99 Concentrations in Wells at Waste Management Area A-AX.

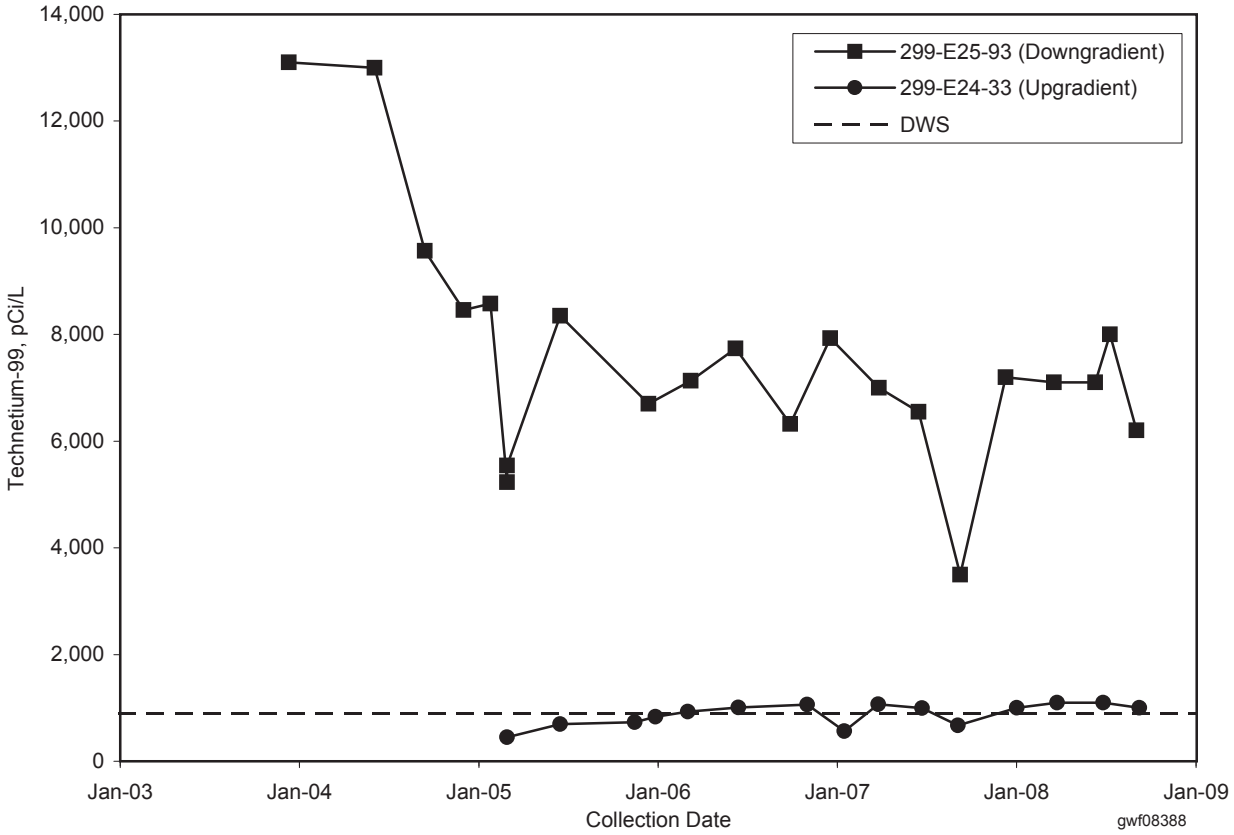

Figure 2.11-12. Uranium Concentrations in Well 299-E17-14 at the 216-A-36B Crib.

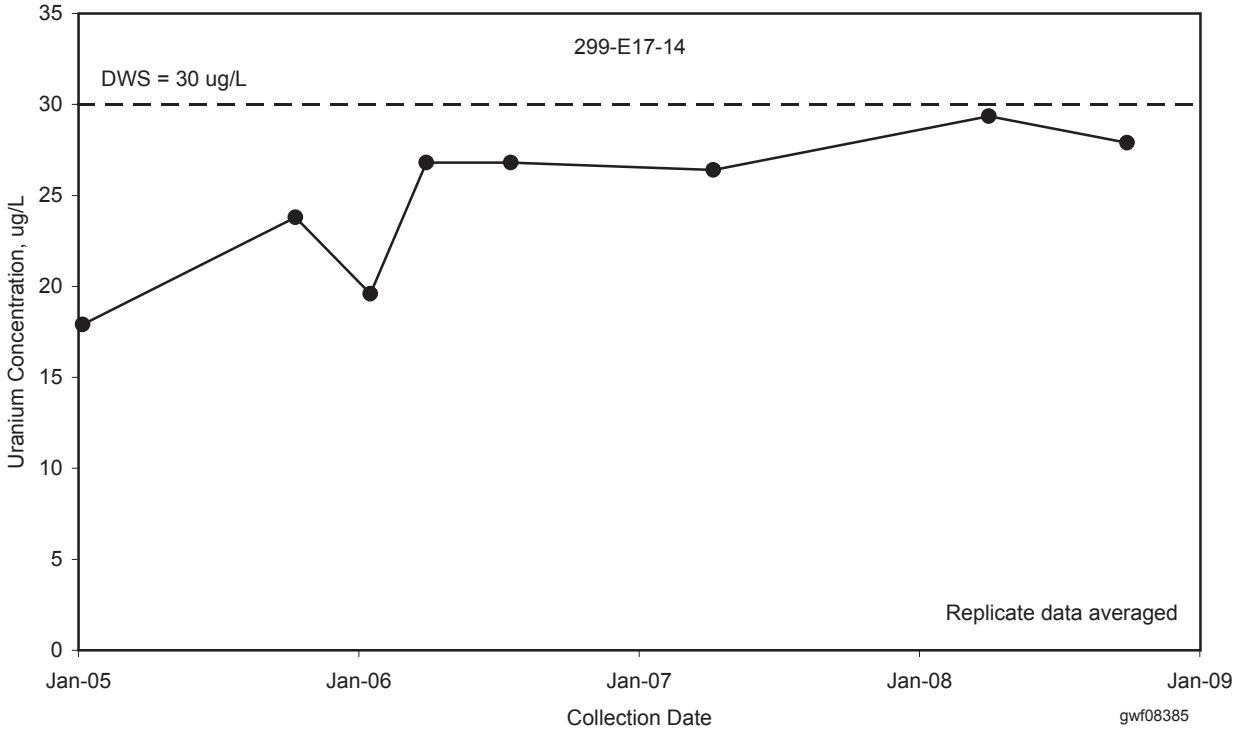

Figure 2.11-13. Locations of New Aquifer Tubes in the 200-PO-1 Operable Unit.

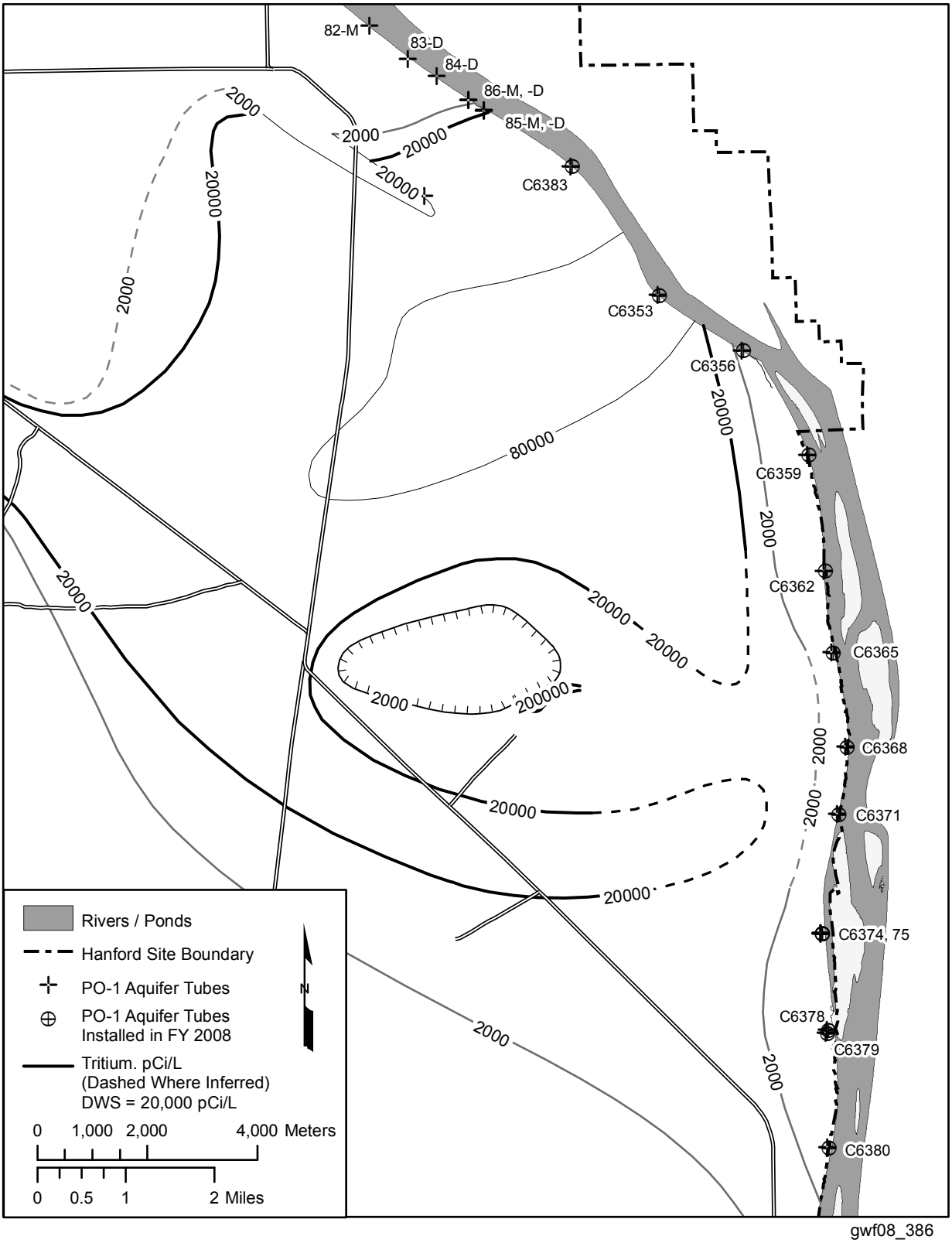

Figure 2.11-14. Nitrate Concentrations in 216-A-36B Crib Wells.

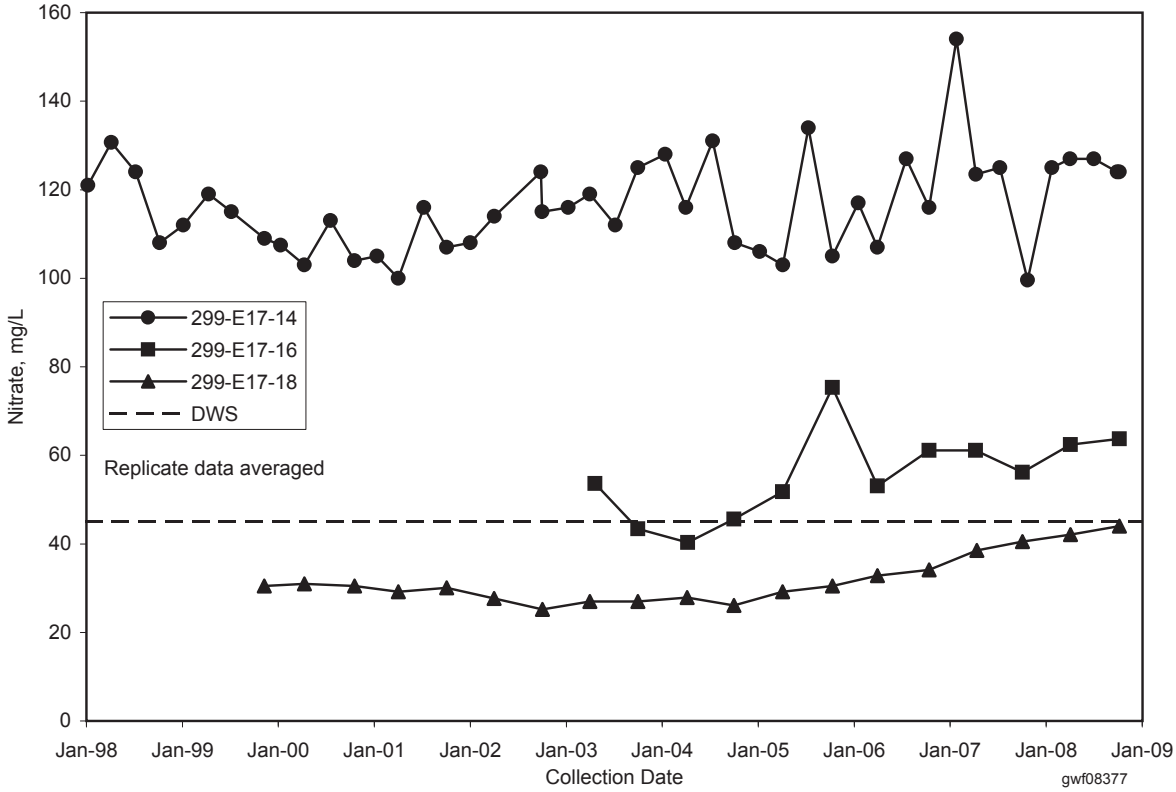

Figure 2.11-15. Nitrate Concentrations in 216-A-10 Crib Wells.

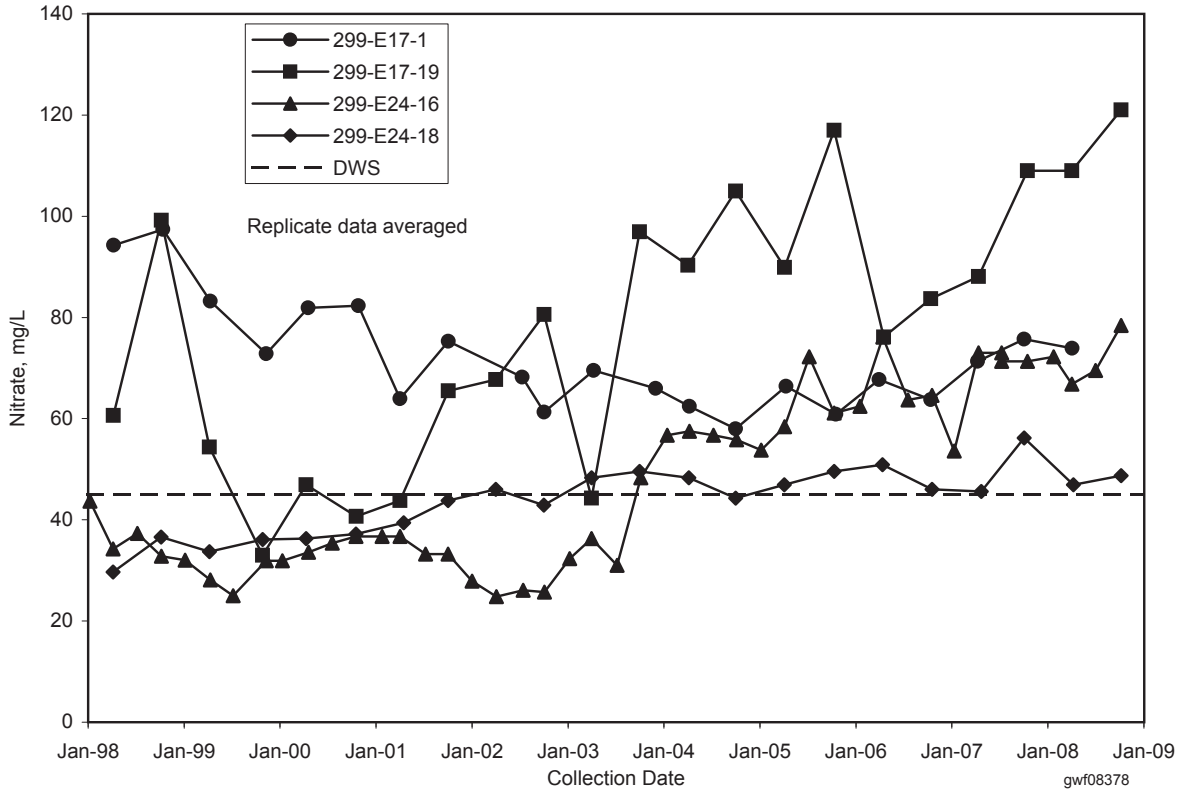

Figure 2.11-16. Nitrate Concentrations in 216-A-37-1 Crib Wells.

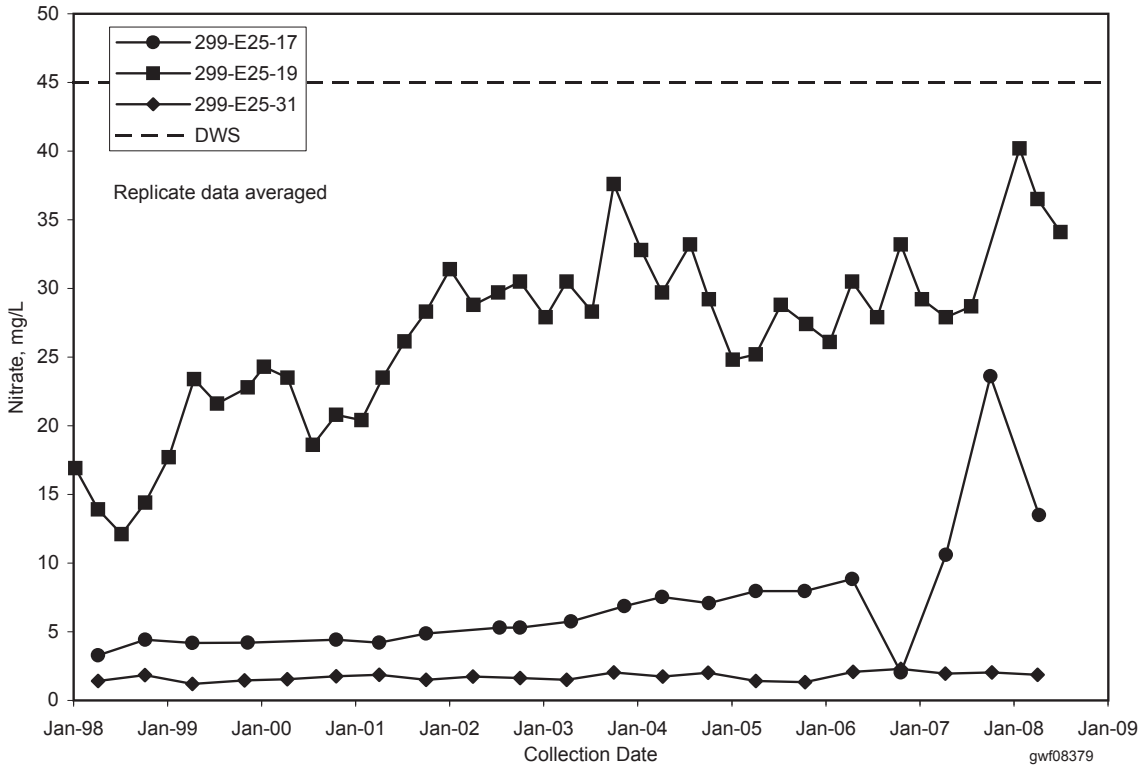

Figure 2.11-17. Nitrate Concentrations in Downgradient Wells at Waste Management Area A-AX.

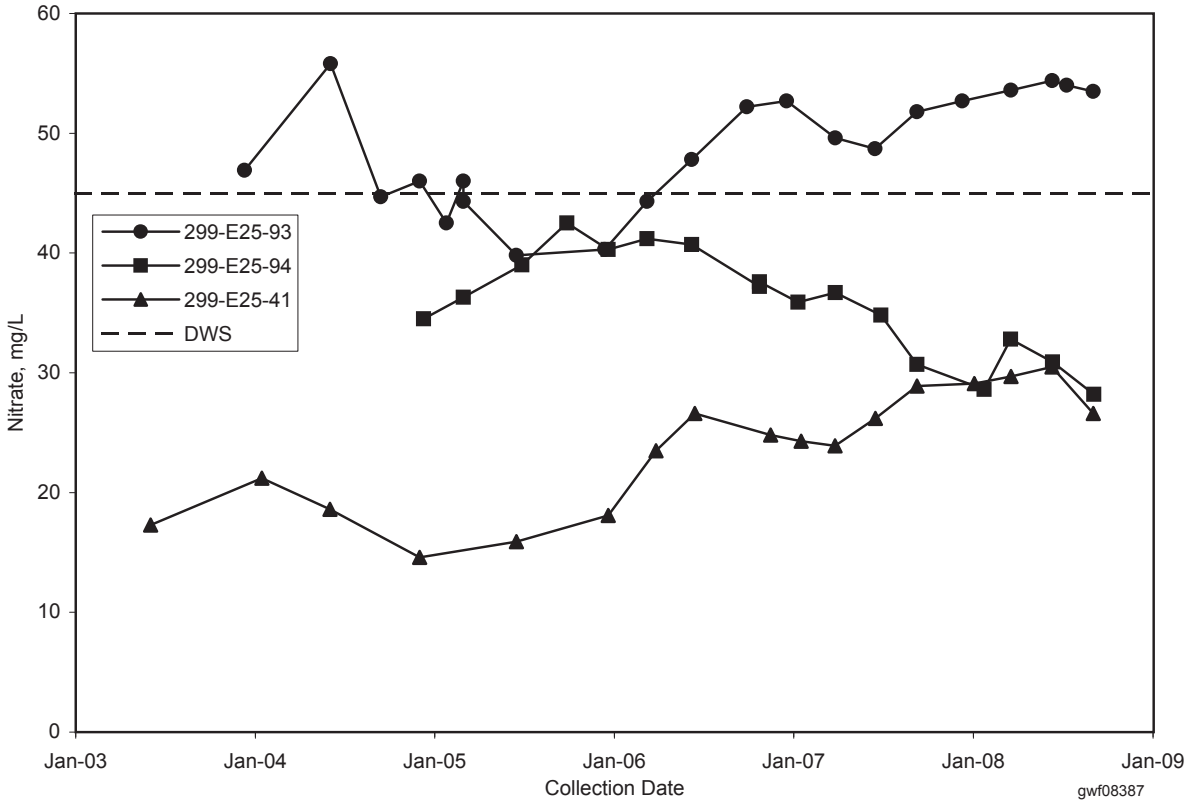

Figure 2.11-18. Technetium-99 Concentrations in Southeastern the 200 East Area, Upper Part of Unconfined Aquifer.

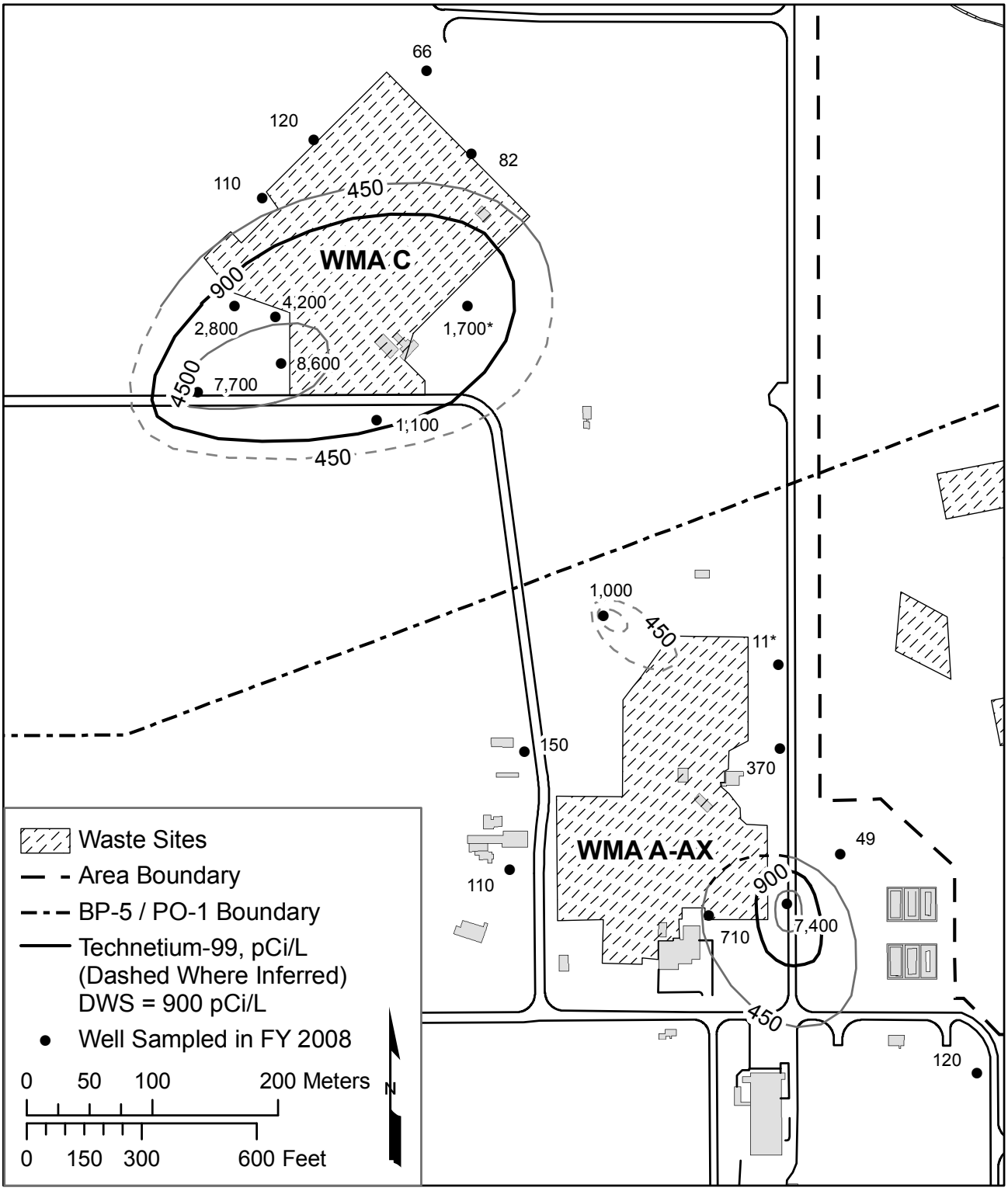

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Figure 2.11-19. Sulfate Concentrations in Wells at Waste Management Area A-AX.

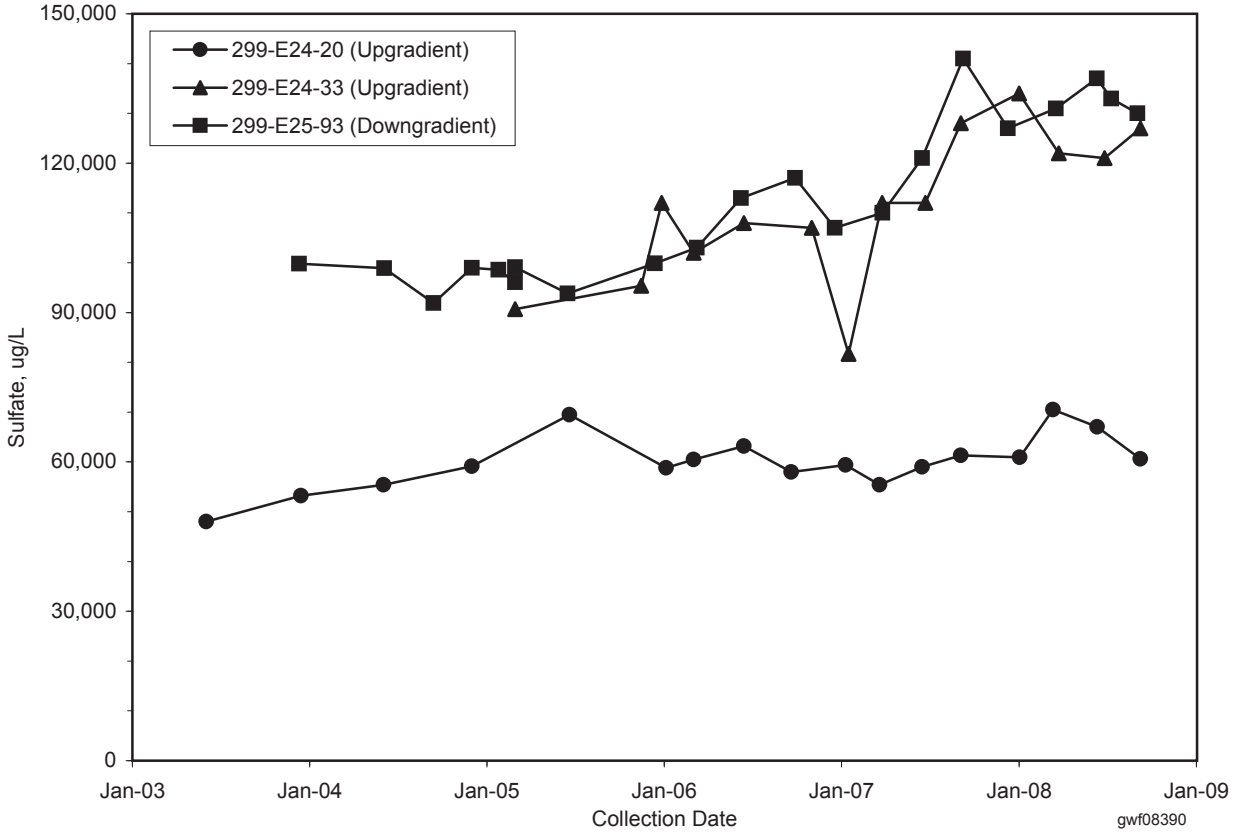
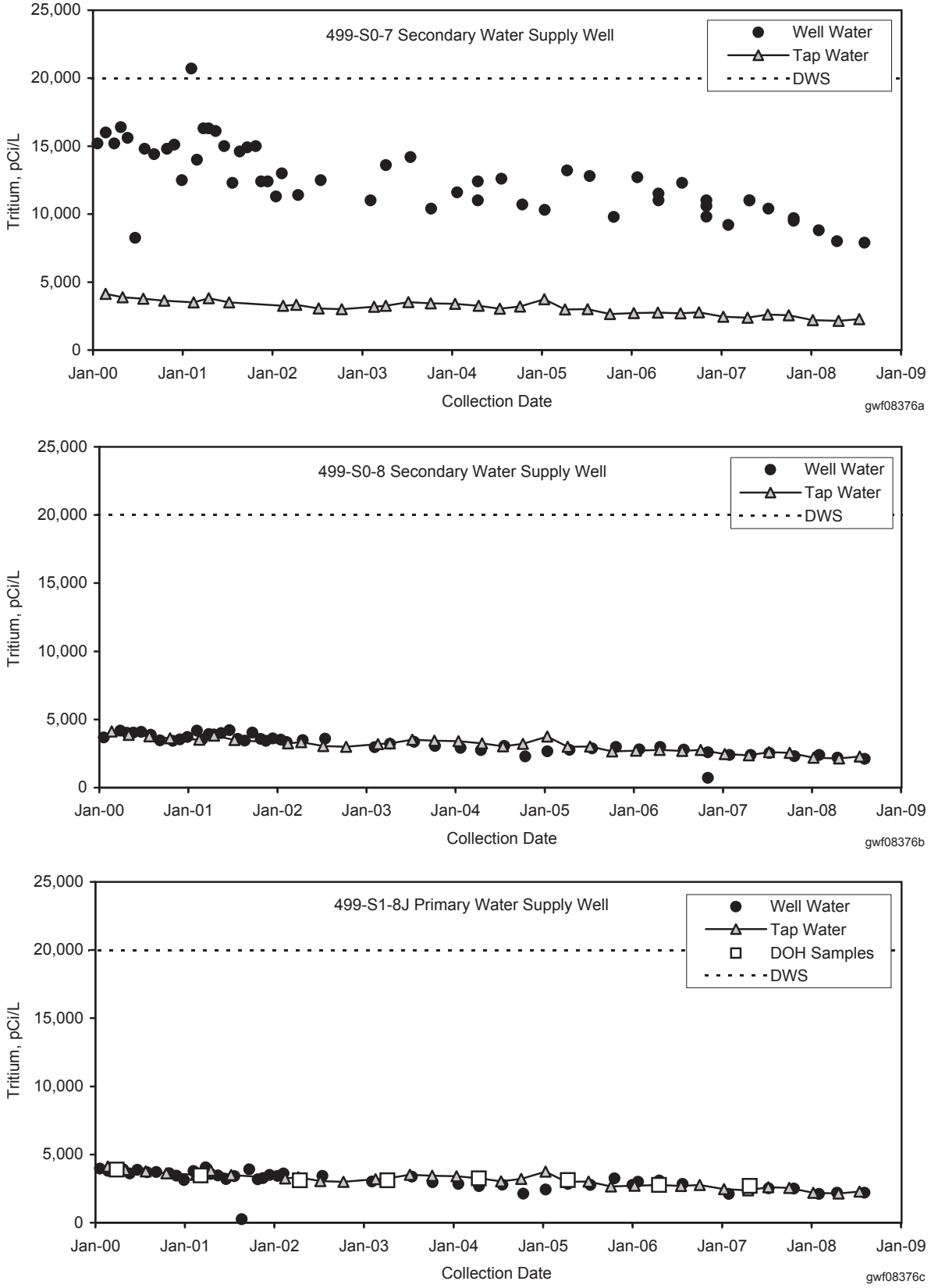


Figure 2.11-20. Tritium Concentrations in 400 Area Water Supply Wells.



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