2.8 200-ZP-1 Operable Unit

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The 200-ZP-1 Operable Unit addresses groundwater contaminant plumes beneath the northern and central parts of the 200 West Area and the western 600 Area. The operable unit lies within the larger 200-ZP-1 groundwater interest area, informally defined to facilitate scheduling, data review, and interpretation (Figure 1.0-1). Figure 2.8-1 shows facilities and wells in this region.

Groundwater in the north portion of the 200 West Area predominantly flows toward the east-northeast, but is locally influenced by the 200-ZP-1 Pump-And-Treat System and effluent discharges to the State-Approved Land Disposal Site (Figure 2.8-2). The groundwater flow rates typically range from 0.0001 to 0.5 m/day within the 200-ZP-1 groundwater interest area. However, flow rates and gradients in proximity to the extraction and injection wells will be substantially greater. The water table continues to decline at a rate of approximately 0.21 m/yr. The water table in the 200 West Area was influenced by past discharge of wastewater and the aquifer is still re-equilibrating after the termination of discharges. The flow direction in the northern part of the groundwater interest area has changed ~35º over the past decade from a north-northeastern direction to a more eastern direction, but the changes from year to year are becoming less apparent as the water returns to natural groundwater levels.

The groundwater flow direction has changed ~35 degrees over the past decade, but the changes from year to year are becoming less apparent as the natural groundwater levels are approached.

Flow in the central part of the 200 West Area (southern part of the 200-ZP-1 groundwater interest area) is strongly influenced by the operation of the 200-ZP-1 Pump-And-Treat System. Four monitoring wells (299-W15-1, 299-W15-7, 299-W15-11, and 299-W15-46) were converted to extraction wells in fiscal year (FY) 2008. The 200-ZP-1 Pump-and-Treat System has 14 extraction wells in the vicinity of the primary cribs and trenches and west of Waste Management Area (WMA) TX-TY (Figure 2.8-1). The treatment system removes carbon tetrachloride and other volatile organic compounds. Treated effluent is re-injected into the aquifer to the west of the area. A small groundwater mound is associated with the injection wells, and a region of draw down is associated with the extraction wells, causing flow to converge on the extraction zone from all directions. The injection wells, which are due west of Low-Level WMA 4, also have affected groundwater flow and contaminant concentrations beneath this facility (Appendix B).

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

- Principal sources of groundwater contamination included former cribs, trenches, and single-shell tank farms 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.
- Active waste sites include the Low-Level Burial Grounds and the State-Approved Land Disposal Site, where tritium-contaminated water is discharged.
- In September 2008, the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Washington State Department of Ecology (Ecology) signed a final record of decision for groundwater remediation, which will include pump-and-treat and flow-path control.

- Carbon tetrachloride is the principal contaminant of concern in groundwater and exceeds the drinking water standard (5 µg/L) under most of the operable unit. The high-concentration center of the plume has shrunk, but the margins of the plume continued to spread.
- Other groundwater contaminants include trichloroethene, chloroform, nitrate, fluoride, chromium, iodine-129, technetium-99, and tritium. The size of the trichloroethene plume has decreased and the concentrations are declining.
- The distribution of carbon tetrachloride with depth is complex and not well characterized. Drilling activities to date have not identified any significant dense, non-aqueous phase liquid contamination. Depth-discrete sampling in new wells has helped define the vertical distribution of contaminants. The highest concentrations of carbon tetrachloride and other contaminants is not always near the top of the aquifer.
- An interim action pump-and-treat system removed 461.5 kg of carbon tetrachloride in FY 2008 and over 11,000 kg since 1994. Four monitoring wells were converted to extraction wells to enhance removal of carbon tetrachloride.
- A vapor extraction system has removed over 79,000 kg of carbon tetrachloride since 1991, preventing it from reaching groundwater.
- A small pump-and-treat system near WMA T removed 23.8 g of technetium-99 in FY 2008. Aquifer testing was conducted to aid in locating future technetium-99 extraction wells.
- Four *Resource Conservation and Recovery Act of 1976* (RCRA) sites are located in the 200-ZP-1 Operable Unit. At Low-Level WMA 4, total organic carbon concentrations in a downgradient well exceeded the critical mean value in August 2008. The site will be monitored under an assessment program in FY 2009.
- Statistical evaluations have been suspended at Low-Level WMA 3 because the site has no upgradient wells. Emplacement of new wells has been postponed until the effects of the expanded pump-and-treat system for carbon tetrachloride are evaluated.
- RCRA monitoring at WMAs T and TX-TY continued under assessment programs.

Groundwater is monitored to assess the performance of the interim action pump-and-treat system for carbon tetrachloride contamination, to track other contaminant plumes, and to support four RCRA units and the State-Approved Land Disposal Site. Data from facility-specific monitoring also are integrated into the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) groundwater investigations. Section 2.8.1 describes contaminant plumes and concentrations. Section 2.8.2 summarizes operable unit activities. Section 2.8.3 discusses groundwater monitoring of facilities under CERCLA, RCRA, state permits, and the *Atomic Energy Act of 1954* (AEA).

2.8.1 Groundwater Contaminants

Several areas of groundwater contamination are monitored in the 200-ZP-1 groundwater interest area. Wells in the 200-ZP-1 groundwater interest area are sampled for constituents based on the final remedy (EPA, 2008, *Declaration of the Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington*), which identifies carbon tetrachloride as the principal contaminant of concern. Other contaminants are trichloroethene, chloroform, nitrate, chromium, fluoride, tritium, iodine-129, technetium-99, and uranium. Additional contaminants are detected but at lower levels or in less extensive areas.

Plume areas (square kilometers) above the drinking water standard in the 200-ZP-1 Operable Unit:

****Carbon tetrachloride — 11.15***
Chromium — 0.05
Iodine-129 — 0.75
Nitrate — 6.09
Technetium-99 — 0.08
Trichloroethene — 0.09
Tritium — 0.75
Uranium — 0.09
****Also includes portion of plume beneath 200-UP-1 Operable Unit.***

The goal of the final remedy is to design and implement a remediation system to remove the principal contaminant of concern, carbon tetrachloride, and seven additional contaminants (chromium [total], hexavalent chromium, iodine-129, nitrate, technetium-99, trichloroethene, and tritium), throughout the vertical extent of the unconfined aquifer. Groundwater contamination is widely dispersed in the 200-ZP-1 Operable Unit and consists of overlapping contaminant plumes (i.e., all of the highest concentrations or the lowest concentrations do not necessarily occur at the same location), and, depending on contaminant density, can be present from the top to the base of the unconfined aquifer.

2.8.1.1 Carbon Tetrachloride

Carbon tetrachloride is the principal contaminant of concern in the 200-ZP-1 Operable Unit.

Carbon tetrachloride is the principal contaminant of concern for the 200-ZP-1 Operable Unit and is found at levels greater than the drinking water standard (5 µg/L) in the groundwater under most of the 200 West Area (Figure 2.8-3). This figure represents carbon tetrachloride contamination in the upper part of the unconfined aquifer (~15 m). The 200-ZP-1 Operable Unit feasibility study (DOE/RL-2007-28, *Feasibility Study for the 200-ZP-1 Groundwater Operable Unit*) includes illustrations showing the areal extent of the carbon tetrachloride plume at different depths. The maximum extent of the plume at all depths (i.e., the footprint of the plume) extends beyond the contours shown on Figure 2.8-3, particularly to the north and east of the 200 West Area. The main sources of carbon tetrachloride are three of the primary cribs and trenches that received waste from the Plutonium Finishing Plant. Carbon tetrachloride is present primarily in two phases in the subsurface beneath the 200-ZP-1 Operable Unit: gaseous and dissolved in groundwater. Both of these phases migrate uniquely in the sediments beneath this operable unit. Active and passive systems have been extracting gaseous carbon tetrachloride from the vadose zone (unsaturated zone overlying groundwater), for many years and are discussed in Section 3.3. This report focuses primarily on the dissolved phase of carbon tetrachloride in the upper portion of the aquifer (upper ~15 m). While carbon tetrachloride concentrations tend to be higher in the upper to middle portion of the aquifer, this is not always the case. There are a few wells that have shown the highest concentration at the bottom of the aquifer. The target for interim remediation during FY 2008 has been the upper portion of the aquifer, particularly those areas where carbon tetrachloride is greater than 2,000 µg/L (e.g., proximity of the cribs and trenches and west of the TX-TY Tank Farm). For the past seven years an extensive effort has been made to collect depth-discrete groundwater samples during well drilling to better define the three-dimensional distribution of contamination across

the operable unit. While these wells are most often completed to screen the interval showing the highest contaminant concentration, there are a few instances when wells are completed to screen other portions of the aquifer to support specific remediation strategies.

Significant features of the carbon tetrachloride plume in the upper part of the aquifer include the following.

- The extent of carbon tetrachloride at the drinking water standard (5 µg/L) (Figure 2.8-3) has increased in FY 2008. The 5 and 50 µg/L contour interval in the northeastern corner of 200 West Area has expanded downgradient to the northeast, based on increases in wells 299-W12-1 and 699-48-71, and side-gradient to the south.
- The FY 2008 concentrations of carbon tetrachloride in well 699-48-71 (located ~400 m north of the northeast corner of 200 West Area) continue to increase steadily in this region (Figure 2.8-4). The annual average carbon tetrachloride concentration increased from the FY 2007 concentration of 34 to 62 µg/L in FY 2008.
- The area of carbon tetrachloride at levels greater than 2,000 µg/L west of WMA TX-TY was steady. Well 299-W15-765 (screened through the upper 10.7 m of the aquifer) increased from the annual average concentration of 2,300 µg/L in FY 2007 to 2,800 µg/L in FY 2008. Well 299-W11-87 (located southeast of T Plant) increased from an annual average concentration of 1,700 µg/L in FY 2007 to 2,100 µg/L in FY 2008.
- The highest carbon tetrachloride concentration in FY 2008 for the 200 West Area was in extraction well 299-W15-44 (4,900 µg/L). Well 299-W15-44 is screened through the upper ~11 m of the aquifer and is located south-west of the WMA TX-TY.
- The highest annual average carbon tetrachloride concentration in FY 2008 for the 200 West Area was in extraction well 299-W15-34 (2,800 µg/L). Well 299-W15-34 is screened through the upper ~18 m of the aquifer. This value is up from an annual average concentration of 2,600 µg/L in FY 2007.

Figure 2.8-3 shows the extent of contamination near the upper part of the aquifer, but the three-dimensional extent is more complex. Drilling of new deep wells in the 200-ZP-1 groundwater interest area indicate in a few areas the highest carbon tetrachloride concentrations are found deeper in the aquifer. The FY 2007 Hanford Site Groundwater Monitoring (DOE/RL-2008-01) includes several cross-sections within the 200-ZP-1 Operable Unit that illustrate the vertical distribution of carbon tetrachloride in this area. Depth-discrete sampling during drilling in FY 2008 provides additional insight on the vertical distribution of carbon tetrachloride and is shown in Figure 2.8-5.

Depth-discrete groundwater samples were taken in three new wells (299-W11-88, 699-43-69, and 699-45-69C) completed in the 200-ZP-1 Operable Unit during FY 2008. Well 299-W11-88 (located ~1,100 m northeast of WMA T) was sampled during drilling and carbon tetrachloride concentrations ranged from 1,100 to 1,700 µg/L at depths of 4.24 to 28.34 m below the water table (87.81 m below ground surface [bgs]) (Figure 2.8-5). The well was completed with a screened interval of 135.63 to 147.82 m bgs, immediately above basalt. This interval does not monitor

the zone of elevated contaminants identified during the depth discrete sampling. The screened interval was specifically selected to monitor the lowest part of the aquifer above the basalt. The highest carbon tetrachloride in well 299-W11-88 after well completion was 9.9 µg/L. Well 699-43-69 (located ~700 m east of the 200 West Area) was sampled during drilling and carbon tetrachloride concentrations ranged from 140 to 240 µg/L at depths of 30.62 to 44.32 m below the water table (94.48 m bgs). The well was completed with a screened interval of 121.98 to 132.64 m bgs, immediately below the lower mud unit. This interval monitors the zone of elevated contaminants identified during the depth discrete sampling. The average carbon tetrachloride concentration after well completion was 220 µg/L. Well 699-45-69C (located ~700 m east of the 200 West Area) was sampled during drilling and carbon tetrachloride concentrations ranged from 15 to 22 µg/L at depths of 20.73 to 26.43 m below the water table (90.67 m bgs). The well was completed with a screened interval of 111.86 to 116.43 m bgs, immediately below the lower mud unit. This interval monitors the zone of elevated contaminants identified during the depth discrete sampling. The average carbon tetrachloride concentration after well completion was 23.5 µg/L.

2.8.1.2 Trichloroethene

The trichloroethene plume in the 200-ZP-1 groundwater interest area was much smaller in FY 2008 than in FY 2007.

Trichloroethene is detected at levels above the drinking water standard (5 µg/L) in the 200-ZP-1 groundwater interest area. The main trichloroethene plume extends north and northeast from the primary cribs and trenches, particularly the 216-Z-9 Trench. The size and configuration of the plume has decreased significantly since FY 2007 (Figure 2.8-6). Concentrations throughout the plume also are lower than in FY 2007. The most noticeable decline is in the southwestern portion of WMA T (e.g., well 299-W10-4). The maximum trichloroethene concentration was 14 µg/L during December 2008 in well 299-W15-44 (located near the southwest corner of WMA TX-TY). This well had an annual average trichloroethene concentration of 7.8 µg/L in FY 2008.

2.8.1.3 Chloroform

During FY 2008, the annual average chloroform concentrations in the 200-ZP-1 groundwater interest area remained below the 80 µg/L drinking water standard (defined for total trihalomethane). Concentrations are declining throughout the groundwater interest area. Possible chloroform sources include biodegradation of carbon tetrachloride and sanitary sewer discharges to the 2607-Z Tile Field. Chloroform also is found near WMAs TX-TY and T, as well as at depth below the water table to the northeast of these areas.

Depth-discrete sampling in new wells 299-W11-88 and 299-W43-69 had elevated chloroform up to ~51 m below the water table.

Depth-discrete sampling in new wells drilled during FY 2008 showed chloroform at depth in the aquifer. New well 299-W11-88 (located ~1,100 m northeast of WMA T) had the maximum concentration of chloroform (39 µg/L at ~110 m bgs) when sampled ~22.24 m below the water table (~87.81 m bgs). The well was completed with a screened interval of 135.63 to 147.82 m bgs. The well was completed immediately above basalt and does not monitor the zone of elevated contaminants identified during the depth discrete sampling. Well 299-W10-33 (completed near the bottom of the unconfined aquifer in September 2007) had a maximum chloroform concentration of 46 µg/L during depth discrete sampling. Concentrations in this well were below the detect limit (1.0 µg/L) during the February and August 2008.

2.8.1.4 Nitrate

Nitrate concentrations were above the drinking water standard (45 mg/L, as nitrate) beneath much of the 200-ZP-1 groundwater interest area (Figure 2.8-7). The maximum concentration in well 299-W10-4 (near the 216-T-36 Crib) decreased to 2,820 mg/L in FY 2008 from 3,810 mg/L in FY 2007. The annual average nitrate concentration in this well increased to 2,600 mg/L in FY 2008 from 2,464 mg/L in FY 2007. Multiple sources of nitrate probably exist in this area, including the cribs near WMA T and the primary cribs and trenches. Nitrate concentrations in well 299-W10-27 on the northeast corner of WMA TX-TY decreased in FY 2008.

Nitrate concentrations in well 299-W10-27 on the northeast corner of Waste Management Area TX-TY decreased in FY 2008.

Of the new wells, well 299-W11-88 had the highest nitrate concentration (274 mg/L) at a depth of 37.44 m below the water table (~87.81 m bgs) (Figure 2.8-8). The well was completed immediately above basalt and does not monitor the zone of elevated contaminants identified during the depth discrete sampling. During three sampling events in FY 2008, the average nitrate concentration was 67 mg/L in well 299-W11-88. Nitrate is found at depth below the water table because it was a co-contaminant with carbon tetrachloride when released to the soil column, and carbon tetrachloride is denser than water.

2.8.1.5 Chromium

Chromium contamination is found at levels above the drinking water standard (100 µg/L) at WMAs T and TX-TY (Figure 2.8-9). The hexavalent form of chromium is soluble and mobile in water. Figure 2.8-9 shows two areas of chromium contamination. One is a small area centered on well 299-W14-13, east of WMA TX-TY. In FY 2008, the maximum chromium concentration was in well 299-W14-13 at 640 µg/L. The annual average concentration declined from 660 µg/L in FY 2007 to 560 µg/L in FY 2008. The second area is larger and associated with WMA T and the adjacent past-practice disposal facilities. The highest annual average chromium concentration in well 299-W10-4 (located southwest of the WMA) declined from 475 µg/L (filtered) in FY 2007 to 420 µg/L in FY 2008. The chromium contamination at WMA T extends from well 299-W10-4 to the downgradient wells to the east, although there are no wells within the tank farm to ensure continuation of the plume. Sections 2.8.3.3 and 2.8.3.4 provide further information about chromium near WMAs T and WMA TX-TY, respectively.

Well 299-W14-13 had the highest chromium results in the 200-ZP-1 Operable Unit at 640 µg/L.

2.8.1.6 Fluoride

Fluoride contamination at levels greater than the primary drinking water standard (4 mg/L) historically has occurred in a local area around T Tank Farm. Well 299-W10-8 (located at the northwest corner of the tank farm) had the FY 2008 maximum fluoride concentration of 4.56 mg/L, and an annual average concentration of 4.36 mg/L. Release of lanthanum fluoride used in the bismuth phosphate process is a possible cause of this contamination.

2.8.1.7 Tritium

Tritium contamination at levels greater than the drinking water standard (20,000 pCi/L) in the 200-ZP-1 groundwater interest area is restricted mainly to a plume extending northeast from waste disposal facilities of WMAs T and TX-TY. These WMAs have multiple potential sources of tritium. In addition, tritium from permitted discharges at the State-Approved Land Disposal Site is found in the groundwater (Figure 2.8-10). Section 2.8.3.5 discusses tritium at the State-Approved Land Disposal Site.

During FY 2008, the tritium plume had the same general configuration as in FY 2007. Data downgradient to the northeast remains sparse because of a lack of wells in the area. The highest tritium concentrations in water-table wells remained at well 299-W14-13 (located east of WMA TX-TY), where the concentration in FY 2008 ranged from 270,000 to 1.2 million pCi/L. The annual average declined from 1.5 million pCi/L in FY 2007 to ~830,000 pCi/L in FY 2008. Well 299-W11-88 (located ~1,100 m northeast of WMA T) was sampled during drilling and had tritium concentrations from 5,180 to 1,410 pCi/L at depths of 4.3 to 28.4 m below the water table (~87.81 m bgs) (Figure 2.8-11). The well was completed immediately above basalt and does not monitor the zone of elevated contaminants identified during the depth discrete sampling. During FY 2008, tritium was not detected in routine samples from well 299-W11-88. Tritium levels in the 200-ZP-1 groundwater interest area continue on a downward trend in most wells in the network.

The highest tritium concentration was in a well east of Waste Management Area TX-TY where concentrations averaged ~830,000 pCi/L.

2.8.1.8 Iodine-129

Iodine-129 is found in the 200-ZP-1 groundwater interest area and has origins in the WMA TX-TY as (Figure 2.8-12). In FY 2008, the highest iodine-129 concentration (37.6 pCi/L) was in well 299-W14-13. The average annual concentration in this well declined from 38.3 pCi/L in FY 2007 to 31 pCi/L in FY 2008. Elevated iodine-129 also is found locally near WMA T (Section 2.8.3.3). Determining the extent of iodine-129 contamination is difficult because the detection limit is often near or above the 1.0 pCi/L drinking water standard.

2.8.1.9 Technetium-99

Technetium-99 within the 200-ZP-1 groundwater interest area is found at levels significantly above the drinking water standard (900 pCi/L) on the east (downgradient) side of WMA T and centered on two areas in the vicinity of WMA TX-TY (Figure 2.8-13). The maximum technetium-99 concentration (9,100 pCi/L) in FY 2008 was in well 299-W11-42 (located near the northeast corner of WMA T). The annual average concentration for the well was 7,500 pCi/L. Well 299-W11-88 (located ~1,100 m northeast of WMA T) was sampled during drilling and had technetium-99 concentrations between 130 and 260 pCi/L at a depth of 4.3 to 37.55 m below the water table (~87.81 m bgs) (Figure 2.8-14). The well was completed immediately above basalt and does not monitor the zone of elevated contaminants identified during the depth discrete sampling. During FY 2008, technetium-99 was undetected at 2.3 to 0.1 pCi/L in well 299-W11-88 after well completion. Well 299-W11-46 (located at the northeast corner of T Tank Farm) was converted to an extraction well in FY 2007 to mitigate technetium-99. The well is screened between 6.22 to 9.32 m below the water table (74.05 m bgs) and had an annual average technetium-99 concentration of 9,300 pCi/L in FY 2008. The maximum concentration in well 299-W11-46 was 18,000 pCi/L. This is down an order of magnitude from the FY 2007 annual average concentration of 97,000 pCi/L and maximum of 63,200 pCi/L. Sections 2.8.3.3 and 2.8.3.4 provide more information on technetium-99 contamination at WMAs T and TX-TY, respectively.

Technetium-99 within the 200-ZP-1 Operable Unit is found above the drinking water standard (900 pCi/L) downgradient of Waste Management Areas T and TX-TY.

2.8.1.10 Uranium

The highest uranium result during routine sampling in the 200-ZP-1 groundwater interest area was in well 299-W11-37 (located ~800 m northeast of WMA T). This well had a maximum concentration of 48.8 µg/L (unfiltered), and an annual average concentration of 48 µg/L (unfiltered) during FY 2008. Uranium levels have been

Only one well exceeded the drinking water standard (30 µg/L) for uranium in the 200-ZP-1 Operable Unit.

decreasing steadily since FY 2001. This is the only well to exceed the drinking water standard (30 µg/L) in the 200-ZP-1 groundwater interest area during FY 2008.

2.8.1.11 Other Constituents Monitored

Other constituents detected in groundwater at concentrations above the preliminary target action levels include antimony, arsenic, iron, and manganese. Methylene chloride and trichloroethene are monitored for the groundwater interest area as degradation products of carbon tetrachloride. Antimony concentrations in several wells at levels exceeded the drinking water standard (6 µg/L) in FY 2008. However, antimony results have been problematic. Detections are typically very close to the reported detection limit and are sporadic. Most detections preceding and during FY 2008 are believed to be false-positive results. Antimony from a filtered sample in well 299-W10-27 was reported as detected at 42.2 µg/L, but the unfiltered sample from the same event was below detection at 32.0 µg/L. A result of 36.6 µg/L also was reported in May 2008 in a filtered sample from well 299-W14-16, but all results before and since have been below detection.

During FY 2008, filtered arsenic was detected at levels above the 10 µg/L drinking water standard in only one well (299-W10-4) located southwest of WMA T. The maximum concentration was 10.8 µg/L. This concentration is slightly higher than the FY 2007 maximum of 10.3 µg/L. The Hanford Site filtered groundwater background for arsenic is 11.8 µg/L (95th percentile) (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*).

Iron was present at levels above the 300 µg/L secondary drinking water standard in eight groundwater monitoring wells and six wells during drilling in FY 2008. The maximum concentration in an unfiltered sample during routine sampling was 1,700 µg/L in well 299-W10-4. The filtered concentration was 20.0 µg/L. An unfiltered sample during drilling in well 299-W11-18 (located ~500 m northeast of WMA T) was 14,300 µg/L and the filtered sample was 124 µg/L. Both results are suspect. Iron is a naturally occurring component of the aquifer sediment and is found in well materials, particularly during drilling and corrosion after completion. Elevated iron levels in unfiltered samples from particulate material are possible. The background iron concentration for Hanford Site filtered groundwater is 55.3 µg/L (DOE/RL-96-61).

In FY 2008, manganese was detected at levels above the 50 µg/L secondary drinking water standard in filtered and unfiltered samples from several 200-ZP-1 groundwater interest area wells. The maximum concentration in FY 2008 was 309 µg/L for a filtered sample from well 299-W10-27 (located near the northeast corner of WMA TX-TY). The annual average was 270 µg/L in a filtered sample. Elevated manganese values in the first few years of sampling are common for newer wells at the Hanford Site, and are likely a reaction of groundwater with freshly crushed rock surfaces and corrosion of well materials. The elevated manganese levels in this well have persisted for ~7 years. The background manganese concentration for Hanford Site filtered groundwater is 2.2 µg/L (DOE/RL-96-61).

Methylene chloride was not detected at levels above the drinking water standard (5 µg/L) in the 200-ZP-1 groundwater interest area during FY 2008. The maximum concentration reported (3.7 µg/L) was from well 299-W15-36, located ~100 m east of the north end of the 216-Z-20 Crib. Methylene chloride (dichloromethane) can be a degradation product or impurity in carbon tetrachloride (tetrachloromethane), but is also a common laboratory contaminant.

Tetrachloroethene is often detected at levels below the drinking water standard (5 µg/L) in the 200-ZP-1 groundwater interest area. A total of six wells had detectable concentrations in FY 2008. The maximum concentration was 2.1 µg/L in wells 299-W10-4 (located near the southwest corner of WMA T) and 299-W10-24 (located near the northeast corner of WMA T).

2.8.2 Operable Unit Activities

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Within the 200-ZP-1 Operable Unit, interim actions have been implemented for remediation of carbon tetrachloride, chloroform, and trichloroethene in the vicinity of the 216-Z Liquid Waste Disposal Units (primary cribs and trenches). The final remedy for the 200-ZP-1 Operable Unit will remediate carbon tetrachloride and seven other contaminants of concern throughout the vertical extent of the aquifer in accordance with EPA, 2008 signed in September 2008. Several reports (e.g., SGW-38923; DOE/RL-2008-02) provide the most recent update of the status of the remediation.

2.8.2.1 Status of Five-Year Review of Action Items

The second CERCLA five-year review was published in November 2006 (DOE/RL-2006-20). This document provided a comprehensive evaluation of the status of groundwater and source operable unit investigations and cleanup actions. All findings pertinent to the 200-ZP-1 Operable Unit for the 200 Area National Priority List (40 CFR 300, Appendix B) were completed in FY 2007.

2.8.2.2 CERCLA Investigations

DOE/RL-2003-55, *Remedial Investigation/Feasibility Study Work Plan for the 200-ZP-1 Groundwater Operable Unit*, was prepared in FY 2004 and implemented in FY 2005. The remediation investigation report (DOE/RL-2006-24, *Remedial Investigation Report for 200-ZP-1 Groundwater Operable Unit*) was published in October 2006. The feasibility study (DOE/RL-2007-28) and the proposed plan (DOE/RL-2007-33, *Proposed Plan for Remediation of 200-ZP-1 Groundwater Operable Unit*, were completed in July 2008. The final selected remedy for the 200-ZP-1 Operable Unit includes four components.

A final remedy for the 200-ZP-1 Operable Unit was approved in FY 2008.

- An extensive groundwater pump-and-treat system to capture and treat contaminated groundwater throughout the Operable Unit to reduce the mass of carbon tetrachloride and seven other contaminants of concern by a minimum of 95% in 25 years.
- In addition to the pump-and-treat system, natural attenuation processes will be used to reduce contaminant of concern concentrations to below cleanup levels in 125 years.
- Flow-path control will be achieved by injecting treated groundwater into the aquifer to the northeast and east of the contaminant plumes to slow the natural eastward flow of most of the groundwater. This will keep contaminants of concern within the capture zone of the pump-and-treat system, and increase the time available for natural attenuation processes to reduce the contaminant concentrations not captured by the extraction wells.
- Institutional controls will restrict 200-ZP-1 Operable Unit groundwater use for the foreseeable future until cleanup levels are achieved.

The selected remedy will be implemented in accordance with a remedial design/remedial action work plan being prepared in FY 2009.

2.8.2.3 Interim Action for Carbon Tetrachloride

The current pump-and-treat system is operating in the 200-ZP-1 Operable Unit to contain and capture the high concentration portion of the carbon tetrachloride plume within the upper portion of the aquifer south-west of the WMA TX-TY. The contaminants originating from discharges to the 216-Z-9, 216-Z-1A, and 216-Z-18 Cribs have migrated north and east of the waste sites. The 200-ZP-1 Pump-and-Treat System was implemented as an interim remedial measure in three phases, starting in 1996.

The interim remedial action objectives for the 200-ZP-1 Operable Unit (EPA/ROD/R10 95/114) are as follows.

- ***Reduce contamination in the area of highest concentration of carbon tetrachloride.***
- ***Prevent further movement of these contaminants from the highest concentration area.***
- ***Provide information that will lead to development of a final remedy that will protect human health and the environment.***

The final feasibility study and proposed plan were issued in July 2008 (DOE/RL-2007-28; DOE/RL-2007-33). The final record of decision for the 200-ZP-1 Operable Unit was signed in September 2008 (EPA, 2008).

The remedial action objectives for the pump-and-treat system are to capture the high concentration area of the carbon tetrachloride plume to reduce contaminant mass in the upper portion of the aquifer and to gather information to support remedial investigation/feasibility study decisions (EPA/ROD/R10-95/114, *Declaration of the Interim Record of Decision for the 200-ZP-1 Operable Unit*). The high concentration plume is defined by the 2,000 to 3,000 µg/L plume contour, which initially was centered beneath the Plutonium Finishing Plant and related waste sites. In 2005, concentrations of carbon tetrachloride exceeding the 2,000 µg/L remedial action goal were reported at wells west of the TX-TY Tank Farms. Four monitoring wells were converted to extraction wells and connected to the 200-ZP-1 Pump-and-Treat System. Pumping began in late July 2005 and is ongoing. A tenth well (299-W15-6) was added on September 28, 2006.

To increase treatment system capacity and capture of the high concentration portion of the plume, monitoring wells 299-W15-1, 299-W15-7, 299-W15-11, and 299-W15-46 were converted to extraction wells in FY 2008. Table 2.8-1 shows the major changes to the 200-ZP-1 Pump-and-Treat System. Figure 2.8-15 shows the carbon tetrachloride trends in these wells since FY 2000. The combined pumping rate of the network is ~1,400 L/min. In support of expansion activities, the 200-ZP-1 Pump-and-Treat System was shutdown in May 2008, and except for process and acceptance testing, remained offline until early September 2008.

Three new groundwater monitoring wells (299-W11-88, 699-43-69, and 699-45-69C) were installed in FY 2008 to obtain supplemental data to support the remedial investigation/feasibility study process. Wells 699-43-69 and 699-45-69C were drilled to bound the northeastern downgradient edge of the carbon tetrachloride plume and were screened below the lower mud unit. Both wells are ~700 m east of the eastern boundary of the 200 West Area. Well 299-W11-88, located ~1,100 m northeast of WMA T, was drilled to investigate carbon tetrachloride and uranium and was screened immediately above the basalt. A fourth well (299-W18-253) was installed in the overlying 200-PW-1 Operable Unit to support soil-vapor extraction activities (Section 3.3).

Carbon tetrachloride mass was reduced in the area of highest concentrations through pumping and treating over 304.5 million liters from ten groundwater extraction wells in FY 2008. This resulted in the removal of 461.5 kg of carbon tetrachloride in FY 2008. A recent modeling study indicates that 95% of the simulated carbon tetrachloride mass in the aquifer below the 200-ZP-1 Operable Unit fell between 56,308.5 kg and 111,141.9 kg (PNNL-18118, *Revised Geostatistical Analysis of the Inventory of Carbon Tetrachloride in the Unconfined Aquifer in the 200 West Area of the Hanford Site*). A total of 3.9 billion liters of water have been processed and 11,414.8 kg of carbon tetrachloride have been removed since startup in March 1994.

Over 304.5 million liters of carbon tetrachloride contaminated groundwater were treated in FY 2008 and 461.5 kg of carbon tetrachloride were removed.

Annual average carbon tetrachloride concentrations for FY 2008 ranged from 478 µg/L at extraction well 299-W15-36 to 2,800 µg/L at extraction well 299-W15-34. Annual average concentrations exceeded the 2,000 µg/L remedial action objective at extraction wells 299-W15-6, 299-W15-34, 299-W15-35, 299-W15-40, 299-W15-44, and 299-W15-765. Wells 299-W15-36, 299-W15-43, 299-W15-45, and 299-W15-47 had annual average carbon tetrachloride concentrations below the 2,000 µg/L remedial action objective. Figure2.8-16 shows the current concentrations of carbon tetrachloride in the vicinity of the 200-ZP-1 Pump-and-Treat System and Figure 2.8-17 shows carbon tetrachloride trends in selected wells with concentrations greater than 2,000 µg/L.

2.8.2.4 Ion Exchange Treatability Test

To alleviate the increasing technetium-99 concentrations in the 200-ZP-1 Pump-and-Treat System, an ion exchange treatability test was installed on extraction wells 299-W15-44 and 299-W15-765. The ion exchange system was started in late April 2007; however, a failed pipe connection delayed start of routine testing until July 2007. The system ran uninterrupted until it was shutdown in mid-December 2007.

Groundwater samples were collected from sampling ports twice per week and analyzed for technetium-99, carbon tetrachloride, nitrate, sulfate, chloride, alkalinity, and pH. The criteria for terminating the ion exchange treatability test was when 50% breakthrough of technetium-99 had been measured at the effluent of both of the resin test columns. The 50% breakthrough was the point at which the effluent concentration equaled one-half of the influent concentration. The data collected from the study were used to evaluate the effectiveness of the Purolite resin for selectively removing technetium-99 from groundwater.

Ion exchange resin is an effective method to remove technetium-99.

The results showed the following about the ion exchange resin:

- Adequately removes technetium-99 to below the drinking water standard
- Selectively removes technetium-99 over other anions (i.e., nitrate and sulfate) in solution
- Does not absorb carbon tetrachloride.

Breakthrough occurred approximately 6 to 7 months after the test began for the test columns on well 299-W15-44 and 299-W15-765. The tests were terminated with the EPA and DOE concurrence prior to meeting the 50% breakthrough endpoint because of cold weather complications. At the time of the test's termination, the test columns had attained 8% and 20% breakthrough on wells 299-W15-44 and 299-W15-765, respectively.

Overall, the results suggest that the ion exchange resin is an effective method to remove technetium-99 from the groundwater and will be considered in the final design of the 200-ZP-1 Pump-and-Treat System.

2.8.2.5 Pump-and-Treat Test System for Technetium-99

Concentrations of carbon tetrachloride at all baseline plume wells have continued to remain stable or decline from previous years with only two wells routinely exceeding the 2,000 µg/L remedial action goal.

A pump-and-treat test system began operating in September 2007 as part of a designed interim remediation activity to treat technetium-99 contamination, specifically to the east of and within WMA T. The interim remediation activity was implemented as part of the general remedial guidance for this Hanford Site operable unit, based on EPA/ROD/R10-95/114 and the data quality objectives process (WMP-28389, *T-Area Technetium-99 Data Quality Objectives Summary Report*). The pump-and-treat test system currently consists of two extraction wells (wells 299-W11-45 and 299-W11-46) that dispose of the extracted groundwater via a direct discharge-line connection to the 200 Area Liquid Effluent Retention Facility, and then to the Effluent Treatment Facility.

Extraction wells 299-W11-45 and 299-W11-46 operated sporadically in FY 2008 because of pump problems and scheduled Effluent Treatment Facility process and maintenance activities. Well 299-W11-45 operated ~135 days (the first two quarters of FY 2008) and discharged a total of 8.2 million liters, at an annual average pumping rate of 42 L/min. Well 299-W11-46 operated ~187 days (the first three quarters) and discharged a total of 36.2 million liters, at an annual average pumping rate of 134.4 L/min. This resulted in a total combined volume of 44.4 million liters of groundwater discharged to basin 43 at the Liquid Effluent Retention Facility and a total mass of 23.8 g of technetium-99 removed in FY 2008.

Technetium-99 Test System Aquifer Test Results. Operation of the 200-ZP-1 Pump-and-Treat System induces both horizontal and vertical groundwater-flow components within the aquifer. An aquifer recovery test was conducted in FY 2008 to examine the hydrologic effects of the WMA T Pump-and-Treat Test System remediation activities within the underlying unconfined aquifer system. Ten WMA T wells were monitored during this investigation (299-W10-23, 299-W10-24, 299-W11-39, 299-W11-40, 299-W11-41, 299-W11-42, 299-W11-45, 299-W11-46, 299-W11-47, and 299-W11-48). The aquifer test analyzed water-level measurements for these monitoring wells during the shutdown and restart of the 200-ZP-1 Pump-and-Treat System from May to June of 2008.

Results showed interwell hydraulic property estimates for transmissivity ranged from 300 to 475 m^2/day, and hydraulic conductivity ranged from 6.11 to 9.69 m/d (geometric mean 8.01 m/d). Based on the investigation performed, the capture zone created by the pump-and-treat system has a significant effect on the area surrounding the remediation facility (i.e., 300 m for pumping durations of a month or more). These large-scale aquifer characterization results will be utilized for optimization and site selection of additional extraction wells within the WMA T Pump-and-Treat Test System.

2.8.2.6 Carbon Tetrachloride and Chloroform Attenuation Parameters

J. S. Fruchter

To support implementation of the final selected remedy for the carbon tetrachloride plume in the 200 West Area (EPA, 2008), more information is needed to assess the

fate and transport of the contamination. Parameters describing porosity, sorption, and chemical degradation have the largest influence on predicted plume behavior. Researchers from the Pacific Northwest National Laboratory are conducting a study of chemical degradation parameters under DOE's Environmental Management program. Results of this project will improve the ability to predict future movement of the plume. This effort will help define the pump-and-treat component of the final selected remedy and provide an estimate of where the plume would eventually stabilize in the absence of active remediation. During FY 2007 and FY 2008, long-term experiments involving contact of carbon tetrachloride or chloroform with sediment from the Hanford Site, or representative minerals, were initiated and sampled to determine the rates of chemical degradation across a range of temperatures. Because of the slow rates, some of experiments are expected to continue for five years.

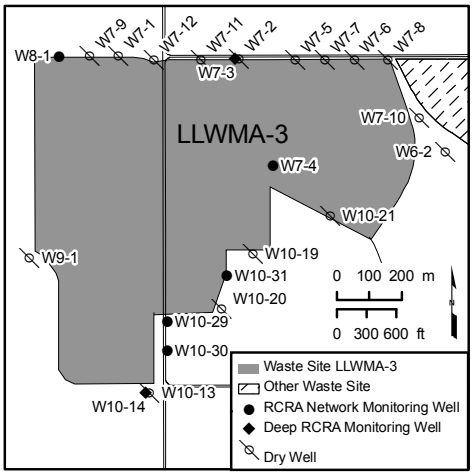
2.8.3 Facility Monitoring

D. G. Horton

This section describes results of monitoring individual facilities (i.e., treatment, storage, or disposal units and tank farm WMAs T and TX-TY). Groundwater at some of these facilities is monitored under the requirements of RCRA for hazardous waste constituents and AEA for radionuclides, including source, special nuclear, and by-product materials. Data for facility-specific monitoring also are integrated into the CERCLA groundwater investigations. Groundwater data for these facilities are available in the Hanford Environmental Information System database and on the data files accompanying this report. Appendix B includes additional information, including well and constituent lists, maps, flow rates, and statistical tables. This section summarizes results of statistical comparisons, assessment studies, and other developments for FY 2008.

2.8.3.1 Low-Level Waste Management Area 3

Groundwater at Low-Level WMA 3 continued to be monitored under RCRA and AEA in FY 2008. Under 40 CFR 265.93(b) as referenced by WAC 173-303-400, the well network was sampled semiannually for RCRA indicator and site-specific parameters (PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste management Areas 1 to 4, RCRA Facilities, Hanford Washington*). Appendix B includes a well location map and lists of wells and constituents monitored for the area. All seven wells in the network were sampled as scheduled during FY 2008, except well 299-W7-4. Well 299-W7-4 is located inside the WMA and was removed from the monitoring network in March 2008 because of safety concerns associated with cave-in potential.



The water table continued to decline beneath Low-Level WMA 3 during FY 2008 (~0.3 m/yr) in response to the greatly reduced discharge of wastewater to surface facilities around the 200 West Area. The groundwater flow in this portion of the 200 West Area is to the east-northeast based on the March 2008 water-level data (Figure 2.8-2). Assuming a water-table gradient of 0.0016 and a range in hydraulic conductivity values of 2.5 to 10 m/day (PNNL-14753, *Groundwater Data Package for the 2004 Composite Analysis*), the estimated flow rate at Low-Level WMA 3 is 0.04 to 0.16 m/day (Appendix B).

Wells 299-W10-19, 299-W10-20, and 299-W10-21 are now dry because of declines in the water table. Nitrate and carbon tetrachloride routinely exceeded drinking water standards in these wells. Carbon tetrachloride continued to exceed drinking water standards in three wells at Low-Level WMA 3 in FY 2008. Nitrate did not exceed the 45 mg/L drinking water standard in any well at the WMA in FY 2008.

Flow and monitoring data collected since RCRA monitoring was instituted in the 1980s indicate that carbon tetrachloride and nitrate are from plumes originating from sources to the south. Since then, changes in flow directions have left Low-Level WMA 3 with no monitoring wells on the upgradient (west) side. For this reason, statistical upgradient/downgradient comparisons have been suspended until background statistics can be re-established. Emplacement of new upgradient wells also has been postponed until the effects of the expanded pump-and-treat component of the final selected remedy (EPA, 2008) in the 200 West Area have been evaluated (Section 2.8.2.2). No suitable upgradient wells are available for use in the interim.

Emplacement of new wells has been postponed until the effects of the proposed expanded pump-and-treat activities in the 200 West Area have been evaluated.

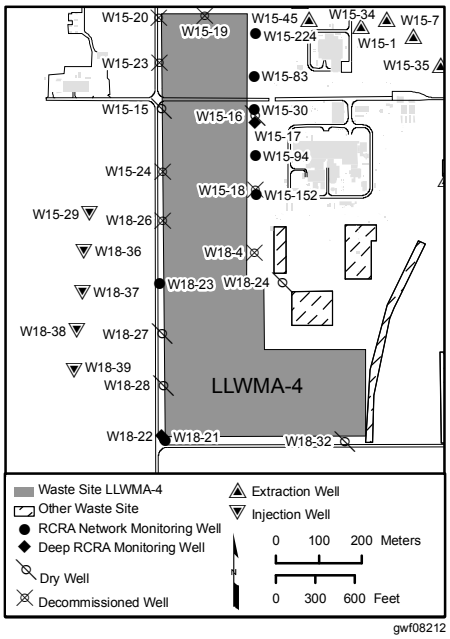
Performance assessment monitoring of radionuclides at Low-Level WMA 3 is designed to complement RCRA detection monitoring and is aimed specifically at monitoring radionuclide materials that are not regulated under RCRA. The current goal of performance assessment monitoring at Low-Level WMA 3 is to gather data to assess changes in concentrations at downgradient wells and to provide sufficient supporting information from upgradient wells to interpret the changes. Under the current monitoring plan (DOE/RL-2000-72, *Performance Assessment Monitoring Plan for the Hanford Site Low-Level Burial Grounds*), technetium-99, iodine-129, tritium, and uranium are monitored specifically for performance assessment.

Contaminants detected in groundwater at Low-Level WMA 3 include the following.

- Technetium-99 concentrations were all less than 20 pCi/L during FY 2008. Section 2.8.1.9 discusses the technetium-99 distribution in the 200-ZP-1 Operable Unit.
- Uranium concentrations at Low-Level WMA 3 were less than 2 µg/L (maximum 1.71 µg/L in well 299-W7-3) during FY 2008.
- Iodine-129 was not detected during FY 2008 and has not been detected in any wells currently in use at Low-Level WMA 3.
- Low-Levels of tritium were detected only in well, 299-W7-3 (28.9 pCi/L) in FY 2008.
- Carbon tetrachloride and associated trichloroethene and chloroform concentrations in Low-Level WMA 3 wells are consistent with those seen in regional plumes. Only carbon tetrachloride was detected at levels above the drinking water standard. The highest concentration was 150 µg/L in well 299-W10-31. Carbon tetrachloride concentrations in well 299-W10-31 show a decreasing trend since the well was drilled in FY 2006.
- The nitrate distribution at Low-Level WMA 3 is consistent with regional plumes (Section 2.8.1.4). The maximum concentration during FY 2008 (37.1 mg/L) was in well 299-W10-31.

2.8.3.2 Low-Level Waste Management Area 4

Groundwater at Low-Level WMA 4 is monitored under RCRA and AEA. Under 40 CFR 265.93(b) as referenced by WAC 173-303-400, the well network was sampled semiannually for RCRA indicator and site-specific parameters (PNNL-14859). Appendix B includes a well location map and lists of wells and constituents monitored for the area. New downgradient well locations had been identified and prioritized under the Tri-Party Agreement Milestone M-24, but the expected pump-and-treat component of the final selected remedy for the 200-ZP-1 Operable Unit has postponed the drilling of new wells in 200 West Area until the effects of the expanded pump-and-treat component are evaluated.



The groundwater flow in this portion of the 200 West Area is generally to the east, based on water-table contours. The flow direction is affected to a large degree by the 200-ZP-1 Pump-and-Treat System, which has extraction wells to the east and injection wells to the west of this RCRA site. The gradient is steeper and has a component to the northeast in the northern part of the area, and is somewhat less steep with a component to the southeast in the southern part of the area. The generalized flow direction, based on the March 2008 water table for the 200 West Area (Figure 2.8-2), was east-northeast in the northern portion of the facility, to slightly south of east in the southern portion. The hydraulic gradient is about 0.004. With a range in hydraulic conductivity values of 10 to 25 m/day, the estimated flow rate at Low-Level WMA 4 using these values is ~0.4 to 1.0 m/day (Appendix B). Two wells in the Low-Level WMA 4 monitoring network, upgradient wells 299-W15-15 and 299-W18-23, went dry during FY 2008.

The general groundwater flow to the east at Low-Level Waste Management Area 4 is largely affected by injection wells to the west and extraction wells to the east.

As in previous years, downgradient wells 299-W15-30, 299-W15-83, 299-W15-94, and 299-W15-224 continued to exceed the statistical comparison value for total organic halides in all samples during FY 2008. Well 299-W15-30 is a replacement for well 299-W15-16, which has gone dry. The DOE previously reported the exceedance of the statistical comparison value in well 299-W15-16 (now dry) to the EPA and Ecology in August 1999. The exceedances also have been iterated in annual groundwater reports. The elevated total organic halide concentrations are consistent with observed levels of carbon tetrachloride from Plutonium Finishing Plant operations (Sections 2.8.1.1 and 2.8.2) although more data are needed from the new wells to establish trends. Carbon tetrachloride concentrations display downward or level trends in all wells in the network for which historical data are available. During FY 2008, the maximum carbon tetrachloride concentration in well 299-W15-94 declined from 830 µg/L in FY 2007 to 310 µg/L in FY 2008. Known sources of carbon tetrachloride include the 216-Z-9 Trench, 216-Z-1A Tile Field, and 216-Z-18 Crib (DOE/RL-2006-20). Based on historical groundwater monitoring and interpretations of carbon tetrachloride plumes in the 200 West Area (e.g., DOE/RL-92-16, *200 West Groundwater Aggregate Area Management Study Report*), as well as the extensive source investigations in the 200 West Area (DOE/RL-2006-51, *Remedial Investigation Report for the Plutonium/Organic Rich Process Condensate/Process Waste Group Operable Unit: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*), these liquid waste disposal facilities were determined to be the principal sources of this contaminant in 200 West Area groundwater.

Total organic carbon exceeded the statistical comparison value in two wells (299-W15-30 and 299-W15-225) sampled in February 2008. A request for data review was submitted because the high total organic carbon concentration was much greater than historical concentrations. Both wells were resampled and the new results were less than the critical mean. Well 299-W15-224 exceeded the critical mean in August 2008. Again, requests for data review were submitted and samples submitted for reanalysis. Results from the reanalysis confirmed the exceedance and a groundwater quality assessment plan was written and submitted to Ecology. The other indicator parameters, pH and specific conductance did not exceed the comparison values for FY 2008. Appendix B lists statistical comparison values for use in FY 2009.

Performance assessment monitoring of radionuclides at Low-Level WMA 4 is designed to complement the RCRA detection monitoring. The current goal of performance assessment monitoring at Low-Level WMA 4 is to gather data to assess changes in concentrations at downgradient wells and to provide sufficient supporting information from upgradient wells to interpret the changes. Under the current monitoring plan (DOE/RL-2000-72), technetium-99, iodine-129, tritium, and uranium are monitored specifically for performance assessment.

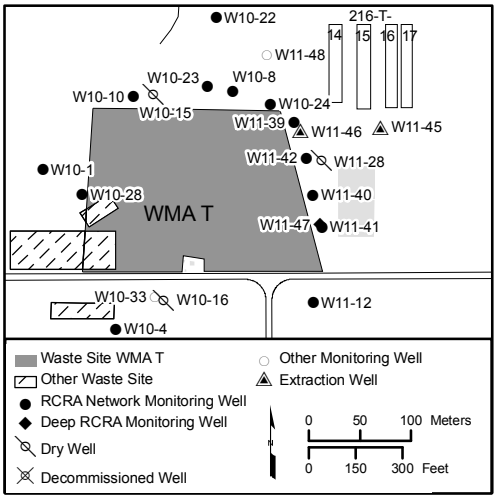
Contaminant characteristics at Low-Level WMA 4 include the following.

- In FY 2007, the technetium-99 concentrations increased in several wells on both the west (upgradient) and east (downgradient) sides of Low-Level WMA 4. Wells upgradient of WMA TX-TY containing high concentrations of technetium-99 were converted to extraction wells for the pump-and-treat system in mid-2005. The resulting increases in technetium-99 concentration in the injection water, coupled with a 20 to 25% increase in injection volume from the addition of new extraction wells, could have caused the increases in technetium-99 concentration in wells at Low-Level WMA 4 during FY 2007. A temporary extraction system for technetium-99 was applied to the extraction wells at WMA TX-TY in FY 2007 and was stopped near the end of FY 2007. The technetium-99 concentrations in wells at Low-Level WMA 4 increased only in well 299-W15-30 in FY 2008 (maximum concentration of 120 pCi/L). The technetium-99 concentrations in all other wells either decreased or remained steady. These decreases may be the result of extraction well operation in proximity to WMA TX-TY. However, other factors may have caused the recent fluctuations of technetium-99 concentrations at Low-Level WMA 4, because changes in technetium-99 at Low-Level WMA 4 appear fairly quickly after changes in the pump-and-treat system.
- The highest annual average uranium concentration in FY 2008 was 22 µg/L in upgradient well 299-W18-21, which is consistent with the FY 2007 concentration of 21 µg/L. In FY 2007, the uranium concentration was high in upgradient wells 299-W15-15 and 299-W18-23. The uranium concentration in well 299-W15-15 was 12.7 µg/L in FY 2007, but decreased to 7.7 µg/L at the end of FY 2007 before the well went dry. The FY 2007 average uranium concentration was 9.8 µg/L in well 299-W18-23, but decreased to 4.8 µg/L before going dry in mid FY 2008. The highest uranium concentration at downgradient locations was 3.20 µg/L in well 299-W15-152. This was a slight increase from 2.16 µg/L in FY 2007. These concentrations are consistent with regional concentrations.

- Iodine-129 was not detected in Low-Level WMA 4 wells during FY 2008.
- The highest tritium concentrations were 1,600 pCi/L in downgradient wells 299-W15-83 (1,900 pCi/L in FY 2007) and 299-W15-152 (1,400 pCi/L in FY 2007). The tritium concentration also increased from 1,000 pCi/L at the end of FY 2007 to 1,400 pCi/L at the end of FY 2008 in well 299-W15-30. The tritium concentration decreased during FY 2008 in upgradient well 299-W18-21 from 1,430 pCi/L to 900 pCi/L. The tritium concentration remained steady in all other wells during FY 2008. Tritium concentrations at Low-Level WMA 4 are consistent with regional concentrations.
- Nitrate continued to exceed the drinking water standard at all monitoring wells in Low-Level WMA 4, except downgradient well 299-W15-17 (27 mg/L) and deep well 299-W18-22 (19 mg/L). The maximum concentration in FY 2008 was in upgradient well 299-W18-23 (141 mg/L), before the well went dry in mid FY 2008. The highest nitrate concentration in all other downgradient wells was between 104 and 129 mg/L and trends remained steady. Nitrate contamination is likely unrelated to waste disposal at the burial grounds. Some of the nitrate contamination is related to injection of treated water upgradient of the burial ground. The treatment system does not remove nitrate from the water.
- Concentrations of carbon tetrachloride, trichloroethene, and chloroform are consistent with regional plumes (Sections 2.8.1.1, 2.8.1.2, and 2.8.1.3). In FY 2008, the maximum concentration of carbon tetrachloride was in well 299-W15-94 (310 µg/L). All wells in the network with results above detection show steady or decreasing trends. Chloroform and trichloroethene concentrations remained below the drinking water standard. No wells had trichloroethene concentrations above detection limits.

2.8.3.3 Waste Management Area T

WMA T is located in the north-central part of the 200 West Area and consists of the T Tank Farm with its ancillary equipment (e.g., diversion boxes and pipelines). The tank farm contains twelve 2-million-liter tanks and four 208,000-liter tanks constructed between 1943 and 1944. Seven of the tanks in the WMA are known or suspected to have leaked (RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates*). This section describes groundwater monitoring at WMA T. Appendix B includes a well location map and lists of wells and constituents monitored for the area.



The objective of RCRA groundwater monitoring at WMA T is to assess the extent and rate of movement of dangerous wastes in groundwater that have a source from the WMA (40 CFR 265.93(d) as referenced by WAC 173-303-400). PNNL-15301, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area,* documents the groundwater assessment plan for WMA T. In addition to monitoring dangerous waste constituents for RCRA assessment, the site is monitored under CERCLA and AEA. WMA T originally was placed in RCRA assessment monitoring because of elevated specific conductance in downgradient well 299-W10-15 (WHC-SD-EN-AP-132, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Areas T and TX-TY*). This area remains in assessment because of continued elevated contaminants observed in downgradient wells.

Chromium and nitrate are found in groundwater near Waste Management Area T.

Dangerous waste constituents found in groundwater near WMA T in FY 2008 are chromium and nitrate. These constituents probably originate from more than one source, including the WMA. Other constituents found near the WMA in FY 2008 include carbon tetrachloride, trichloroethene, fluoride, tritium, and technetium-99. The carbon tetrachloride and trichloroethene do not appear to be from WMA T (Sections 2.8.1.1 and 2.8.1.2). Tritium is believed to be part of a regional plume, although a contribution from WMA T cannot be disregarded. The technetium-99 plume, located east (downgradient) of the T Tank Farm, is attributed in part to the tank farm.

In September 2007, downgradient wells 299-W11-45 and 299-W11-46 were converted to extraction wells to remove technetium-99 from the aquifer east of Waste Management Area T.

In September 2007, downgradient wells 299-W11-45 and 299-W11-46 were converted to extraction wells to remove technetium-99 from groundwater. Extraction of groundwater from the downgradient wells has altered the flow regime. Figure 2.8-18 shows the water-table elevation in several wells at WMA T. The figure shows drawdown in wells around the WMA after extraction began in wells 299-W11-45 and 299-W11-46 and the degree of drawdown increases as the distance between the extraction wells and the measured wells decreases. Prior to the start of extraction, calculated average linear groundwater flow velocities at WMA T ranged from 0.002 to 0.25 m/day, with most values less than 0.1 m/day. The groundwater flow direction beneath the WMA was to the east between 85 and 98º from the north, as determined by trend surface analyses (PNNL-13378; PNNL-14113). Since the initiation of the technetium-99 pump-and-treat, the groundwater flow velocity is closer 0.02 to 0.56 m/day based on the most recent water-table map. The recent groundwater extraction at WMA T has caused slight deviations from prior flow conditions. Figure 2.8-2 is the most current water-table map.

The monitoring network for WMA T includes fourteen wells that are sampled quarterly and two wells sampled semiannually. With a few exceptions, all samples were collected as scheduled in FY 2008. Sampling of well 299-W11-7 was unsuccessful in November and December 2007 because of a broken valve. Upgrades at the Effluent Treatment Facility prevented August 2008 samples from being collected from extraction wells 299-W11-45 and 299-W11-46 because the extraction system was shut down. The Effluent Treatment Facility was back online in November 2008.

An aquifer recovery test was undertaken to examine the effects of the 200-ZP-1 Pump-and-Treat System on the vertical and horizontal flow components within the unconfined aquifer system.

Extraction well 299-W11-45 was shut down on March 6 and restarted on July 7, 2008 and extraction well 299-W11-46 was shut down on May 1 and restarted on June 4, 2008 to perform an aquifer recovery test. Water-table recovery (and drawdown after the extraction wells were restarted) was monitored in eight additional wells at the WMA. The May sampling event at WMA T was postponed in the wells used for the aquifer test until July 2008 to allow uninterrupted completion of the test.

Figure 2.8-9 shows a plume map of FY 2008 annual average chromium concentration in wells in the uppermost part of the aquifer near the WMA T. The map shows that the chromium plume extends from the western and southwestern part of the WMA to northeast of the WMA. The highest annual average chromium concentration in the upper part of the aquifer during FY 2008 was in well 299-W10-4 (420 µg/L filtered and 540 µg/L unfiltered) located at the southwestern corner of the WMA. The chromium concentration in upgradient well 299-W10-28, which had been above the drinking water standard in 2003 through 2006, decreased to an annual average concentration of 65 µg/L (filtered) or 70 µg/L (unfiltered) in FY 2007. Although the annual average chromium concentration in FY 2008 decreased from FY 2007, the

concentration at the end of FY 2008 was 121 µg/L (filtered) compared to 95 µg/L (filtered) at the end of FY 2007. The chromium concentration in the upper part of the aquifer also exceeded the drinking water standard in three downgradient wells where the concentration ranged from 95 to 195 µg/L (filtered) and 100 to 195 µg/L (unfiltered). The chromium concentration increased in some wells and decreased in others. Interpreting the chromium concentration changes is complicated by the intermittent operation of extraction wells in the area.

The highest average chromium concentration found at Waste Management Area T was 420 µg/L (filtered) or 540 µg/L (unfiltered) in well 299-W10-4.

The highest annual average chromium concentration found in wells screened at a depth below the water table in WMA T was 145 µg/L (both filtered and unfiltered) in wells 299-W11-45 and 299-W11-47. The annual average chromium concentration in well 299-W11-46, screened between 6 and 12 m below the water table, was 115 µg/L (filtered) and 120 µg/L (unfiltered). The annual average chromium concentration in adjacent well 299-W11-39 (screened at the water table) was 60 µg/L (filtered) and 55 µg/L (unfiltered). The higher concentrations in the deeper screened wells show that the chromium plume at WMA T extends relatively deep in the aquifer downgradient of the WMA.

A fluoride plume was present north and east of WMA T in FY 2008. The annual average fluoride concentration exceeded the 4.0 mg/L primary drinking water standard in two wells located north of the WMA: well 299-W10-8 (4.36 mg/L) and well 299-W10-23 (4.32 mg/L). These wells have a history of high fluoride concentrations. The annual average fluoride concentration also exceeded the secondary drinking water standard (2.0 mg/L) in eight wells at the WMA, two of which had a reported concentration exceeding the primary drinking water standard in FY 2008 (299-W11-46 and 299-W10-24).

The highest average nitrate concentrations were in upgradient well 299-W10-28 (1,068 mg/L) and well 299-W10-4 (2,566 mg/L).

A local nitrate plume is located within the regional nitrate plume and beneath WMA T (Figure 2.8-7). The plume retains the same general configuration as in FY 2007. The highest annual average nitrate concentrations were in upgradient wells 299-W10-28 (1,068 mg/L) and 299-W10-4 (2,566 mg/L). The highest nitrate concentrations in downgradient wells were between 63 and 761 mg/L. More than one source, including the WMA T, probably contributed to the nitrate plume beneath the WMA, but the higher upgradient concentrations indicate greater contributions from other sources. Section 2.8.1.4 discusses nitrate contamination in the north central part of 200 West Area.

Tritium exceeded the interim drinking water standard (20,000 pCi/L) in one well at WMA T. In FY 2008, the annual average tritium concentration in well 299-W11-12 (located at the southeast corner of the WMA) was 38,000 pCi/L. This is a decrease from 44,000 pCi/L during FY 2007. The tritium concentration has been slowly decreasing in this well since 1998. The source of the tritium is thought to be farther south near the TX and TY Tank Farms, as shown in Figure 2.8-10.

The technetium-99 concentration decreased dramatically throughout the year in well 299-W11-46 after groundwater extraction began for technetium-99 remediation.

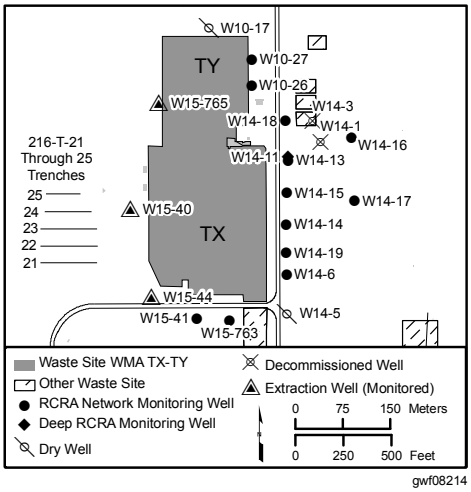
A technetium-99 plume is located along the east (downgradient) side of WMA T (Figure 2.8-13). The maximum technetium-99 concentrations in the upper part of the aquifer are in downgradient well 299-W11-42. The annual average technetium-99 concentration for well 299-W11-42 increased from 1,715 pCi/L in FY 2007 to 7,460 pCi/L in FY 2008. The annual average technetium-99 concentration also increased in downgradient well 299-W11-40 from 1,845 pCi/L in FY 2007 to 6,740 pCi/L in FY 2008. In all other downgradient wells at WMA T, however, the technetium-99 concentration decreased during FY 2008 (Figure 2.8-19).

Figure 2.8-20 shows the technetium-99 concentration in downgradient wells that are screened at depth below the water tables. The technetium-99 concentration decreased in all wells screened deeper in the aquifer in FY 2008. All downgradient wells were affected by the extraction in FY 2008 and the large changes in technetium-99 concentrations are most likely a result of the extraction.

Iodine-129 exceeded the drinking water standard (1 pCi/L) during the first quarter of FY 2008 in well 299-W11-45 (2.76 pCi/L) and well 299-W11-46 (3.23 pCi/L). Iodine-129 was not detected in subsequent samples from either well. Both wells are screened at depth below the water table downgradient of WMA T.

Antimony was reported in several samples near the detection limit during the year. The reported concentrations were the result of problems in the laboratory and were not representative of groundwater (Appendix C).

2.8.3.4 Waste Management Area TX-TY



WMA TX-TY is located in the north-central part of the 200 West Area and consists of the TX and TY Tank Farms and ancillary equipment (e.g., diversion boxes and pipelines). The tank farms contain twenty-four 2.9-million-liter tanks constructed between 1944 and 1952. Twelve of the tanks in the WMA are known or suspected to have leaked. Appendix B includes a well location map and lists of wells and constituents monitored for the area.

WMA TX-TY was originally placed in RCRA assessment monitoring (40 CFR 265.93(d) as referenced by WAC 173-303-400) because of elevated specific conductance in downgradient wells 299-W10-27 and 299-W14-12 (WHC-SD-EN-AP-132). The groundwater assessment plan for WMA TX-TY was updated in FY 2007 (PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*) to incorporate information obtained from new wells drilled since the most recent interim change notice to the previous plan (PNNL-12072-ICN-1, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY at the Hanford Site, Interim Change Notice 1*). The objective of RCRA groundwater monitoring at WMA TX-TY is to assess the concentrations, extent, and rate of movement of dangerous waste in groundwater that have a source from the WMA, as specified in 40 CFR 265.94(a)(2)(ii)(2)(d)(4). In addition to monitoring dangerous waste constituents for RCRA assessments, the site is monitored under AEA and CERCLA.

Twelve of the tanks in Waste Management Area TX-TY are known or suspected to have leaked.

The monitoring network for WMA TX-TY includes 16 wells that are sampled quarterly. All upgradient wells for the WMA were converted to extraction wells for the 200-ZP-1 Pump-and-Treat System in July 2005. All wells were sampled as scheduled during FY 2008, except upgradient wells 299-W15-40, 299-W15-44, and 299-W15-765 that could not be sampled because the 200-ZP-1 Pump-and-Treat System was offline for maintenance and upgrades, and well 299-W15-763 because of a sampling error.

Groundwater flow direction varies beneath the WMA because of influences from the pump-and-treat operation. In the northern part of the WMA, groundwater flow is changing from eastward to westward because of the recently converted extraction wells, as indicated by the arrival of technetium-99 at the wells soon after extraction

began. South of WMA TX-TY, groundwater flow direction is toward extraction wells located south or southwest of the WMA.

Dangerous waste constituents found in groundwater near WMA TX-TY in FY 2008 are chromium and nitrate. Other constituents found near the WMA in FY 2008 include carbon tetrachloride, trichloroethene, tritium, technetium-99, and iodine-129. The carbon tetrachloride and trichloroethene are attributed to Plutonium Finishing Plant operations (Sections 2.8.1.1 and 2.8.1.2).

Dangerous waste constituents found beneath Waste Management Area TX-TY in FY 2008 are chromium and nitrate.

In FY 2008, nitrate concentrations exceeded the drinking water standard (45 mg/L) in all wells in the WMA TX-TY monitoring network. Figure 2.8-7 shows a plume map for nitrate in the area. Overall, the nitrate concentrations remain steady in most wells at the WMA.

The highest annual average nitrate concentration at the WMA during FY 2008 was 695 mg/L in downgradient well 299-W10-27, a decrease from 720 mg/L in FY 2007. The annual average nitrate concentration in other downgradient wells was between 65 and 353 mg/L. The nitrate concentration in most wells remained consistent with FY 2007 concentrations.

Much of the nitrate contamination at WMA TX-TY is attributed to Plutonium Finishing Plant operations, as well as past-practice disposal to cribs and trenches in the area. Some nitrate contamination also may be from WMA TX-TY, although distinguishing the different sources is difficult. Section 2.8.1.4 provides information on nitrate in north-central 200 West Area.

Much of the nitrate contamination at Waste Management Area TX-TY is attributed to Plutonium Finishing Plant operations, as well as past-practice disposal to cribs and trenches in the area.

In FY 2008, chromium was detected above the drinking water standard (100 µg/L) in two wells shown in Figure 2.8-9 and in well 299-W14-11 (completed deeper in the aquifer). The highest annual average chromium concentration was 580 µg/L (unfiltered) and 564 µg/L (filtered) in downgradient well 299-W14-13. This was a decrease from 660 µg/L (filtered) during FY 2007. The chromium concentration has been elevated in this well since it was drilled in 1998 and was elevated in the early 1990s in adjacent but now dry well 299-W14-12. The chromium contamination in the area is accompanied by elevated concentrations of nitrate, iodine-129, technetium-99, and tritium.

Well 299-W14-11 is located next to well 299-W14-13, but is screened between 11.6 and 14.6 m below the water table. The annual average chromium concentration in well 299-W13-11 was 228 µg/L (unfiltered) and 232 µg/L (filtered). This is substantially higher than the annual average of 76 µg/L (filtered) during FY 2007. This indicates that significant chromium may exist deeper in the aquifer than shown by wells screened at the water table, although the highest concentrations appear to be near the water table in the area. The source for the chromium is assumed to be WMA TX-TY because no alternative sources have been identified.

The chromium contamination in the area is accompanied by elevated concentrations of nitrate, iodine-129, technetium-99, and tritium.

In FY 2008, well 299-W14-15 is located south of well 299-W14-13. The annual average chromium concentration in the well was 112 µg/L (unfiltered) and 109 µg/L (filtered). This is the first time that the chromium concentration has been above the drinking water standard in this well. However, the chromium concentration decreased throughout the year from 177 µg/L in November 2007 to 68 µg/L in August 2008 (Figure 2.8-21). The chromium concentration began a dramatic increase in mid-FY 2007, peaked at the beginning of FY 2008, and has decreased since that time. Nitrate, technetium-99, iodine-129, and tritium accompanied chromium, and all five contaminants show the same trend (Figures 2.8-21 and 2.8-22). This indicates that

all five contaminants share a common plume and that the plume passed through the well in a short period of time at the end of FY 2007 and beginning of FY 2008.

A small tritium plume exists along the east-central part of WMA TX-TY (Figure 2.8-10). The tritium concentration exceeded the drinking water standard (20,000 pCi/L) in three wells in the area. The highest FY 2008 average tritium concentration was 830,000 pCi/L in well 299-W14-13, a decrease from 1.5 million pCi/L in FY 2007. The tritium concentration generally has been decreasing since November 2006 when the concentration was 1.76 million pCi/L. However, the decrease accelerated in FY 2008 from 1.2 million pCi/L in November 2007 to 270,000 pCi/L in August 2008. The annual average tritium concentration in adjacent well 299-W14-11 (screened from 11.6 to 14.6 m below the water table) increased from 127,400 pCi/L in FY 2007 to 457,500 pCi/L in FY 2008. The tritium concentrations in these two wells indicate that the highest concentrations are near the water table in this area.

The tritium concentrations in well 299-W14-15 (located south of well 299-W14-13) also exceeded the drinking water standard during FY 2008 with an annual average concentration of 131,000 pCi/L. Although the annual average tritium concentration increased from 97,000 pCi/L in FY 2007, the concentration dropped throughout FY 2008 to 81,000 pCi/L in August 2008 (Figure 2.8-22). The source for the high tritium in the area could be WMA TX-TY, the 242-T Evaporator, the 216-T-19 Crib and Tile Field (which received evaporator condensate from the 242-T Evaporator), the 216-T-26 through 216-T-28 Cribs, or a combination of these potential sources.

The highest concentrations of technetium-99 and other contaminants east of WMA TX-TY are found near the water table.

In FY 2008, technetium-99 exceeded the interim drinking water standard (900 pCi/L) in wells 299-W14-11 and 299-W14-13 at WMA TX-TY. The annual average technetium-99 concentration decreased in well 299-W14-13 from 6,700 pCi/L in FY 2007 to 6,000 pCi/L in FY 2008, but increased in deeper well 299-W14-11 from 2,325 to 4,350 pCi/L. The data from these two wells indicate that the highest technetium-99 concentrations are near the water table in that area, similar to chromium, nitrate, iodine-129, and tritium.

The technetium-99 concentration also exceeded the drinking water standard in two other downgradient wells at WMA TX-TY. The annual average concentration in well 299-W14-15 (south of the wells 299-W14-11 and 299-W14-13) was 1,650 pCi/L during the year, similar to 1,700 pCi/L during FY 2007. The annual average technetium-99 concentration was 1,278 pCi/L in well 299-W10-26. This is the first time that the annual average technetium-99 concentration has exceeded the drinking water standard in this well. The source for the technetium-99 in these wells east of the WMA could be the WMA, one of the past-practice disposal facilities in the area, or both.

Technetium-99 also is above the drinking water standard in wells south and west of the WMA (Figure 2.8-13). Technetium-99 in these wells is likely drawn to the wells from beneath the TX and TY Tank Farms by extraction for the 200-ZP-1 Pump-and-Treat System. Wells 299-W15-44 and 299-W15-765 began operation as extraction wells for the 200-ZP-1 Operable Unit in July 2005 and the technetium concentrations began to increase in these wells shortly thereafter.

Iodine-129 exceeded the 1 pCi/L drinking water standard in three wells at WMA TX-TY during FY 2008 (Figure 2.8-12). The highest iodine-129 concentration measured at the WMA during the reporting period was 37.6 pCi/L in the May 2008 sample from well 299-W14-13. The annual average iodine-129 concentration declined

in the well from 38.3 in FY 2007 to 31 pCi/L in FY 2008. The annual average iodine-129 concentration in adjacent and deeper screened well 299-W14-11 increased from 4.8 pCi/L in FY 2007 to 15.8 pCi/L in FY 2008. Although the difference in iodine-129 concentration between the two wells is less than in the past, the data continue to indicate that the highest iodine-129 contamination resides near the water table, similar to the other contaminants in the area.

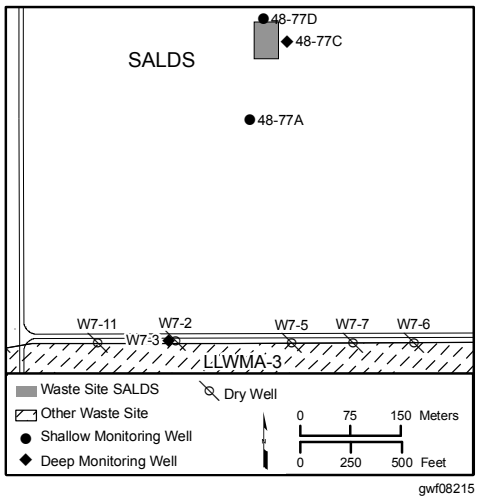
Iodine-129 also was detected in well 299-W14-15, located south of well 299-W14-13. The iodine-129 concentration in this well decreased throughout the year from 8.95 pCi/L in November 2007 to 3.92 pCi/L in August 2008 (Figure 2.8-21).

Manganese exceeded the secondary drinking water standard of 50 µg/L in well 299-W10-27 where the annual average FY 2008 concentration was 270 µg/L (filtered) and 266 µg/L (unfiltered). The manganese concentration has been high in this well since it was first sampled in 2001, although the concentration has decreased dramatically since that time. It is common for new wells on the Hanford Site to have elevated manganese concentrations during the first few years of sampling, but the elevated manganese in this well has persisted. The reason for the elevated manganese is unknown.

Nickel-63 was found in well 299-W14-11 in November 2007 (122 pCi/L) and in well 299-W14-13 in November 2007 (450 pCi/L) and May 2008 (688 pCi/L). One-twenty-fifth of the derived concentration guide (equivalent to 4 mrem or the drinking water standard for gross beta) for nickel-63 is 12,000 pCi/L, larger than the detected concentrations at the WMA.

2.8.3.5 State-Approved Land Disposal Site

The Hanford Site 200 Area Effluent Treatment Facility processes contaminated aqueous waste from Hanford Site facilities. The treated wastewater occasionally contains tritium, which is not removed by the Effluent Treatment Facility, and is discharged to the 200 Area State-Approved Land Disposal Site (SALDS). The SALDS operates on a fiscal year of September 1 to August 30, not the October 1 to September 30 observed by the DOE. During the first 11 months of FY 2008, 75.15 million liters of water were discharged to the SALDS, compared to 13.9 million liters in FY 2007. The expansion of the pump-and-treat systems on the Hanford Site is largely responsible for this increased volume.



A state waste discharge permit (WAC 173-216) requires groundwater monitoring at this site. The permit was granted in June 1995 and the site began operations in December 1995. Groundwater monitoring requirements are described in the site-monitoring plan (PNNL-13121, *Groundwater Monitoring and Tritium Tracking Plan for the 200 Area State- Approved Land Disposal Site*). Groundwater monitoring for tritium was conducted in 12 wells around the facility (Appendix B). The permit stipulates requirements for groundwater monitoring and establishes enforcement limits for concentrations of 15 constituents in three additional wells immediately surrounding the facility (Appendix B).

During FY 2008, 75.15 million liters of water were discharged to the State-Approved Land Disposal Site.

Wells immediately surrounding the facility were sampled four times in FY 2008. Tritium tracking wells were sampled semiannually. Many of the wells in the tritium-tracking network south of the SALDS have gone dry. Water-level measurements in the three wells nearest the SALDS indicated a small, localized groundwater mound centered on well 699-48-77A, a result of discharges from treating

groundwater from extraction wells at the 200-UP-1 Operable Unit and WMA T in the 200-ZP-1 Operable Unit. This mound results in radial flow outward a short distance before the regional northeastward flow predominates. This condition also places several wells south of the SALDS hydraulically downgradient of the facility.

Maximum tritium activities increased by an order of magnitude at well 699-48-77A (820,000 pCi/L), but remained unchanged in the other two proximal wells, 699-48-77C (68,000 pCi/L) and 699-48-77D (120,000 pCi/L). The tritium concentration in well 699-48-77A was the peak concentration for this well in a decade (Figure 2.8-23). This is likely because of several intermittent Effluent Treatment Facility campaigns in FY 2006 and FY 2007 to treat K Basin wastewater.

Concentrations of all chemical constituents with permit limits were within those limits or below detection limits during all of FY 2008. Acetone, benzene, cadmium, chloroform, and tetrahydrofuran were below method detection limits in all samples. Three target metals were found at or near-detection concentrations in well 699-48-77A. Concentrations of lead, copper, and mercury were present at 1.58 µg/L, 0.628 µg/L, and less than detection, respectively. Concentrations of major anions and cations continued at below-background levels observed prior to operation of the facility. The low concentrations are because of dilution by the otherwise clean water discharged to the SALDS.

For all wells, the hydraulic head in March 2008 had declined an average of 0.09 m/yr since March 2007. This average rate of decline includes increasing water levels at the three proximal wells at the SALDS area between March 2007 and March 2008. A less-biased rate of decline can be calculated if water-level changes in the proximal wells are excluded. This calculation shows that the FY 2008 average rate of decline of the water level in the area is 0.26 m/yr, which is consistent to the average calculated for FY 2007 (0.27 m/yr). Numerical flow-and-transport modeling of the SALDS was last conducted in August 2004, as required by the permit (PNNL-14898, *Results of Groundwater Modeling for Tritium Tracking at the Hanford Site 200 Area State-Approved Land Disposal Site – 2004*).

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

CERCLA Monitoring (Appendix A)

- ***Seventy-three wells are scheduled for quarterly to biennial sampling. In FY 2008, five wells were not sampled and 18 other wells were sampled less frequently than planned.***
- ***The DOE installed and began to sample three new groundwater wells in FY 2008.***

Facility Monitoring (Appendix B)

- ***Seven wells are scheduled for semiannual sampling for Low-Level Waste Management Area 3. One well was sampled less frequently than planned in FY 2008.***
- ***Ten wells are scheduled for semiannual sampling for Low-Level Waste Management Area 4. Two of the wells went dry in FY 2008.***
- ***Sixteen wells are scheduled for quarterly to semiannual sampling for Waste Management Area T. The wells were sampled as planned.***
- ***Sixteen wells are scheduled for quarterly to semiannual sampling for Waste Management Area TX-TY. One quarterly sample was missed for four wells.***
- ***Twelve wells are scheduled for quarterly to semiannual sampling for the State-Approved Land Disposal Site. All were sampled as planned.***

Table 2.8-1. Major Changes to the 200-ZP-1 Pump-and-Treat System.

Time Period	Activities
1994 through 1995	Conducted Phase I operations using one extraction well (299-W18-1) and one injection well (299-W18-4).
1996 through 1997	Conducted Phase II operations using three extraction wells (299-W15-33, 299-W15-34, and 299-W15-35) and a single injection well (299-W15-29). Phase I wells 299-W18-1 (extraction) and 299-W18-4 (injection) were converted to monitoring wells.
1997 through 2001	Conducted Phase III operations. Operations started using the existing three wells, plus three more recent wells (299-W15-32, 299-W15-36, and 299-W15-37) and five injection wells (299-W15-29, 299-W18-36, 299-W18-37, 299-W18-38, and 299-W18-39).
2001	Well 299-W15-37 was converted to a monitoring well, reducing the number of extraction wells to five.
2004	Wells 299-W15-45 and 299-W15-47 were brought on-line to replace extraction wells 299-W15-32 and 299-W15-33.
2005	Wells 299-W15-40, 299-W15-43, 299-W15-44, and 299-W15-765 were converted to extraction wells, bringing the number of extraction wells to nine.
2006	Well 299-W15-6 was converted from an out-of-service monitoring well to an extraction well, bringing the number of extraction wells to 10.
2008	Monitoring wells 299-W15-1, 299-W15-7, 299-W15-11, and 299-W15-46 were converted to extraction wells, bringing the number of extraction wells to 14.
All of the extraction wells are completed in the upper portion of the aquifer.	

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Figure 2.8-1. Facilities and Groundwater Monitoring Wells in the 200 West Area.

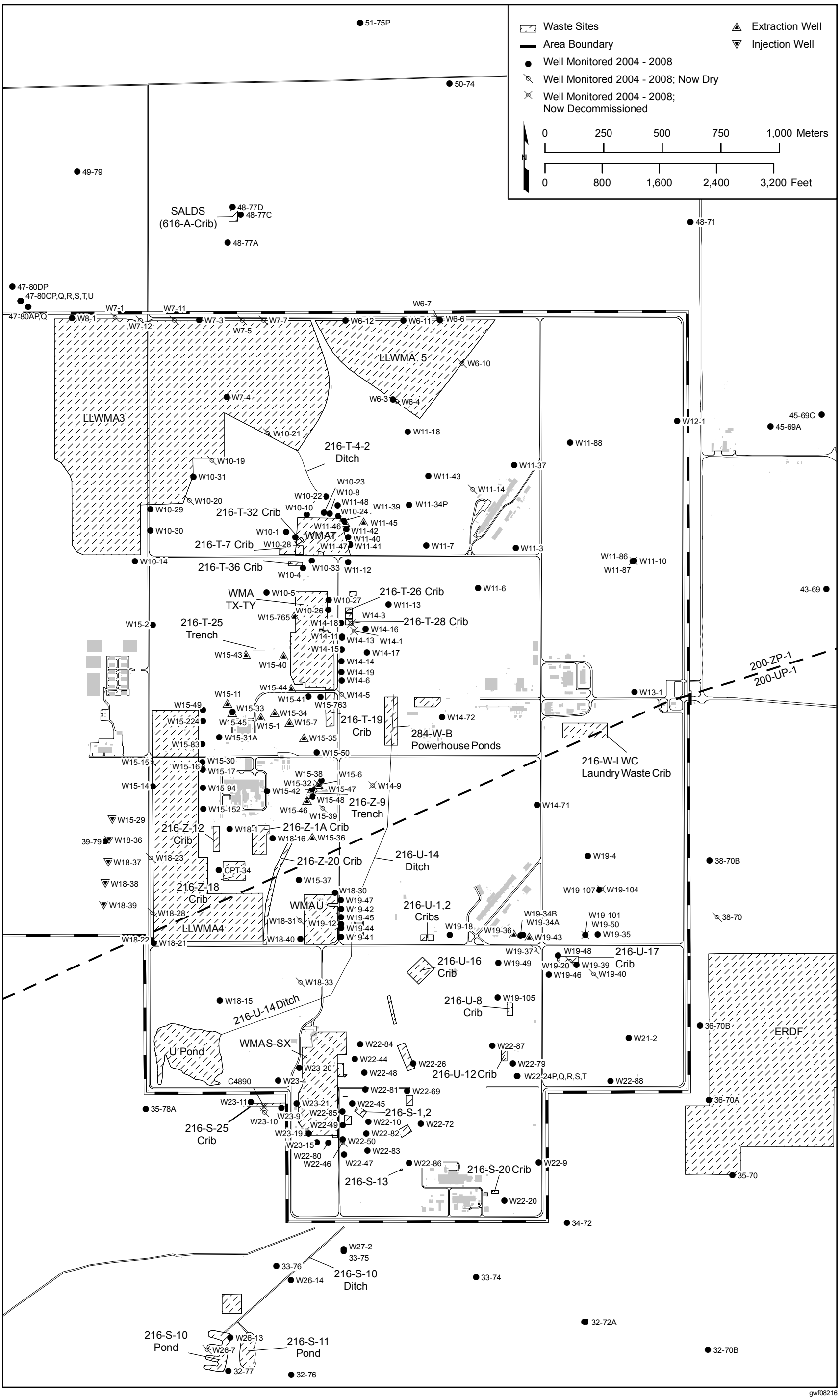

Figure 2.8-2. 200 West Area Water-Table Map, March 2008.

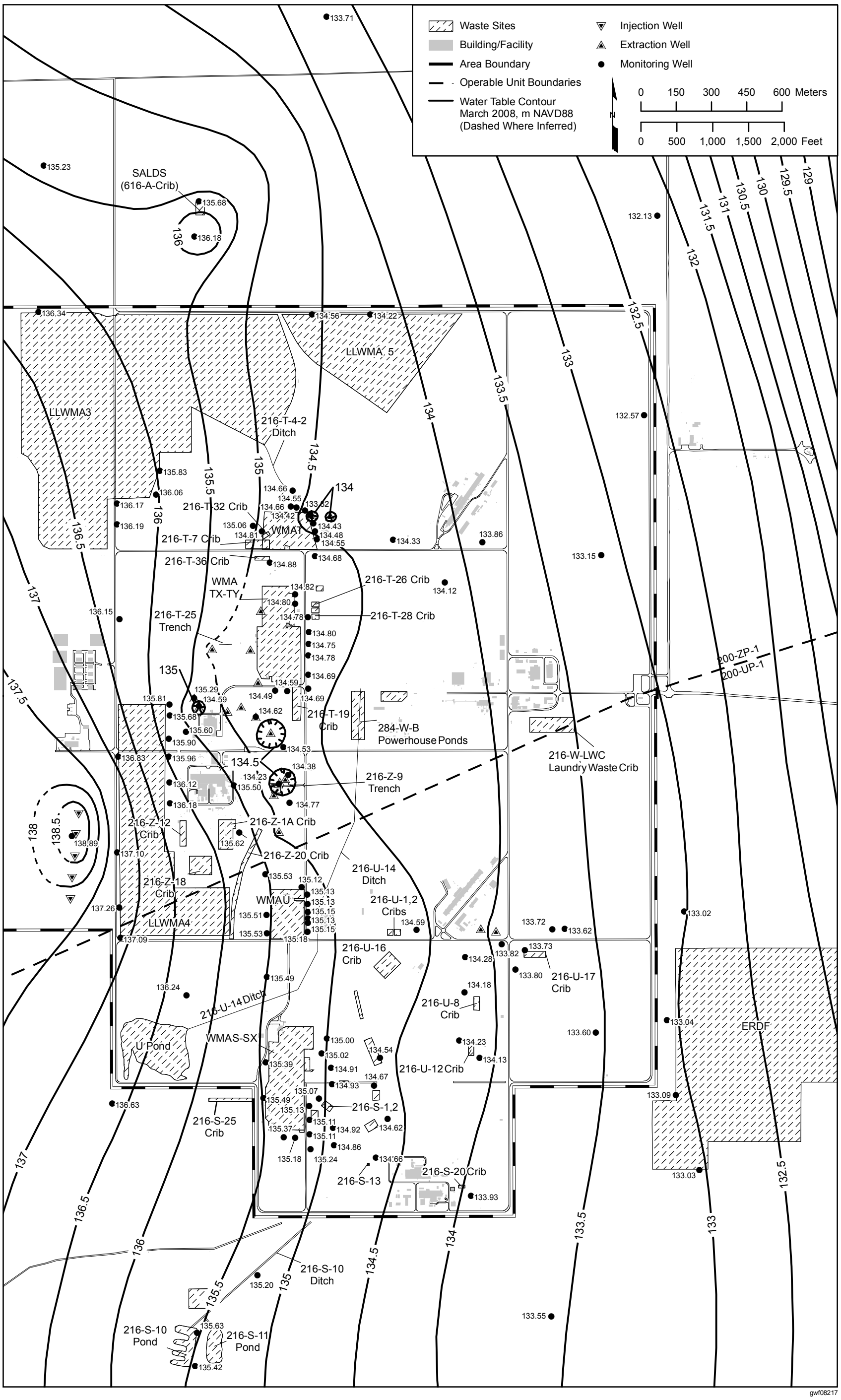

Figure 2.8-3. Average Carbon Tetrachloride Concentrations in the 200 West Area, Upper Part of Unconfined Aquifer.

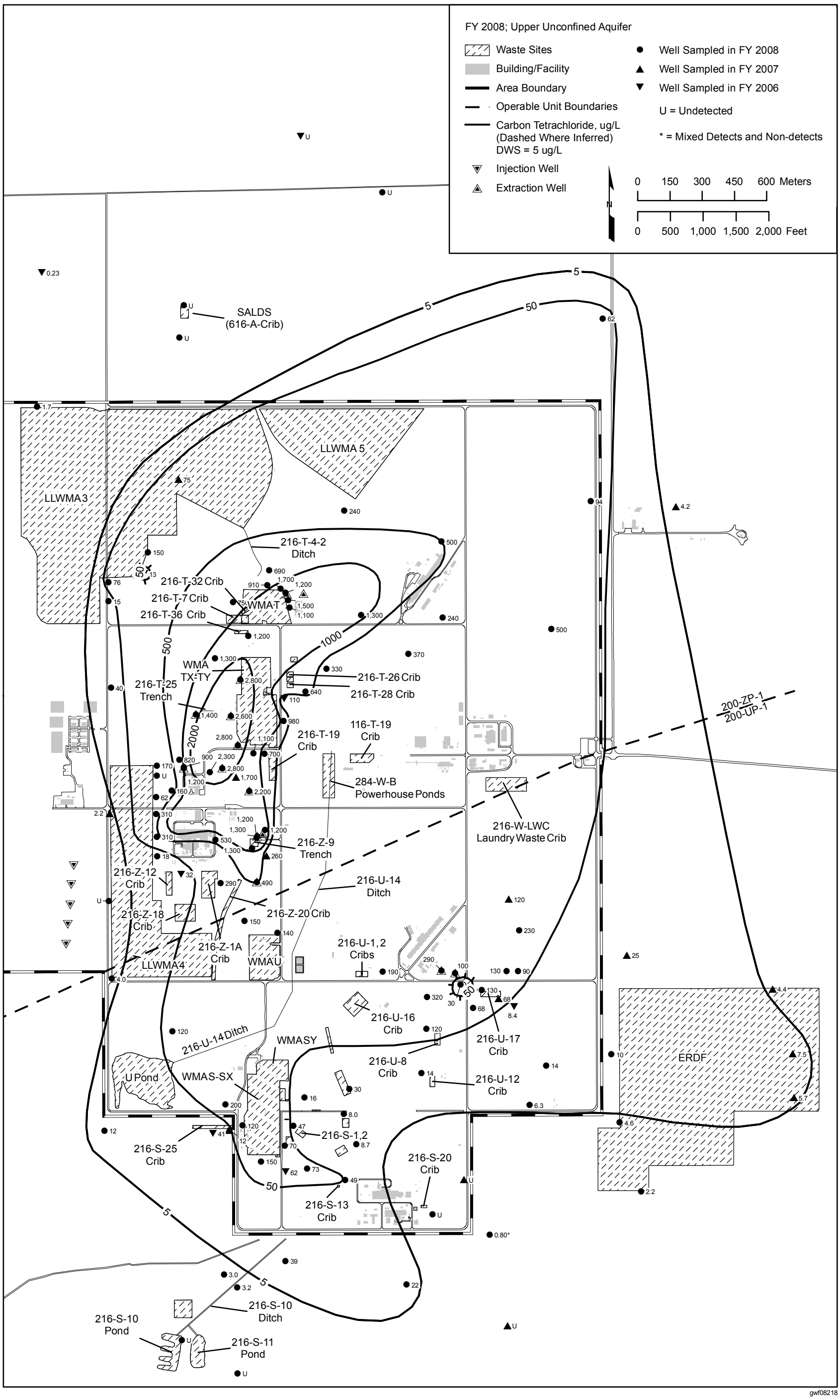

Figure 2.8-4. Carbon Tetrachloride Concentration in Well 699-48-71, Northeast of the 200 West Area.

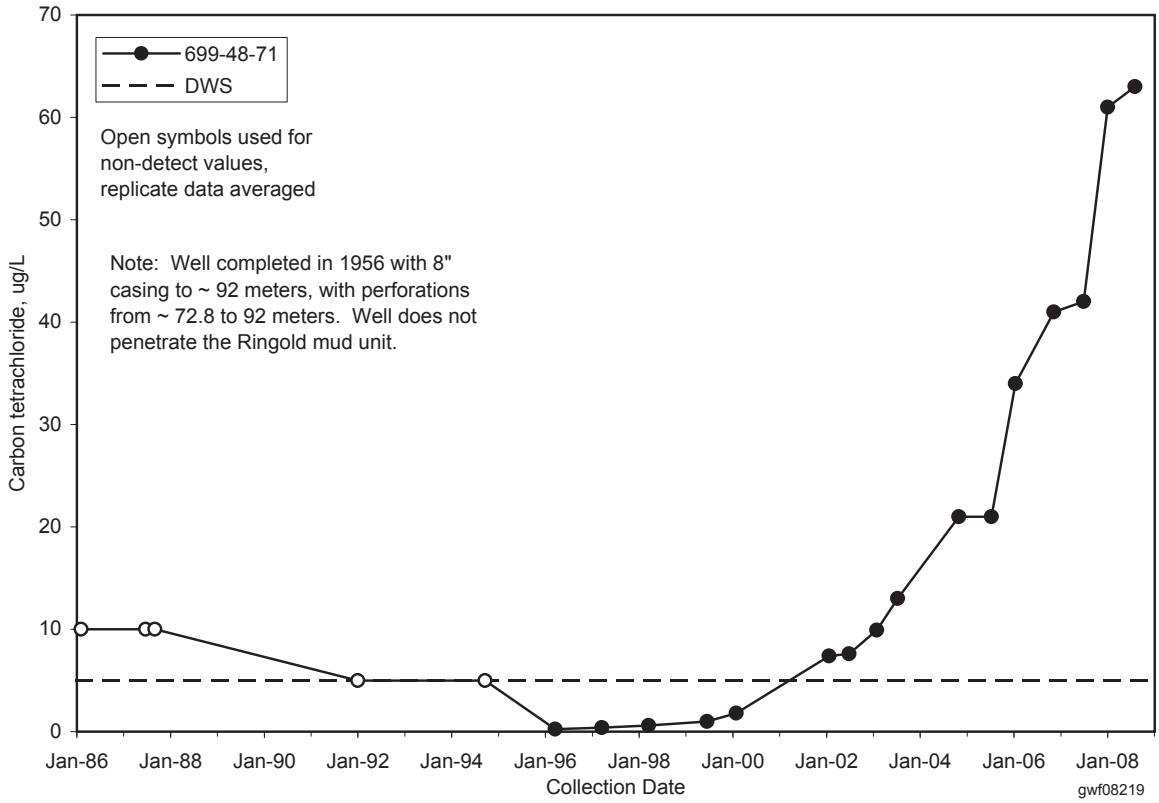

Figure 2.8-5. Carbon Tetrachloride Concentrations During Drilling in New Wells 299-W11-88, 699-43-69, and 699-45-69C.

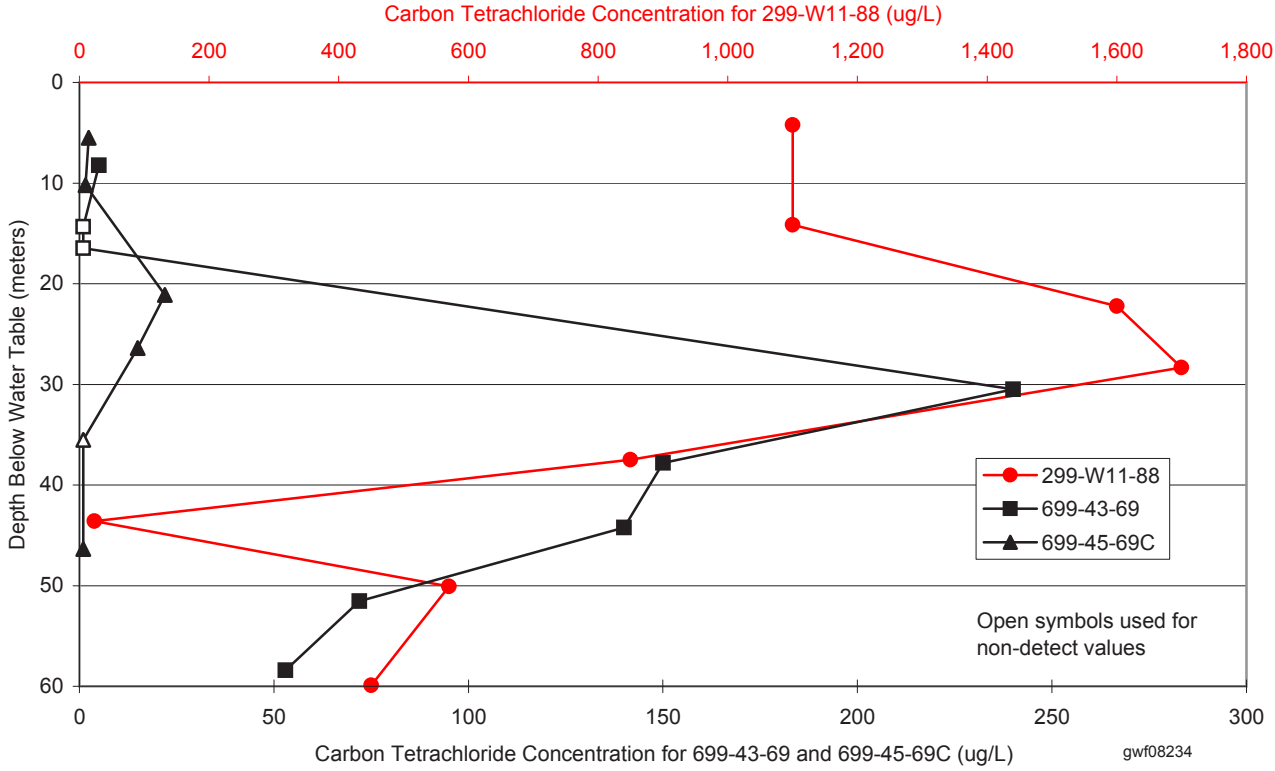

Figure 2.8-6. Average Trichloroethene Concentrations in Central and Northern 200 West Area, Upper Part of Unconfined Aquifer.

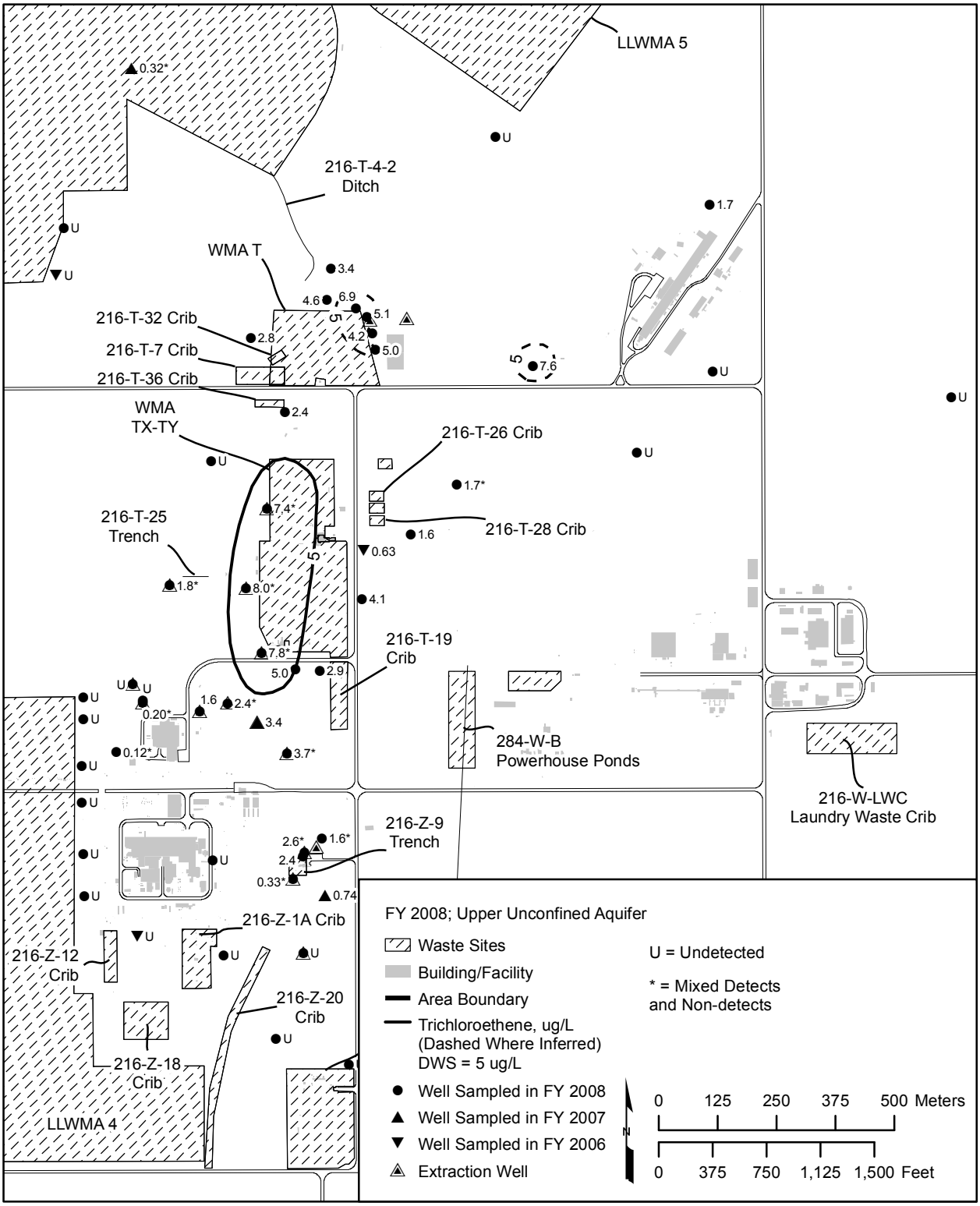

Figure 2.8-7. Average Nitrate Concentrations in Central and Northern 200 West Area, Upper Part of Unconfined Aquifer.

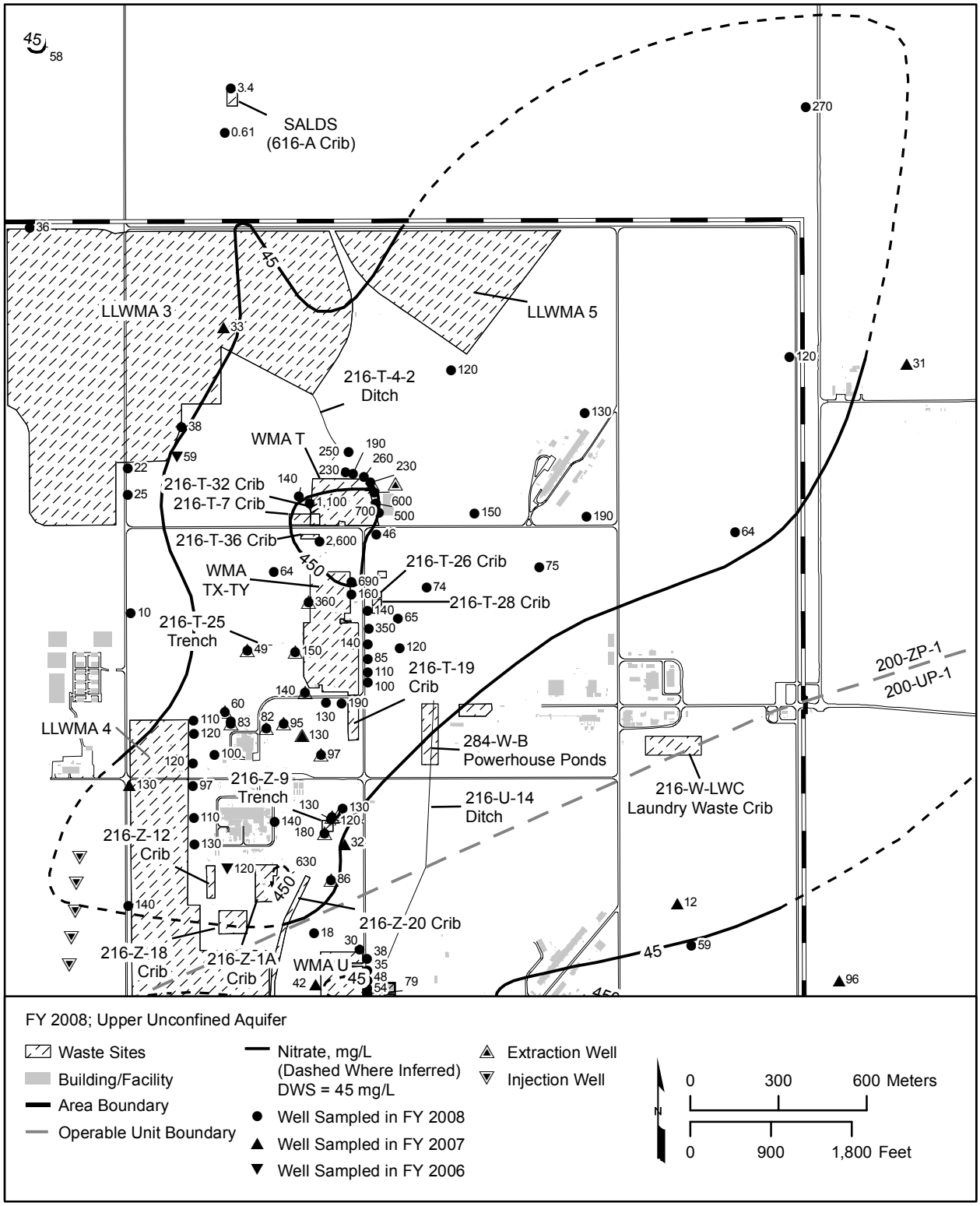

Figure 2.8-8. Nitrate Concentrations During Drilling in New Wells 299-W11-88, 699-43-69, and 699-45-69C.

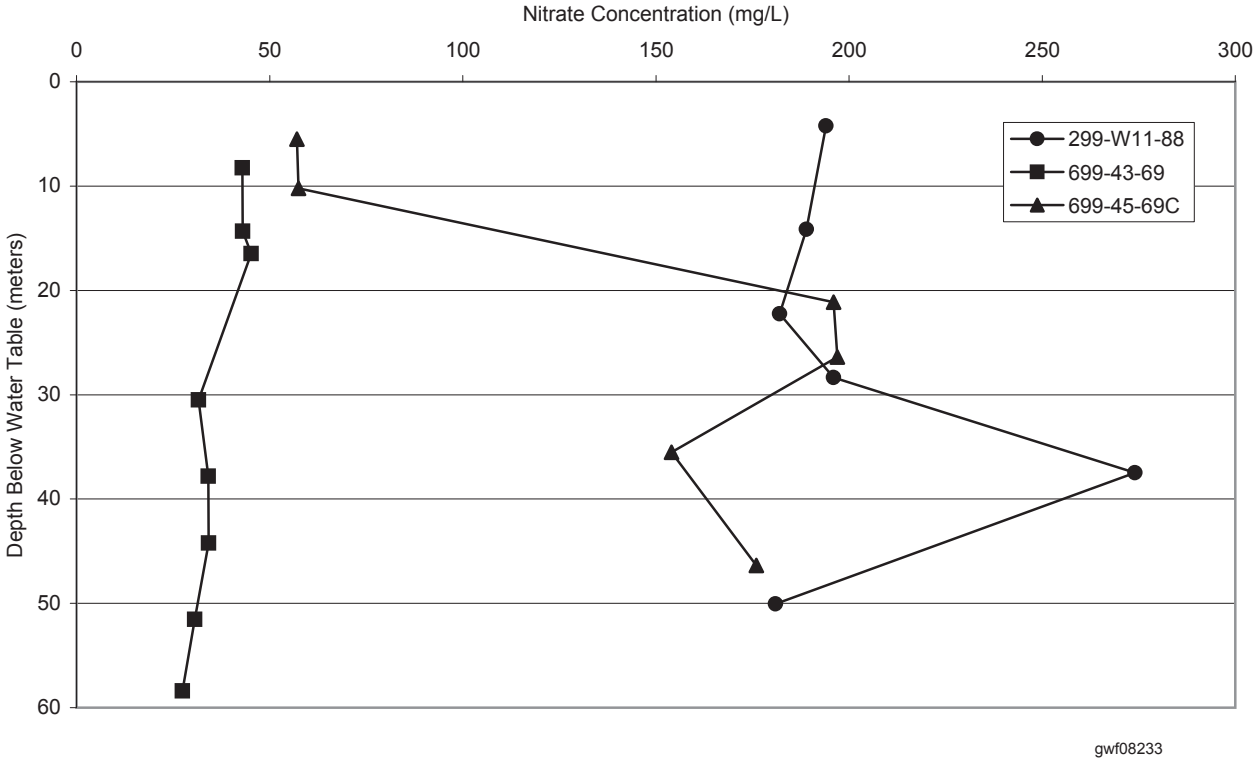

Figure 2.8-9. Average Filtered Chromium Concentrations near Waste Management Areas T and TX-TY, Upper Part of Unconfined Aquifer.

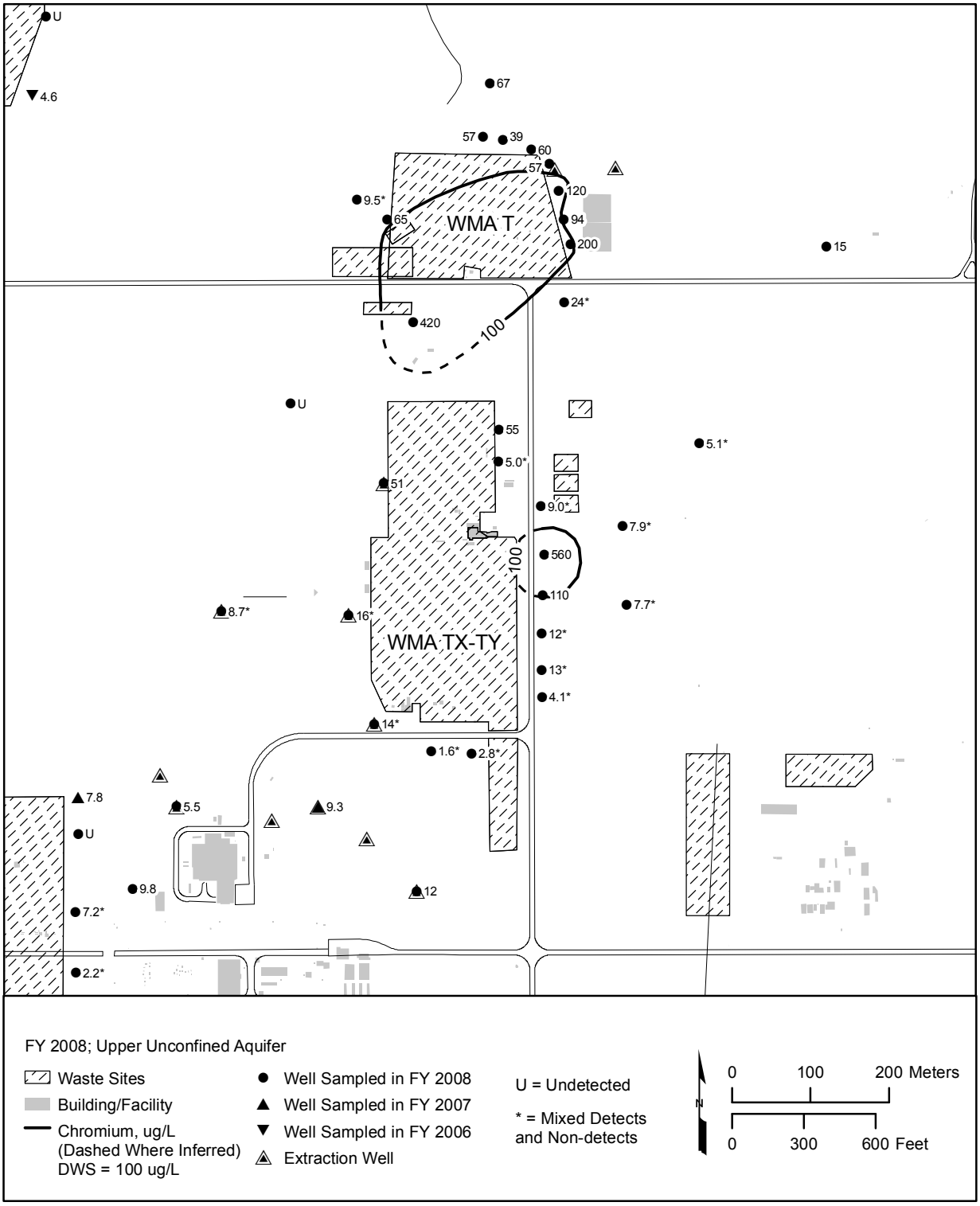

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Figure 2.8-10. Average Tritium Concentrations in Northern 200 West Area, Upper Part of Unconfined Aquifer.

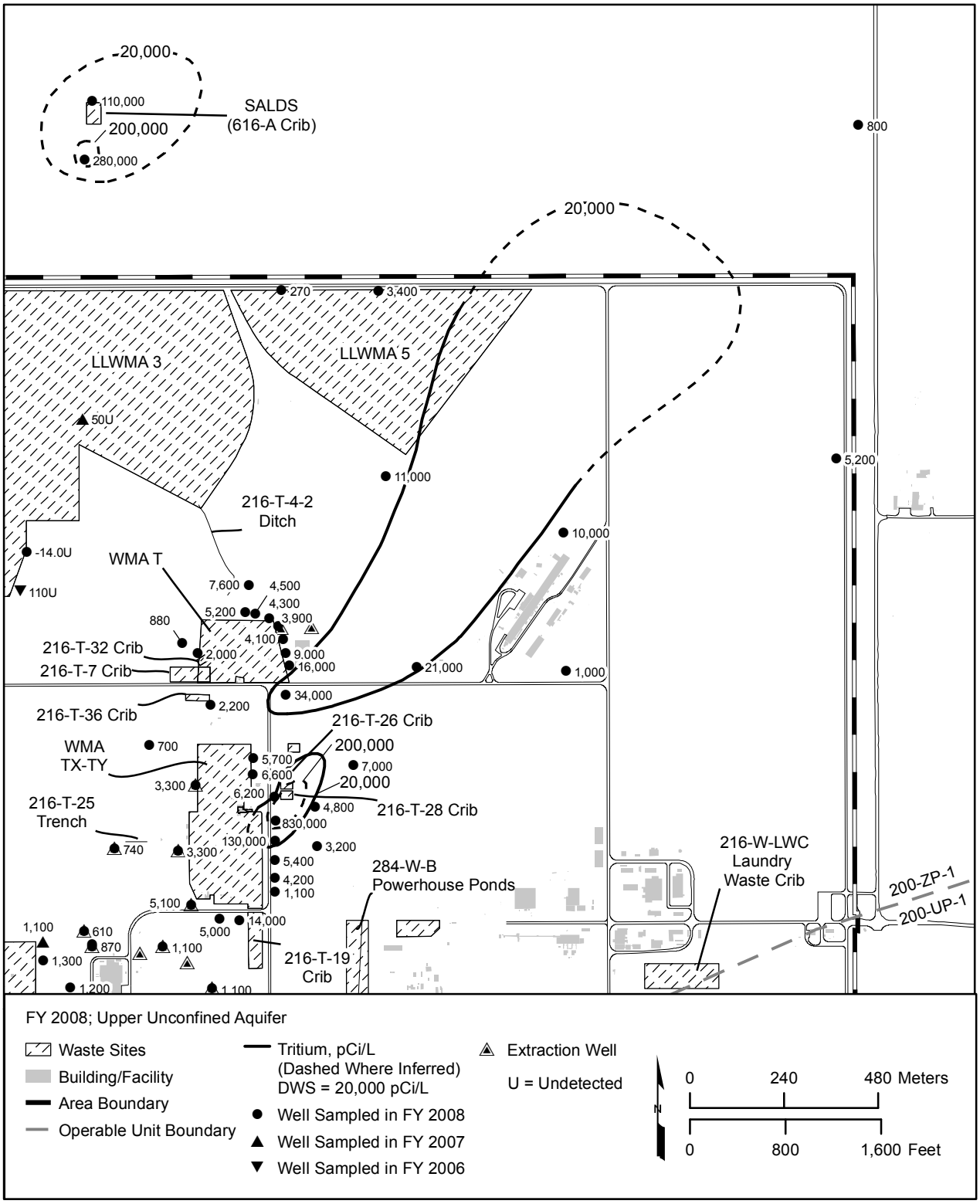

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Figure 2.8-11. Tritium Concentrations During Drilling in New Wells 299-W11-88, 699-43-69, and 699-45-69C.

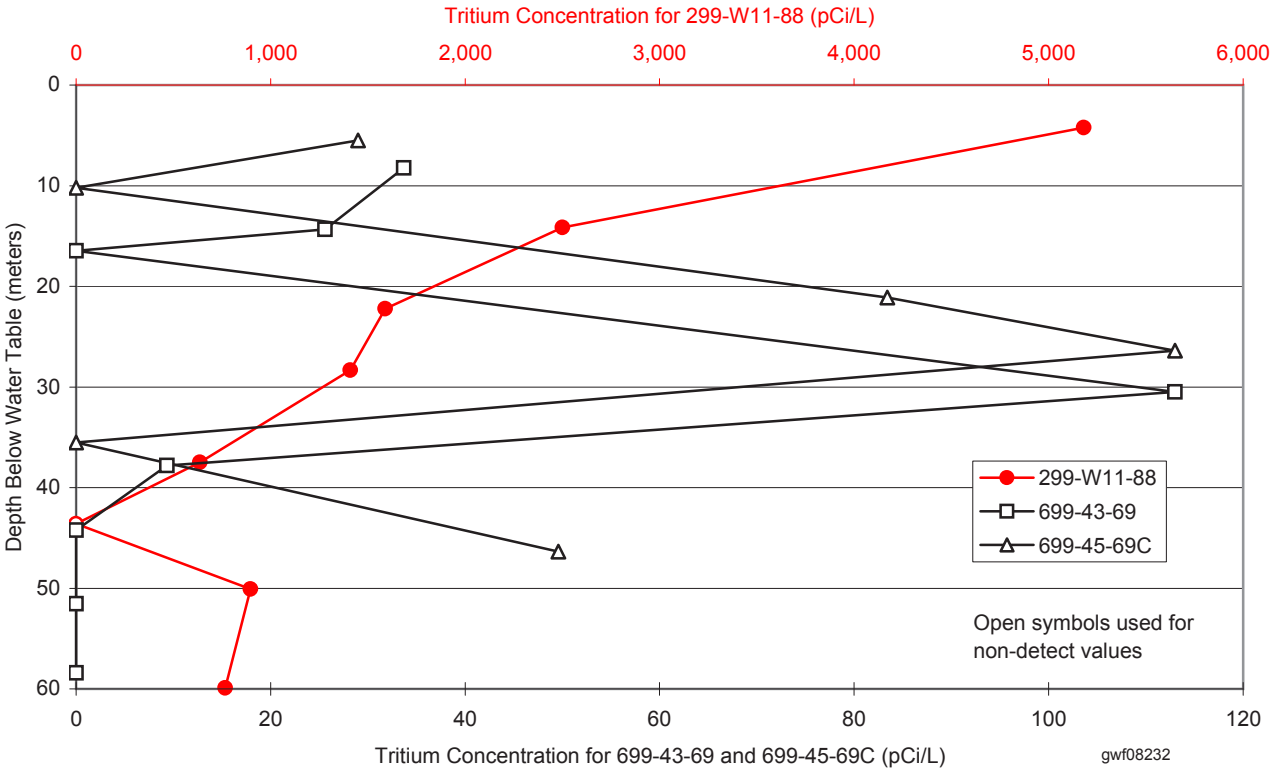


Figure 2.8-12. Average Iodine-129 Concentrations in Northern 200 West Area, Upper Part of Unconfined Aquifer.

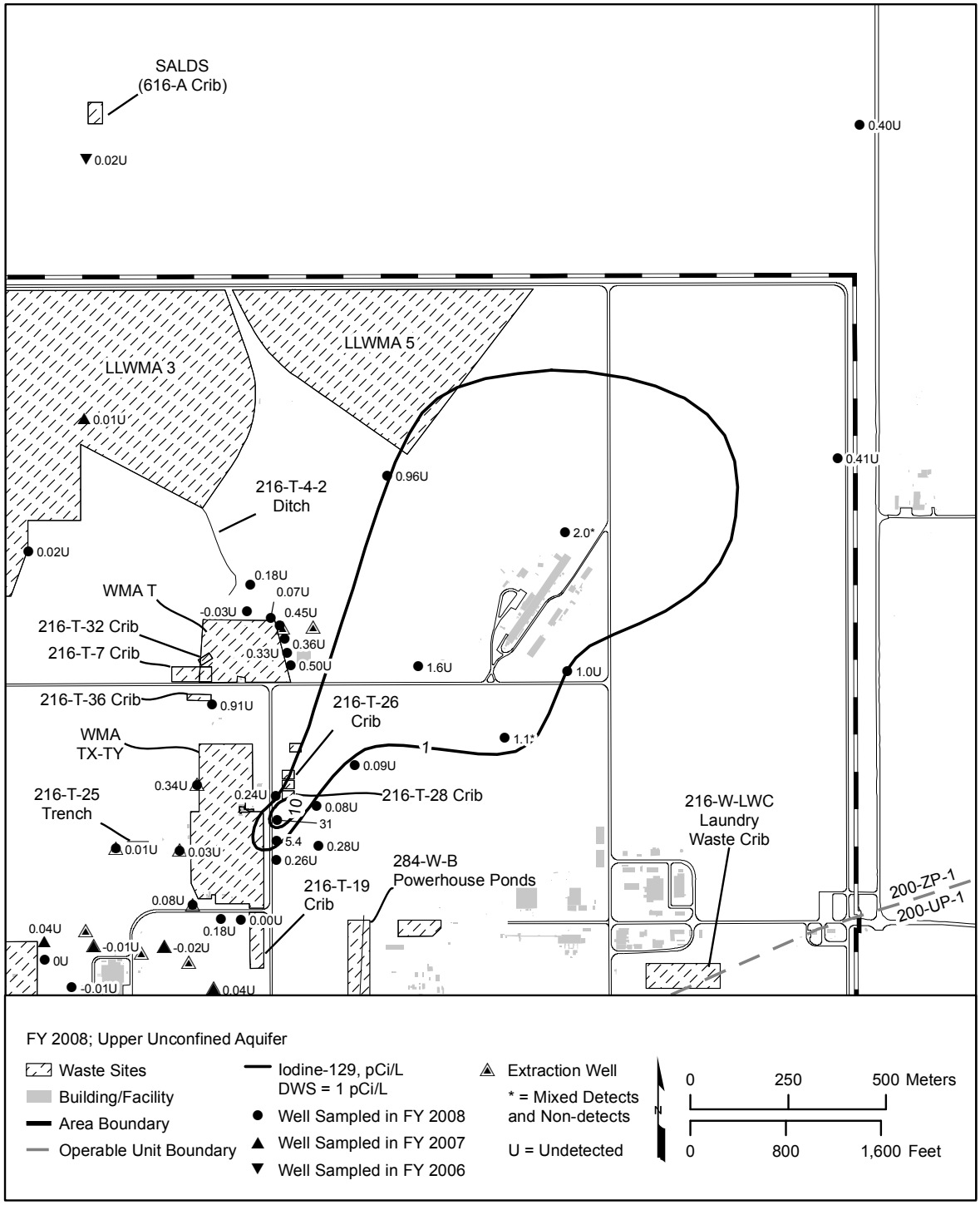


Figure 2.8-13. Average Technetium-99 Concentrations in Northern 200 West Area, Upper Part of Unconfined Aquifer.

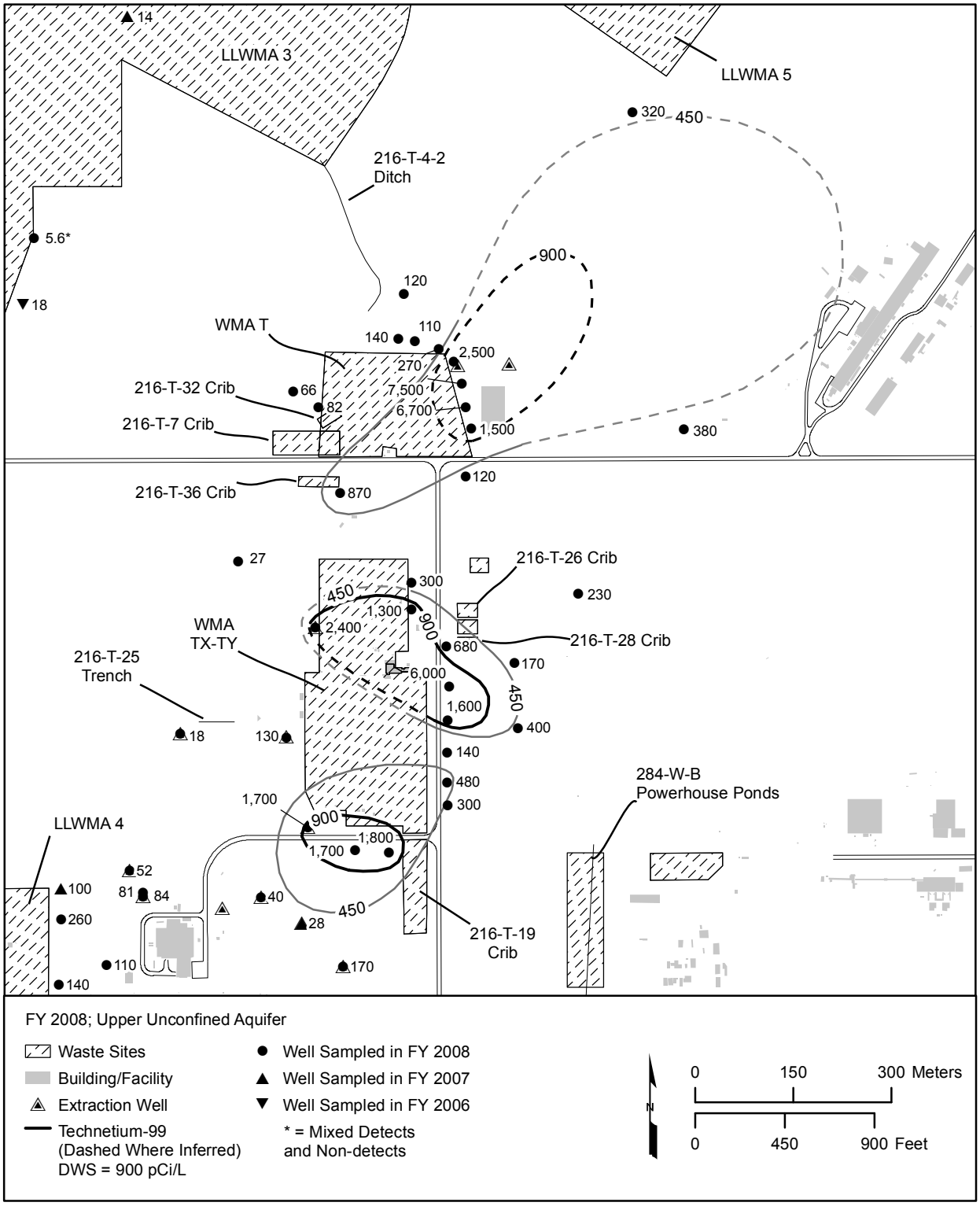


Figure 2.8-14. Technetium-99 Concentrations During Drilling in New Wells 299-W11-88, 699-43-69, and 699-45-69C.

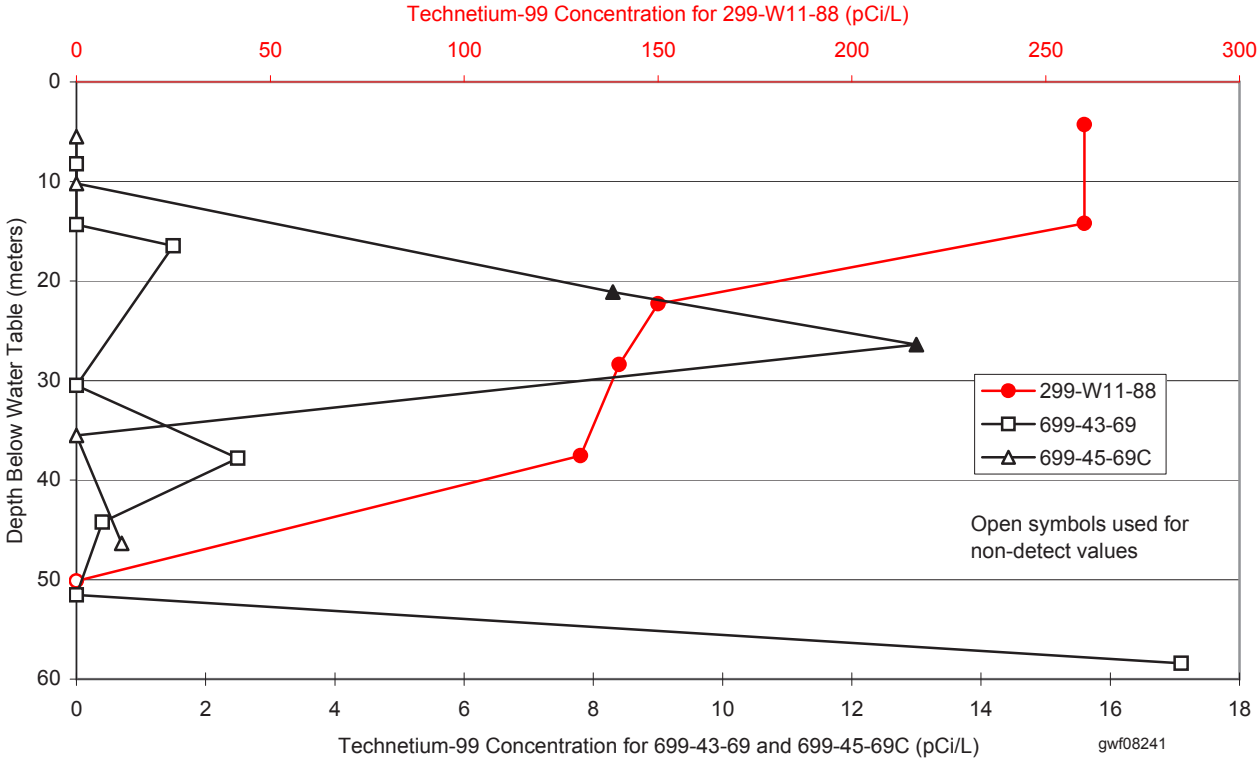


Figure 2.8-15. Carbon Tetrachloride Concentrations in Four Wells Converted to Extraction Wells in FY 2008.

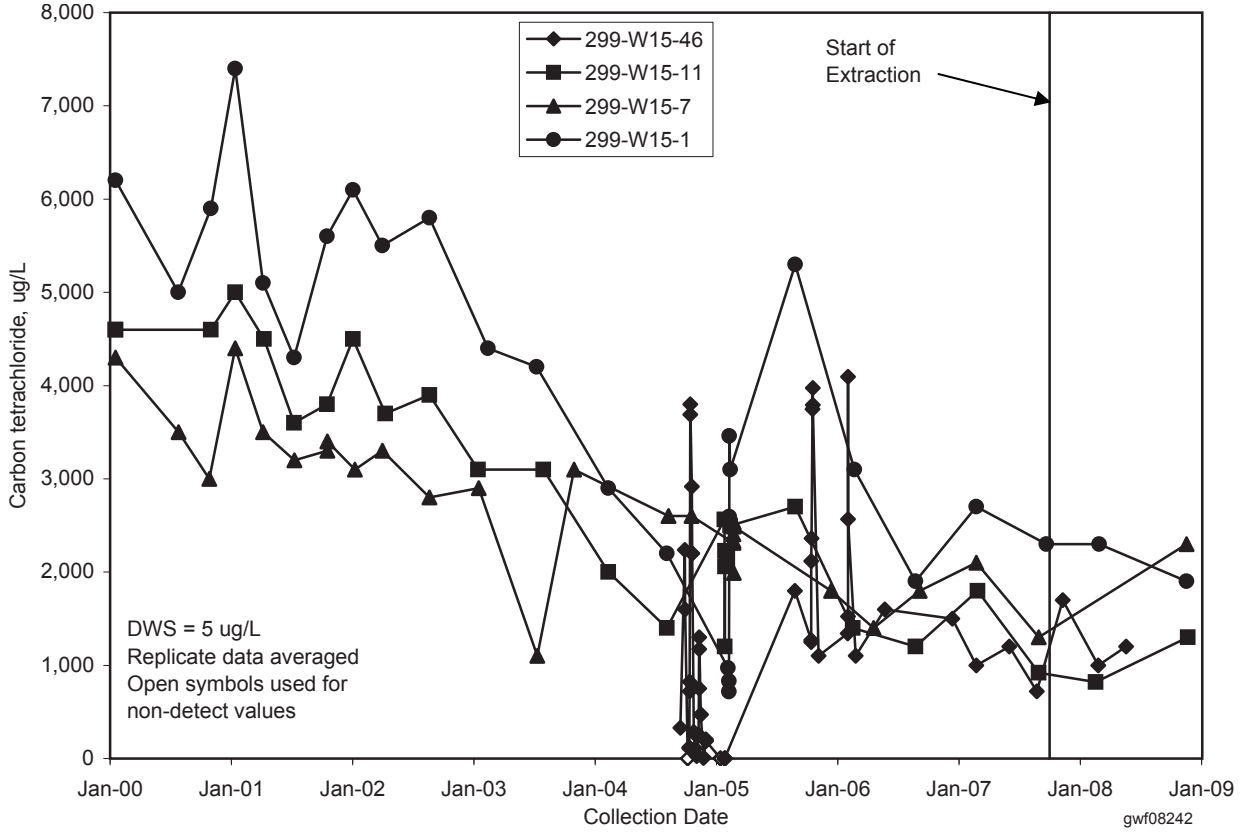


Figure 2.8-16. Carbon Tetrachloride Concentrations in the 200-ZP-1 Pump-and-Treat System.

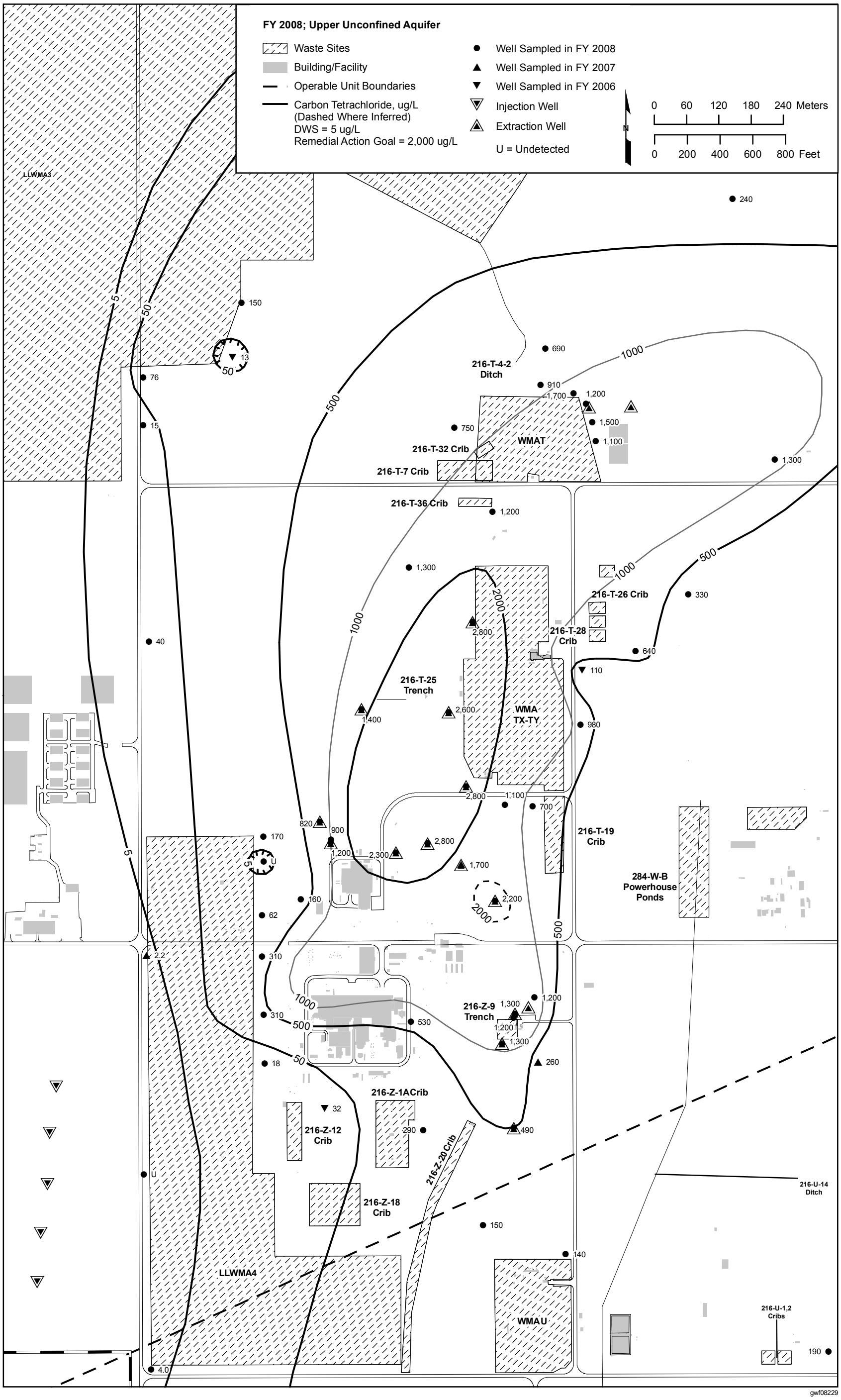
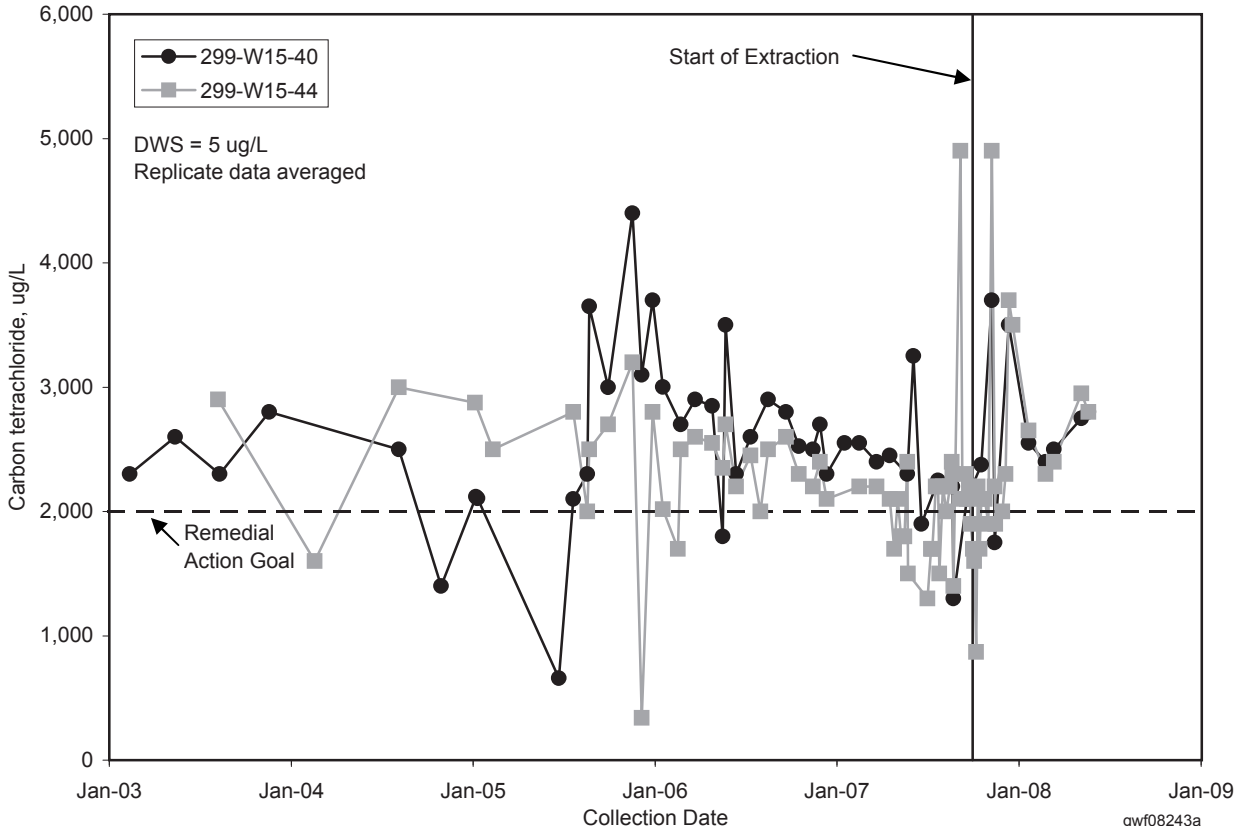


Figure 2.8-17. Carbon Tetrachloride Concentrations Exceeding the Remedial Action Goal.



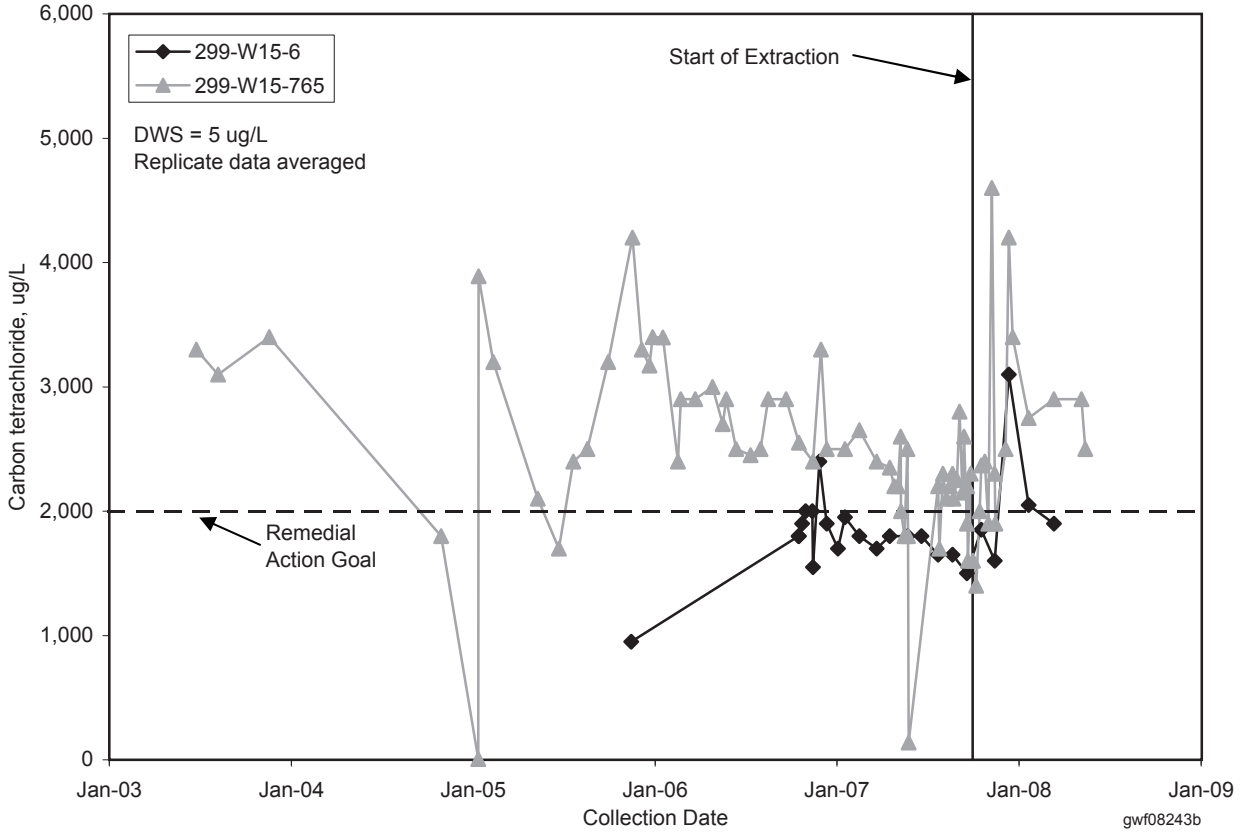


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Figure 2.8-18. Hydrographs for Selected Wells in Waste Management Area T.

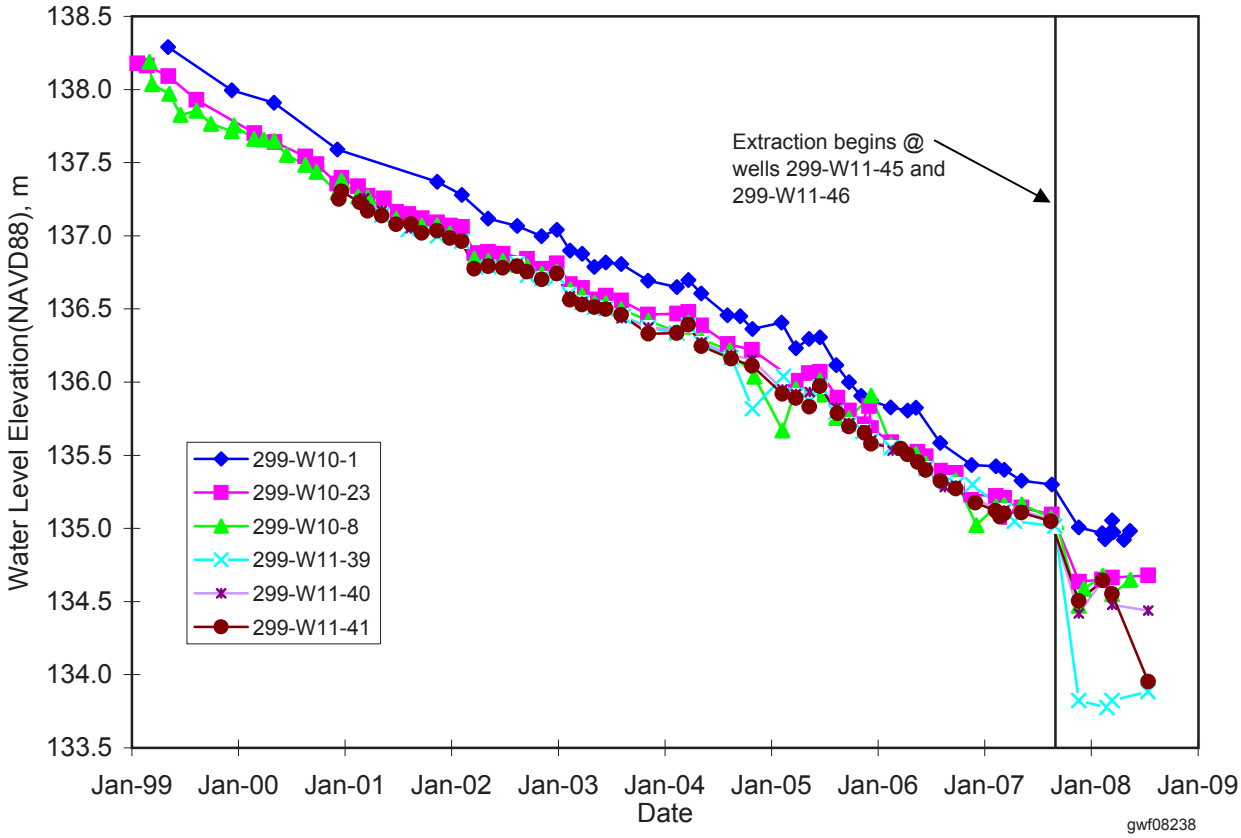


Figure 2.8-19. Technetium-99 Concentrations in Selected Water-Table Wells Downgradient of Waste Management Area T.

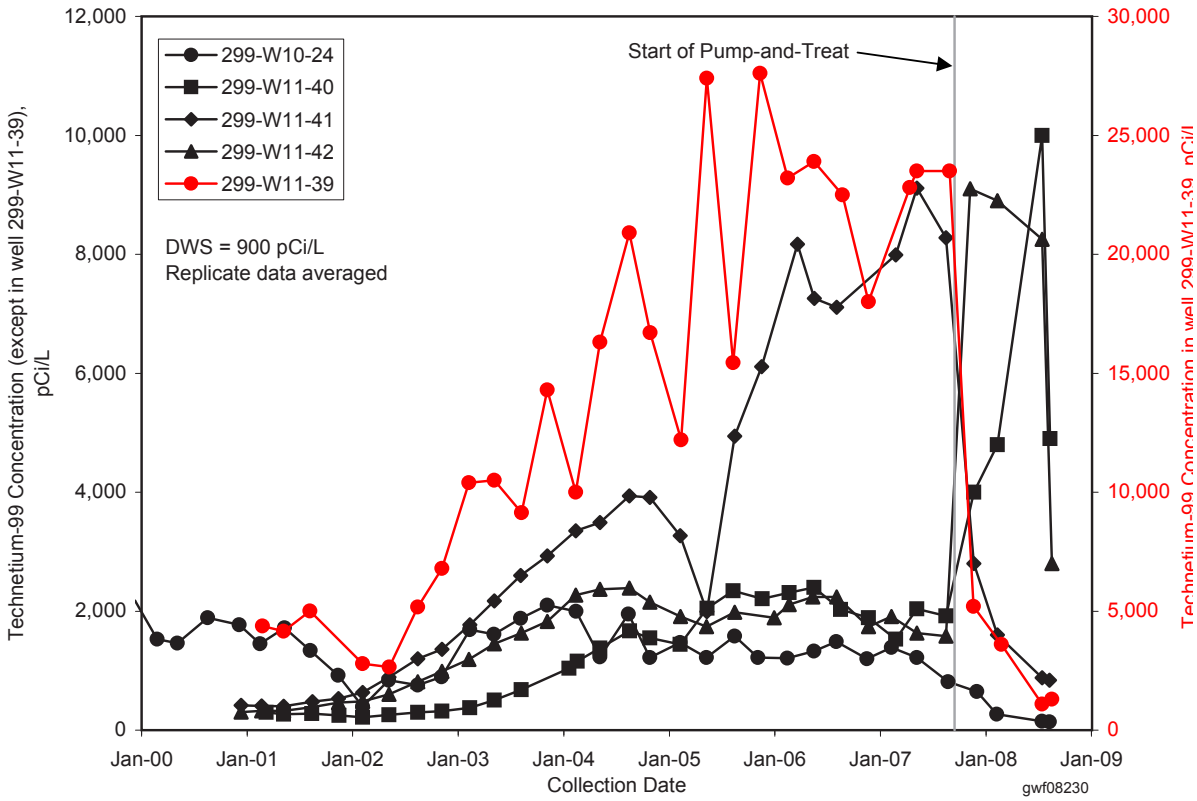


Figure 2.8-20. Technetium-99 Concentrations in Selected Wells Downgradient of Waste Management Area T, Screened at Depth in the Aquifer.

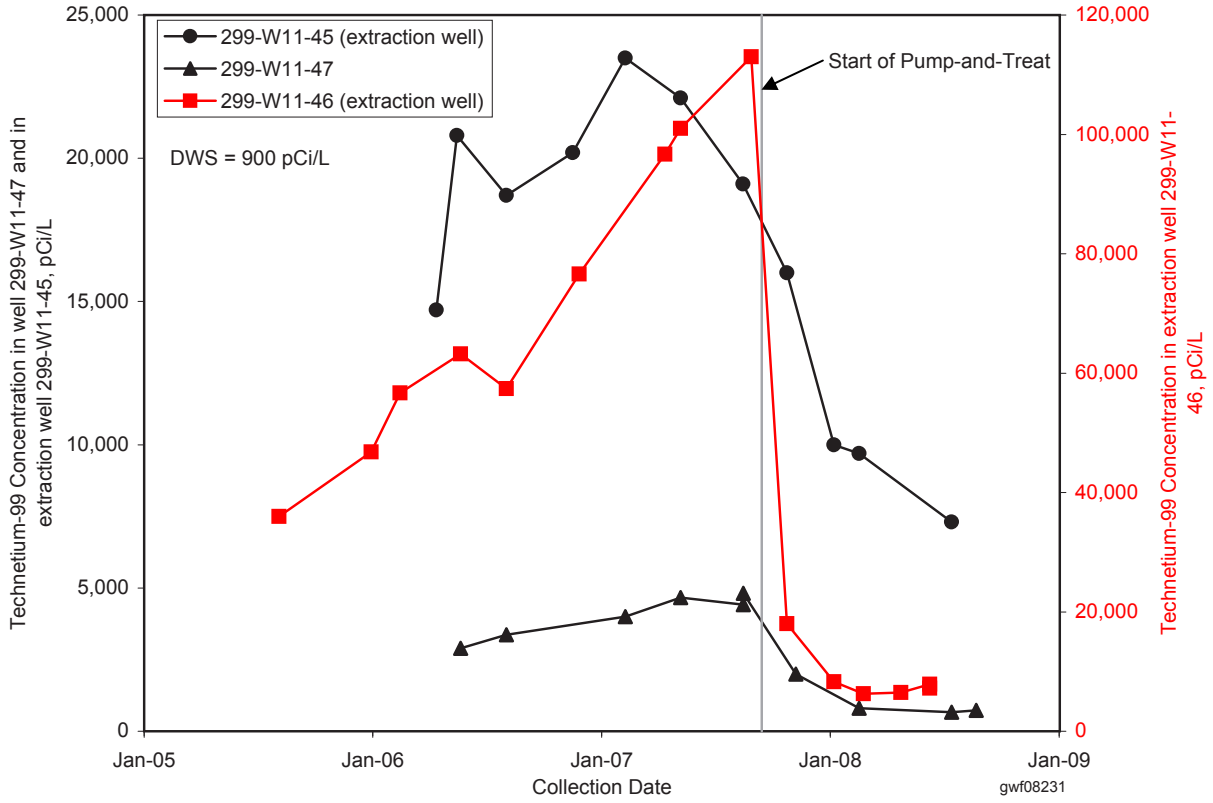


Figure 2.8-21. Chromium and Iodine-129 Concentrations in Well 299-W14-15 at Waste Management Area TX-TY.

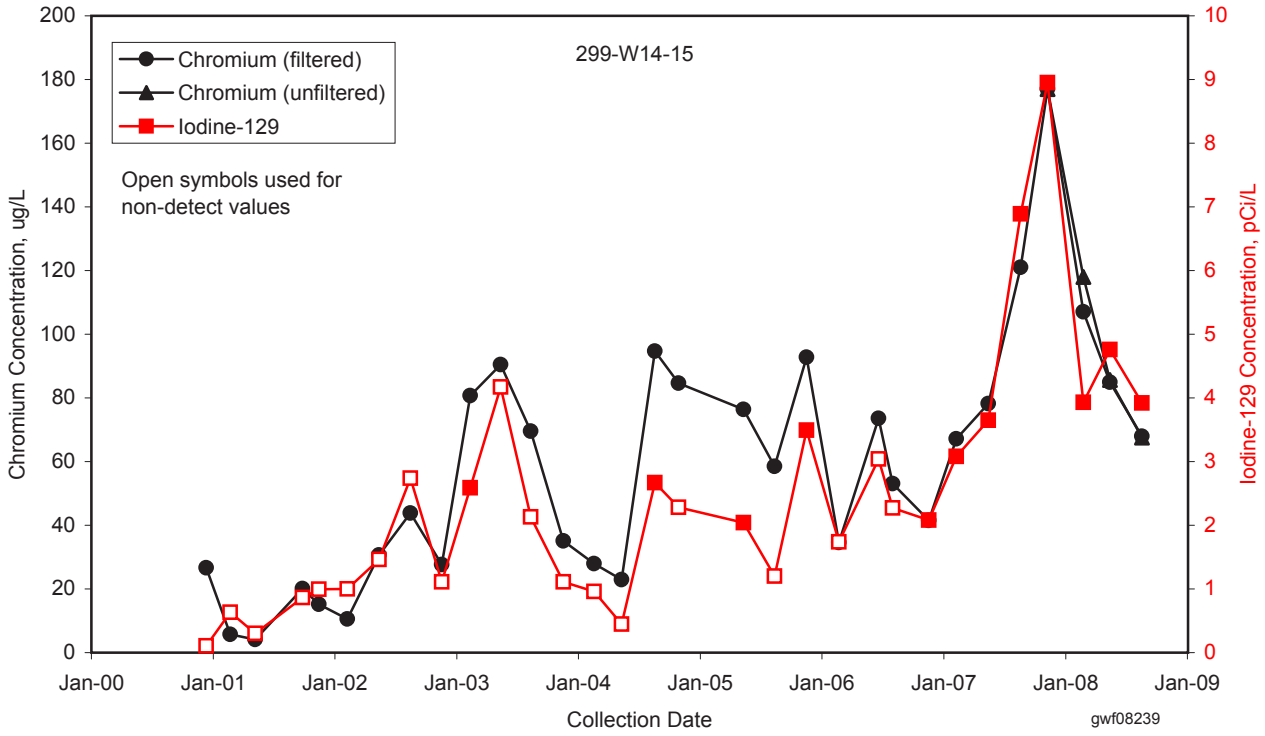


Figure 2.8-22. Nitrate, Tritium, and Technetium-99 Concentrations in Well 299-W14-15 at Waste Management Area TX-TY.

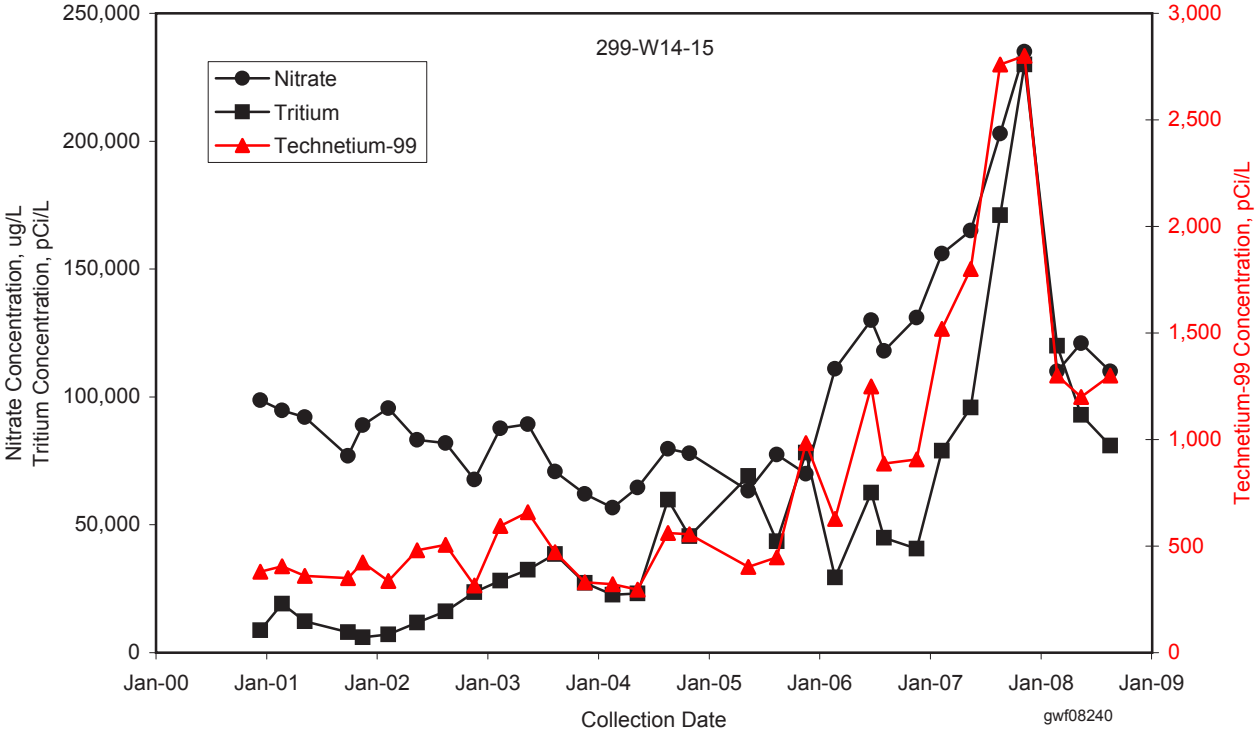
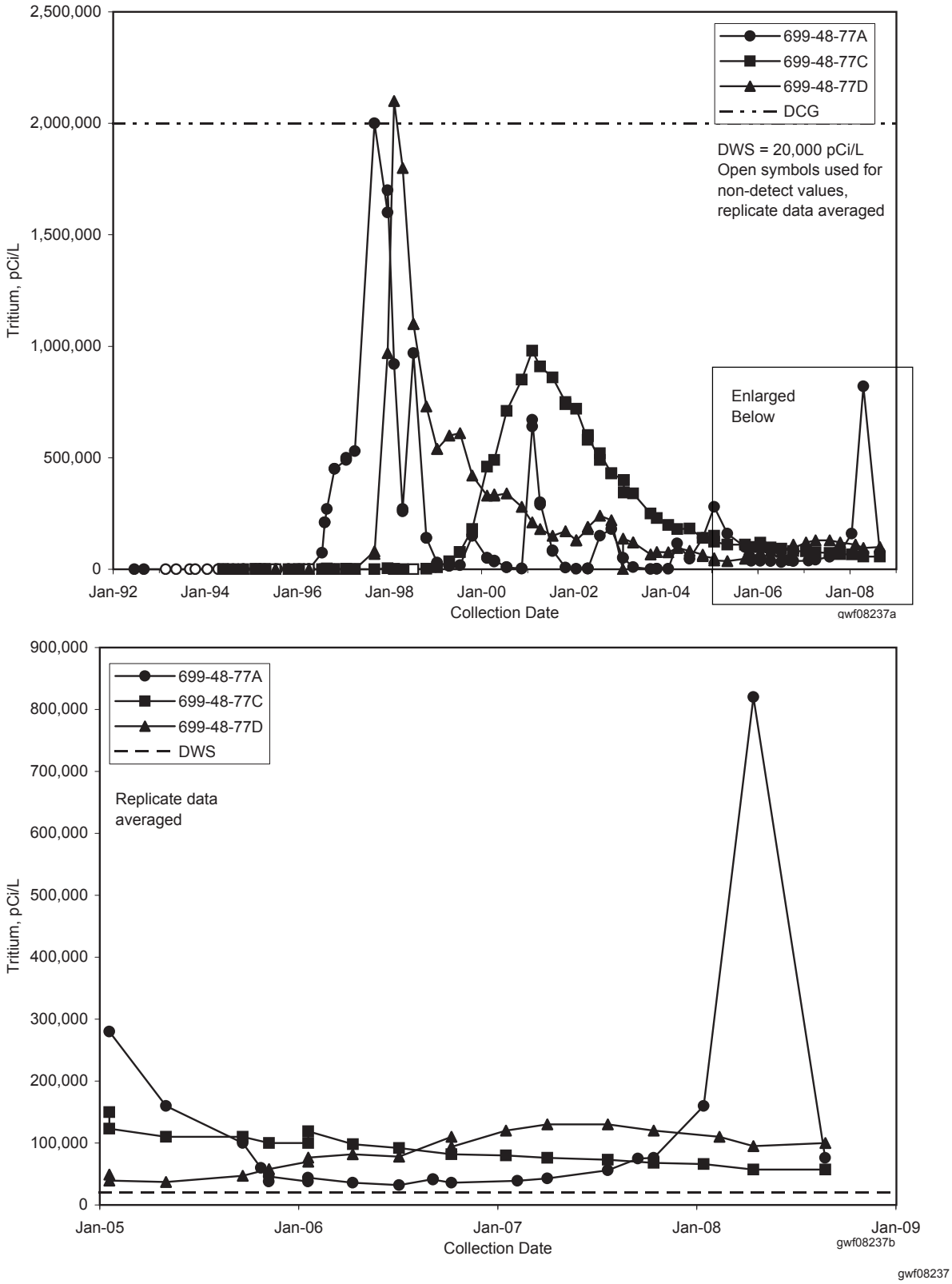


Figure 2.8-23. Tritium Concentrations in Wells Monitoring the State-Approved Land Disposal Site.



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