

300-FF

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300-FF Overview

The 300-FF groundwater interest area is located in the southeastern Hanford Site. It includes the 300-FF-5 operable unit (OU), where groundwater was contaminated by releases at the 300 Area Industrial Complex, the 618-10 Burial Ground/316-4 Crib, and the 618-11 Burial Ground. Table FF.1 summarizes key facts about 300-FF.

300-FF groundwater contamination originated primarily from historical routine disposal of liquid effluent associated with fabrication of nuclear fuel assemblies and research involving the processing of irradiated fuel. Because principal liquid waste disposal facilities have been out of service for decades and most have been remediated by removing contaminated soil (Section 4.0 of [DOE/RL-2004-74](#)), the contamination remaining in the underlying vadose zone and aquifer is residual.

The groundwater in 300-FF is monitored under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), *Atomic Energy Act of 1954* (AEA), and *Resource Conservation and Recovery Act of 1976* (RCRA) ([DOE/RL-95-73](#); [WHC-SD-EN-AP-185](#)). The primary contaminants in the groundwater are uranium, trichloroethene (TCE), *cis*-1,2-dichloroethene (DCE), tritium, and nitrate. The former 300 Area Process Trenches (316-5) are an inactive treatment, storage, and disposal unit regulated under RCRA and undergoing post-closure monitoring.

Groundwater in the unconfined aquifer beneath the southeastern portion of the Hanford Site flows east or southeast toward the Columbia River (Figure FF.1). This flow direction is induced by regional groundwater flow that converges from the northwest, west, and southwest. Flow patterns throughout the region are complicated by the variable permeability of sediment in the upper portion of the unconfined aquifer. Near the Columbia River, groundwater flow is also influenced by river-stage fluctuations. In 2013, groundwater underlying the 300 Area Industrial Complex flowed south-southeast during low river stage (based on measurements made in March) and south-southwest during high river stage (based on measurements made in June).

Contamination is generally found in the upper portion of the unconfined aquifer (i.e., the interval of Hanford formation gravelly sediment that lies below the water table) (Figure FF.2). The thickness of the contaminated portion of the unconfined aquifer is variable because of the undulating contact between the Hanford formation and the underlying Ringold Formation unit E. In addition, significant seasonal fluctuations in water table elevation (Section 3.0 of [PNNL-17034](#)) affect the thickness of the contaminated zone.

Beneath the 300 Area Industrial Complex, the undulating contact reflects paleochannels that act as preferential pathways for groundwater flow (Figure 4-89 in [DOE/RL-2010-99](#)). In the 300 Area, contaminant discharge to the river occurs via riverbank springs that flow across the beach region (riparian zone) during periods of low river stage and by upward movement through the riverbed.

Table FF.1 300-FF at a Glance

Fabrication of nuclear fuel assemblies: 1943–1987 Research in irradiated fuel processing: 1950s–1960s 300-FF includes 300 Area Industrial Complex, 618-10 Burial Ground/316-4 Crib, and 618-11 Burial Ground				
2013 Groundwater Monitoring				
Contaminant	Cleanup Level^a	Maximum Concentration	Plume Area^b (km²)	Shoreline Impact (m)
Uranium (300 Area)	30 µg/L	462 µg/L (399-1-55)	0.50	1430
<i>cis</i> -1,2-dichloroethene (DCE) (300 Area)	16 µg/L	220 µg/L (399-1-16B)	Undefined ^c	Undefined ^c
Trichloroethene (TCE) (300 Area)	4 µg/L	430 µg/L (AT-3-3-D)	Undefined ^c	Undefined ^c
Tritium (618-11)	20,000 pCi/L	1,000,000 pCi/L (699-13-3A)	0.13 ^e	None ^e
Nitrate (618-11)	45 mg/L ^d	122 mg/L (399-1-62)	0.19 ^e	None
Remediation				
Waste Sites (interim action): In progress 2013; 90 percent complete ^f . Groundwater (interim action): Monitored natural attenuation and institutional controls on the use of groundwater. Record of Decision for final remedial action issued in November 2013; implementation anticipated in 2014.				

- a. Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1, Hanford Site 300 Area (EPA et al., 2013)
- b. Estimated area at a concentration greater than the cleanup standard.
- c. Organics are locally present in deeper sediments. Plumes cannot be defined by current data.
- d. 45 mg/L Nitrate ≈ 10 mg/L NO₃-N; DWS
- e. Excludes tritium and nitrate in plume associated with 200-PO and nitrate from off-site.
- f. Sites with status of closed, interim closed, no action, not accepted, or rejected.

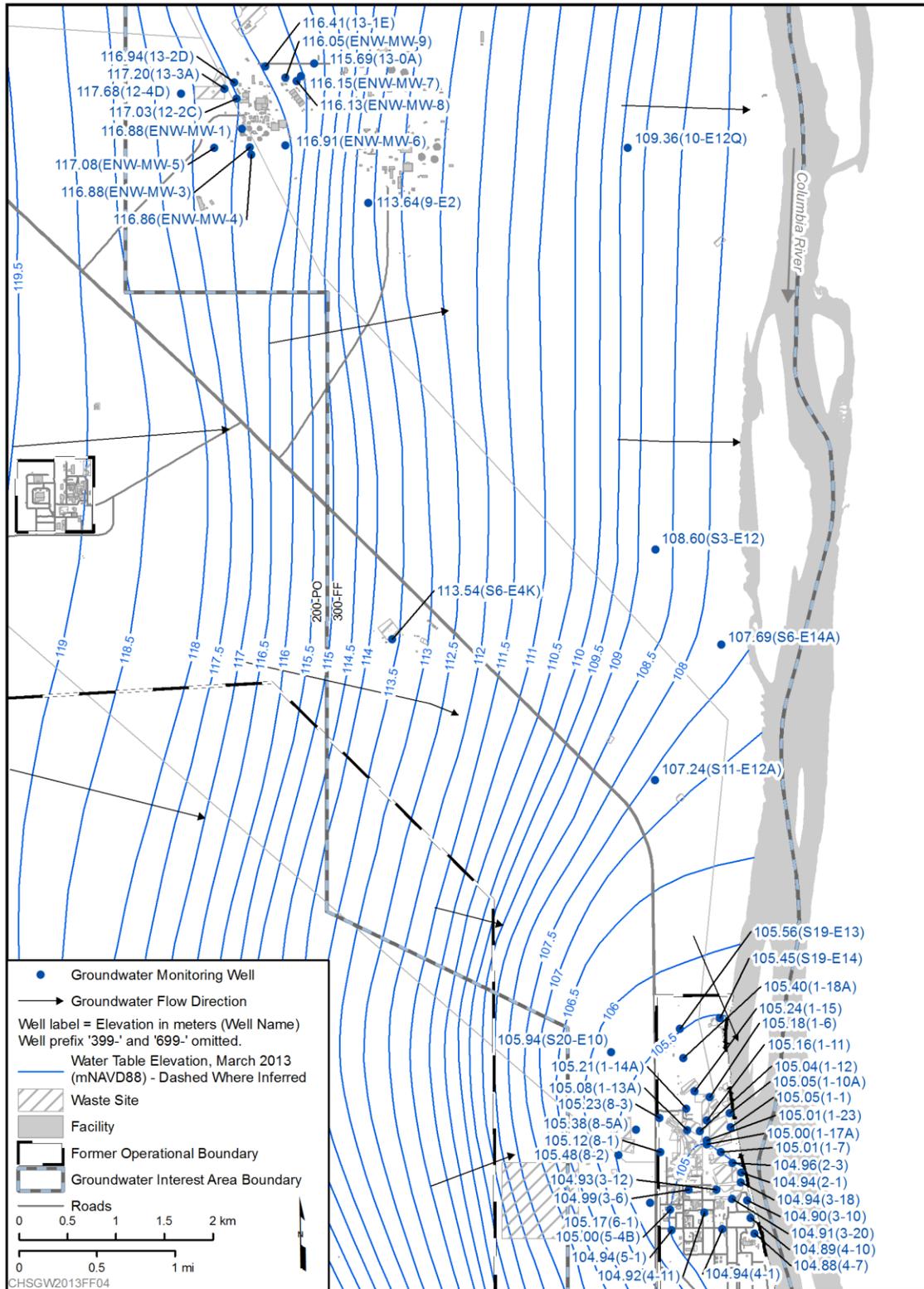


Figure FF.1 300-FF Overview Map with Groundwater Flow

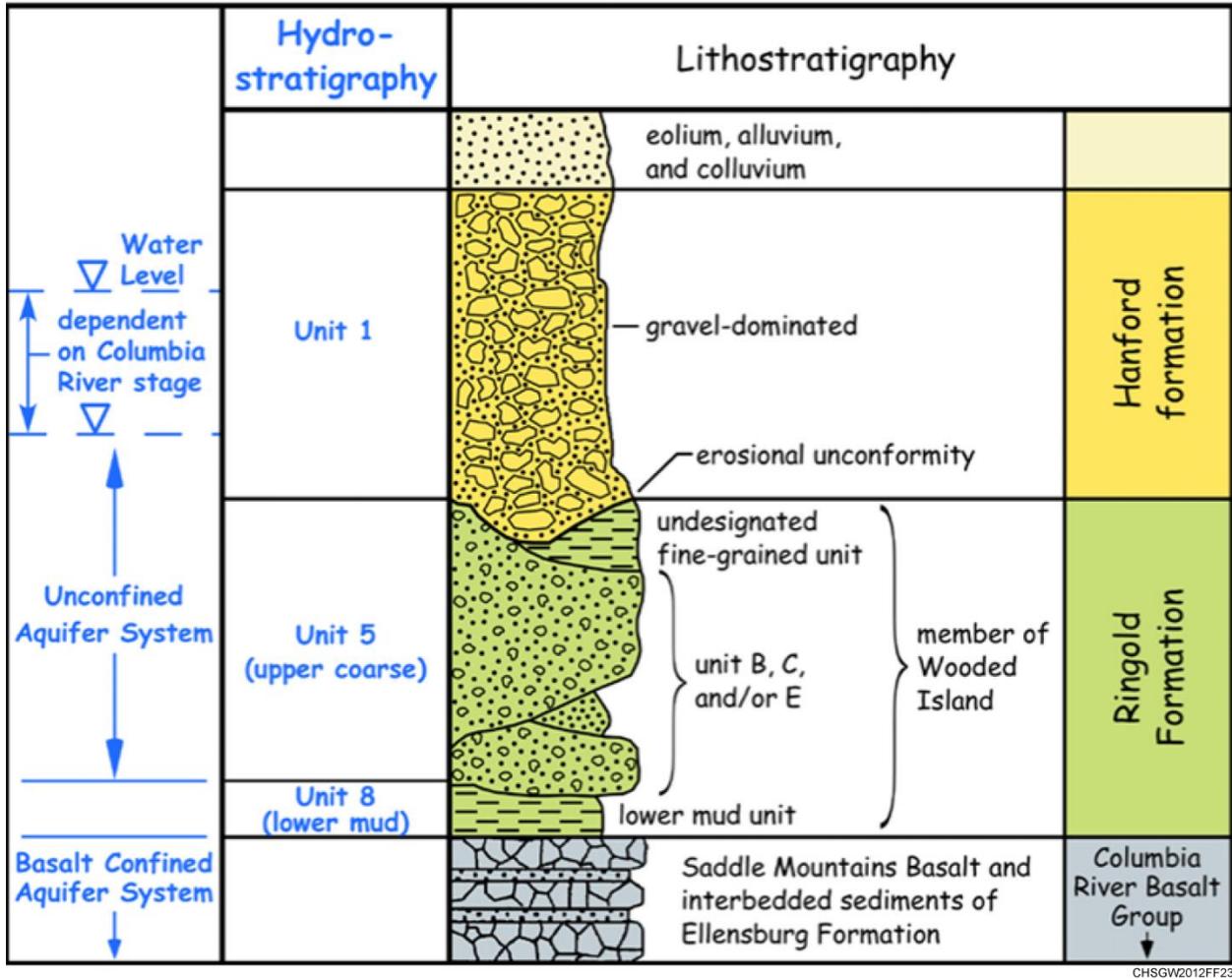


Figure FF.2 300-FF Geology

The rate of contaminant discharge to the river is influenced by daily and seasonal river-stage fluctuations (Section 3.1 of [PNNL-17708](#); Section 2.4.1 of [PNNL-22048](#)). The highest seasonal river elevations typically occur from May through June, and the lowest seasonal river elevations typically occur from September through mid-November (Section 4.4.2 of [DOE/RL-2010-99](#)). Effects of high river elevations include temporary reversal of flow direction, dilution of contamination in groundwater near the river by the intrusion of clean river water, and possible influences on contaminant mobility caused by changes in the geochemical environment. Changes in the geochemical environment are most pronounced where river water intrudes into the aquifer. River water is lower in alkalinity (lower in bicarbonate content) and lower in specific conductance than groundwater (Section 3.6.1.4 of [DOE/RL-2010-99](#)).

Figure FF.3 illustrates how estimates of plume areas in the 300-FF groundwater interest area have changed since 2003.

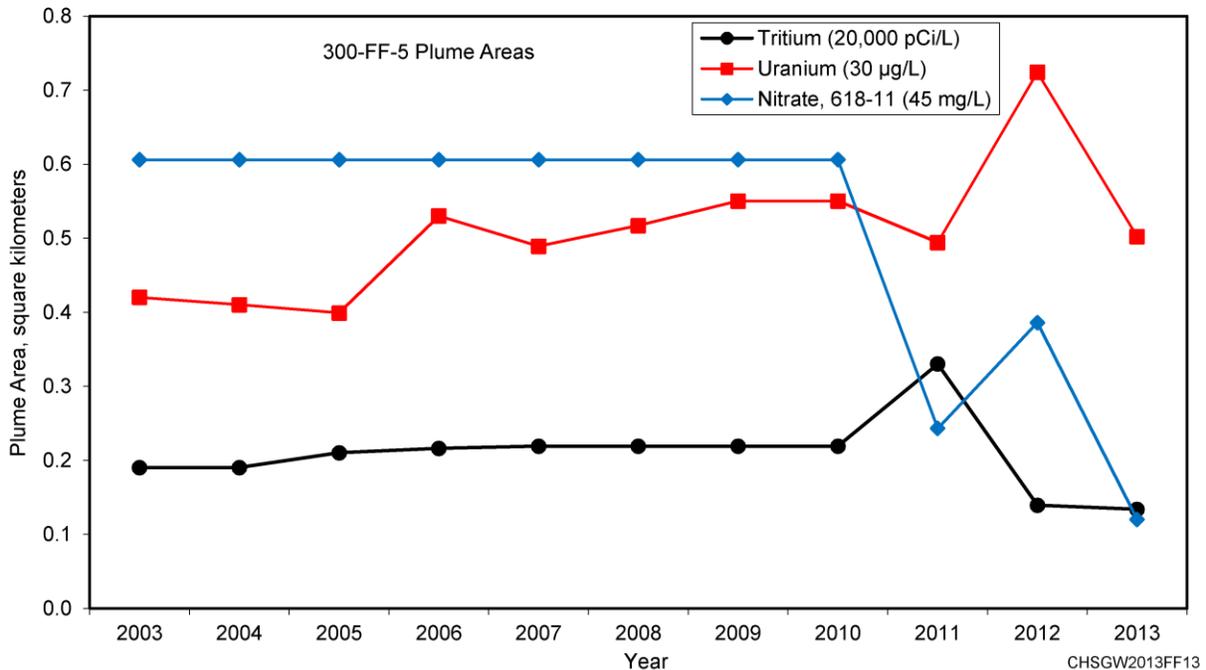


Figure FF.3 300-FF-5 Plume Areas

300-FF CERCLA Activities

The remedial investigation (RI)/feasibility study (FS) ([DOE/RL-2010-99](#), [DOE/RL-2010-99-ADD1](#)) and the proposed plan ([DOE/RL-2011-47](#)) for the 300-FF-5 OU were issued in early July 2013. The public comment period on the proposed plan occurred in July and August 2013. The Record of Decision (ROD) ([EPA et al., 2013](#)) was signed by the Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) on November 25, 2013. The contaminants of concern for groundwater are uranium, gross alpha, TCE, and DCE at the 300 Area Industrial Complex; and tritium and nitrate at the 618-11 Burial Ground.

The remedial action objectives identified in the ROD for 300-FF-5 are as follows:

- Prevent human exposure to groundwater containing concentrations of contaminants of concern (COC) above cleanup levels.
- Prevent COCs migrating and/or leaching through soil that will result in groundwater concentrations above cleanup levels for protection of groundwater, and of surface water concentrations above cleanup levels for the protection of surface water at locations where groundwater discharges to surface water.
- Restore groundwater impacted by Hanford Site releases to cleanup levels which include drinking water standards (DWSs), within a timeframe that is reasonable given the particular circumstances of the site.

The remedial action objectives will be achieved through four remedy components: monitored natural attenuation (MNA) for nitrate, tritium, TCE, and DCE; groundwater monitoring for uranium, gross alpha, nitrate, tritium, TCE, and DCE; enhanced attenuation of uranium using sequestration by phosphate application at the top of aquifer; and institutional controls (ICs).

In accordance with the 2013 ROD, the in-progress interim action will use the cleanup levels in the ROD immediately upon issuance of the ROD. All other aspects of the interim action will continue to be performed in accordance with the existing documents for the interim action. The remedial design report (RDR)/remedial action (RA) work plan (WP) that implements the 2013 ROD is anticipated to be issued in 2014. When the new RDR/RA WP is approved, it will direct future remedial actions and will replace all interim action ROD work plan requirements.

The remedy selected for the 300-FF-5 OU in the 1996 interim action ROD ([EPA/ROD/R10-96/143](#)) was MNA and ICs. Groundwater monitoring required under the 1996 interim action ROD is implemented through a sampling and analysis plan ([DOE/RL-2002-11 Rev 2](#)). Comprehensive sampling events occur semiannually. Most monitoring wells have screens positioned to include the zone occupied by the water table. Several wells are screened in the lower portion of the unconfined aquifer and a few wells are screened in the uppermost confined aquifer.

Wells and aquifer tubes were sampled as planned during 2013, with the following exception. The sampling scheduled for December 2013 was conducted in early 2014 (primarily in January 2014) due to resource constraints. Other minor exceptions to planned monitoring occurred because of maintenance issues and scheduling constraints. Appendix A lists the sampling frequencies, types of laboratory analyses, and sample status for 2013 for the 300-FF-5 OU monitoring wells. Appendix C lists the aquifer tubes. Figure FF.4 shows locations of wells and aquifer tubes sampled in 2013.

DOE's Office of Science, Biological, and Environmental Research (now PNNL Scientific Focus Area) is supporting field research to address the mobility of uranium in the environment under a program referred to as the Integrated Field-Scale Research Challenge. The focus of the research is multi-scale, mass-transfer processes that control the sequestration and mobility of uranium contamination in the subsurface, including the vadose zone and groundwater. During 2013, the following three reports on the field experiments were issued: [PNNL-21733](#); [PNNL-22032](#); and [PNNL-22048](#).

300-FF Uranium

Large volumes of liquid waste containing uranium were discharged to the former South Process Pond (316-1) (1943 to 1975), North Process Pond (316-2) (1948 to 1975), and 300 Area Process Trenches (316-5) (1975 to 1987). Discharge of cooling water with small quantities of non-hazardous maintenance and process waste continued at the 300 Area Process Trenches until December 1994 (Section 2.1 of [PNNL-13645](#)). Contaminated soil was removed from the 300 Area Process Trenches in 1991; additional excavation of contaminated soil occurred at this site and at other major liquid waste disposal sites in the 300 Area Industrial Complex from 1997 through 2000.

The areal extent of uranium-contaminated groundwater that exceeds the cleanup level (30 µg/L, DWS) is estimated to be 0.5 square kilometers beneath the 300 Area Industrial Complex. The persistence of the plume is attributed to resupply of mobile uranium from sources in the vadose zone and the periodically rewetted zone (the deepest part of the vadose zone through which the water table rises during high river stage) (Section 4.4.4.3 of [DOE/RL-2010-99](#)).

300-FF Uranium – Low River Stage

During seasonal low water table conditions, the highest uranium concentrations are often observed near the river, where uranium introduced inland during the preceding period of high water table conditions (due to groundwater contact with residual uranium in the lower vadose zone) has migrated downgradient to the shoreline, and intrusion of river water into the zone beneath the shoreline is lessened because of the lower river stage (Section 3.3 of [PNNL-17034](#)). The plume map (Figure FF.5) shows the uranium concentrations for the seasonal low water table conditions in January 2014 (most of the wells scheduled for sampling in December 2013 were not sampled until January 2014). Figures FF.6 and FF.7 show the uranium concentration trends at locations representative of near-river conditions.

An area of uranium groundwater contamination developed in 2008 downgradient from the former 618-7 Burial Ground. The contaminant plume resulted from the infiltration of dust-control water and soil fixatives used during remediation activities conducted at this site during 2007 and 2008. In addition to uranium, increases in the concentrations of chromium and constituents associated with soil fixatives (for example, calcium and chloride) also occurred at well 399-8-5A, which is adjacent to the waste site. By the end of 2010, concentrations at nearby downgradient wells 399-8-5A and 399-8-1 continued to decrease, indicating passage of the contaminant plume (Figure FF.8). However, uranium concentrations increased again in samples collected after the seasonal high water table conditions in 2011 (August), in 2012 (August and November), and in 2013 (August), suggesting that mobile uranium remains in the lower portion of the vadose zone near well 399-8-5A. The uranium plume appears to be recognizable along its projected migration path. Increases in uranium concentrations above DWS were measured in 2013 during low water conditions at the nearest downgradient well (well 399-8-1, approximately 340 meters to the southeast) (Figure FF.5) and during the following high water conditions at monitoring wells 399-6-3 and 399-1-59 (approximately 595 meters and 810 meters, respectively, to the southeast) (Figure FF.9). Some variability in uranium concentrations at downgradient wells, such as well 399-3-6, may be associated with the migration of this plume.

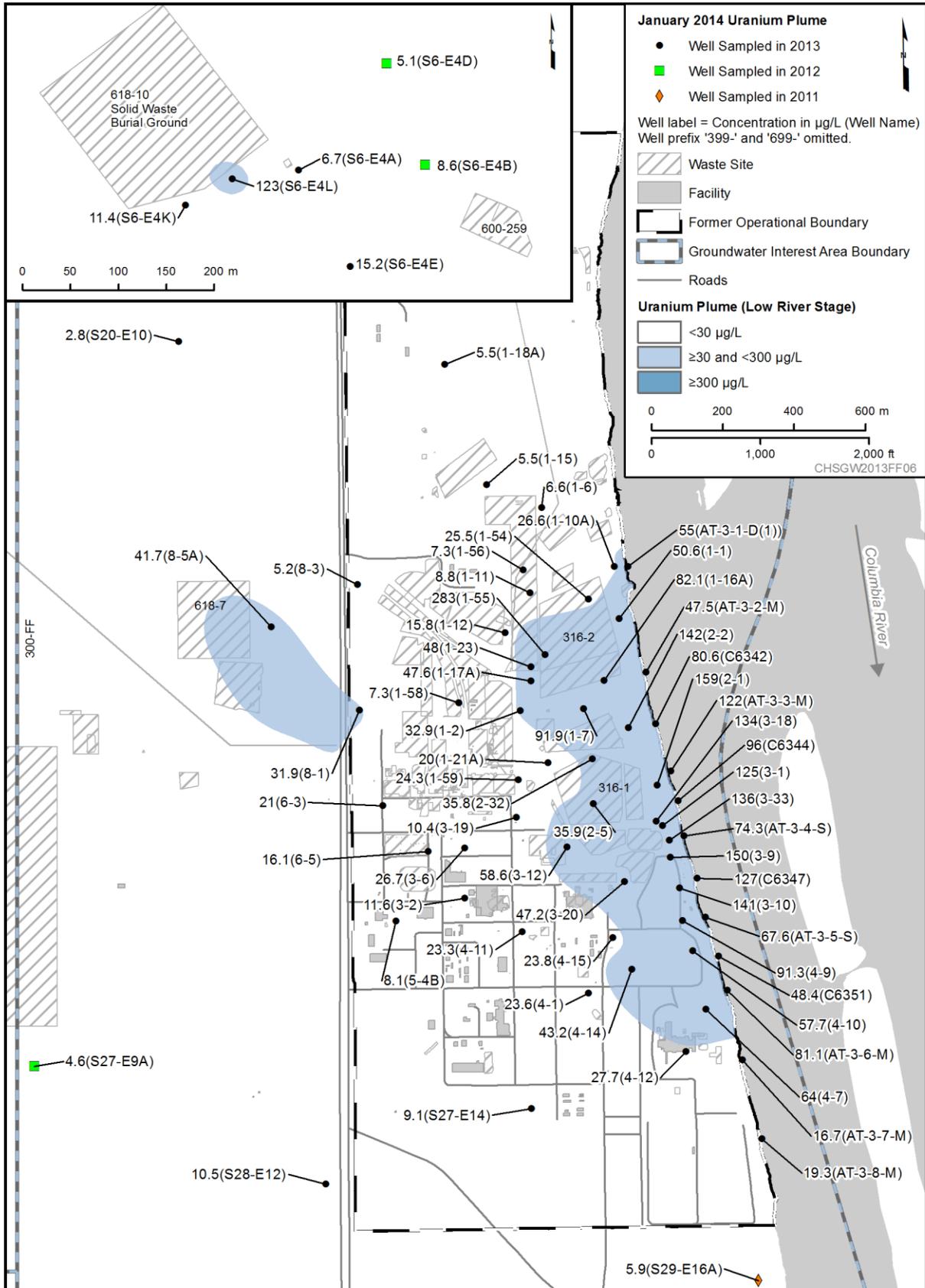


Figure FF.5 300-FF 2012 Uranium Plume, January 2014 (Low River Stage)

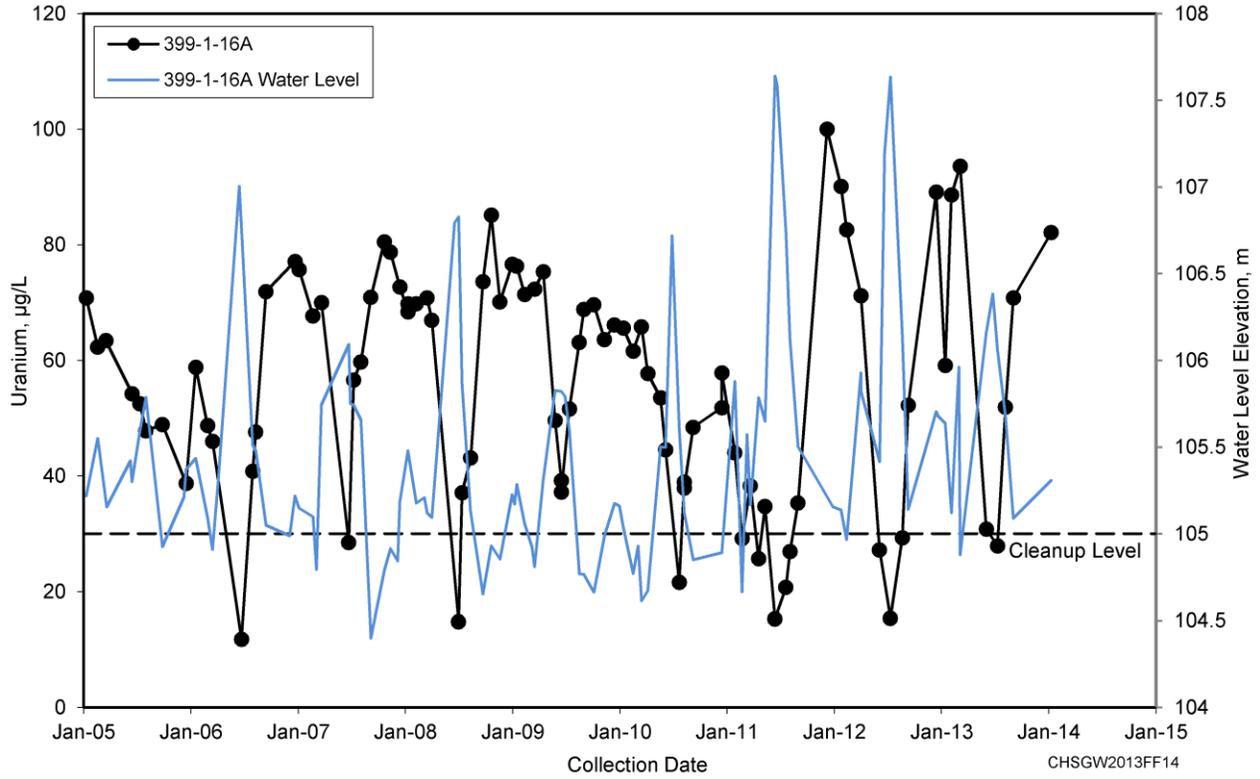


Figure FF.6 Uranium and Water Level Data for Well 399-1-16A (Near River)

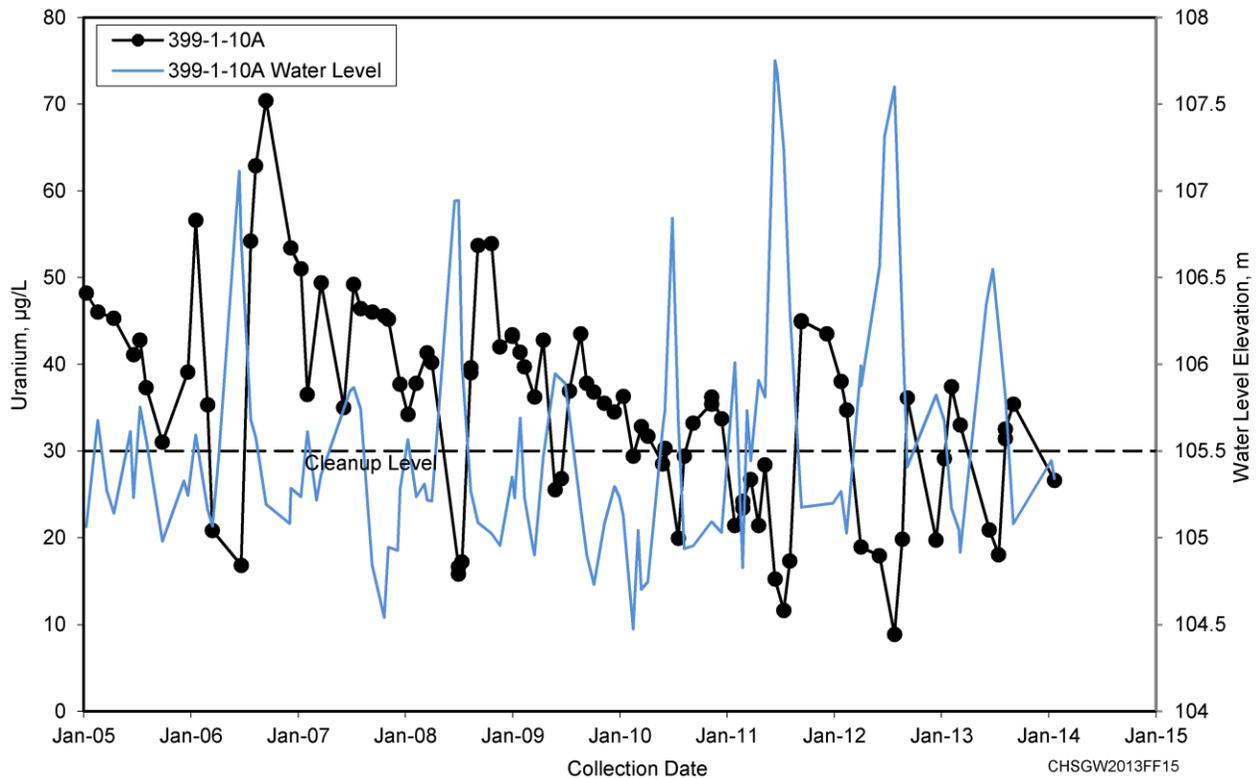


Figure FF.7 Uranium and Water Level Data for Well 399-1-10A (Near River)

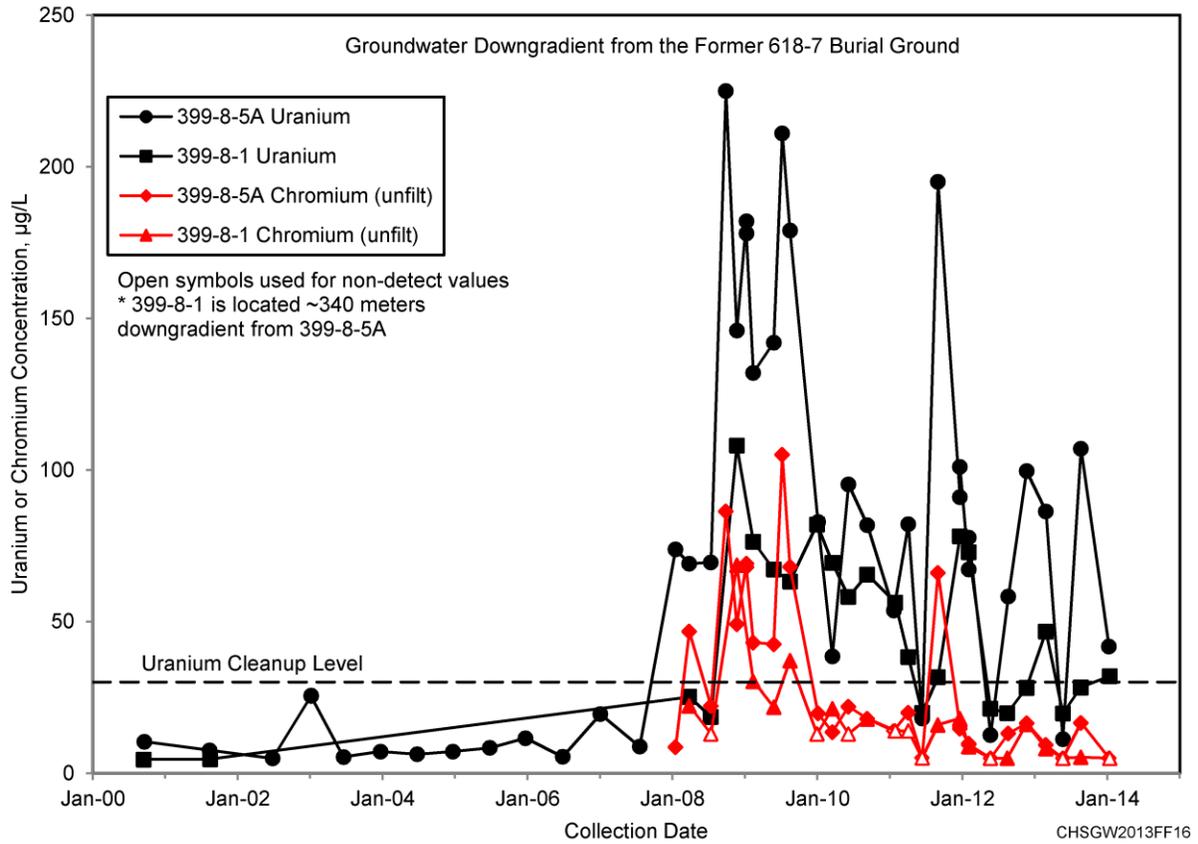


Figure FF.8 Uranium and Chromium Data for Wells 399-8-5A and 399-8-1, Downgradient of 618-7 Burial Ground

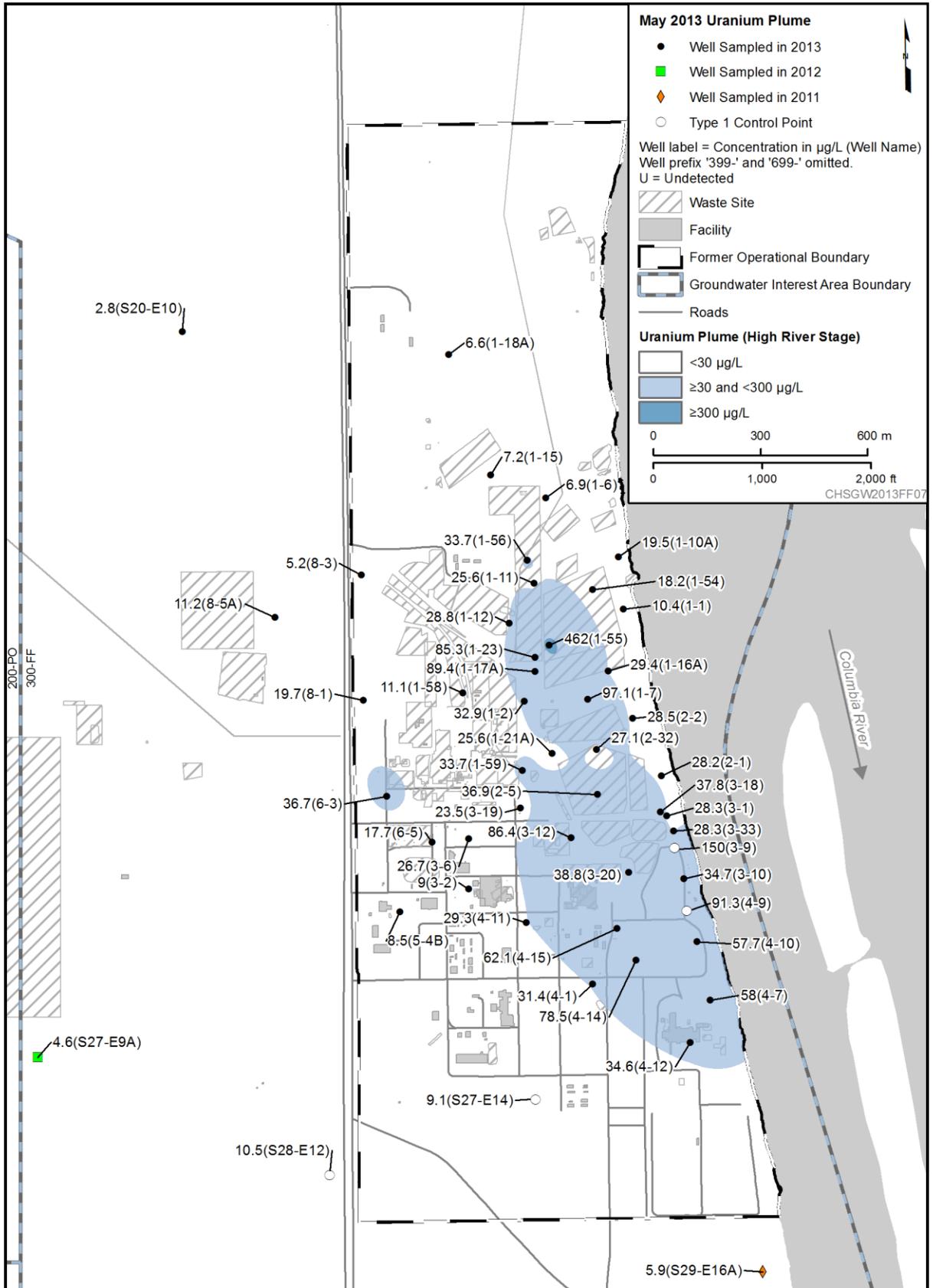


Figure FF.9 300-FF Uranium, High River Stage

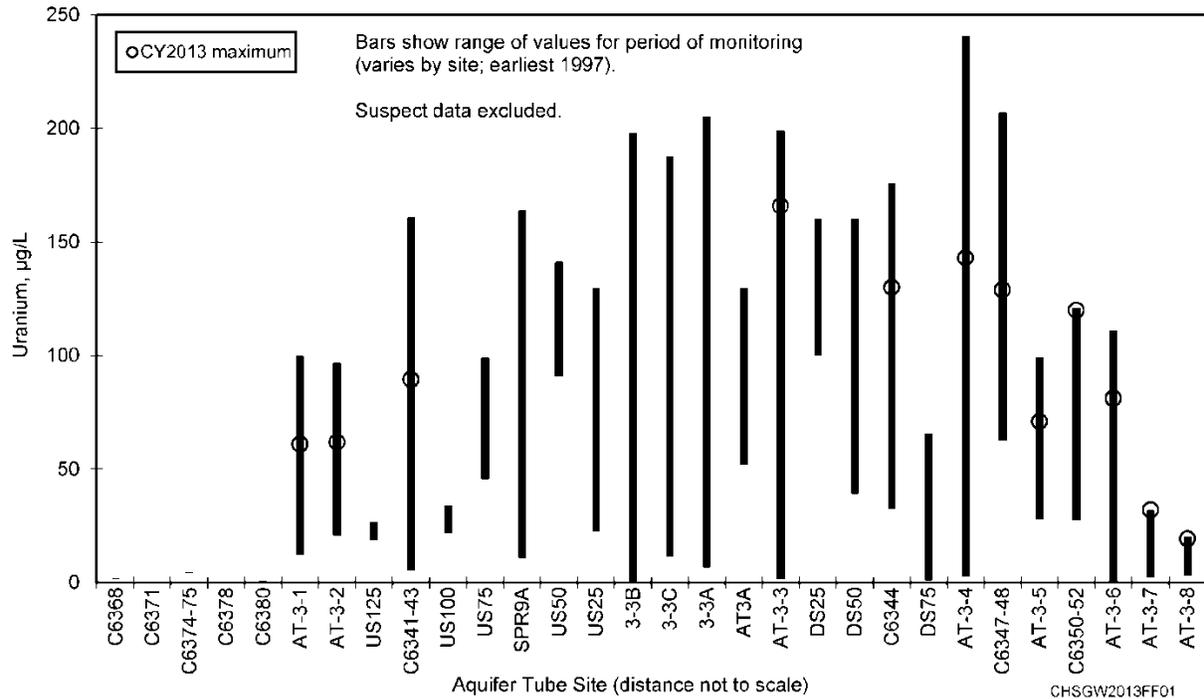


Figure FF.11 300-FF Aquifer Tube Sample Data

Two river shore seeps at 300-FF were sampled in 2013 during low river stage. Seeps occur when groundwater drains from the aquifer, and the groundwater elevation locally is higher than the river elevation. The seep, which is exposed on the ground surface, is considered surface water rather than groundwater. The results of the seep analyses for uranium and nitrate are shown as information on the plume maps for those contaminants but were not used during preparation of the plume configurations.

Seep number "300 Area Spr DR 42-2", on the river shore downgradient from the 316-1 South Process Pond, was sampled on September 3, 2013. The uranium result was approximately 130 µg/L. The uranium concentration in nearby aquifer tube C6341 was 41.5 µg/L in a sample collected on December 18. The uranium concentration in upgradient well 399-2-2 was 142 µg/L in January 2014.

Seep number "300 Area Spring 42-2", on the river shore downgradient from the 316-5 Process Trenches and 316-2 North Process Pond, was sampled on September 4, 2013. The uranium result was approximately 29.6 µg/L, based on the sum of uranium isotopic results. The uranium concentrations in nearby aquifer tubes AT-3-1-D, AT-3-1-M, and AT-3-1-S were 55 µg/L, 29.5 µg/L, and 17 µg/L, respectively, in samples collected in January 2014. The uranium concentration in upgradient well 399-1-10A was 26.6 µg/L in January 2014.

Uranium concentrations also are detected in groundwater near the 618-10 Burial Ground/316-4 Crib, located northwest of the 300 Area Industrial Complex (Figure FF.5). From 1948 to 1956, uranium-contaminated organic solvents were disposed to the 316-4 Crib, which is adjacent to the easternmost corner of the 618-10 Burial Ground (Section 3.6.33 of BHI-00012, *300-FF-3 Operable Unit Technical Baseline Report*). The crib and some of the contaminated adjacent soil were removed in 2003 and 2004, and the site was partially backfilled. However, some uranium contamination was known to remain in the soil beneath the excavated site (Sections 3.4.1.4 and 3.4.2.1 of [DOE/RL-2006-20](#); [EPA/ESD/R10-00/524](#)).

Uranium concentrations increased above the DWS in 2004 in wells 699-S6-E4A and 699-S6-E4L near the southeastern fence line of the 618-10 Burial Ground and the 316-4 Crib. This increase was caused by infiltration of dust-control water applied during the 316-4 Crib excavation and backfilling. Concentrations were elevated again in well 699-S6-E4L in 2012 and 2013 (2013 maximum was 145 µg/L) (Figure FF.12). The 2012 and 2013 increases are attributed to infiltration of dust-control water during removal actions that started in 2011 at the 618-10 Burial Ground. Because the water table elevation in this area has steadily declined by 1 meters since 1998, the increase in uranium is not attributed to rewetting of the vadose zone by seasonal changes in the water table.

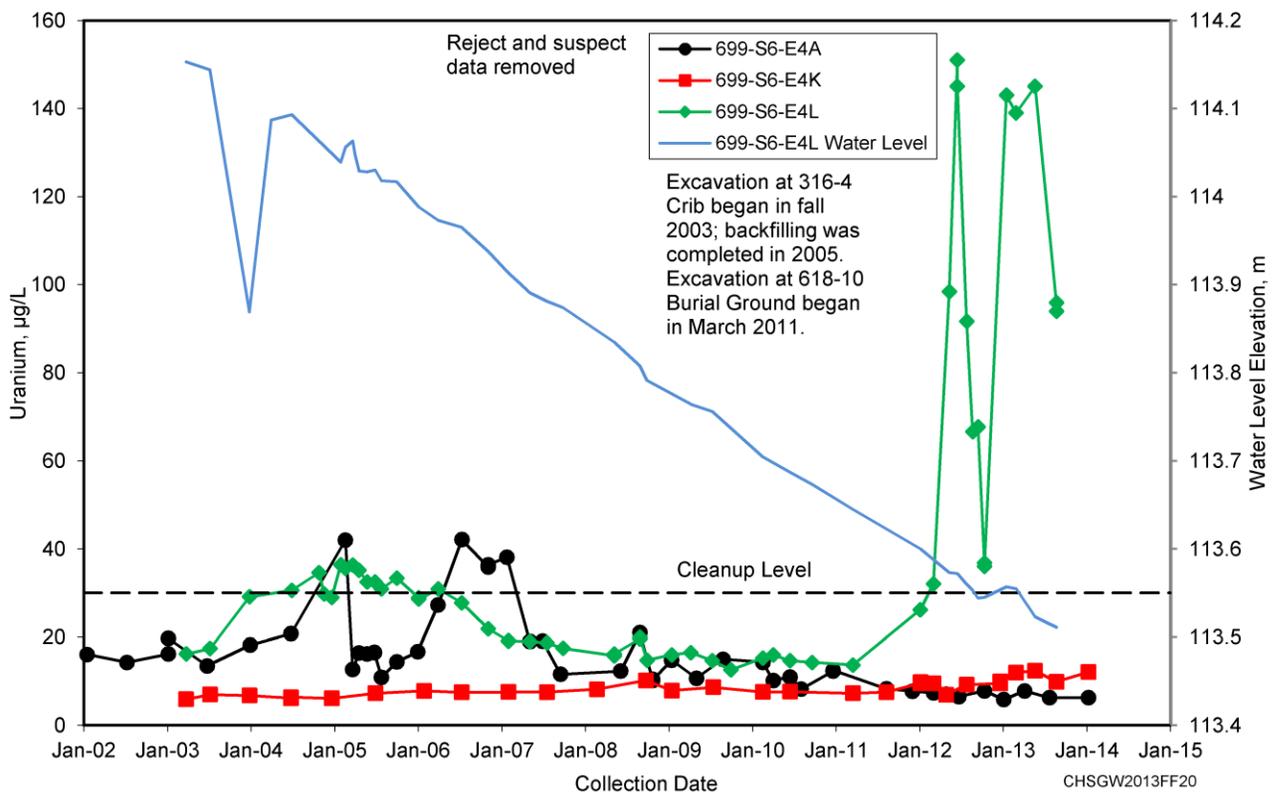


Figure FF.12 Uranium and Water Level Data for Wells 699-S6-E4A, 699-S6-E4K, and 699-S6-E4L

300-FF Uranium – High River Stage

Uranium concentrations for the seasonal high water table conditions in June 2013 are shown on Figure FF.9. Groundwater elevations were high during April through July in 2013. The water table was elevated sufficiently to rewet a portion of the vadose zone where residual amounts of mobile uranium remain at some locations. The rewetting of the vadose zone mobilized uranium into the groundwater causing higher concentrations in several wells adjacent to the former 300 Area Process Trenches (316-5) and the North Process Pond (316-2) (Figures FF.13, FF.14, and FF.15). The positive correlation between water table elevation and uranium concentration suggests that at or near these locations, uranium remains in the lower portion of the vadose zone and is available to be remobilized during periods of high water table conditions. During low water conditions, these high concentrations declined to more typical seasonal values. Elevated uranium concentrations measured in the downgradient wells the following winter likely reflect the migration of the elevated uranium concentrations measured farther inland in the summer.

Typical characteristics of the plume during seasonal high water table conditions include lowered concentrations along portions of the Columbia River shoreline and increased concentrations farther inland near source areas. The reduction in concentrations near the shoreline is caused by dilution from intrusion of river water into the aquifer. The increase in concentrations near source areas is caused by mobilization of residual contamination resulting from temporary elevation of the water table.

Uranium concentrations in wells that monitor the lower portion of the unconfined aquifer in the 300 Area Industrial Complex are typical of natural background levels (estimated to range between 0.5 and 12.8 µg/L [Table ES-1 of [DOE/RL-96-61](#)]), indicating little or no downward migration of contaminant uranium below the saturated Hanford formation sediment. Hydrographs for wells screened in saturated Hanford formation sediment or underlying Ringold Formation unit E sediment are virtually identical, indicating no significant vertical gradients.

Contamination has not been detected in the few wells that monitor the uppermost confined aquifer, which is a low-to-moderately permeable interval within the Ringold Formation lower mud unit. Hydrographs for two of these confined wells (399-1-16C and 399-1-17C) show a distinct upward hydraulic gradient, with a head difference in 2013 of approximately 8 to 9 meters. These two wells are screened across the basalt/Ringold lower mud contact and show confined basalt aquifer conditions. The hydrograph for a third well identified as a confined well (399-1-18C) shows very little head difference. Because this well is responding similarly to the unconfined and confined Ringold aquifers, it was completed in the lowest Ringold sediment rather than in the basalt confined aquifer. Gross alpha activity in 300-FF is attributed to uranium and exceeded the cleanup level (15 pCi/L, DWS) at numerous wells in the 300 Area Industrial Complex groundwater where uranium concentrations were also elevated during the high water table conditions in 2013. Gross alpha activity exceeded the cleanup level at the 618-10 Burial Ground and the 316-4 Crib.

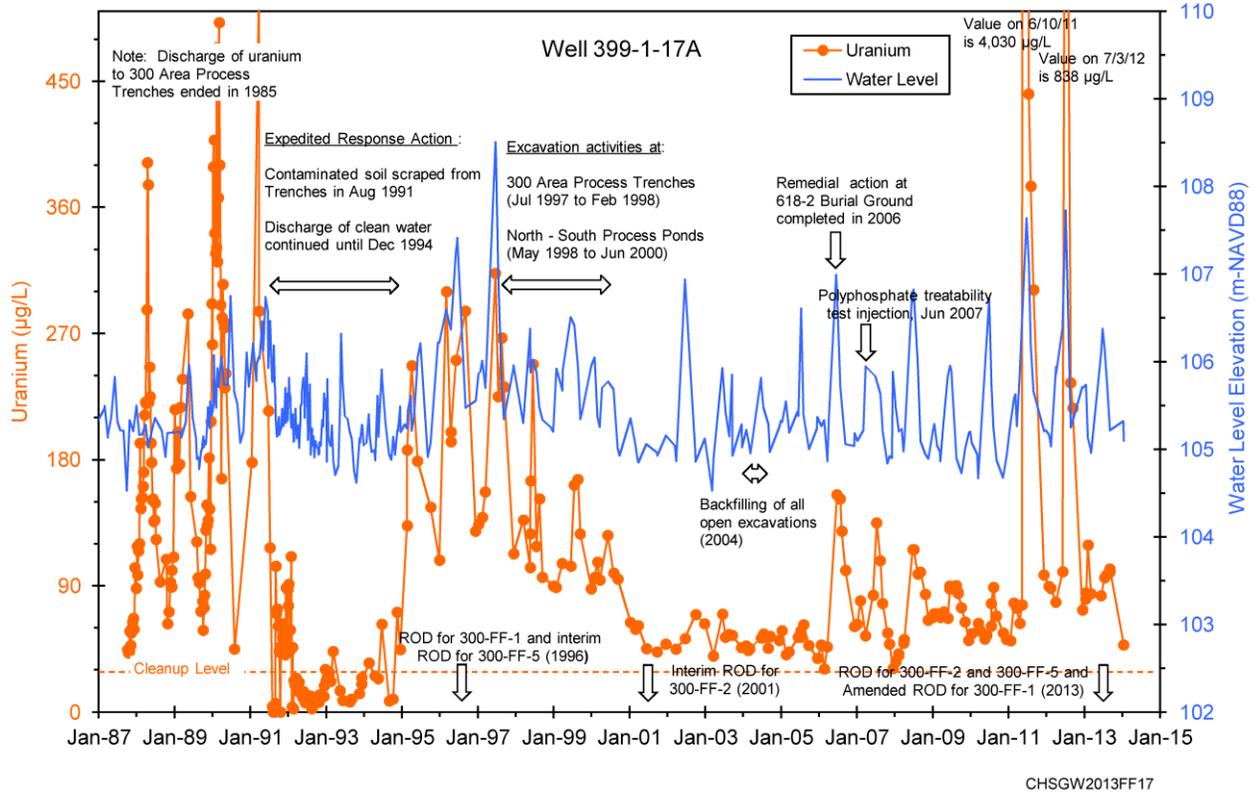


Figure FF.13 Uranium and Water Level Data for Well 399-1-17A (Inland)

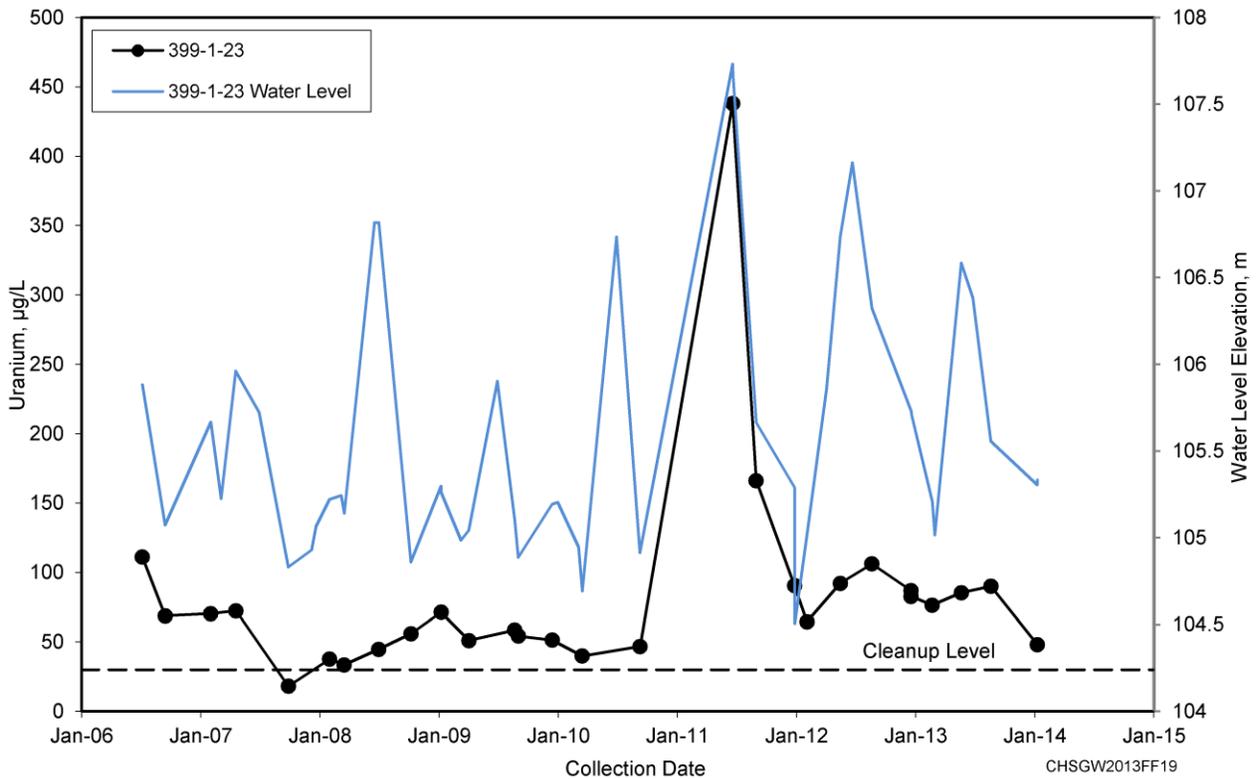


Figure FF.14 Uranium and Water Level Data for Well 399-1-23 (Inland)

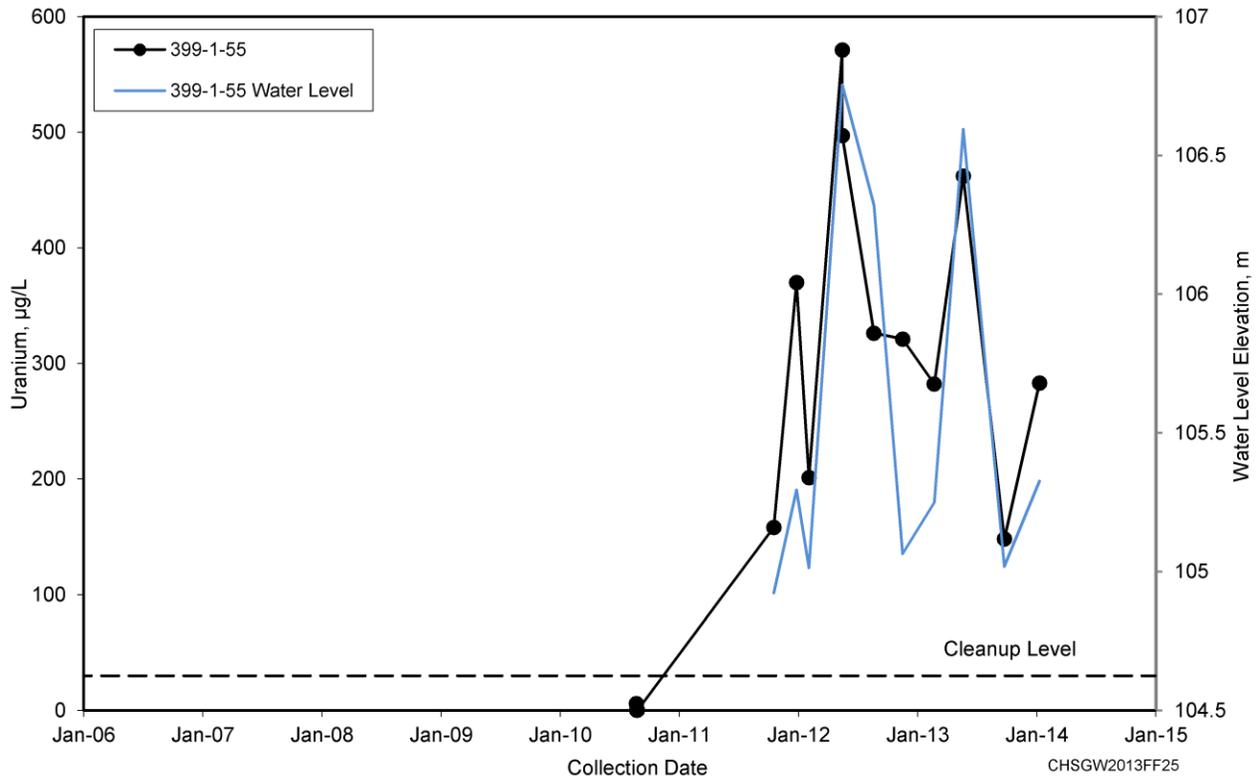


Figure FF.15 Uranium and Water Level Data for Well 399-1-55 (Inland)

300-FF Tritium

Tritium is found in groundwater associated with the 618-11 Burial Ground at concentrations exceeding the cleanup level (20,000 pCi/L, DWS). The source of the plume is tritium gas released from buried radiological solid wastes in a series of caissons located along the north wide of the burial ground (Section “Burial Ground Results” in [PNNL-13675](#)). The narrow tritium plume extends for approximately 1.2 kilometers to the east of (downgradient from) the 618-11 Burial Ground. The plume passes just to the north of the Energy Northwest Columbia Generating Station (Figure FF.16). The plume appears to be contained within the saturated Hanford formation gravels portion of the unconfined aquifer. The tritium concentrations attributed to the 618-11 Burial Ground lie within the larger, lower concentration tritium plume that is part of 200-PO (Section 4.4.5 of [DOE/RL-2010-99](#)).

Tritium concentrations near the 618-11 Burial Ground have declined from the maximum values observed in 1999 and 2000 (Figure FF.17). The trend in groundwater at well 699-13-3A, adjacent to the eastern fence line of the burial ground, suggests that an episodic event of unknown nature caused a tritium release from buried materials to contaminate groundwater. The relatively constant tritium concentrations at well 699-13-3A since 2006 suggest that buried materials are providing an ongoing source of tritium to groundwater. At wells farther downgradient from the 618-11 Burial Ground, such as wells 699-13-2D and 699-12-2C, concentration trends reflect the plume’s migration. The conceptual model for the plume, including a simulation of plume evolution over time, indicates that tritium concentrations will be below the cleanup level when the plume reaches the Columbia River (Section 5.1 of [PNNL-15293](#)). Groundwater wells monitored by Energy Northwest do not show evidence of this plume above the DWS, and tritium is not detected in Energy Northwest water supply wells ([Mee, 2012](#)).

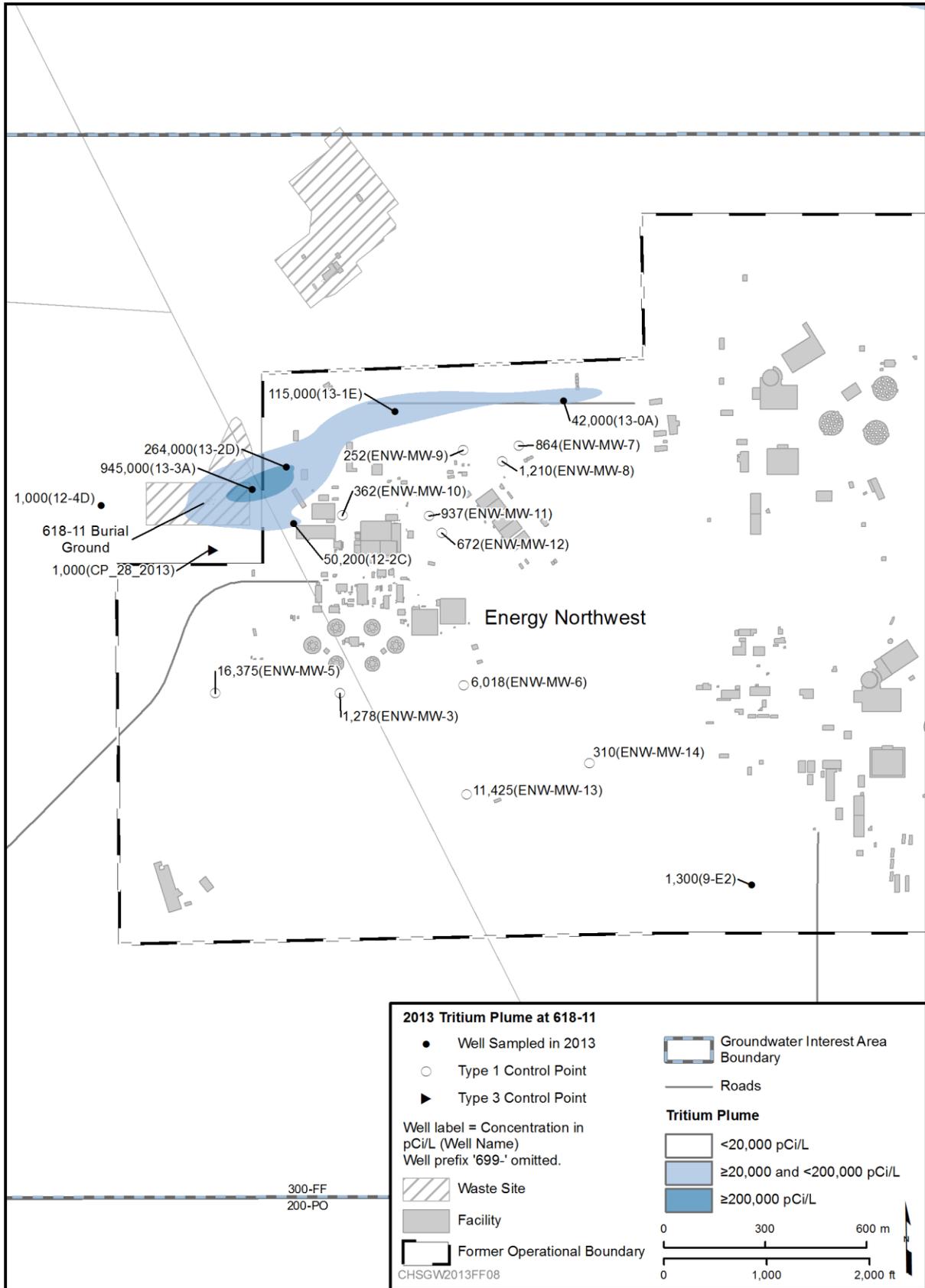


Figure FF.16 Tritium near the 618-11 Burial Ground

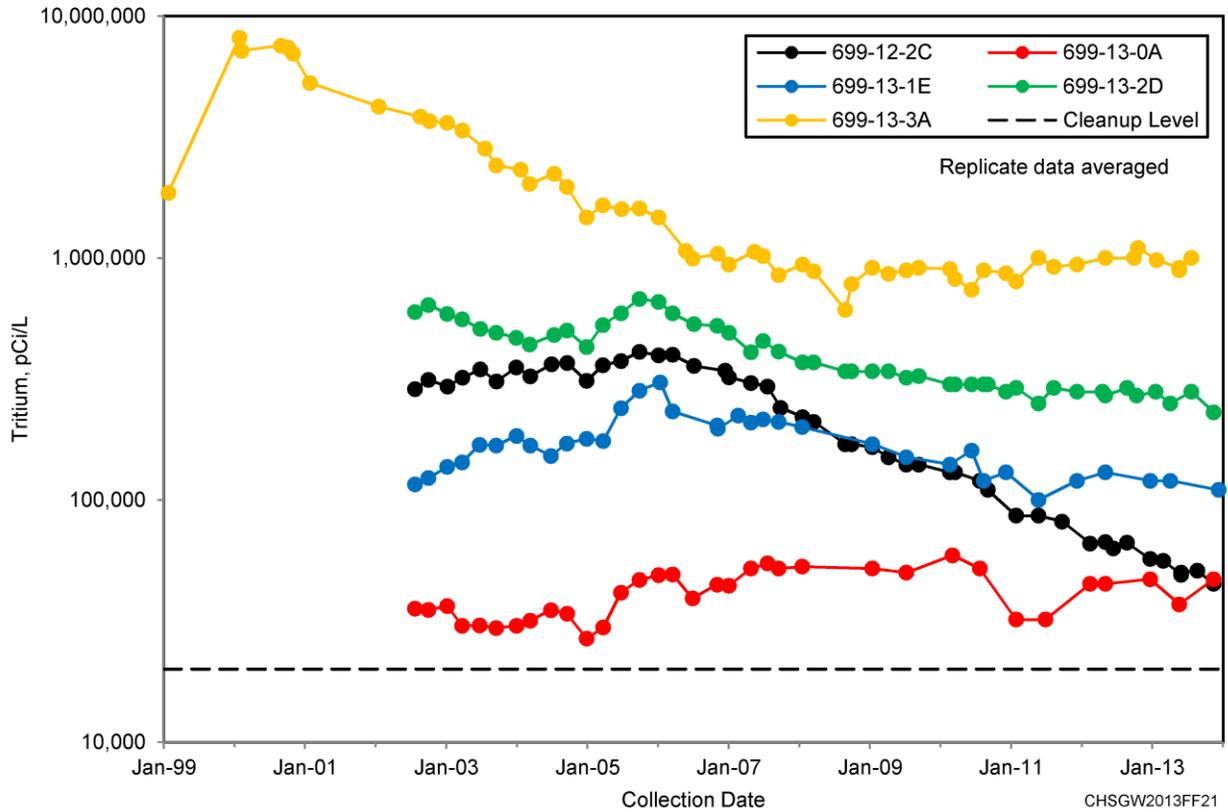


Figure FF.17 300-FF Tritium Data for Wells 699-12-2C, 699-13-0A, 699-13-1E, 699-13-2D, and 699-13-3A

300-FF Nitrate

Nitrate concentrations exceeding the 45 mg/L cleanup level (DWS [i.e., 10 mg/L measured as nitrogen in nitrate]) are found near the 618-11 Burial Ground (Figure FF.18). Nitrate exceeding 45 mg/L also is found in the southern portion of the 300 Area Industrial Complex. The principal sources of nitrate currently observed in 300 Area Industrial Complex groundwater are agricultural and industrial activities not associated with the Hanford Site.

Nitrate at the 618-11 Burial Ground. Nitrate concentrations near the 618-11 Burial Ground continue to exceed the cleanup level (Figures FF.18, FF.19, and FF.20). Concentrations at well 699-13-3A have generally decreased since 2010; the maximum concentration during 2013 was 116.0 mg/L (Figure FF.19). Historical records for materials sent to the 618-11 Burial Ground do not indicate significant quantities of nitrate-bearing wastes. Given that the elevated nitrate contamination in the groundwater corresponds to the elevated tritium contamination, which is attributed to the 618-11 Burial Ground, the nitrate contamination is also attributed to the 618-11 Burial Ground (Section 4.4.5 of [DOE/RL-2010-99](#)).

Nitrate in the 300 Area Industrial Complex. The nitrate concentrations exceeding the DWS in the southern portion of the 300 Area Industrial Complex reflect the migration of nitrate-contaminated groundwater into the 300 Area Industrial Complex from sources to the southwest. For example, the maximum nitrate concentration near the southwestern corner of the 300 Area Industrial Complex (at well 699-S28-E12 in the 1100-EM interest area) was 193 mg/L in April 2013, and the concentration at well 699-S27-E14, approximately 616 meters to the northeast, was 95.6 mg/L in April 2013. Nitrate also migrates into the 300 Area Industrial Complex from the northwest as part of the site-wide plume that originates in the 200 East Area, with concentrations typically ranging from 25 to 30 mg/L.

Seep number "300 Area Spr DR 42-2", on the river shore downgradient from the 316-1 South Process Pond, was sampled on September 3, 2013. The nitrate result was 21.9 mg/L. The nitrate concentration in upgradient well 399-2-2 was 24.4 mg/L in January 2014.

Seep number "300 Area Spring 42-2", on the river shore downgradient from the 316-5 Process Trenches and 316-2 North Process Pond, was sampled on September 4, 2013 and had a nitrate concentration of 15.3 µg/L. The nitrate concentrations in nearby aquifer tube AT-3-1-M and in upgradient well 399-1-10A were 14 mg/L and 25.5 mg/L, respectively, in January 2014.

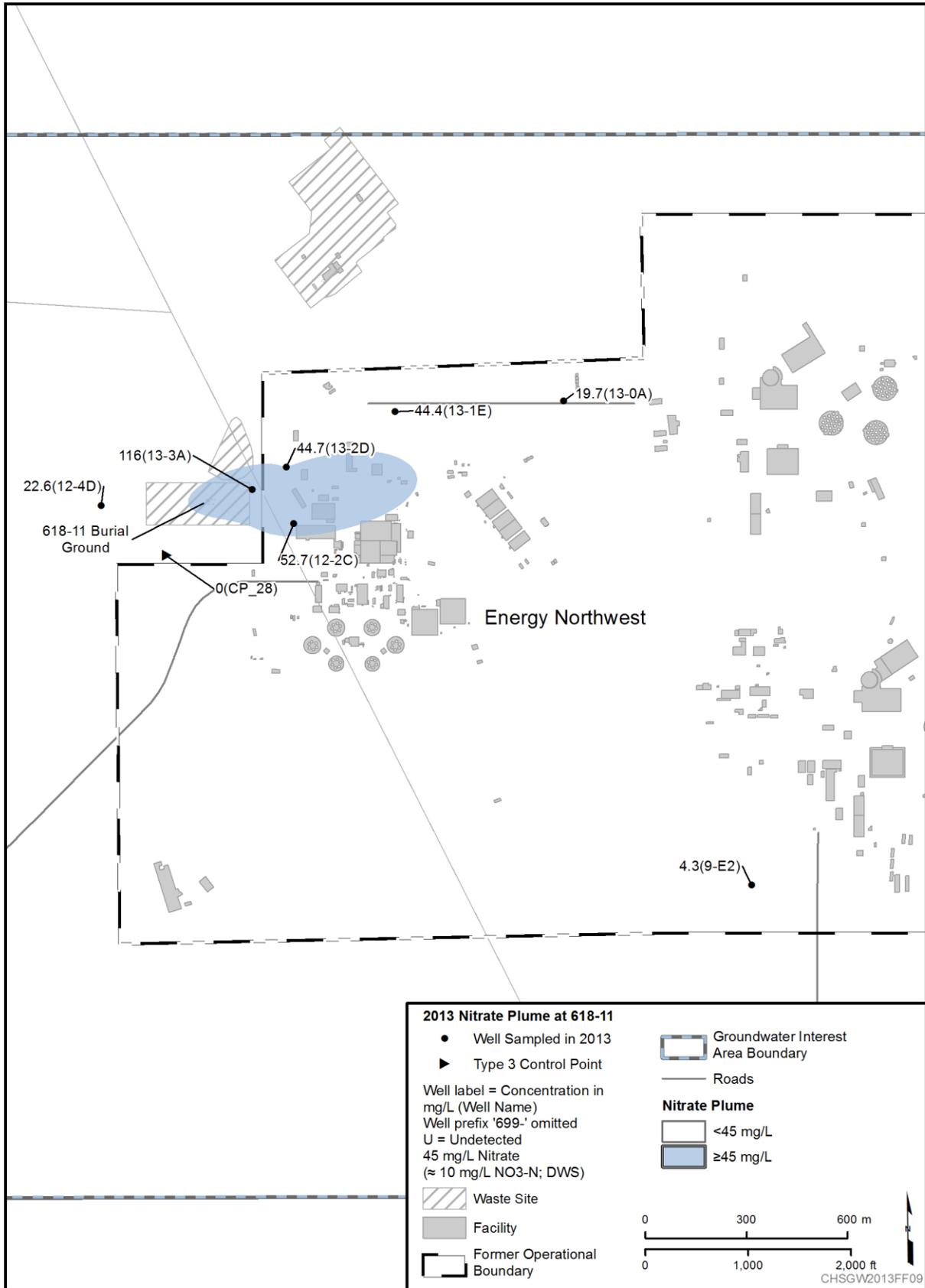


Figure FF.18 Nitrate near the 618-11 Burial Ground

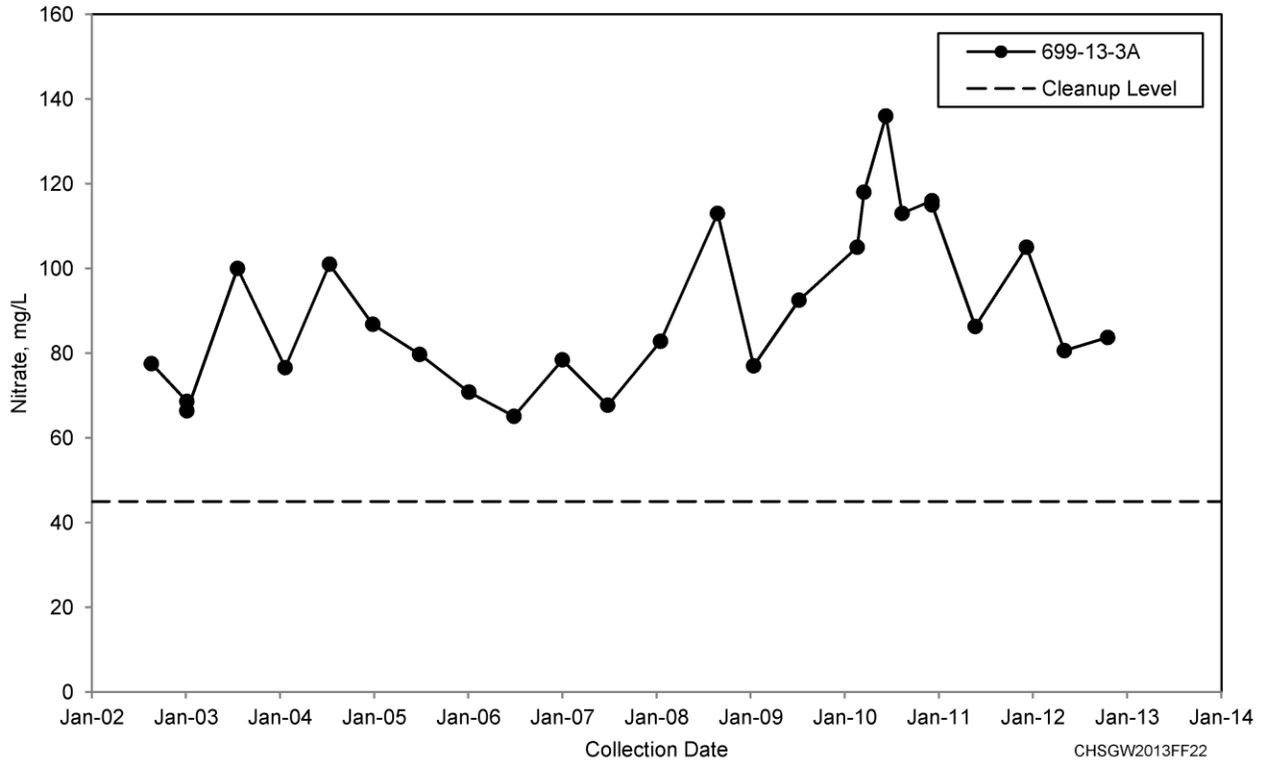


Figure FF.19 Nitrate Data for Well 699-13-3A

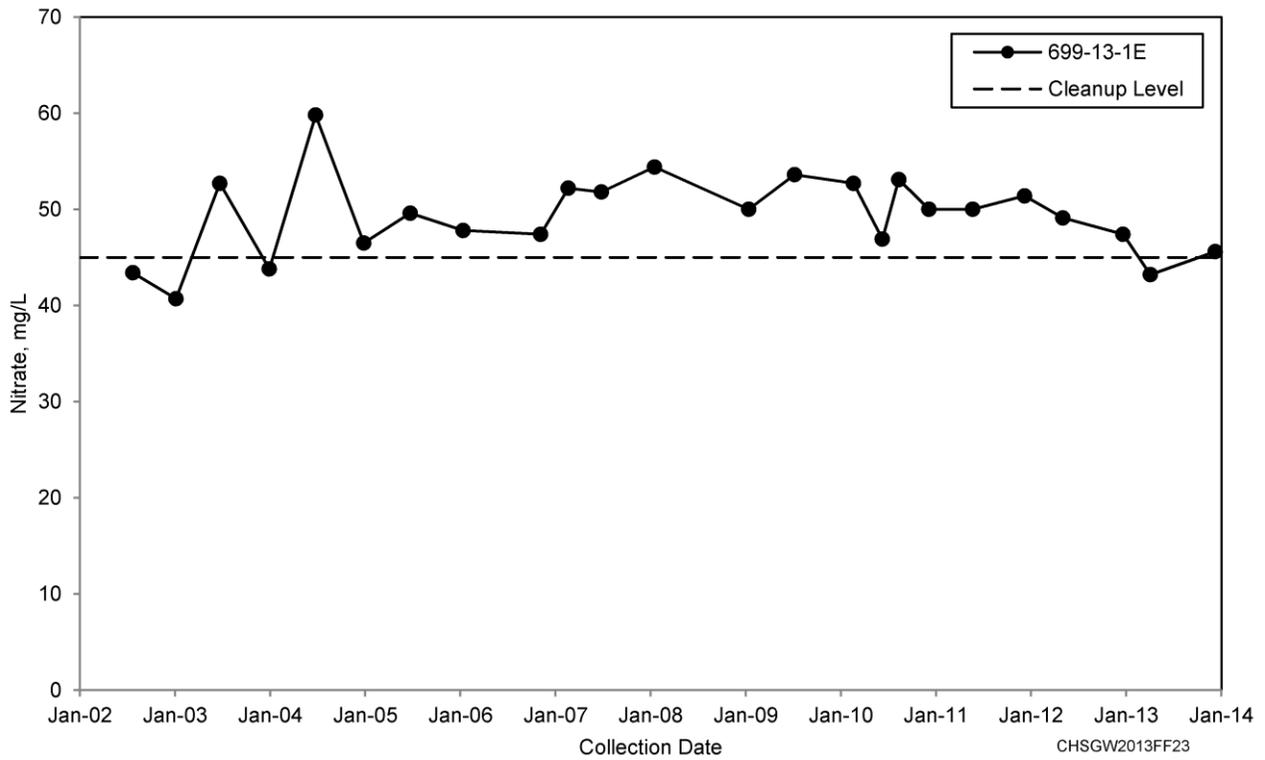


Figure FF.20 Nitrate Data for Well 699-13-1E

300-FF Trichloroethene (TCE)

Two volatile organic compounds (VOCs), TCE and DCE, are found in localized areas in groundwater beneath the 300 Area Industrial Complex at concentrations exceeding their cleanup levels. DCE is a degradation product of TCE and tetrachloroethene (PCE). The original compounds degrade by dechlorination under conditions that include very low oxygen and the presence of certain types of microbes (Section 1.2 of [PNNL-17666](#)).

TCE and PCE were widely used in the 300 Area Industrial Complex in degreasing operations associated with the fuels fabrication process (Section 3.3.4 of BHI-00012, *300-FF-2 Operable Unit Technical Baseline Report*; Section 2.0 of [EMO-1026](#); Section 1.0 of [WHC-MR-0388](#)). TCE was the primary degreaser used until the 1970s, followed by PCE in the 1970s and 1980s. TCE and PCE were discharged to the South Process Pond (316-1) and North Process Pond (316-2). PCE was evaluated in the RI/FS and was not found to be a contaminant of concern in the 300 Area.

TCE concentrations did not exceed the cleanup level (4 µg/L) in 2013 in any 300-FF wells. The maximum concentration in the 300 Area Industrial Complex was 2.7 µg/L at well 399-1-16B, which is screened in the lower portion of the aquifer. At the 618-10 Burial Ground the maximum concentration was 3.5 µg/L in well 699-S6-E4L, screened in the upper portion of the aquifer.

During drilling in 2006, TCE (maximum concentration of 630 µg/L) was encountered in groundwater associated with an interval of relatively finer-grained sediment within Ringold Formation unit E (Section 2.1 of [PNNL-17666](#)). Because this finer-grained interval has a very low permeability and does not readily yield groundwater, monitoring wells have not been screened in this interval. This interval is incised by the river channel. Contamination slowly migrates within these sediments and into overlying or adjacent permeable Hanford formation sediment, as evidenced by periodic detections of TCE in aquifer tube samples that are collected from screens positioned near this contact (Section 4.8.4.4 of [DOE/RL-2010-99](#)).

TCE was detected in 2013 at concentrations exceeding the cleanup level at two aquifer tubes that are screened proximal to, or within, the finer-grained interval of Ringold Formation sediment that is contaminated by TCE (Figure FF.21). Consistent with results from previous years, in 2013, the highest concentration (430 µg/L) was observed at aquifer tube AT-3-3-D, which is the aquifer tube believed to be placed in the finer-grained interval of Ringold Formation unit E sediment. Elevated concentrations are also consistently observed at aquifer tube AT-3-7-D, where the highest TCE concentration in 2013 was 80 µg/L. The origin for the TCE in groundwater at this aquifer tube is not known, but is most likely associated with past disposal of TCE used in the manufacture of nuclear fuel.

Seep number "300 Area Spr DR 42-2," on the river shore downgradient from the 316-1 South Process Pond, was sampled on September 3, 2013 and the TCE result was estimated at 1.1 µg/L. The TCE concentration in nearby aquifer tube C6341 was <0.5 µg/L in a sample collected on December 18. The TCE concentrations in upgradient well 399-2-2 was 1.4 µg/L in January 2014.

Seep number "300 Area Spring 42-2," on the river shore downgradient from the 316-5 Process Trenches and 316-2 North Process Pond, was sampled on September 4, 2013 and had no detectable TCE. The TCE concentrations in nearby aquifer tube AT-3-1-M and in upgradient well 399-1-10A were both <0.5 µg/L in January 2014.

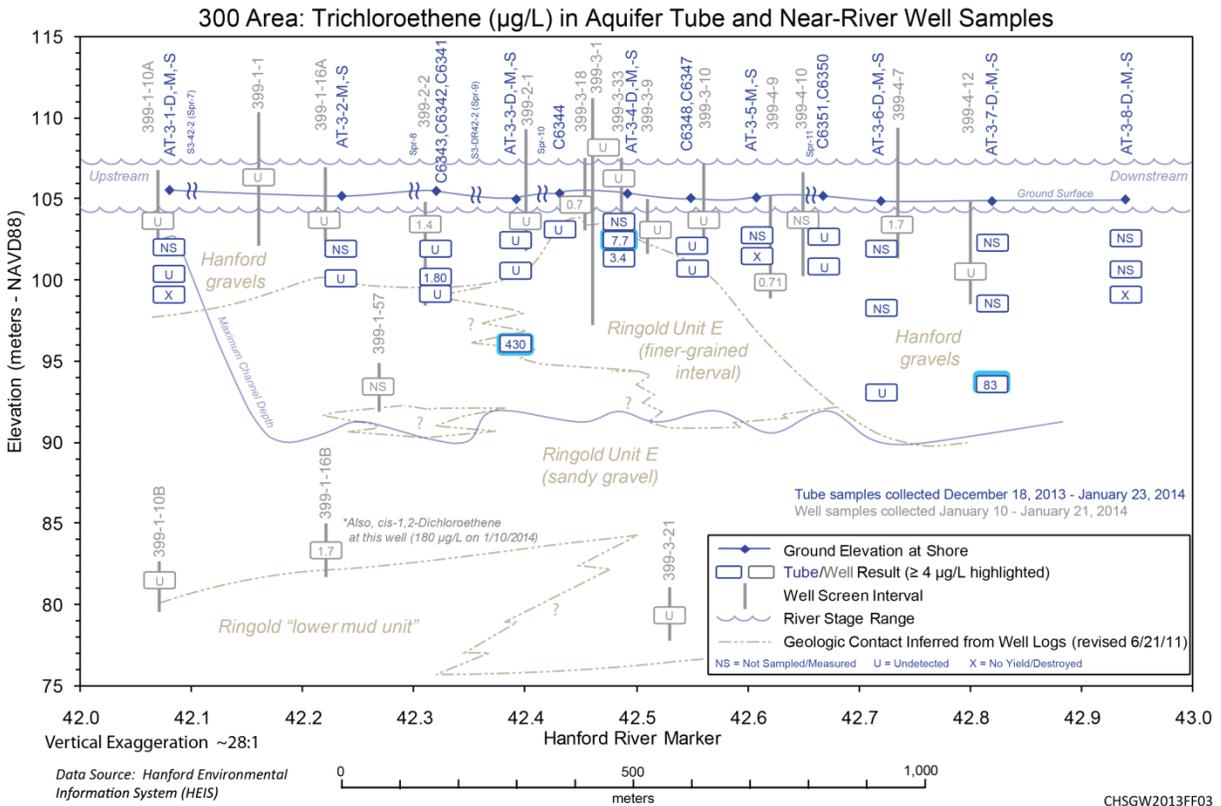


Figure FF.21 TCE in Aquifer Tube and Near-River Well Samples

In the lower portion of the unconfined aquifer, DCE concentrations continue to exceed the cleanup level (16 $\mu\text{g/L}$) at one well (399-1-16B). The maximum concentration in 2013 was 220 $\mu\text{g/L}$ (Figure FF.22). Well 399-1-16B is downgradient from the 300 Area Process Trenches (316-5) and North Process Pond (316-2). It is screened in Ringold Formation gravelly sediment. The elevation of the well's screen is approximately 7 meters deeper than the elevation of the Columbia River's maximum channel depth (Section 4.4.4.5 of [DOE/RL-2010-99](#)). The origin for DCE is likely degradation of TCE and/or PCE disposed to the former North Process Pond (316-2) and/or 300 Area Process Trenches (316-5) (Sections 3.1 and 3.3 of [PNNL-17666](#); Section 4.4.4.5 of [DOE/RL-2010-99](#)). The DCE concentration (69 $\mu\text{g/L}$) also exceeded the cleanup level in 2013 in a sample from well 399-1-57, which is located 80 meters to the southeast of well 399-1-16B, but in the mid-portion of the unconfined aquifer and in finer-grained, less permeable sediment (Section 4.4.4.5 of [DOE/RL-2010-99](#)).

DCE concentrations did not exceed the cleanup level in 2013 in any 300-FF aquifer tubes. The maximum concentration (1.8 $\mu\text{g/L}$) was observed at aquifer tube AT-3-4-M.

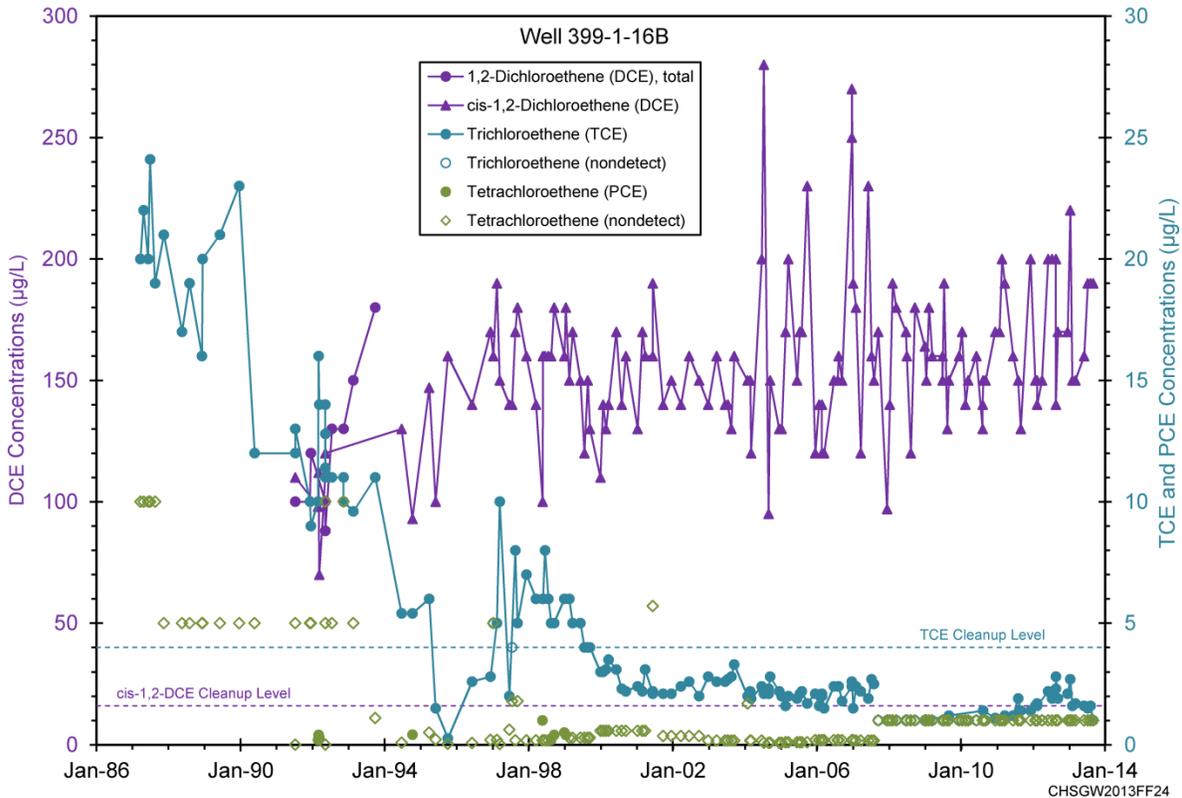


Figure FF.22 300-FF DCE, TCE, and PCE Data for Well 399-1-16B

300-FF RCRA – 316-5 Process Trenches

One unit in the 300-FF interest area, the former 300 Area Process Trenches (316-5), is monitored per the Hanford Facility RCRA Permit ([WA7890008967](#)). The 316-5 process trenches received effluent discharges of mixed waste from fuel fabrication and nuclear research laboratories in the 300 Area Industrial Complex from 1975 through 1987, followed by continued discharge of cooling water with small quantities of non-hazardous maintenance and process waste until December 1994. A comprehensive description of the facility and its history of operations is provided in Section 2.1 of [PNNL-13645](#).

The trenches were remediated in 1991 under a CERCLA expedited response action by scraping contaminated soil to the north end of the facility ([DOE/RL-92-32](#)). Additional removal actions were performed in 1997 and 1998, followed by backfilling and surface restoration in 2004 (Section 3.0 of [DOE/RL-2004-74](#)). The modified closure plan ([DOE/RL-93-73](#)), which is incorporated into the Hanford Facility RCRA Permit (WA7890008967), states that groundwater remediation is deferred to 300-FF-5 under CERCLA.

RCRA post-closure groundwater monitoring under the corrective action program of [WAC 173-303-645](#)(11) uses wells at four locations: one upgradient (northwest) and three downgradient (east, southeast, and south) of the former 300 Area Process Trenches (Figure FF.23). The most distant downgradient location is approximately 200 meters to the southeast, along the dominant groundwater flow path from the trenches. Groundwater flows generally toward the south-southeast beneath the former trenches. The estimate for flow rate in March 2013 was 25 meters per day (Table B.1, Appendix B). Two wells are at each of the four locations (Figure FF.23). The well with the well number ending in "A" is screened near the water table, and the well with the well number ending in "B" is screened in the lower portion of the unconfined aquifer (Table B.38, Appendix B). The sampling schedule for the eight wells is designed to accommodate two semiannual sampling events, with four time-independent samples collected during each period to provide data amenable to statistical analysis. As a result, the wells are sampled during eight months of the year: the first sampling event covers December, January, February, and March; and the second sampling event covers June, July, August, and September. During 2013, sampling was performed as planned with the exception that the sampling scheduled for December 2013 was conducted in January 2014 (Table B.38, Appendix B). Reports on the effectiveness of the corrective action-monitoring program were prepared semiannually in accordance with [WAC 173-303-645](#)(11)(g). The results for 2013 are provided in SGW-56519 and SGW-56886.

Groundwater monitoring to meet RCRA requirements is conducted in accordance with [WHC-SD-EN-AP-185](#). The constituents monitored under this plan include chemical uranium, TCE, and DCE. Uranium as a metal was included in the monitoring plan as an indicator and was incorporated by reference in the Hanford Facility RCRA Permit (WA7890008967). The permit concentration limits for uranium, TCE, and DCE are 30 µg/L, 5 µg/L and 70 µg/L, respectively. Table B.40 in Appendix B summarizes data from 2013.

Analytical results for TCE were all below the detection limit of 1 µg/L (January and February 2013) and 0.5 µg/L (March 2013 through January 2014) during 2013, with the exception of all eight samples from well 399-1-16B, where the maximum concentration was estimated to be 2.7 µg/L ("300-FF Trichloroethene (TCE)" Section). Analytical results for DCE were all below the detection limit of 1.0 µg/L during 2013, with the exception of all eight samples from well 399-1-16B, where concentrations ranged from 150 to 220 µg/L ("300-FF Trichloroethene (TCE)" Section); and all eight samples from well 399-1-17B, where the maximum concentration was estimated to be 3.0 µg/L. Uranium was detected at five of the monitoring wells in 2013. In the three downgradient wells screened in the upper portion of the unconfined aquifer, maximum concentrations ranged from 31.4 to 119 µg/L ("300-FF Uranium" Section). Concentrations at wells 399-1-10A and 399-1-16A, which are near the Columbia River, declined in early summer when the river stage was high and increased in autumn with the arrival of uranium that had been remobilized upgradient. Concentrations at upgradient well 399-1-18A are consistent with background levels for saturated Hanford formation sediment and ranged from 5.5 to 7.13 µg/L during 2013. Concentrations in the lower portion of the unconfined aquifer were typically below detection levels, with the exception of well 399-1-16B, where the maximum concentration was 10.7 µg/L. Uranium is reported as total uranium in an unfiltered sample.

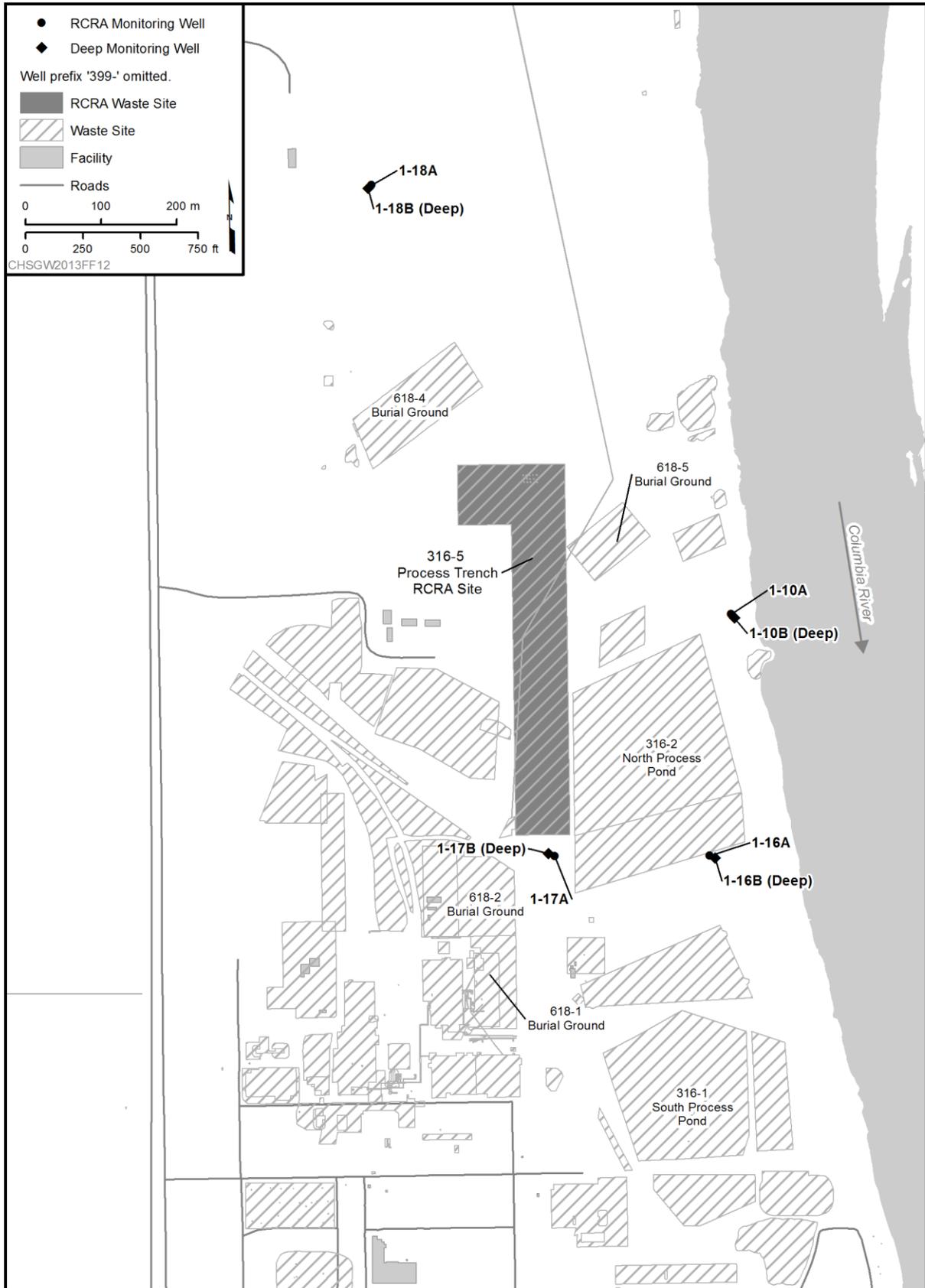


Figure FF.23 316-5 Process Trenches