200-BP

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200-BP Overview

The 200-BP groundwater interest area includes groundwater and the associated contaminant plumes beneath the northern half of the 200 East Area and adjacent portions of the surrounding 600 Area. The 200-BP interest area includes the 200-BP-5 groundwater operable unit (OU), and six RCRA sites. The main process separation facilities overlying the OU were in 200 East Area, B Plant, and Semi Works; however, liquid waste from the other process separation facilities at Hanford were stored or released at sites overlying 200-BP. Waste sites that have/are affecting groundwater include various liquid waste disposal sites (cribs, ditches, and ponds), the 216-B-5 Injection Well, and leaking underground storage tanks (USTs) (Waste Management Area [WMA] B-BX-BY and WMA C).

Nitrate, iodine-129, technetium-99, and uranium are the most extensive groundwater plumes in 200-BP. These contaminants emanate mainly from local sources, except for iodine-129 which predominantly migrated into 200-BP from 200-PO in the late 1980s and early 1990s. Other contaminants with smaller areal extent within 200-BP include cyanide, strontium-90, tritium, cesium-137, and plutonium-239/240. Table BP.1 lists plume areas and other pertinent facts about 200-BP.

The U.S. Department of Energy (DOE) conducts groundwater monitoring in 200-BP under the Atomic Energy Act of 1954 (AEA), Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and Resource Conservation and Recovery Act of 1976 (RCRA) requirements. AEA monitoring requirements are defined at the 218-E-10 and 218-E-12B Burial Grounds by DOE/RL-2000-72 and at WMA C by *Tri-Party Agreement Change Notice Form Groundwater Sampling and Analysis Plan for the 200-BP-5 Operable Unit,* TPA-CN-578. DOE performs CERCLA monitoring via DOE/RL-2001-49 to define the changing geometry of waste constituents in the groundwater. Finally, six RCRA sites (WMA B/BX/BY, WMA C, 216-B-63 Trench, Low-Level Waste Management Area [LLWMA]-1, LLWMA-2, and LERF) are monitored under different RCRA plans as discussed later in this chapter. Groundwater conditions in 200-BP include unconfined, semi-confined, and confined. The unconfined aquifer within the 200 East Area boundary is the primary aquifer impacted by past waste disposal operations and is associated with the suprabasalt sediment of the Ringold Formation, Cold Creek unit, and Hanford formation (Figure BP.1). The greatest concentration/activity of nitrate, technetium-99, and uranium in 200-BP are within the northwest portion of the 200 East Area, also referred to as the B Complex (e.g., 241-B-BX-BY single shell UST area “Waste Management Area B-BX-BY” and adjacent liquid waste sites). These plumes extend both to the northwest and southeast within an ancestral Columbia River paleochannel that incised semi-consolidated gravels and cohesive fluvial-lacustrine Ringold deposits (Figure BP.2). Figure BP.2 provides the latest interpretation of the incising ancestral Columbia River/cataclysmic glacial flooding paleochannel entering the 200 East Area from the northwest. Figure BP.2 does not include the Cold Creek and Hanford sediments in order to depict the paleochannel. The channel was later filled with unconsolidated gravels and fluvial overbank/eolian sediments (PNNL-19702). A portion of the Cold Creek deposits and Ringold deposits were later incised by glacial fluvial cataclysmic flooding followed by Hanford sediment deposition (PNNL-19702).

Semi-confined aquifers are present to the east and west of the higher permeability paleochannel. More specifically, the semi-confined aquifers in these areas are where Unit 9B overlie and the Elephant Mountain Basalt underlie the Ringold Unit 9C. Contaminants in the semi-confined area along the west side of the 200 East Area is limited to nitrate, tritium, and uranium, thought to be associated with the 216-B-12 Crib. However, tritium near the bottom of the semi-confined aquifer may be associated with PUREX Cribs from 200-PO. Contaminants in the semi-confined area east of the 200 East Area is associated with B Pond and is limited to iodine-129 and tritium.

Within the Rattlesnake Ridge interbed, uppermost basalt confined aquifer, contamination exceeding the drinking water standard (DWS) is limited to technetium-99 at well 299-E33-12 (e.g., beneath the B Complex area). The contamination was associated with one of the adjacent liquid waste cribs (e.g., BY Cribs), which released liquid scavenged waste to the soil column in the early 1950s. This contaminant waste had a high density promoting downward migration into the confined aquifer before well 299-E33-12 was properly sealed in 1979.

Farther north, within the Gable Mountain/Gable Butte Gap (Gable Gap) the unconfined aquifer consists of not only the Ringold, Cold Creek, and Hanford formations, but also the Rattlesnake Ridge and Selah Interbeds because of erosion of the Elephant Mountain and Pomona basalt as portrayed in PNNL-19702.

Depths from land surface to the water table in 200-BP range from less than 1 meter to 105 meters, with the greatest thickness occurring in the south portion of the OU (e.g., 200 East Area). The thickness of the unconfined aquifer (e.g, saturated sediments) varies from less than a meter north of the 200 East Area to more than 40 meters in the Gable Gap.

Groundwater flow within the unconfined aquifer in the south part of 200-BP, south of Gable Mountain, saw major changes in 2011. The flow direction completed an 180^{o} flow direction change in July 2011 because of ongoing water table declines in the 200 East Area and the temporal Columbia River stages. Since July 2011 the flow direction has maintained a south-southeast flow from the south part of the Gable Gap into the northwest quarter of the 200 East Area (Figure BP.3). Merging with this flow, into the 200 East Area, are contributions from the west and east as portrayed in the Hanford Site water table map (Figure BP.4) and more specifically with the 200 East Groundwater Flow Map (Figure BP.35).

Table BP.1 200-BP at a Glance

B Plant Operations: 1945–1952 (Plutonium separation) 1967–1985 (Strontium and Cesium recovery)			
2013 Groundwater Monitoring			
Contaminant	DWS	Maximum Concentration[a]	**Plume Area[b] (km^2)**
Nitrate	45 mg/L	1,680 mg/L (299-E33-47)	7.9
Iodine-129	1 pCi/L	7.54 pCi/L (299-E27-22)	4.5
Technetium-99	900 pCi/L	36,000 pCi/L (299-E33-18)	2.4
Uranium	30 µg/L	3,300 µg/L (299-E33-18)	0.5
Strontium-90	8 pCi/L	980 pCi/L (299-E28-25)	0.6
Cyanide	200 µg/L	1,520 µg/L (299-E33-47)	0.4
Tritium	20,000 pCi/L	22,000 pCi/L (299-E33-15)	0.2
Remediation			
B Complex perched aquifer pump-and-treat (treatability test): • Being performed by the 200-DV-1 Operable Unit • Test successful; ~ 349,400 liters pumped in 2013 Final action 200-BP-5 record of decision scheduled for 2016.			

a. 2013 Maximum concentration within the regional unconfined aquifer (i.e., excludes the perched aquifer beneath the B Complex). Note strontium-90 activity is greater in well 299-E28-23, but was not sampled in 2013.

b. Estimated area above listed DWS.

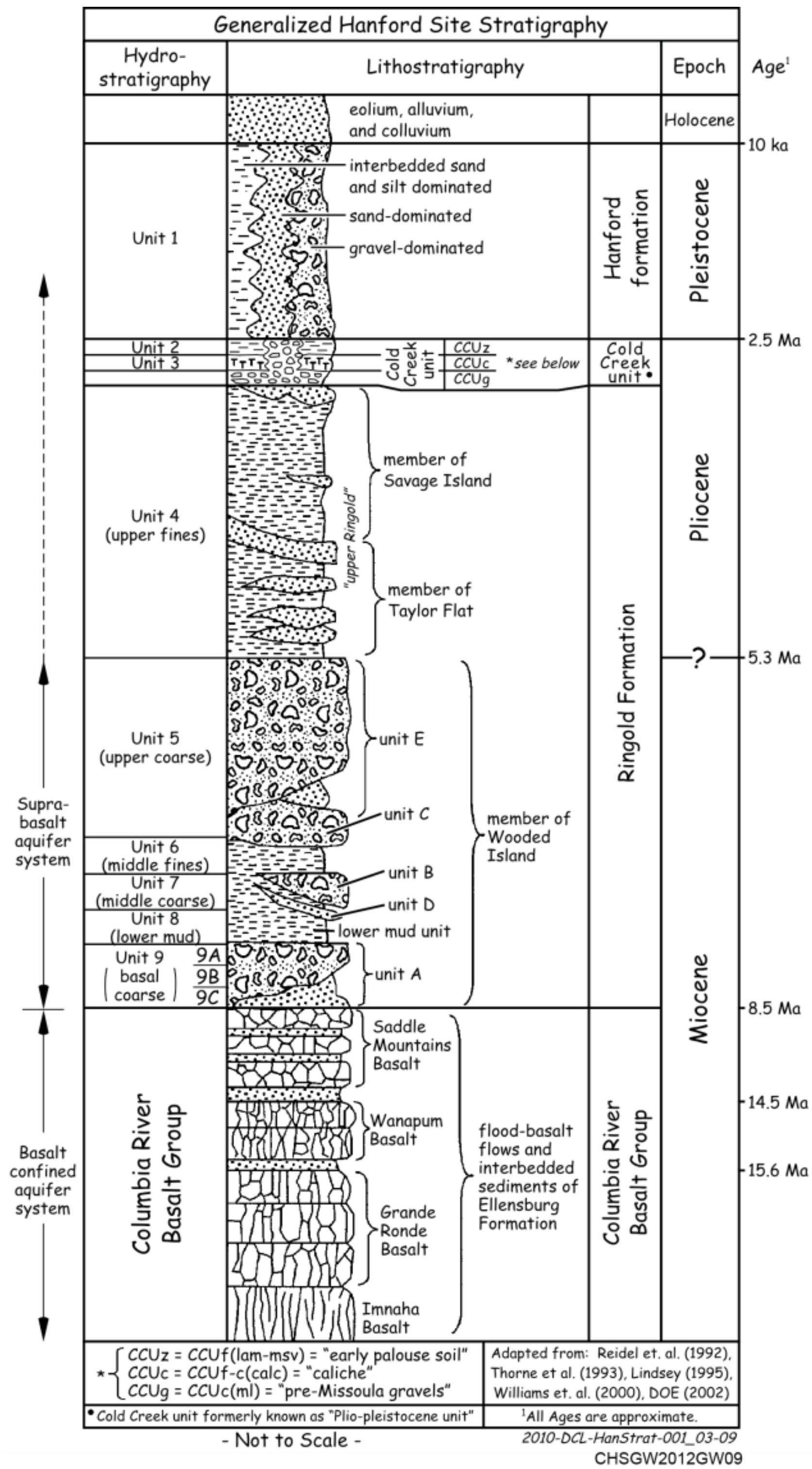

Figure BP.1 200-BP Geology

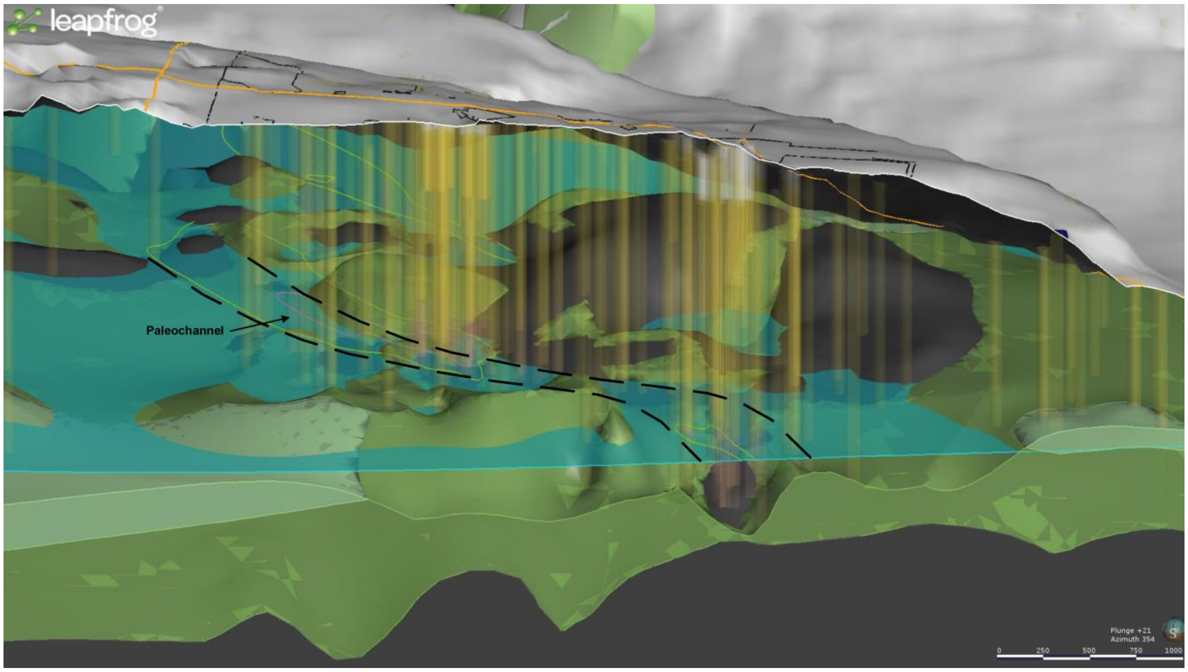

Figure BP.2 3D View of the Incising Ancestral Columbia River/Cataclysmic Glacial Flooding Paleochannel Entering the 200 East Area From the Northwest. Plumes Are a Depiction From 2011 Annual Report.

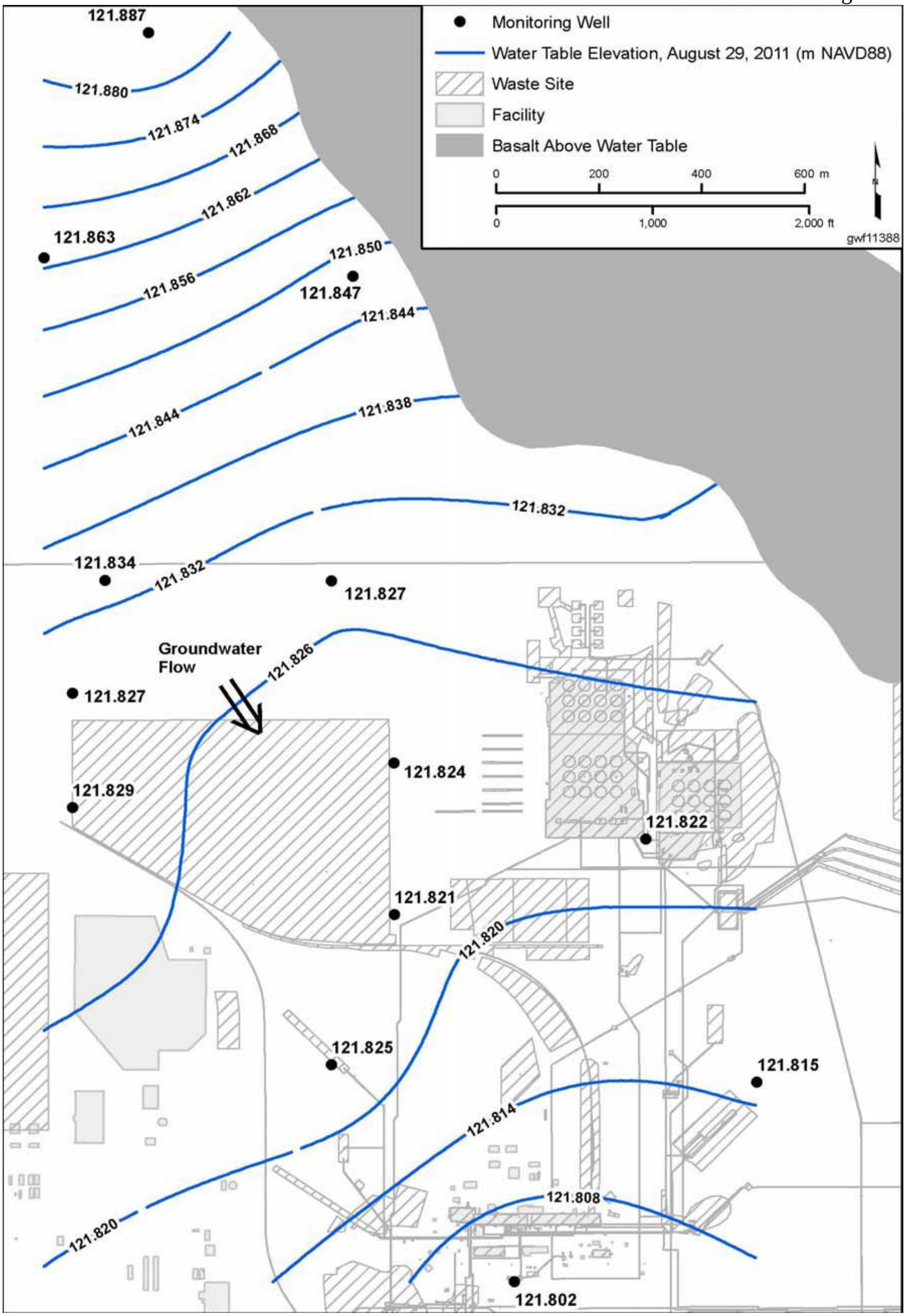

Figure BP.3 Groundwater Flow into the 200 East Area After the Flow Direction Change in 2011

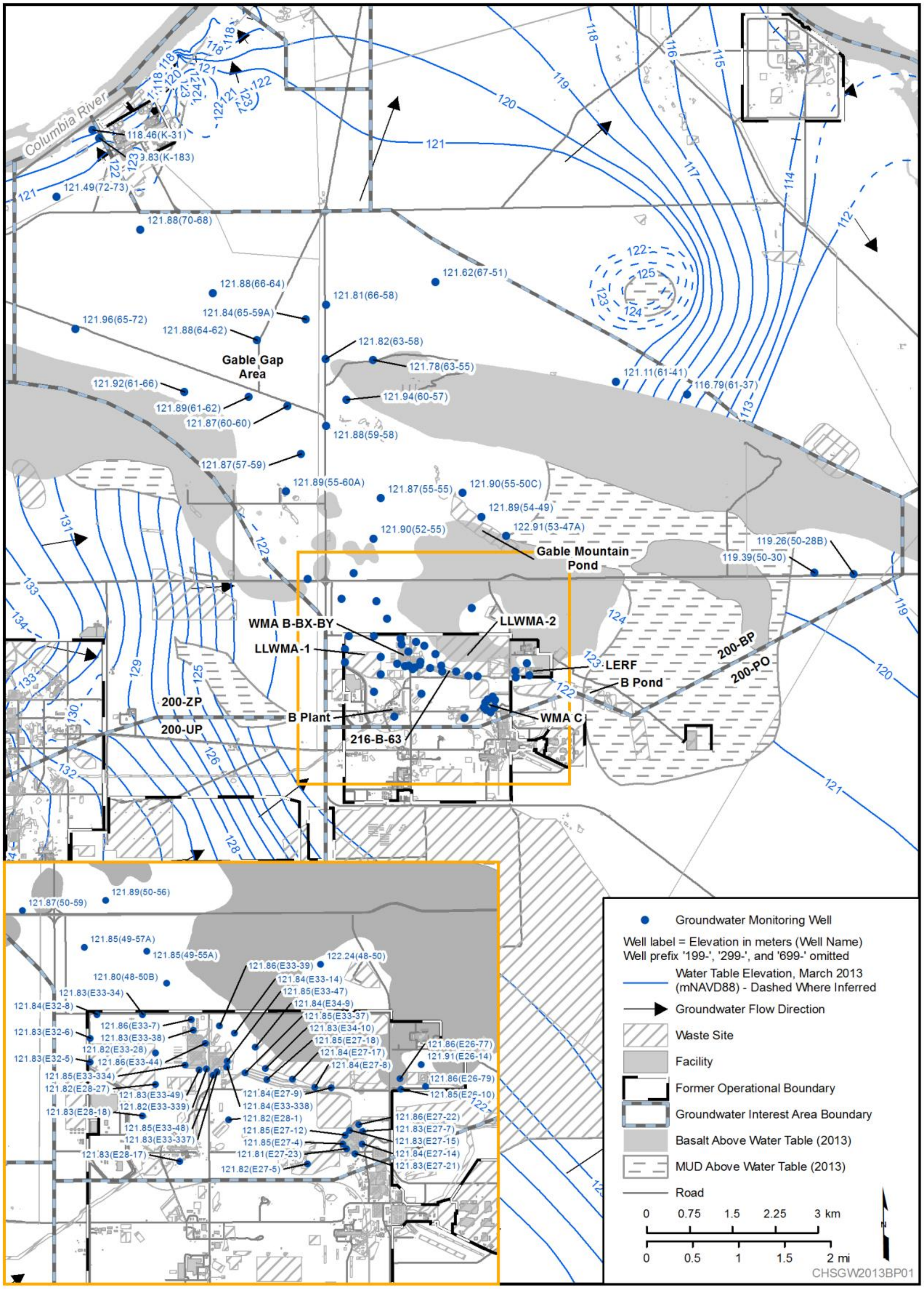

Figure BP.4 200-BP Overview with Groundwater Flow

200-BP CERCLA Activities

The 200-BP-5 OU has completed a draft decisional remedial investigation report (RIR) describing the nature and extent of contamination and identify contaminants of potential concern (COPCs) to support a future feasibility study (FS). Other ongoing CERCLA activities performed in 2013 are discussed in this section and included groundwater monitoring, expansion of the low-gradient monitoring network across the 200 East Area, completion of perched water planning documents, ongoing removal of contaminated perched water near WMA B-BX-BY, completion of a *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*, DOE/RL-2013-46, and locating 3 deep aquifer wells near the 216-B-12 Crib.

Groundwater monitoring in 2013 continued under CERCLA as described in DOE/RL-2001-49 Rev. 1. This sampling analysis plan (SAP) identifies sampling requirements for monitoring ten COPCs: nitrate; iodine-129; technetium-99; uranium; cyanide; stronitum-90; tritium; cesium-137; plutonium-239/240; and cobalt-60. The integrated groundwater monitoring network within the 200-BP-5 OU is shown in Figure BP.5. Table A.16 of Appendix A lists wells, constituents, and 2013 sampling status.

The plume areas have changed significantly the last two years within the northwest portion of the 200 East Area and within the ancestral Columbia River/cataclysmic glacial flooding paleochannel entering the 200 East Area from the northwest. The overall areal interpreted and calculated plume sizes for the major contaminants are reflected in Figure BP.6. Specific discussions of the major changes in plume configurations are discussed in the contaminant sections below.

In 2013, the water level network was expanded to support additional analysis of flow directions associated with the low hydraulic gradients observed in the 200 East Area (SGW-54165). Gyroscopic analyses were completed in 2013 at several of the sixty plus well network locations. Barometric response corrections are planned in 2014.

A document to support evaluation of uranium impacts to perched water, SGW-53604, recommended characterization of the extent of contamination in the Cold Creek silt dominated deep vadose zone perching horizon near WMA B-BX-BY. In parallel with this document, a draft of DOE/RL-2013-37 was submitted to the Washington State Department of Ecology (Ecology) and stakeholders in 2013. Follow on activities addressed by SGW-53604 include:

- Drill two boreholes in 2014 to characterize the extent of perched water contamination and utilize these wells in the perched water treatability test, if perching conditions are encountered.
- Decommission well 299-E33-18. The well, drilled in 1950, was decommissioned in July 2013 for three reasons: it extended through the contaminated perching horizon; was not Washington Administrative Code (WAC) compliant; and was considered an accelerated conduit for downward migration of contaminated perched water into the underlying aquifer. A replacement well is planned in 2014.

Also, the ongoing perched water treatability test at WMA B-BX-BY removed the following in 2013:

- Approximately 349,400 L (92,300 gal) of perched water containing approximately 193 Kg of nitrate, 0.014 Ci of technetium-99, and 17.9 kg of uranium.

At the Modular Storage Units Facility a monitoring network is planned to be installed based on the 2013 *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*, DOE/RL-2013-46. The well drilling is planned to begin in 2014 (see Figure BP.5 for Modular Storage Units Facility location).

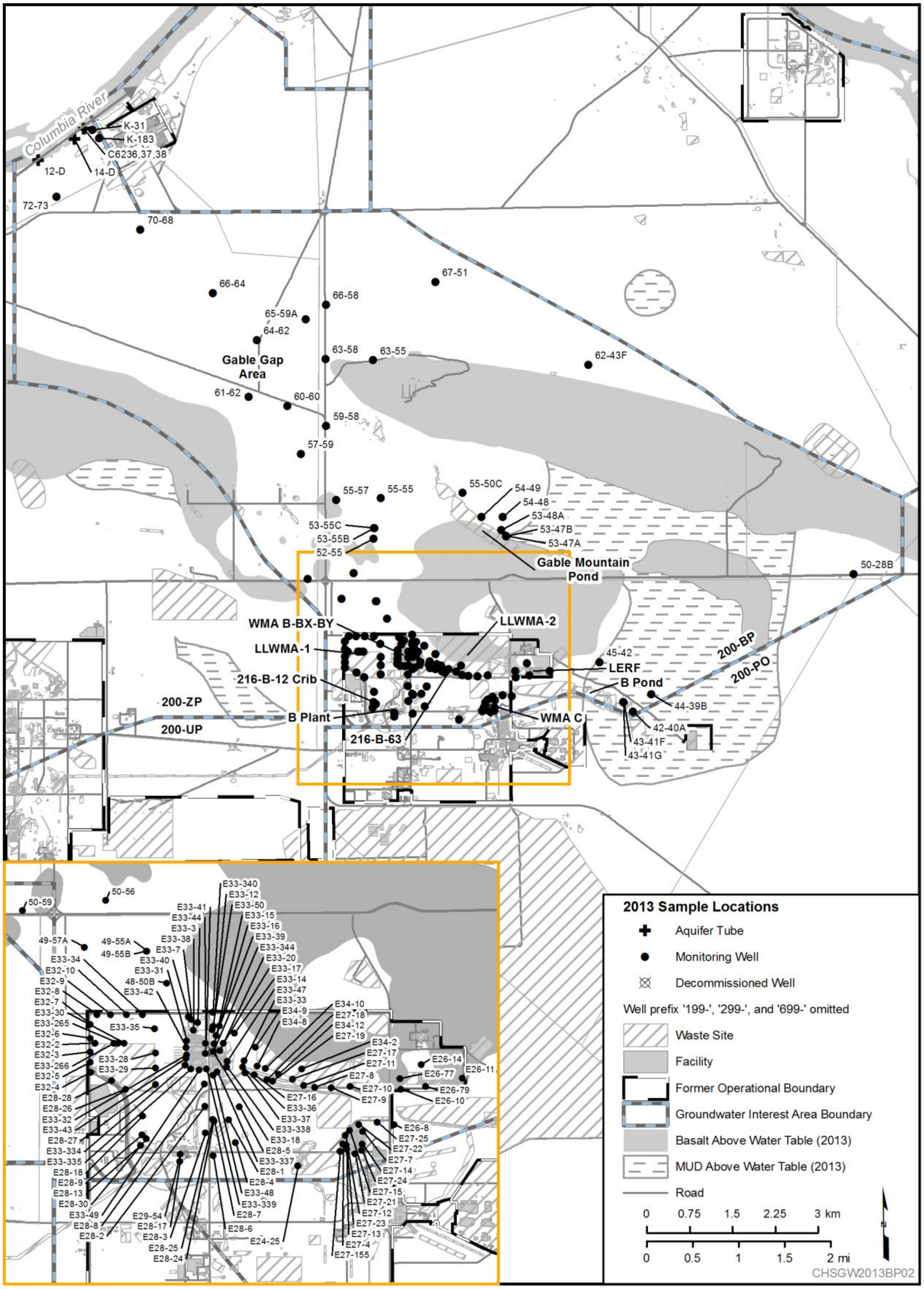

Figure BP.5 200-BP 2013 Sample Locations

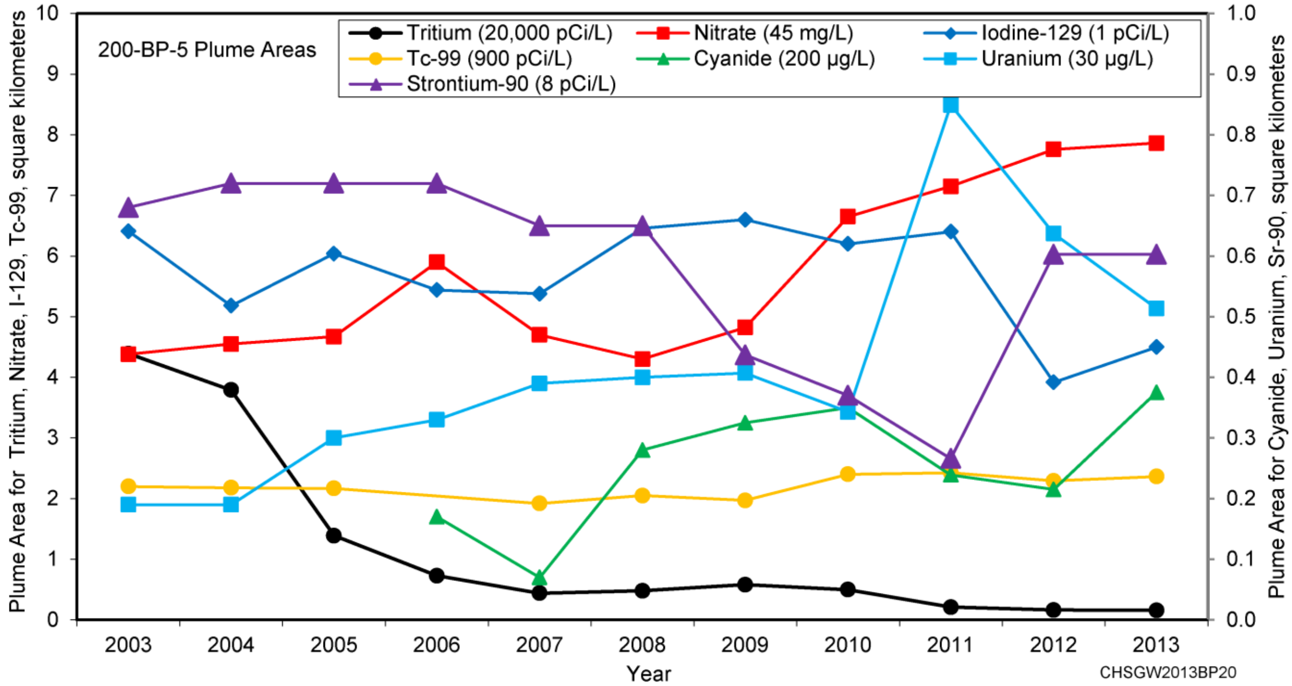

Figure BP.6 200-BP 2013 Plume Areas

Finally, three deep wells near the 216-B-12 Crib were identified for future drilling. These wells are targeted for monitoring the elevated nitrate, tritium, and uranium observed when drilling two remedial investigation (RI) wells in this area. Further details are presented in the associated sections.

200-BP Nitrate

The most extensive plume in 2013 within 200-BP OU continues to be nitrate (Figure BP.7). Nitrate sources have been identified as: BY Cribs, 216-B-7A&B Cribs, 216-B-8 Crib, 241-BX-102 unplanned release, releases with B tank farm (part of WMA B-BX-BY), 216-B-12 Crib, 216-B-5 Injection Well, 216-B-2-2 Ditch, WMA C, Gable Mountain Pond, and Gable Gap (See Figures BP.5 and BP.35 for locations).

BY Cribs. Liquid waste contaminated with nitrate received at the BY Cribs in the past continues to migrate through approximately 70 meters of vadose zone to groundwater. Prior to the 2011 groundwater flow reversal, nitrate concentrations were centered beneath this site ranging between 1,350 to 1,700 mg/L (Figure BP.8). The concentrated plume in Figure BP.8 was the result of minimal groundwater flow between 2006 and 2011 and continuous nitrate infiltration into the aquifer at an average concentration of approximately 200,000 mg/L based on *Hanford Soil Inventory Model*, RPP-26744. Since 2011, this concentrated nitrate plume has migrated and expanded to the southeast as shown in Figures BP.9 and BP.10. The concentrated nitrate plume center migrated past wells 299-E33-16 and 299-E33-17, located approximately 250 meters southeast of the BY Cribs, in early 2013 (1,400 and 1,410 mg/L, respectively). By summer/fall 2013 concentrations decreased by 200 mg/L in each of these wells. The migration rate is consistent with derived flow rates associated with the low-gradient water level monitoring network measured results as discussed in the RCRA WMA B-BX-BY Section later in this chapter.

B Tank Farm. The highest 2013 nitrate concentration (1680 mg/L) in 200-BP and the B Complex area (e.g., WMA B-BX-BY and nearby waste sites) was at well 299-E33-47 (Figure BP.7). The source of nitrate at this well was determined to be associated with an unplanned release within the 241-B tank farm as discussed in DOE/RL-2012-53. The 2012 and 2013 growing plume extent is shown in Figures BP.9 and BP.10. Because this plume has expanded beyond the existing monitoring well network, a new well 299-E33-361 is planned to be drilled in 2014 to monitor this area. This planned well is being designed for conversion to a groundwater extraction well, if needed.

241-BX-102 Unplanned Release and 216-B-7A&B Cribs. Contaminated pore water within a perched water horizon, located approximately 3 meters above the unconfined aquifer is sourced from both the 241-BX-102 Unplanned Release and 216-B-7A&B Cribs. The contaminated perched horizon water is monitored and removed by well 299-E33-344. Nitrate at well 299-E33-344 has ranged between 326 to 810 mg/L since installation in 2007 (Figure BP.11). The total estimated nitrate removed by extraction at well 299-E33-344 is 360 kilograms dating from August 2011 through December 2013. Continued pumping at this well is planned for the foreseeable future. Two additional wells are planned for 2014 to further characterize contamination in the perched water horizon.

216-B-12 Crib, B Plant, and 216-B-5 Injection Well. South of the 216-B-12 Crib nitrate concentrations remained relatively stable at well 299-E28-30, ranging from 55.8 to 60.2 mg/L since installation in 2010. However, to the east at well 299-E29-54 concentrations increased from 65.1 to 126 mg/L between 2012 and 2013. Nitrate also increased from 58.9 mg/L in 2011 to 102.1 mg/L in 2013 at well 299-E28-6. The increases may be associated with concentrated nitrate found in the lower part of the aquifer during the 2010 RI drilling at wells 299-E28-30 and 299-E29-54 as discussed in DOE/RL-2011-01. Concentrations at approximately 8 meters below the water table at well 299-E28-30 were nearly 900 mg/L. To better assess the horizontal and vertical extent of the plume in this area, three additional well installations were added to the Hanford Site well drilling priority list in 2013. These wells are planned to be screened at the discrete depth where elevated nitrate, tritium, and uranium were found in the aquifer (e.g., approximately 8 meters below the water table).

216-B-2 Ditches. The nitrate concentrations near the eastern portion of the 216-B-2 Ditches, in well 299-E27-10, have declined from 66.4 mg/L in February 2010 to 48.3 mg/L in October 2013. Nitrate concentrations to the east, south, and west of well 299-E27-10 have similar concentrations, not exceeding at 60.2 mg/L in 2013. It is expected that the concentrations trends in wells 299-E26-10, 299-E27-9, and 299-E27-25 will mimic the trend at well 299-E27-10.

Waste Management Area (WMA) C. Nitrate concentrations at three WMA C wells exceeded DWS in 2013. The greatest concentration (110 mg/L) was at well 299-E27-14, located on the southeast side of WMA C. The plume extends throughout the 15.5 meters thick aquifer. Well 299-E27-24 was installed in 2010 in the lower portion of the unconfined aquifer. The nitrate concentration in well 299-E27-24 has been stable, ranging between 68 and 72 mg/L since sample collection began in 2010.

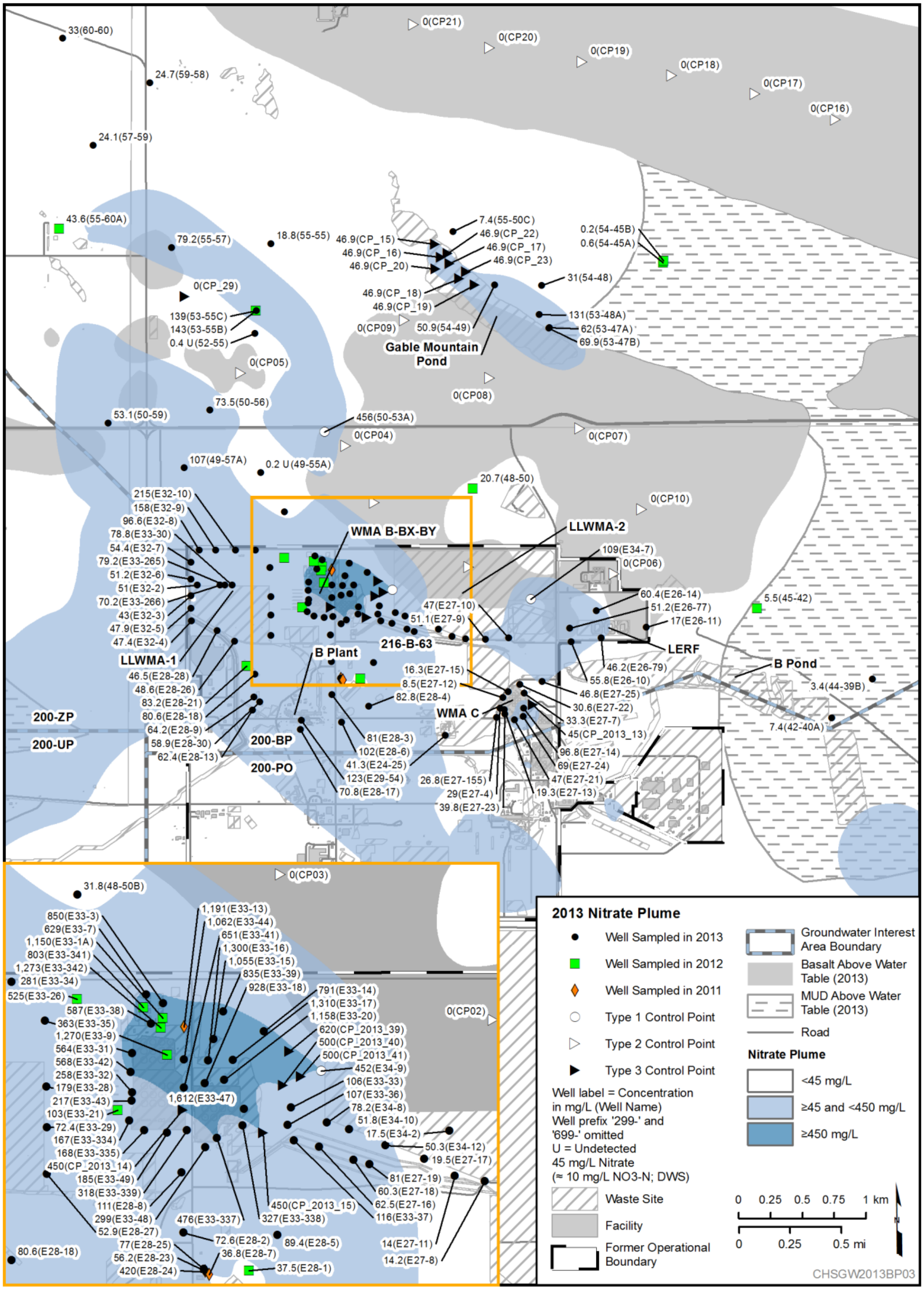

Figure BP.7 200-BP 2013 Nitrate Plume

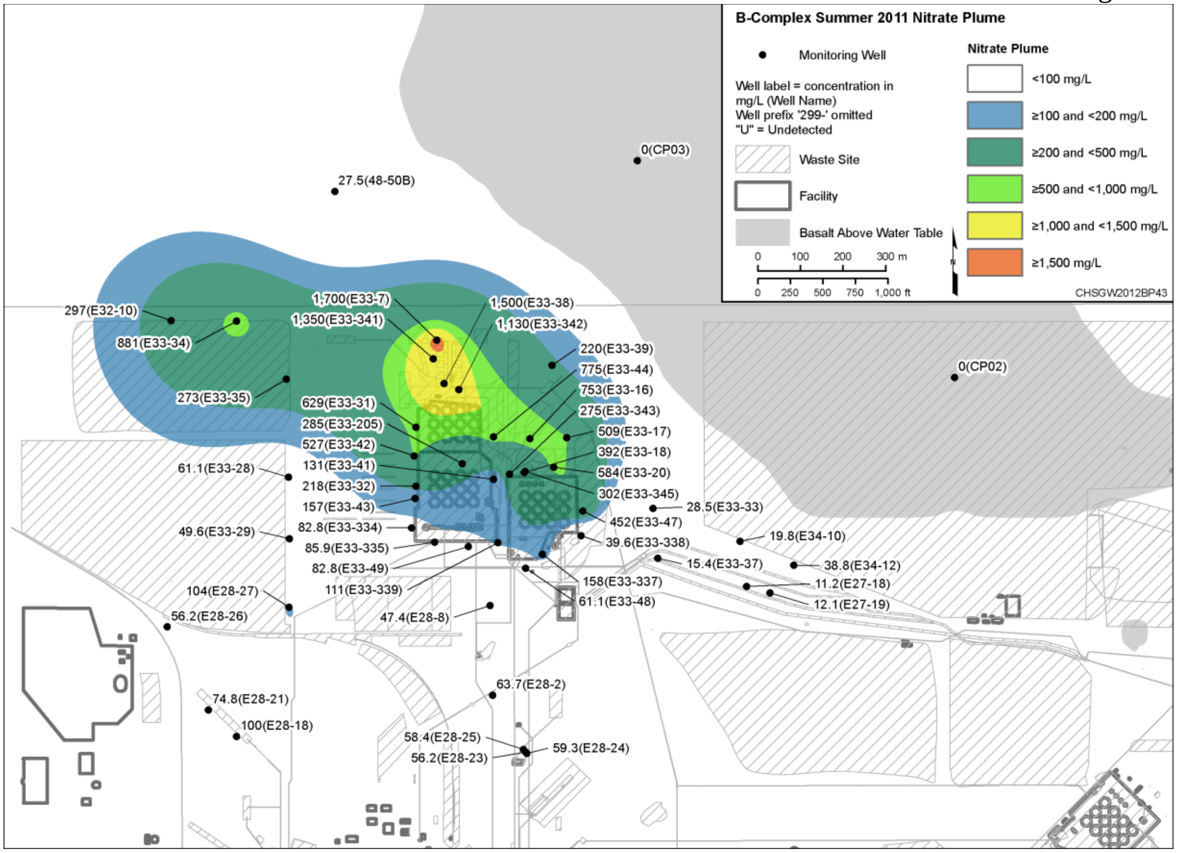

Figure BP.8 200-BP Nitrate Near BY Cribs, Summer 2011

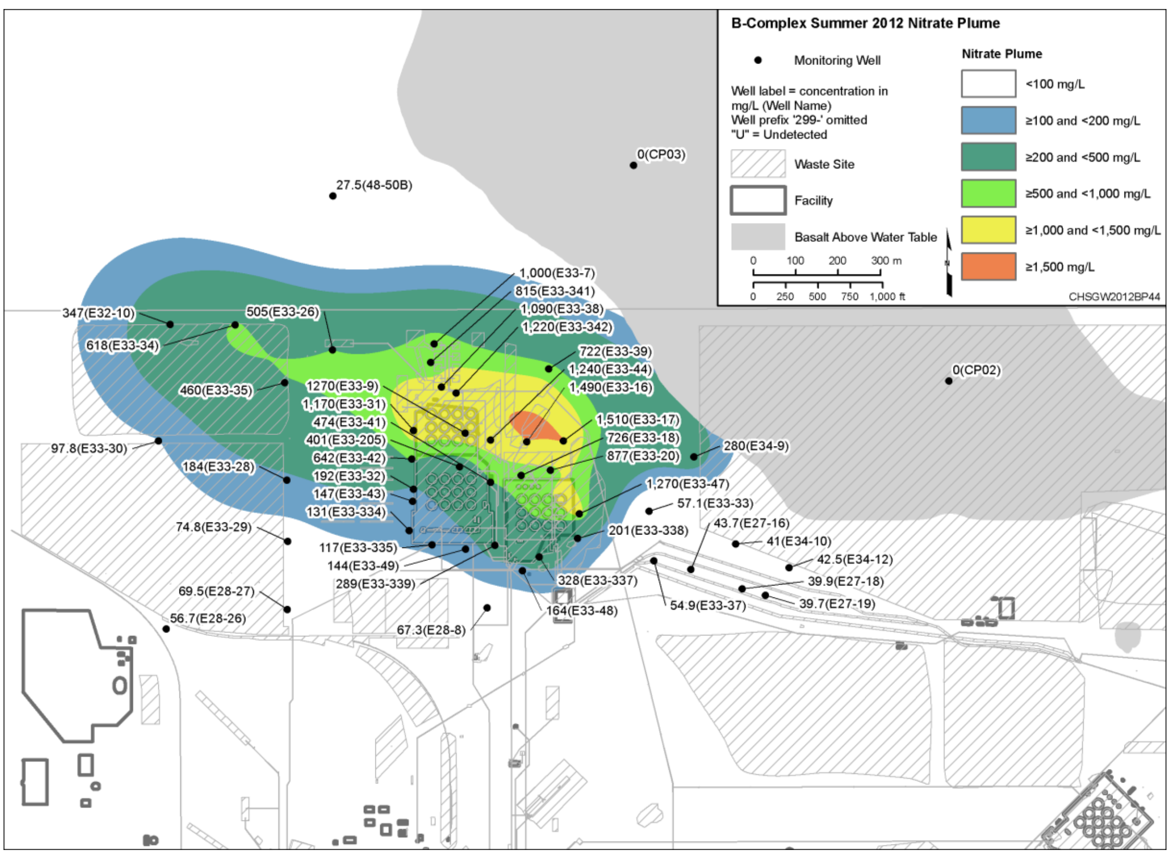

Figure BP.9 200-BP Nitrate Near BY Cribs, Summer 2012

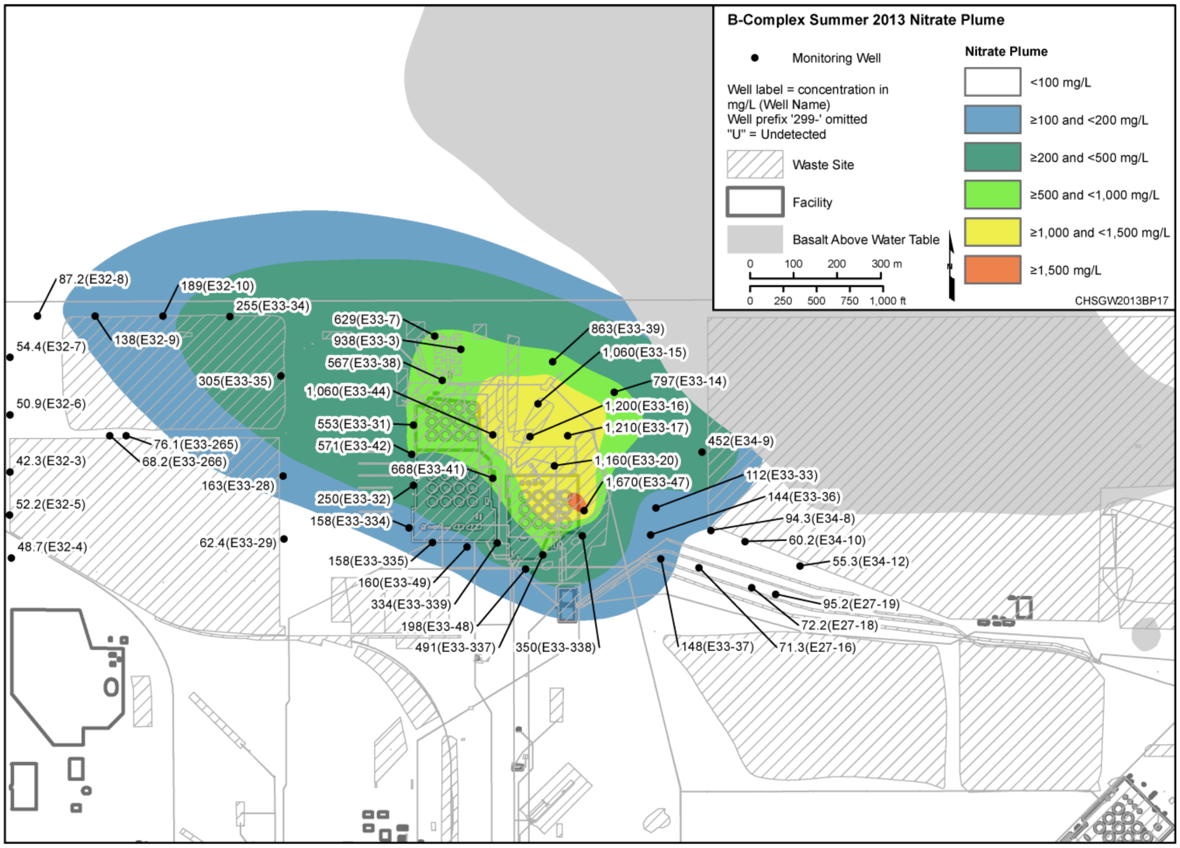

Figure BP.10 200-BP Nitrate Near BY Cribs, Summer 2013

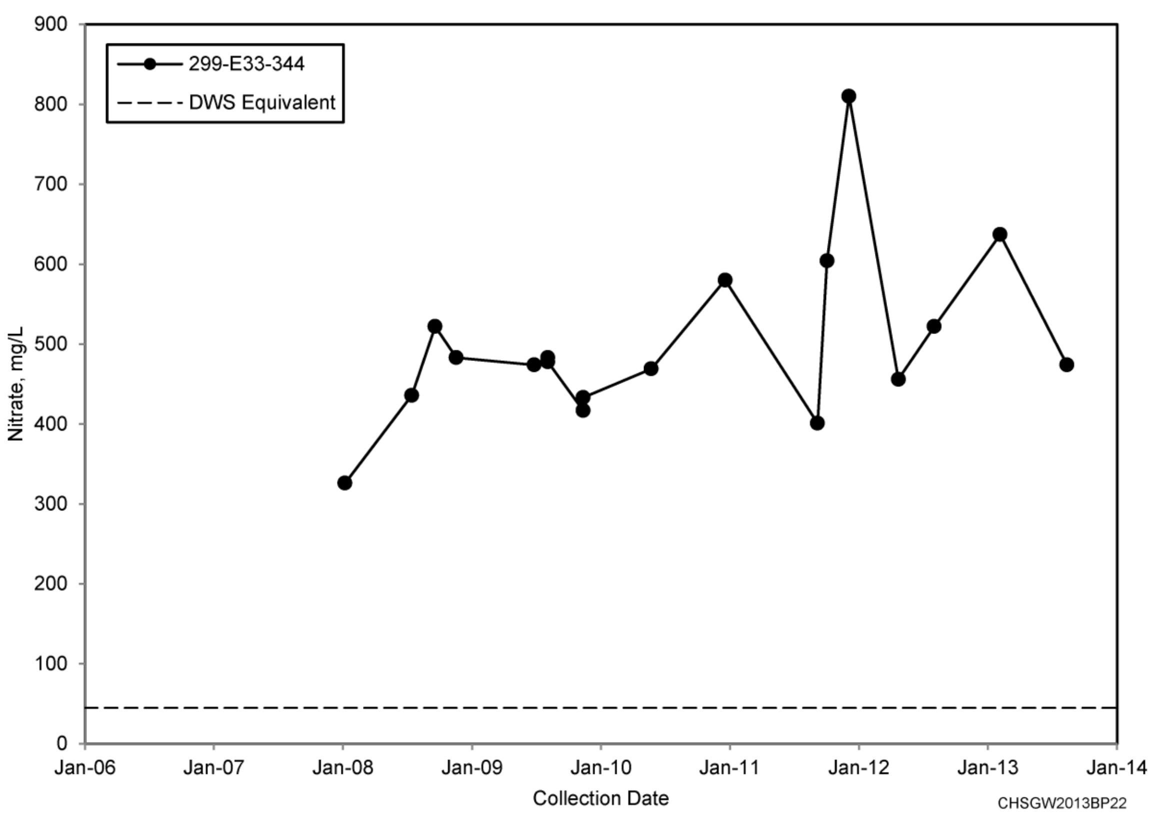

Figure BP.11 200-BP Nitrate Data for Well 299-E33-344

Gable Mountain Pond (216-A-29). The highest nitrate concentration in 2013 at the former Gable Mountain Pond was 131 mg/L at well 699-53-48A. Over the previous 6 years, concentrations at this well have decreased from 210 mg/L. The aquifer at this well is approximately 2 meters thick as defined by the underlying basalt. Concentrations in other wells in this area are approximately half or less than the concentration at well 699-53-48A, and the aquifer thickens at these wells. The areal extent of nitrate exceeding DWS closely outlines the area of the former pond, with concentrations diminishing to the west as the aquifer increases in thickness.

Gable Gap. Prior to termination of discharges to Gable Mountain Pond, nitrate from the BY Cribs migrated north towards 699-50-53A creating a significant plume as depicted in Figure 1F-3 of DOE/RL-95-59. Since the termination of discharges to Gable Mountain Pond, nitrate migrated north-northwest as depicted in Figure 1F-5 of DOE/RL-95-59 and Figure BP.7. Since 2007, concentrations at well 699-53-55C have been stable with a slight decrease since 2010. Concentrations have also been stable at well 699-55-57; however, concentrations declined significantly at well 699-57-59 and have risen in the short term at well 699-55-60A. Thus, the nitrate plume geometry portrayal of the nose of the nitrate plume in this area.

200-BP Iodine-129

Three sources in the southeastern 200 East Area (216-A-10 Crib vicinity, 216-A-29 Ditch, and B Pond) were contributors to the widespread distribution of iodine-129 within the 200 East Area and Gable Gap (Figure BP.12). Other potential sources of iodine-129 to groundwater include the BY Cribs, 241-BX-102 unplanned release, and the 216-B-8 Crib.

The plume area remained relatively stable until 2012 when it started decreasing (Figure BP.6). Two reasons for the decrease in plume area in 2013 as compared to 2012 are:

1) The iodine-129 plume northwest of 200 East Area decreased in 2012. This change was driven by the decrease in iodine-129 in well 699-50-56 and the non-detect iodine-129 level (less than 0.26 pCi/L) in well 699-55-60A.
2) The iodine-129 plume near B Pond was not counted in the total area from the shallow unconfined aquifer in 2013 because the contamination is considered to be within the Ringold mud unit and not in the unconfined aquifer. The extent of the plume in this area is shown on Figure BP.12

Overall iodine-129 activity in 2013 within 200-BP ranged from approximately 7 pCi/L near WMA C (299-W27-22) to less than 1 pCi/L at wells in the northern part of Gable Gap. The northwest plume extent reflects the primary flow path in the late 1980s when discharges to Gable Mountain Pond were terminated.

B Pond. Four 200-BP wells were sampled and analyzed for iodine-129 near B Pond in 2013. Results at two of the wells exceeded DWS, 699-43-41F (1.85 pCi/L) and 699-45-42 (2.21 pCi/L). Both of these wells are located in the unconfined aquifer, very near the 200-PO boundary. Concentrations in the other wells, 699-42-40A and 699-43-41G, which are located beneath a silt/clay unit and considered to reside in the semi-confined aquifer, were below DWS.

Waste Management Area C. All twelve wells at WMA C had iodine-129 levels exceeding DWS and are associated with past migration of greater iodine-129 activity to the east/southeast. The levels at WMA C ranged from 2.5 to 7.5 pCi/L. Iodine-129 levels detected near WMA C have been relatively consistent over the past two decades.

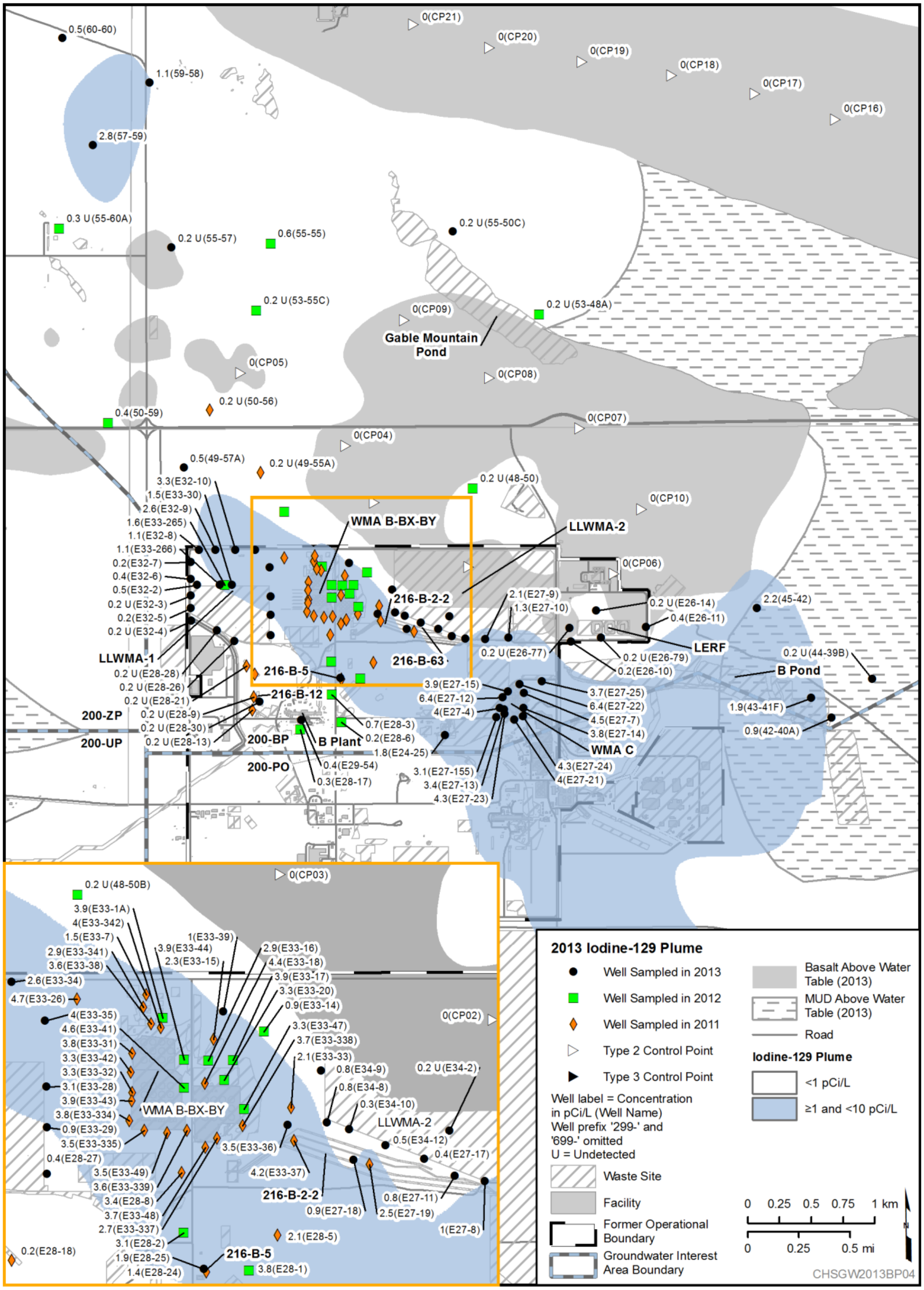

Figure BP.12 200-BP 2013 Iodine-129 Plume

Low-Level Waste Management Area 2. Elevated iodine-129 has been detected in the wells along the south side of LLWMA-2 since monitoring began in the early 1990s. The greatest activity was in well 299-E27-10 when sampling began, but has continued to decline and is currently near DWS. Only the east LLWMA-2 wells (299-E27-8, 299-E27-9, 299-E27-10, and 299-E27-11) continue to have activity levels greater than DWS. These wells define the northern extent of iodine-129 in this area.

216-B-5 Injection Well. The spatial distribution of iodine-129 at wells near the 216-B-5 Injection Well indicates a source to the east of the site. The 1 pCi/L DWS contour extends south of this waste site, between wells 299-E28-3 and 299-E28-24.

216-B-2 Ditches. Elevated iodine-129 levels were detected in wells beneath the 216-B-2 Ditches as early as the 1990s. Past levels were greatest in well 299-E33-36, located north of the head end of the ditches. Iodine-129 in this well remains fairly high (3.53 pCi/L), greater than to the east or south, indicating the central portion of the plume that migrated to the northwest in the past.

B Complex to Gable Gap. Because the activity in well 699-49-57A and other adjacent wells decreased below DWS, the northwestern extent of the plume in 2013 was closer to the 200 East Area than in 2012. There may be relatively small areas of contamination between wells that may be identified in the future, but currently the data reflects the plume geometry presented in Figure BP.12. In Gable Gap, the 1 pCi/L iodine-129 contour geometry remained the same as activity levels have remained stable in the wells monitoring this area.

200-BP Technetium-99

Technetium-99 sources have been identified at: BY Cribs, 216-B-7A&B Cribs, 216-B-8 Crib, 241-BX-102 unplanned release, releases with B tank farm (WMA B-BX-BY), WMA C and Gable Gap. Estimated plume distribution is shown in Figure BP.13. Three general plume areas are present within 200-BP; one area north of 200 East, one near WMA B-BX-BY, and one near WMA-C. The largest of the three plumes is near WMA B-BX-BY and sources include the BY Cribs, 216-B-7A&B Cribs, 216-B-8 Crib, 241-BX-102 unplanned release, and releases associated with the B tank farm.

BY Cribs. Technetium-99 in 200-BP is primarily from liquid waste associated with the BY Cribs, which received a mean inventory of 128.6 Ci of technetium-99 (Appendix C of RPP-26744). Prior to the 2011 groundwater flow reversal, technetium-99 activity beneath the BY Cribs exceeded 30,000 pCi/L in all three wells located within the BY Cribs footprint (Figure BP.14). The increased activity was the result of minimal groundwater flow between 2006 and 2011 and continuous technetium-99 infiltration into the aquifer at an average activity of approximately 3.8 µCi/L based on RPP-26744. Since 2011 this concentrated technetium-99 plume has migrated and expanded to the southeast as shown in Figures BP.15 through BP.17. Peak technetium-99 activity migrated past wells 299-E33-16 and 299-E33-17, located approximately 250 meters southeast of the BY Cribs, in early 2013 (31,000 and 24,000 pCi/L, respectively). By summer 2013 activity decreased 2,000 pCi/L in each of these two wells. The migration rate is consistent with derived flow rates associated with the low-gradient water level monitoring network measured results as discussed in the RCRA WMA B-BX-BY Section below.

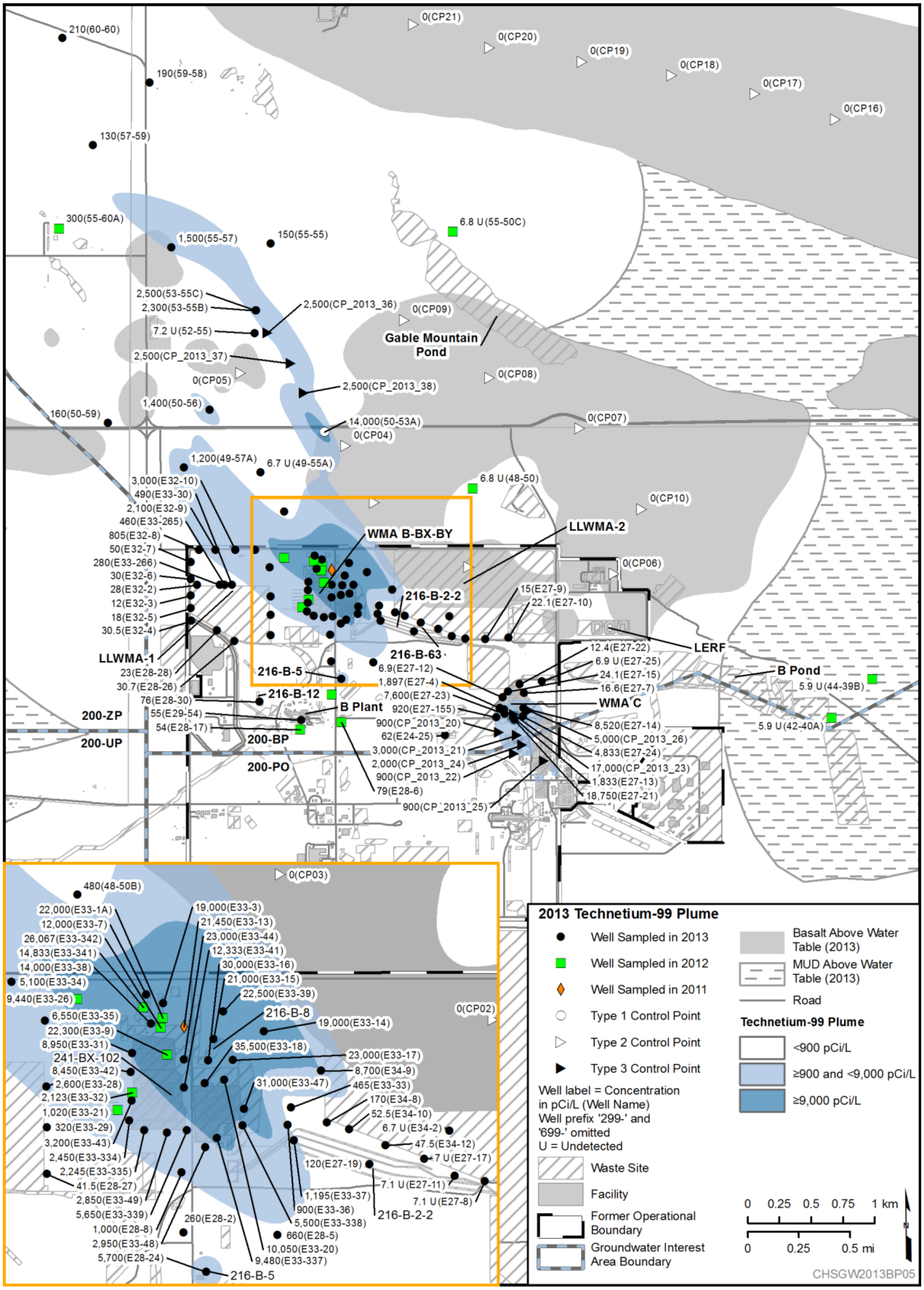

Figure BP.13 200-BP 2013 Technetium-99 Plume

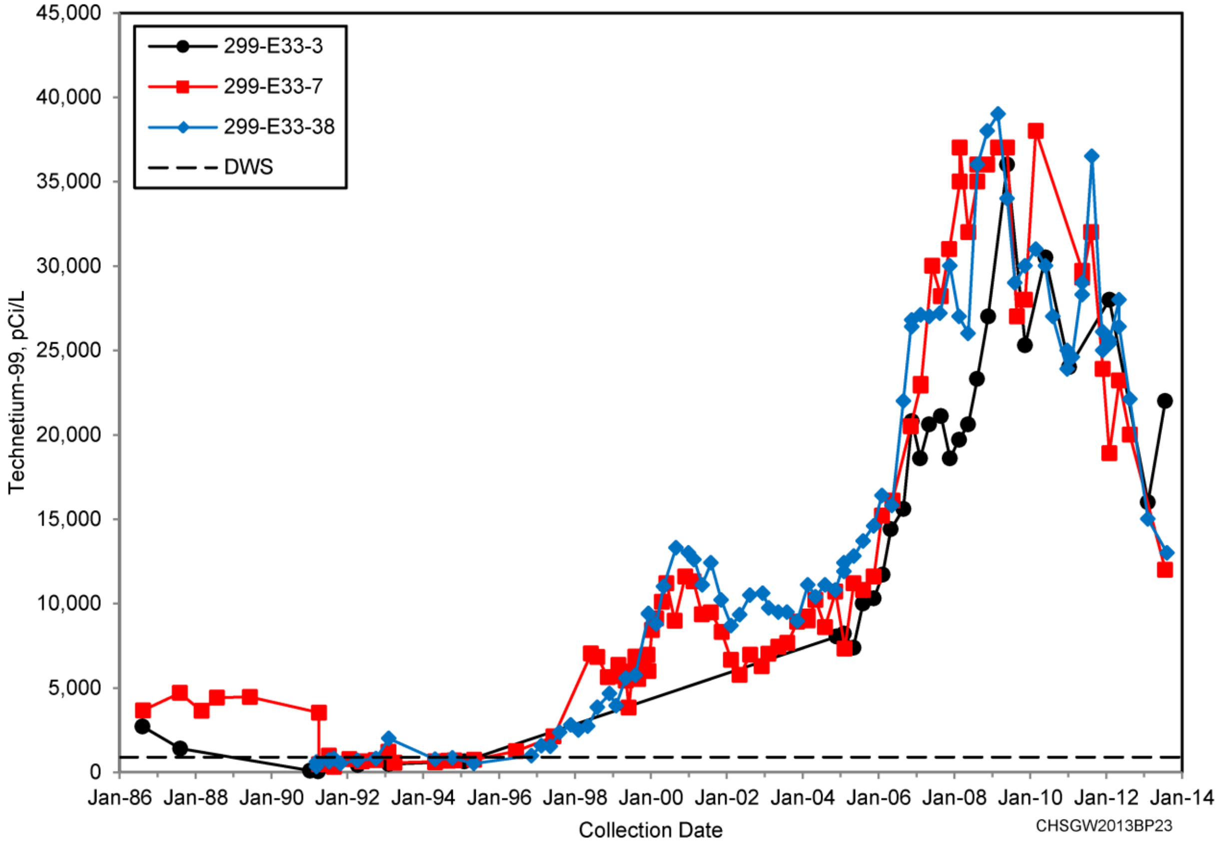

Figure BP.14 200-BP Technetium-99 Data for Wells 299-E33-3, 299-E33-7, and 299-E33-38

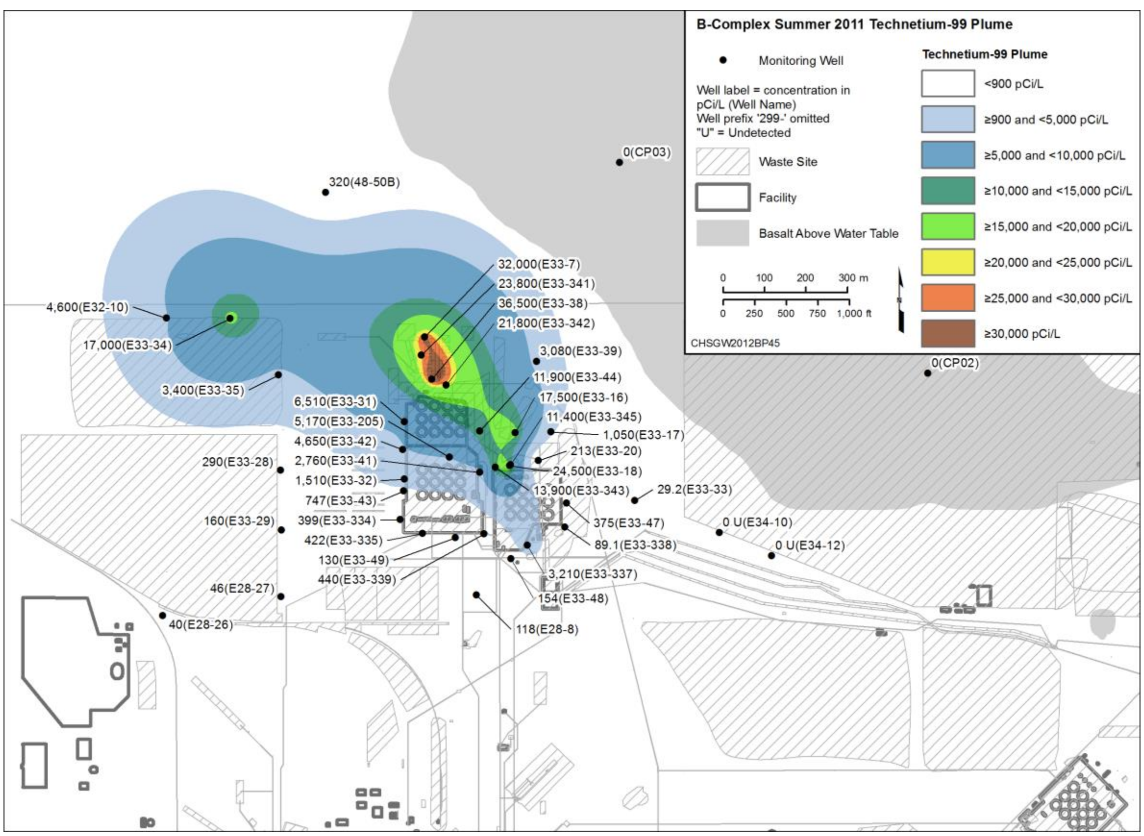

Figure BP.15 200-BP Technetium-99 near BY Cribs, Summer 2011

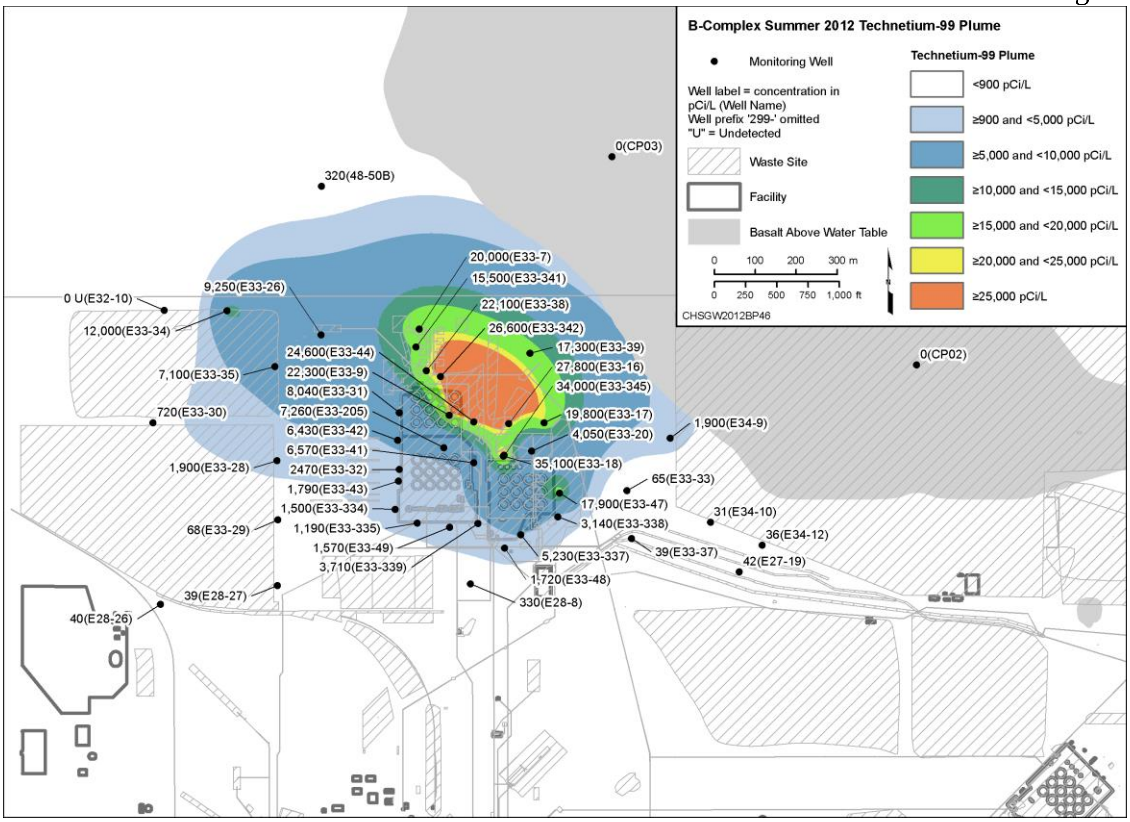

Figure BP.16 200-BP Technetium-99 near BY Cribs, Summer 2012

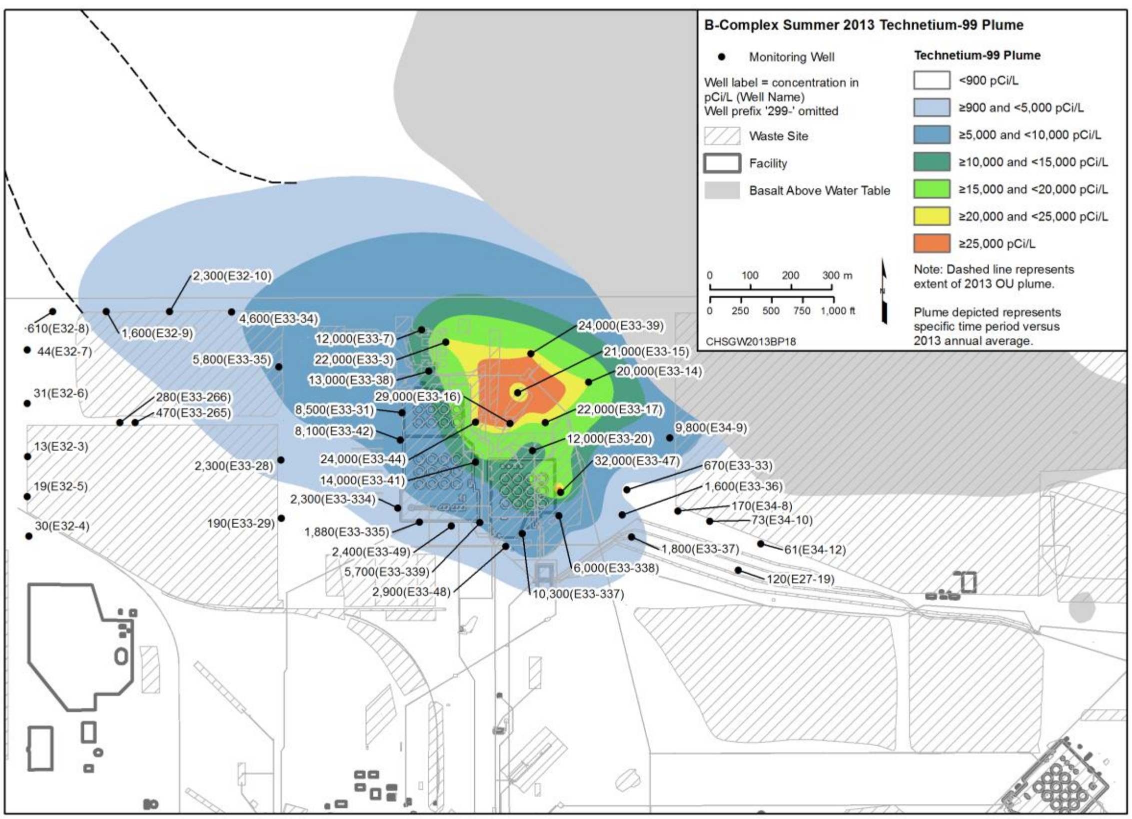

Figure BP.17 200-BP Technetium-99 near BY Cribs, Summer 2013

241-BX-102 Unplanned Release and 216-B-7A&B Cribs. The greatest technetium-99 activity in 200-BP in 2013 occured at well 299-E33-18, with a maximum activity of 36,000 pCi/L. The ratio of technetium-99 to nitrate in groundwater is potentially useful for evaluating source contributions. The technetium-99 to nitrate ratio associated with this area indicates a potentially different source than the other high activity wells in this area, due to the greater technetium-99 activity and lower nitrate concentration (Figure BP.18). This is consistent with the type of waste released; metal waste from the 241-BX-102 tank. By comparison, the technetium-99 to nitrate ratio in perched well 299-E33-344 is much lower because of mixing with 216-B-7A&B waste. The total estimated technetium-99 removed through extraction at 299-E33-344 is 2.1×10^{-2} curies dating from August 2011 through December 2013.

Two other areas of technetium-99, located along the south boundary of the 241-B and BX tank farms, at wells 299-E33-337 and 299-E33-339 may be related to the 241-BX-102 unplanned release; however, the technetium-99 to nitrate ratios at wells 299-E33-337 and 299-E33-339 are different from wells 299-E33-18 and 299-E33-343, which are considered sourced by the 241-BX-102 unplanned release (Figure BP.18). Other possible sources within the 241-B and BX tank farms are currently under assessment as discussed in DOE/RL-2012-53.

B Tank Farm. A new contaminant source was identified in 2012 at the 241-B tank farm, affecting two groundwater wells, 299-E33-47 and 299-E33-338 (Figure BP.17). Two observations at well 299-E33-47 differentiate this plume from the upgradient 241-BX-102 unplanned release: (1) the technetium-99 to nitrate ratio, and (2) the presence of cyanide. The source is considered to be associated with at tributyl phosphate waste release as discussed in DOE/RL-2012-53. Because this plume has expanded beyond the existing monitoring well network, a new well is planned to be drilled in 2014 to monitor the extent of contamination.

Waste Management Area C. In 2013, the same seven WMA C monitoring wells as in 2012 exceeded the 900 pCi/L DWS for technetium-99 (Figure BP.19). However, activity is trending down in well 299-E27-23, which had the greatest activity of all WMA C wells for the past 6 years. The elevated technetium-99 activity at well 299-E27-23, near or above 20,000 pCi/L from 2010 to 2012, appears to be migrating to well 299-E27-21 based on September 2013 data. A further discussion of the contamination in wells 299-E27-21 and 299-E27-23 is provided in the document *WMA C October through December 2013 Quarterly Groundwater Monitoring Report*, SGW-56777. Also discussed in SGW-56777 is the potential for two separate releases, monitored by wells 299-E27-21 and 299-E27-14.

Gable Gap. Prior to termination of discharges to Gable Mountain Pond, technetium-99 from the BY Cribs migrated north towards 699-50-53A creating a significant plume as depicted in Figure 1.3 of DOE/RL-95-59. Since the termination of discharges to Gable Mountain Pond, technetium-99 migrated north-northwest as depicted in Figure 1-5 of DOE/RL-95-59 and Figure BP.13. Since 2010, activity at well 699-53-55C has decreased. Activity has also decreased slowly at well 699-55-57 since monitoring began in 1991. Likewise activity has declined at well 699-57-59 since 2009; however, activity rose in 2012 at well 699-55-60A. Thus, the nose of the technetium-99 plume geometry is portrayed to be contracting to the northwest and migrating westward from 699-55-57 to 699-55-60A in this area.

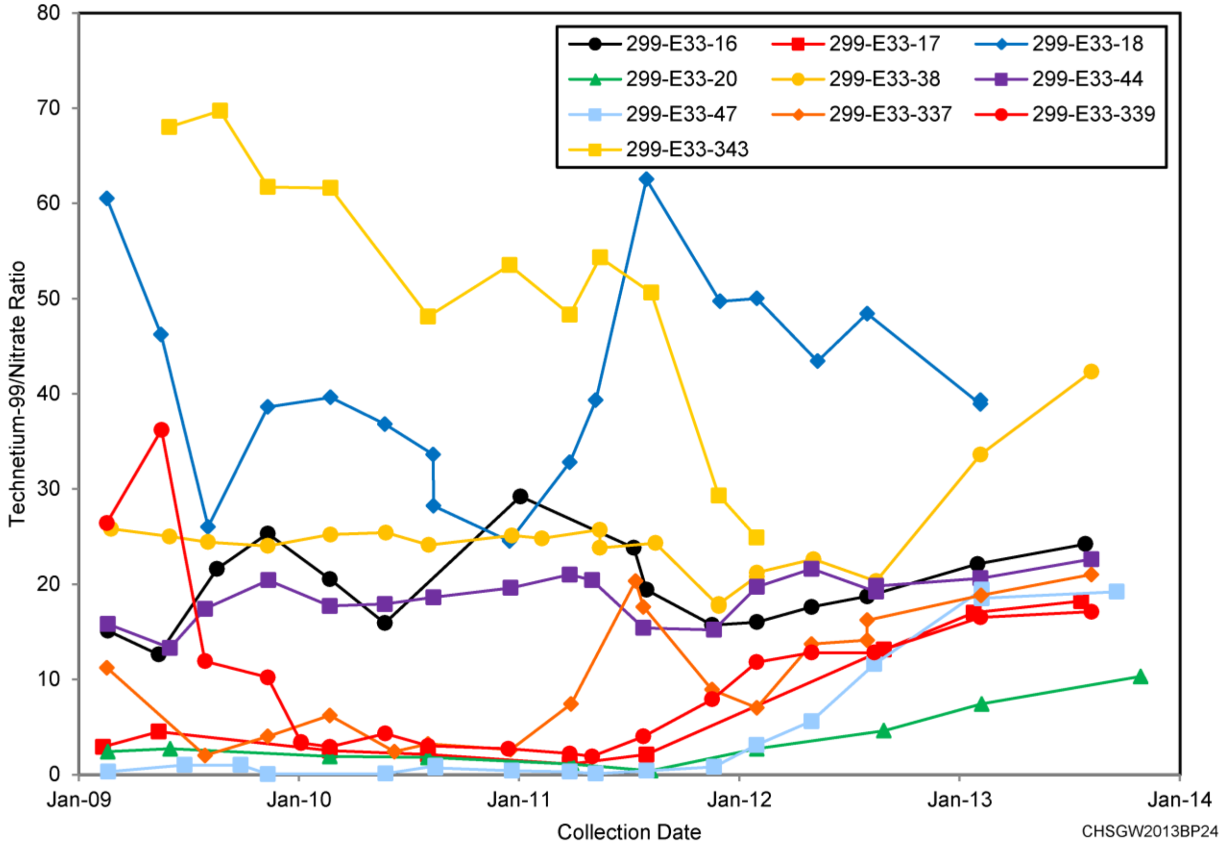

Figure BP.18 200-BP Technetium-99 in Wells Associated with B Complex

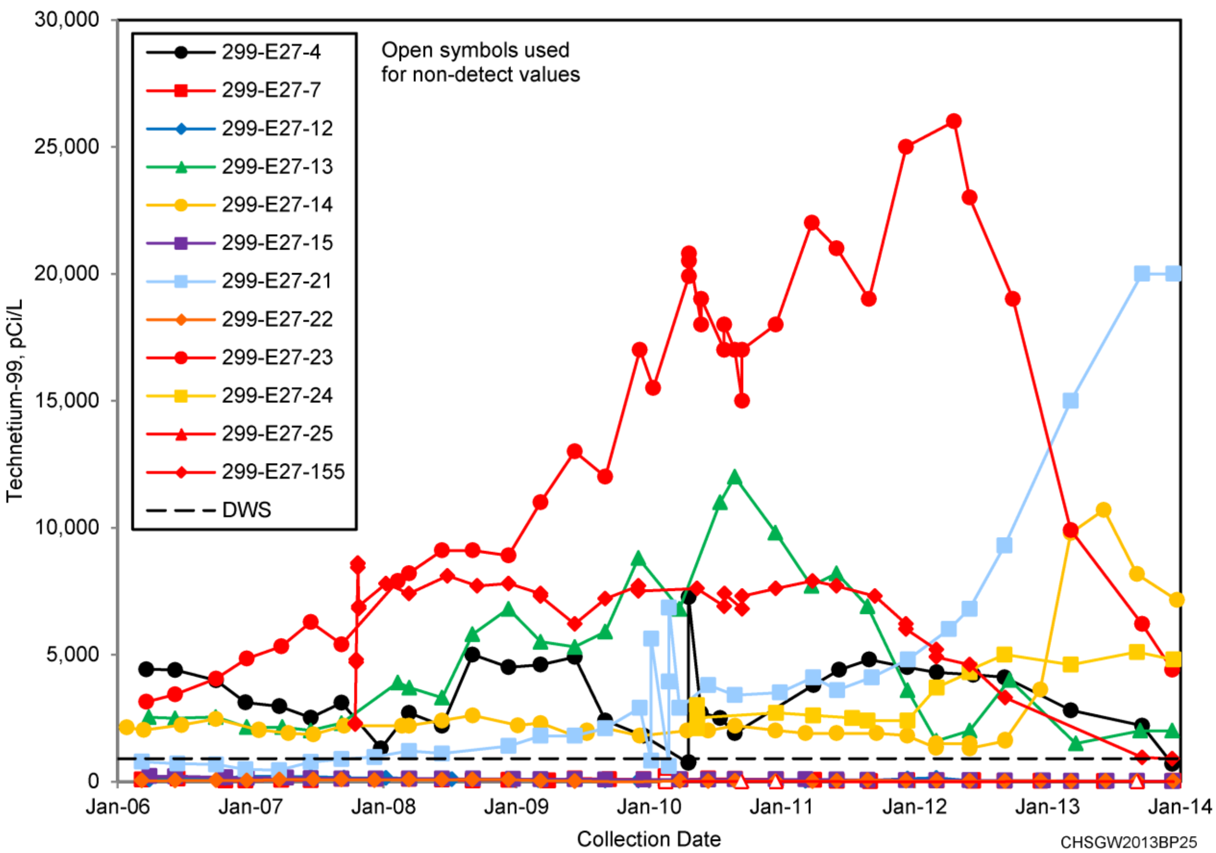

Figure BP.19 200-BP Technetium-99 Data for Wells Bounding WMA C

200-BP Uranium

Uranium found in 200-BP groundwater primarily originated from large disposal inventories to the 216-B-12 Crib and the 241-BX-102 unplanned release (Figure BP.20). The uranium inventory disposed to these sites exceeded 10,000 kilograms, which is at least an order of magnitude greater than other waste sites within 200-BP.

216-BX-102 Unplanned Release. Rough order of magnitude calculations indicated that 1,050 kilograms of water-extractable uranium may reside in the Cold Creek silt-dominated unit approximately 3 meters above the aquifer (Figure BP.21). The estimate was based on sample results from three boreholes in an east-west orientation within the perched water zone. To address the groundwater impact associated with contaminant migration from the perching horizon, DOE initiated a perched water treatability test in August 2011. Approximately 32 kg of uranium has been removed within this horizon through December 2013.

Well 299-E33-18 had the greatest uranium concentration in the unconfined aquifer in 2013 (3,330 µg/L) in 200-BP. This well is located 39 meters east of well 299-E33-343, which had the greatest groundwater uranium results from 2008 to 2011 (Figure BP.22). The maximum result at well 299-E33-343 was 5,500 µg/L in June 2009. The migration of the high-concentration portion of this plume is attributed to the groundwater flow direction change from the northwest to the southeast. The results of this flow change are seen by comparing the spatial distribution of the uranium plume from summer 2011 (Figure BP.23), when the flow change was initiated, and summer 2012 (Figure BP.24). Continued southeast migration of the uranium plume beneath the 241-B and BX tank farms has extended beyond existing monitoring wells as seen in Figure BP.20. As a result, a new well is planned to be drilled in 2014 to monitor the extent of uranium.

216-B-12 Crib. The source of the past elevated uranium near well 299-E28-18 has been linked to the 216-B-12 Crib, as discussed further in DOE/RL-2011-01. The extent of the uranium plume is uncertain due to the relatively low number of wells in this area, but is believed to be defined to the east by wells 299-E28-2, 299-E28-3, and 299-E28-24 (Figure BP.20). A south plume defined by wells 299-E28-6, 299-E28-17, and 299-E29-54 is also considered to be sourced by the 216-B-12 Crib. Uranium near the 216-12 crib has been detected deeper in the unconfined aquifer. During drilling of well 299-E28-30, the highest concentration of uranium was detected approximately 8 meters below the water table. The current monitoring wells in the vicinity of the 216-B-12 Crib are screened above a depth of 8 meters below the water table, or only partially screened in the interval where the highest concentrations were detected. Therefore, to better assess the horizontal and vertical extent of the deeper unconfined uranium concentrations, three additional well installations were added to the M-24 future drilling list in 2013. These wells are planned to be screened at the discrete depth where elevated nitrate, tritium, and uranium were found in the aquifer (e.g., approximately 8 meters below the water table).

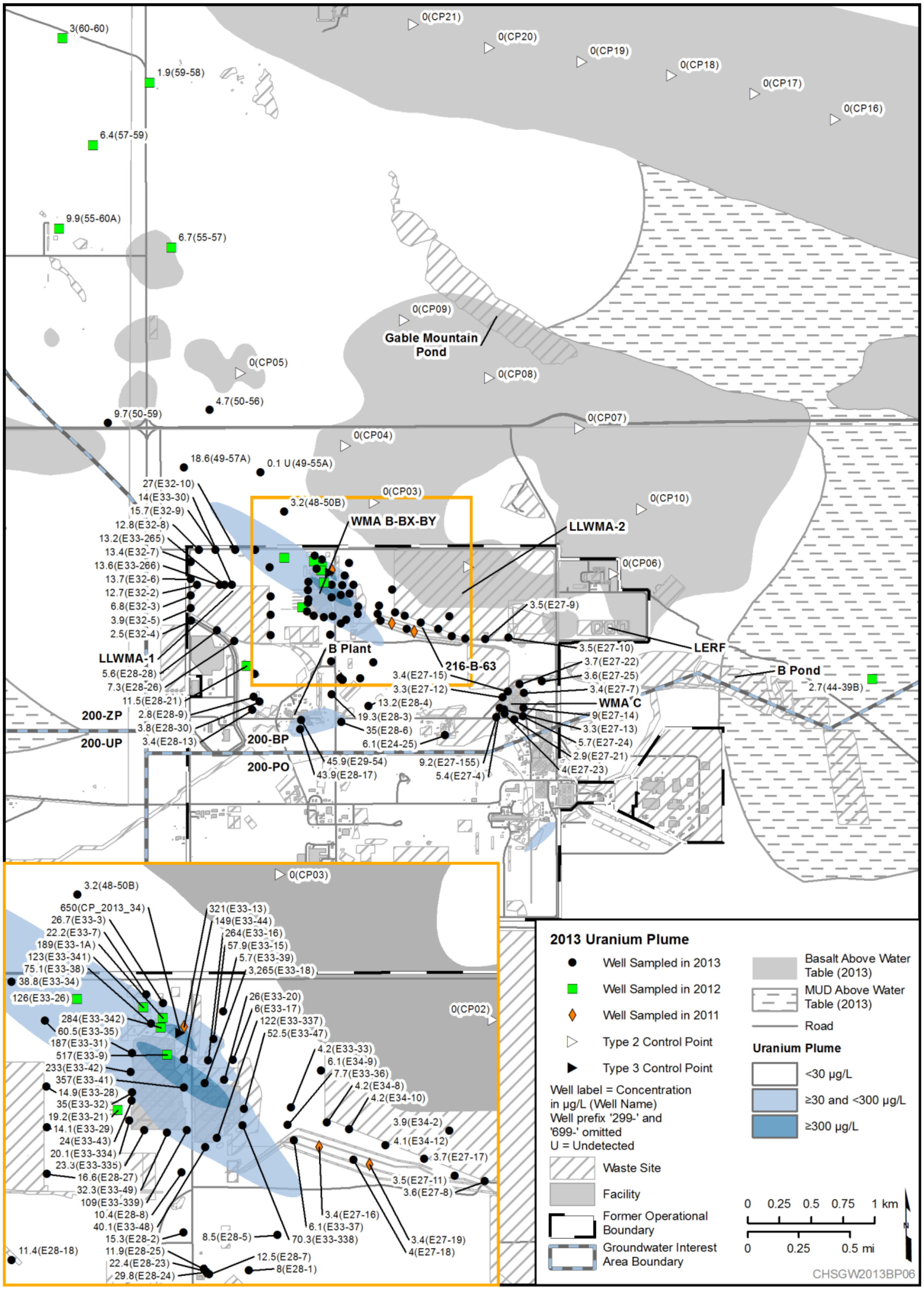

Figure BP.20 200-BP 2013 Uranium Plume

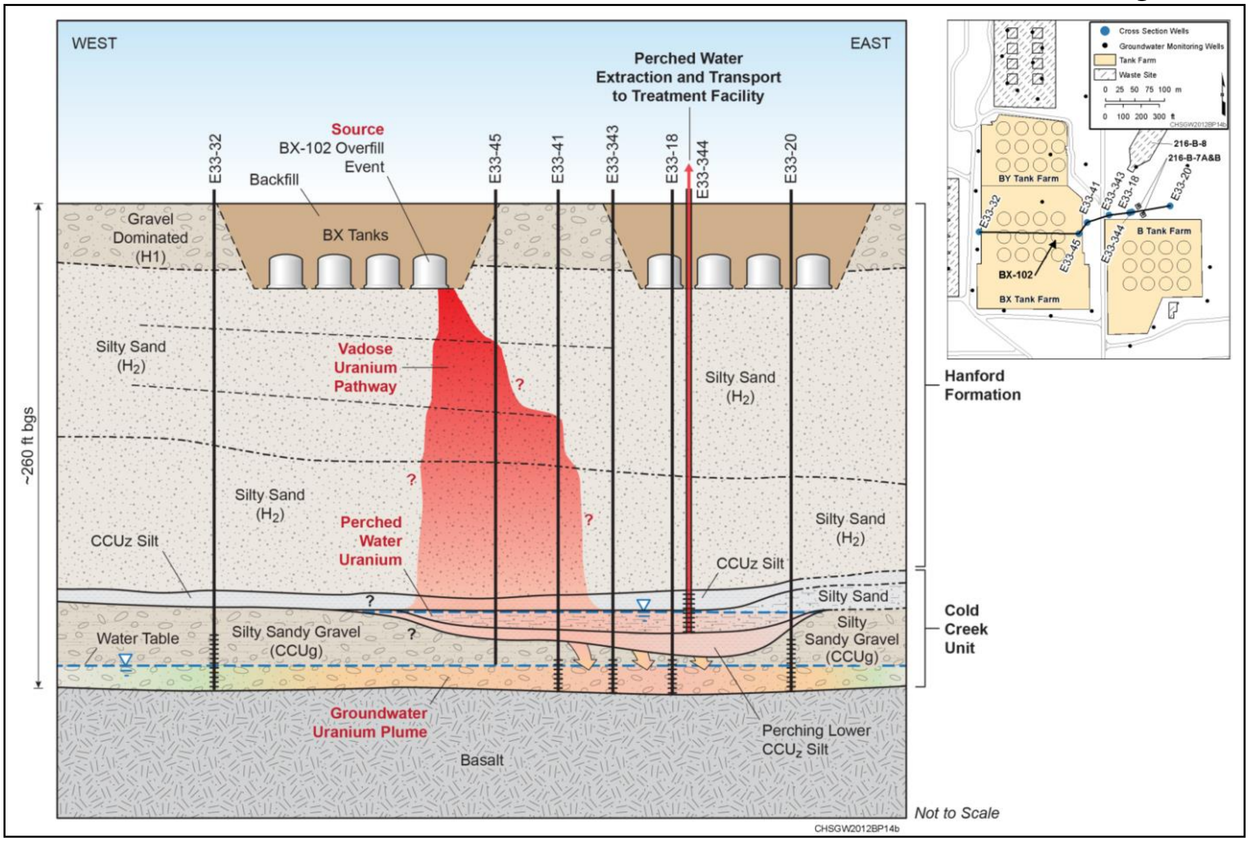

Figure BP.21 Uranium Conceptual Site Model for 216-BX-102 Unplanned Release

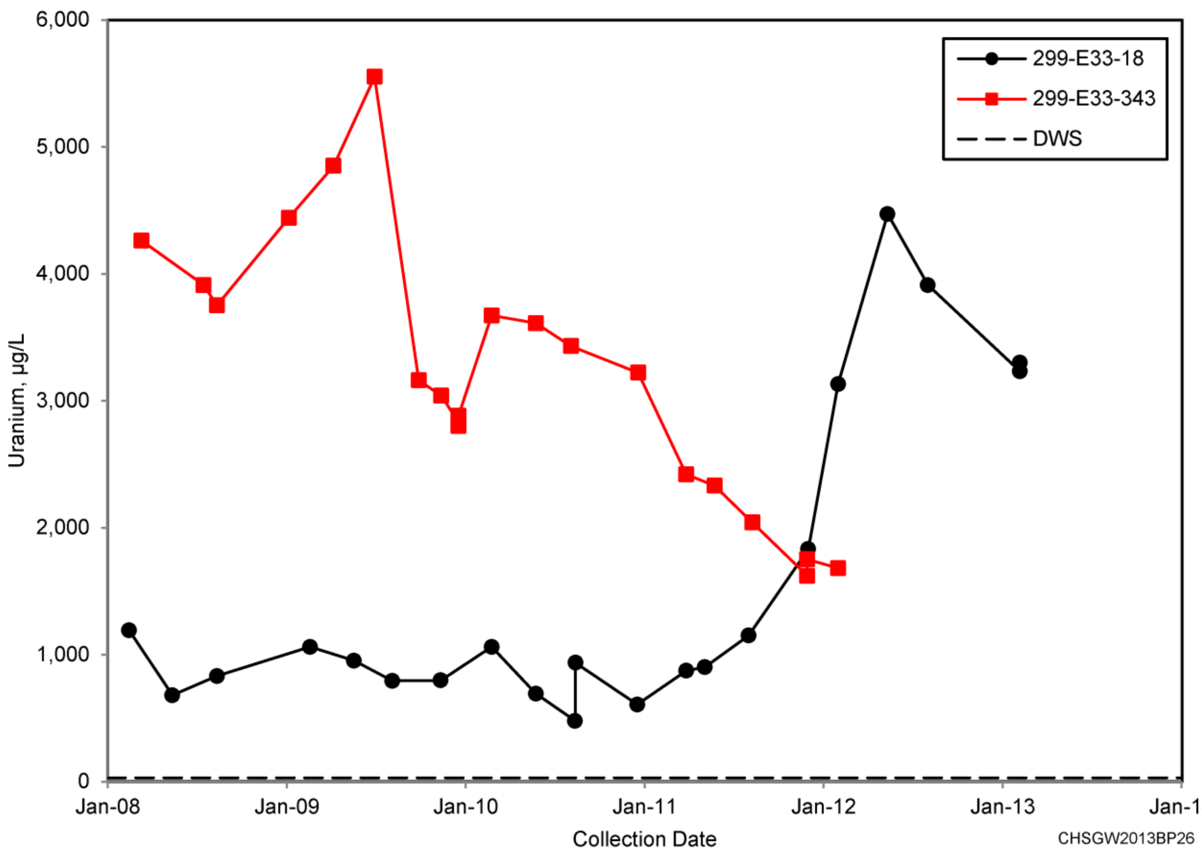

Figure BP.22 200-BP Uranium in Wells 299-E33-18 and 299-E33-343

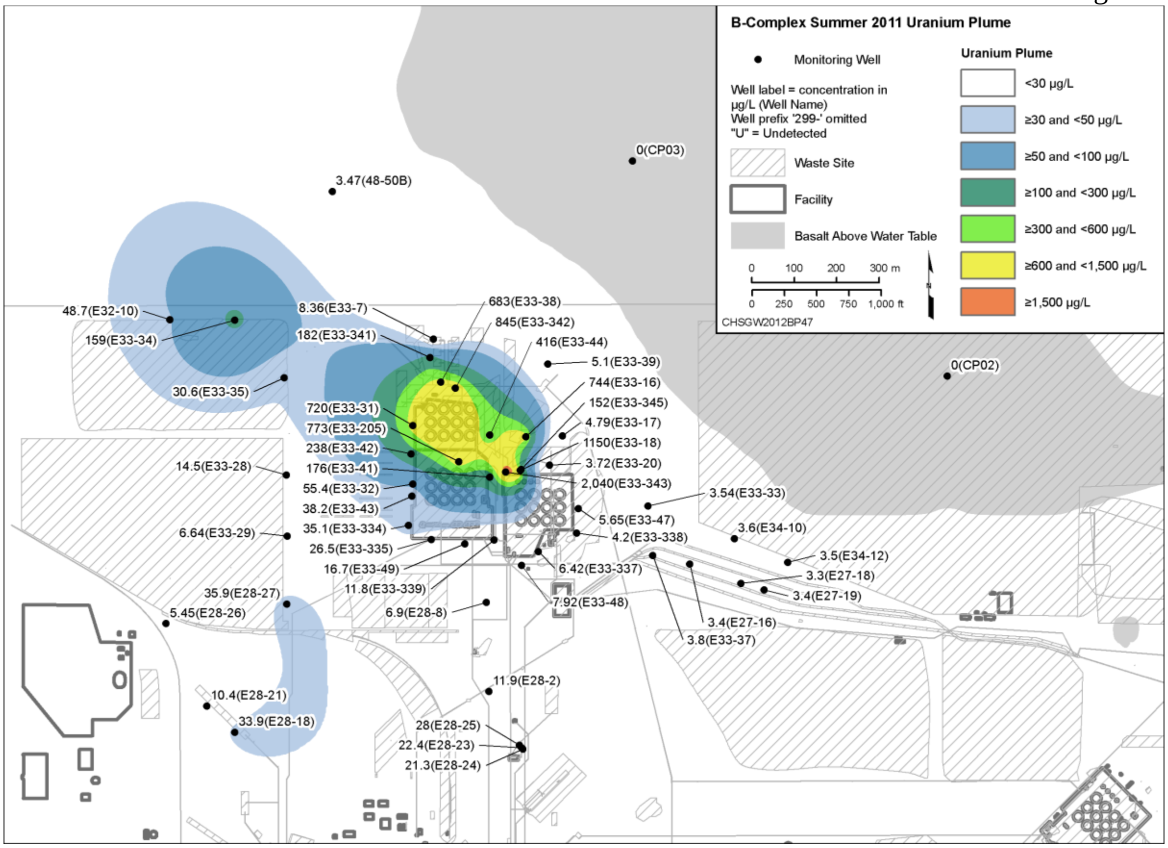

Figure BP.23 200-BP Uranium near WMA B-BX, Summer 2011

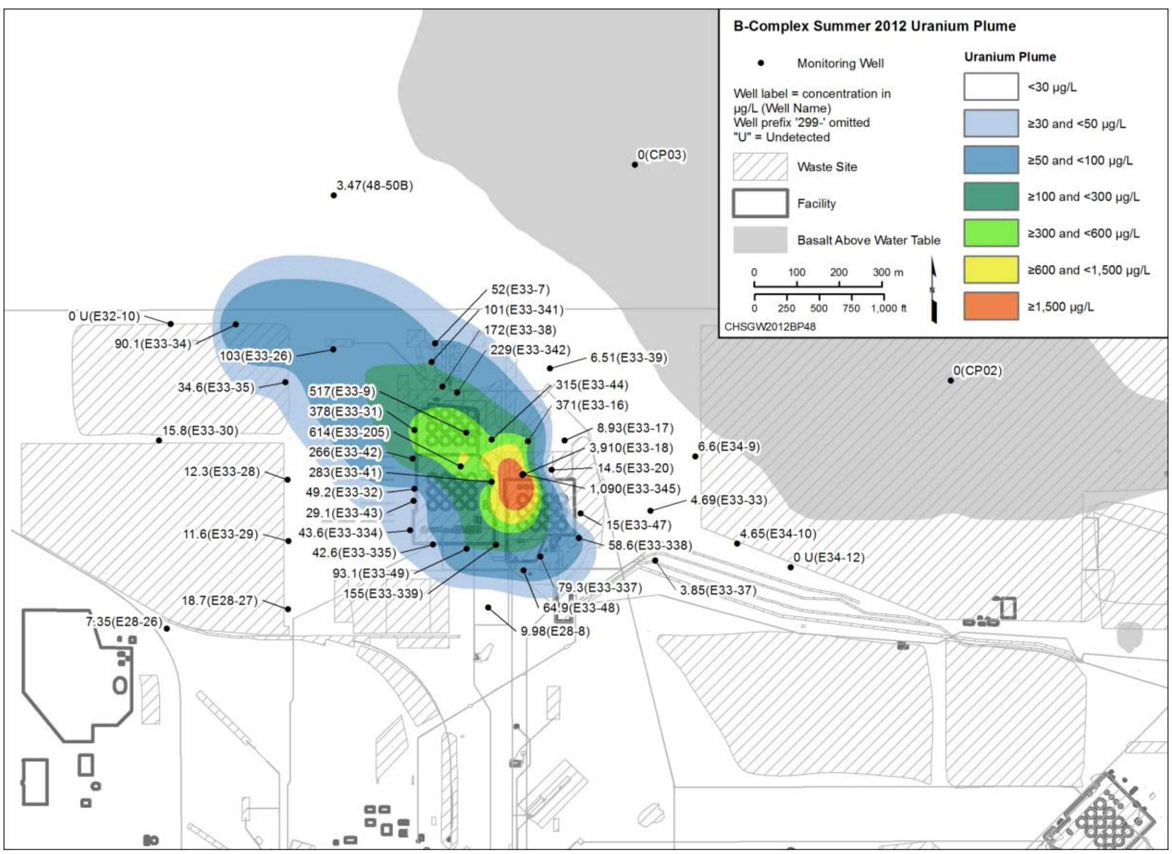

Figure BP.24 200-BP Uranium near WMA B-BX, Summer 2012

200-BP Strontium-90

Strontium-90 is only found at two locations in 200-BP, the former Gable Mountain Pond (inactive and dry since the mid to late 1980s) and the 216-B-5 Injection Well (Figure BP.25). Strontium-90 tends to bind to vadose zone sediments, so it only reached groundwater at locations where the vadose zone is relatively thin (e.g. at Gable Mountain Pond where the vadose zone thickness is less than 12 meters thick), or where waste was injected into the aquifer (216-B-5 Injection Well).

Gable Mountain Pond. The greatest historical strontium-90 activity reported at Gable Mountain Pond has been at well 699-53-47A (beneath the southeastern portion of the once active pond). The activity at this well has steadily decreased from 1,320 pCi/L in 1997 to 200 pCi/L in 2013 (Figure BP.26). Five other wells were sampled at Gable Mountain Pond in 2013 and four of them had detectable levels of strontium-90, ranging from 16 to 220 pCi/L. Well 699-55-50C, located to northwest of Gable Mountain Pond, contains no detectable strontium-90. The areal extent of strontium-90 activity exceeding DWS closely outlines the area of the former pond, with activity diminishing to the west as the aquifer increases in thickness.

216-B-5 Injection Well. Strontium-90 has relatively low mobility in the subsurface and does not migrate significant distances within the aquifer. The plume exceeding DWS grew to the northwest from the mid-1990s to 2012 as displayed in Figure 1.4 of DOE/RL-95-59 and Figure BP.25, respectively. Wells northwest of well 299-E28-2 had few strontium-90 detections over the past two decades. Out of 210 samples collected between 1986 and 2012, strontium-90 was detected only 11 times. The detection results ranged between 0.372 and 2.2 pCi/L, which is below the 8 pCi/L DWS. The relatively small number of detections and low activities detected indicates that the strontium-90 has not migrated significant distances from the 216-B Injection Well to the northwest and is less mobile than modeled in DOE/RL-95-59.

Since the 2011 flow reversal, activity has increased at well 299-E28-24, located 5 meters southeast of the 216-B-5 Injection Well, from 180 pCi/L in 2012 to 880 pCi/L in 2013 (Figure BP.27). Two additional wells were added to evaluate the extent of strontium-90 southeast migration (299-E28-4 and 299-E28-7). Well 299-E28-7, located 12 meters southeast of well 299-E28-24, was analyzed with 540 pCi/L of strontium-90 in 2013 (Figure BP.27). No strontium-90 was detected at other wells to the east and southeast (e.g., well 299-E28-1 and 299-E28-4, respectively). Conversely, strontium-90 levels at wells to the northwest, 299-E28-2 and 299-E28-25, decreased.

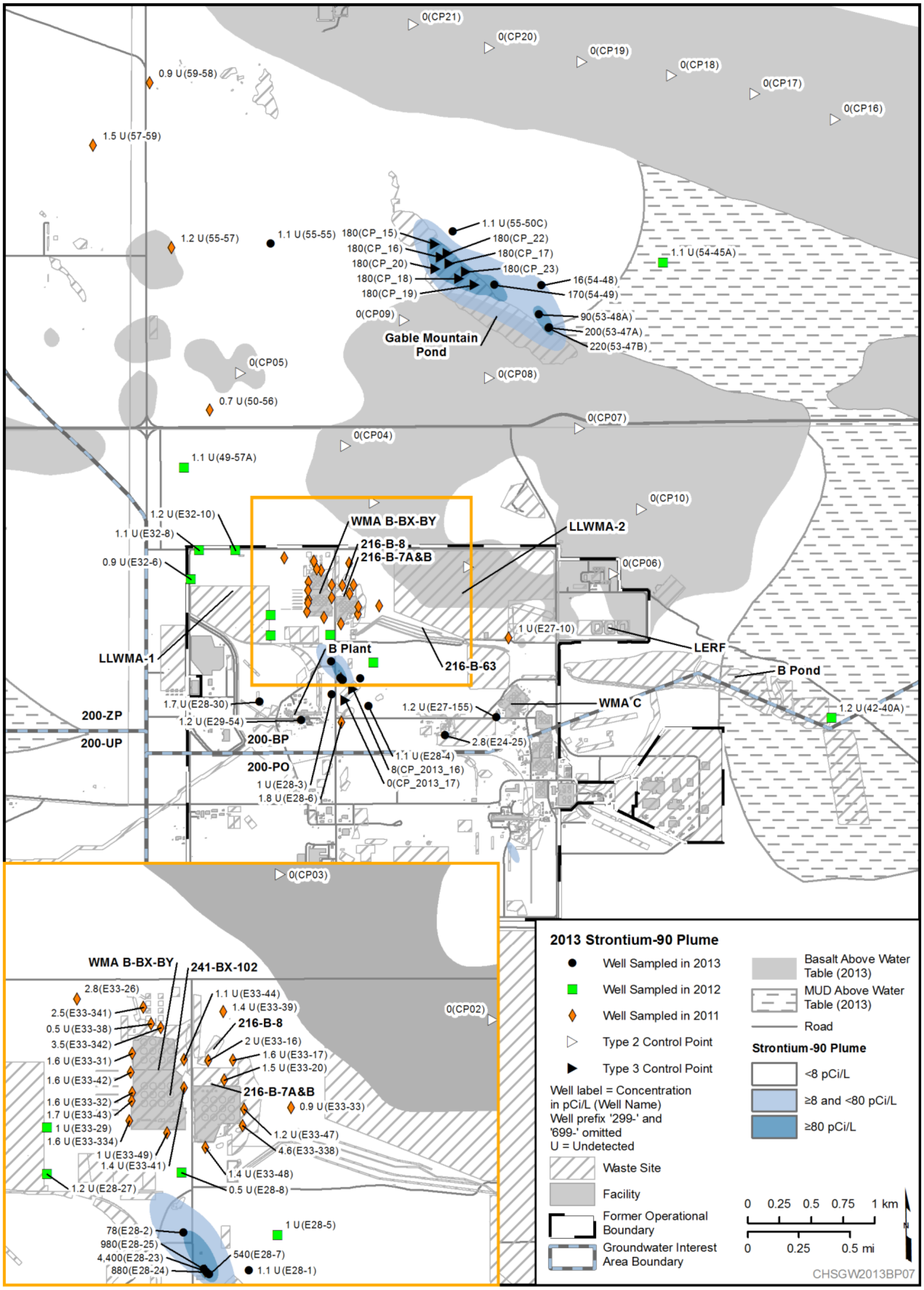

Figure BP.25 200-BP 2013 Strontium-90 Plume

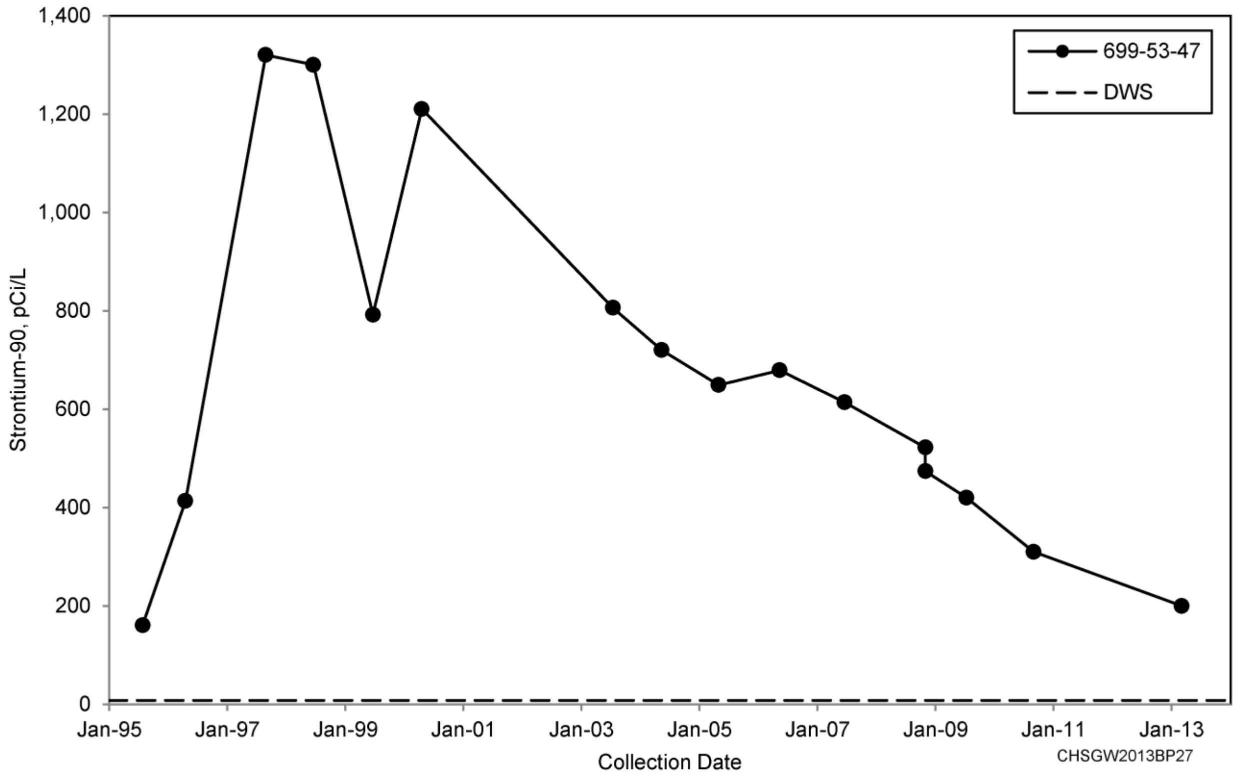

Figure BP.26 200-BP Strontium-90 in Well 699-53-47A

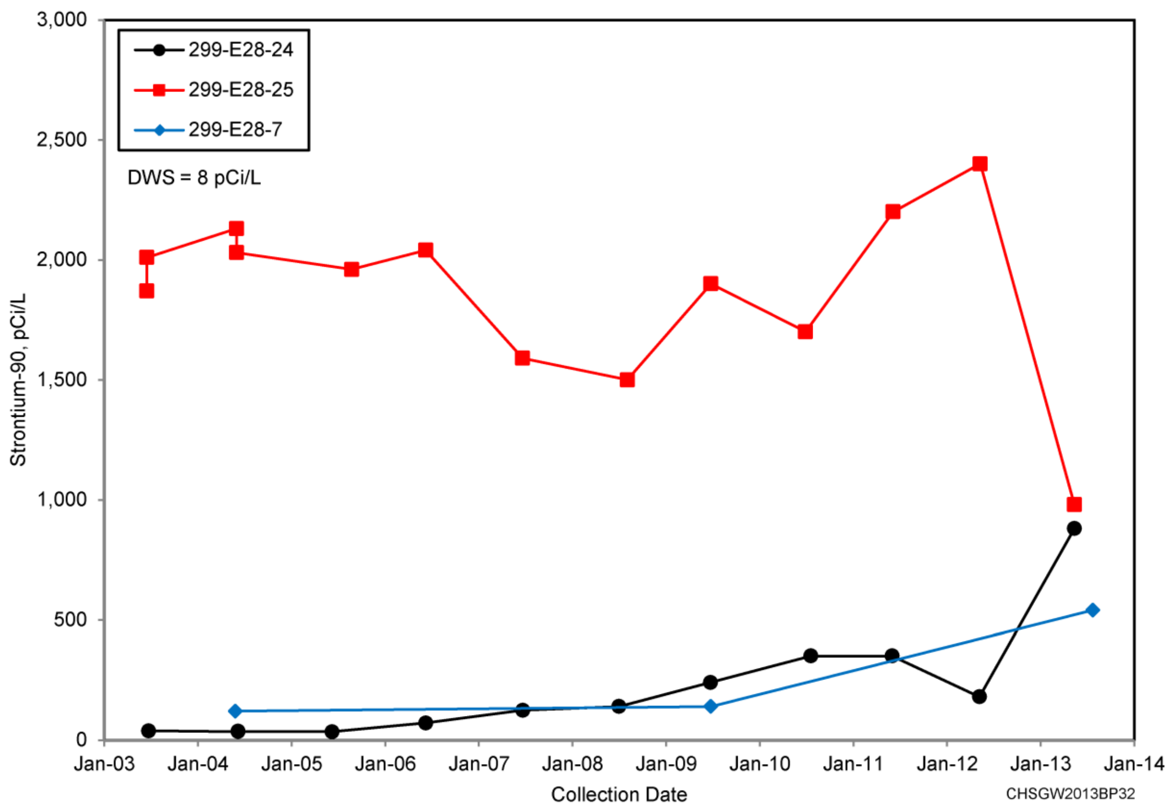

Figure BP.27 200-BP Strontium-90 in Wells 299-E28-7, 299-E28-24, and 299-E28-25

200-BP Cyanide

Cyanide found in 200-BP groundwater originated from disposal of tributyl phosphate wastes scavenged for cesium-137. After scavenging was completed, the tank supernatant, including the remaining dissolved ferrocyanide compounds, was discharged to the BY Cribs. In the late 1990s, cyanide concentrations began to increase in the groundwater beneath the BY Cribs along with nitrate and technetium-99. In addition, low concentrations of cyanide detected in the vicinity of WMA-C are attributed to historical releases of ferrocyanide-containing waste at that facility, discussed further in the "200-BP-5 RCRA – WMA C" section presented later in this chapter.

BY Cribs. The distribution of cyanide above the 200 µg/L DWS extends both northwest and southeast from the BY Cribs (Figure BP.28). The plume configuration has contracted from the northwest and expanded to the southeast since the flow reversed from northwest to the southeast in 2011, as seen with the other co-contaminants (e.g., nitrate and technetium-99) in the same area.

The maximum 2013 cyanide concentration from the BY Crib source was at well 299-E33-3 (999 µg/L), located beneath the northeast part of the BY Cribs (Figure BP.28). Trends for cyanide in wells near the BY cribs are shown in Figure BP.29. Cyanide results beneath the 216-B-8 Crib were much lower than last year; however, north and east of the 216-B-8 Crib the cyanide concentrations remained constant or increased.

241-B Tank Farm. One other well, 299-E33-47, located in the B Complex has also had very high cyanide concentrations. The maximum 2013 concentration in this well (1520 µg/L) was greater than any other well in 200-BP. As discussed in DOE/RL-2012-53, this high concentration area is associated with a release in the 241-B tank farm. Continued southeast migration of this cyanide plume is extending beyond existing monitoring wells as shown on Figure BP.30. As a result, a new well is planned to be drilled in 2014 to monitor the expanding extent.

Gable Gap. Cyanide concentrations to the north, near Gable Gap, have decreased in recent years. The greatest cyanide concentration associated with this plume is at well 699-53-55C. Concentrations have decreased at this well from 195 µg/L in 2009 to 137 µg/L in 2013 (Figure BP.31). Concentrations in nearby wells have also decreased and are lower in concentration than at well 699-53-55C.

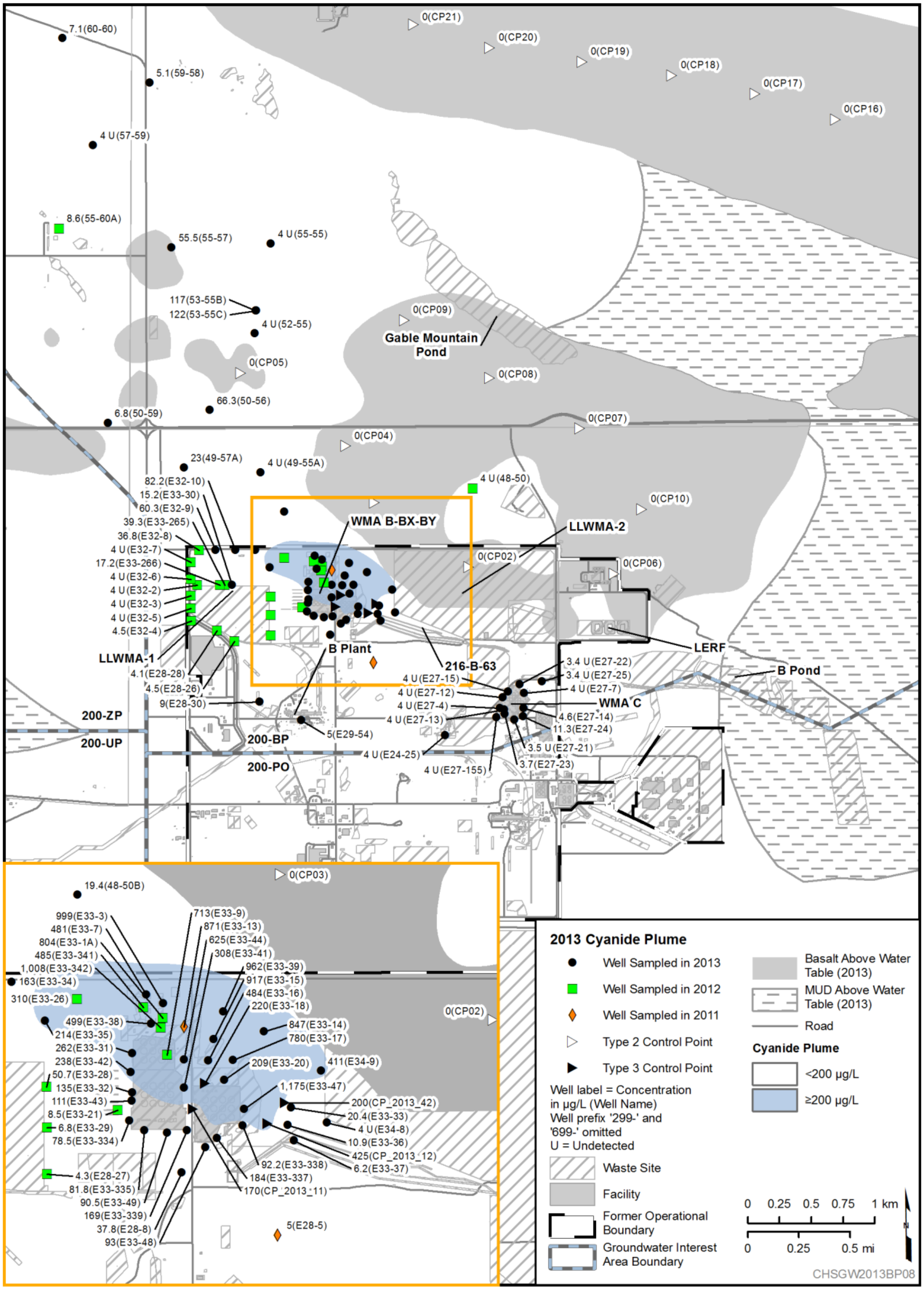

Figure BP.28 200-BP 2013 Cyanide Plume

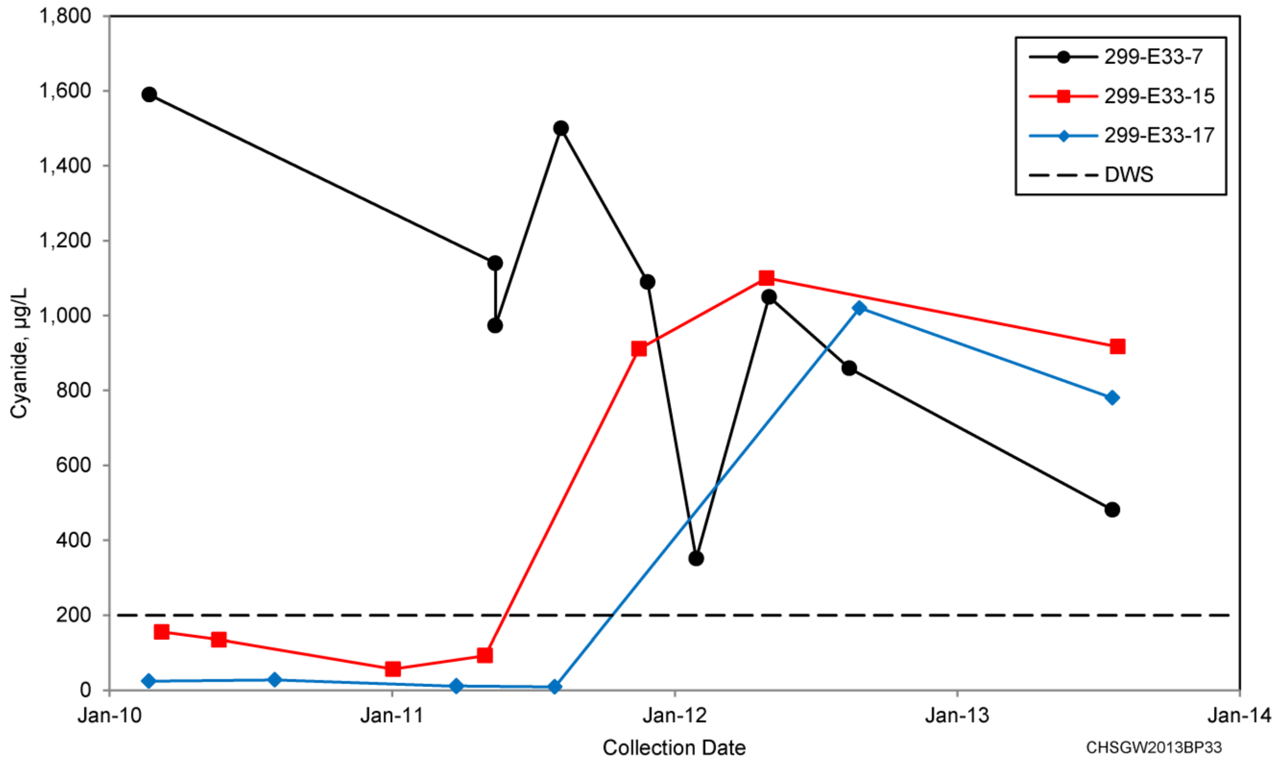

Figure BP.29 200-BP 2011, 2012, 2013 Cyanide Maximum Concentrations Associated with the BY Crib Plume

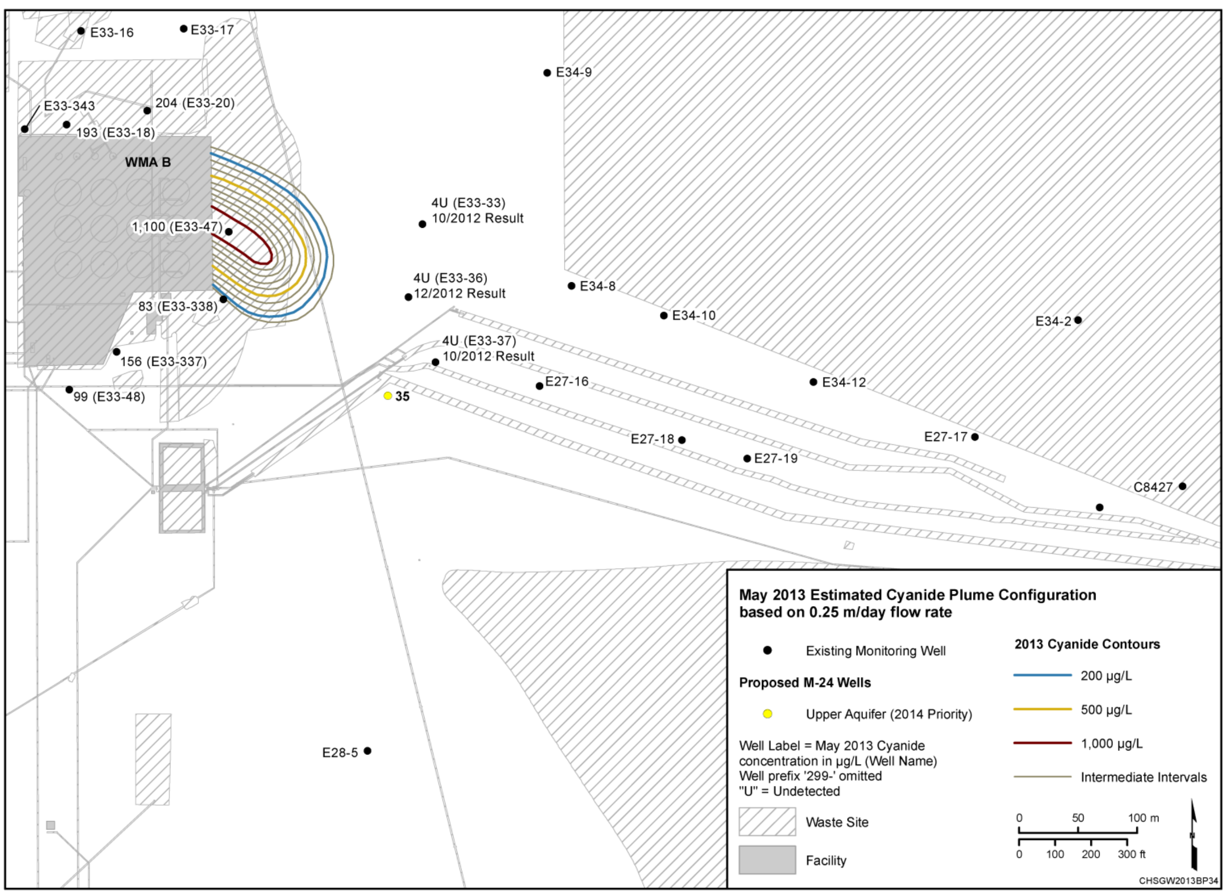

Figure BP.30 200-BP May 2013 Cyanide Estimated Plume Configuration Associated with the 241-B Tank Farm Release

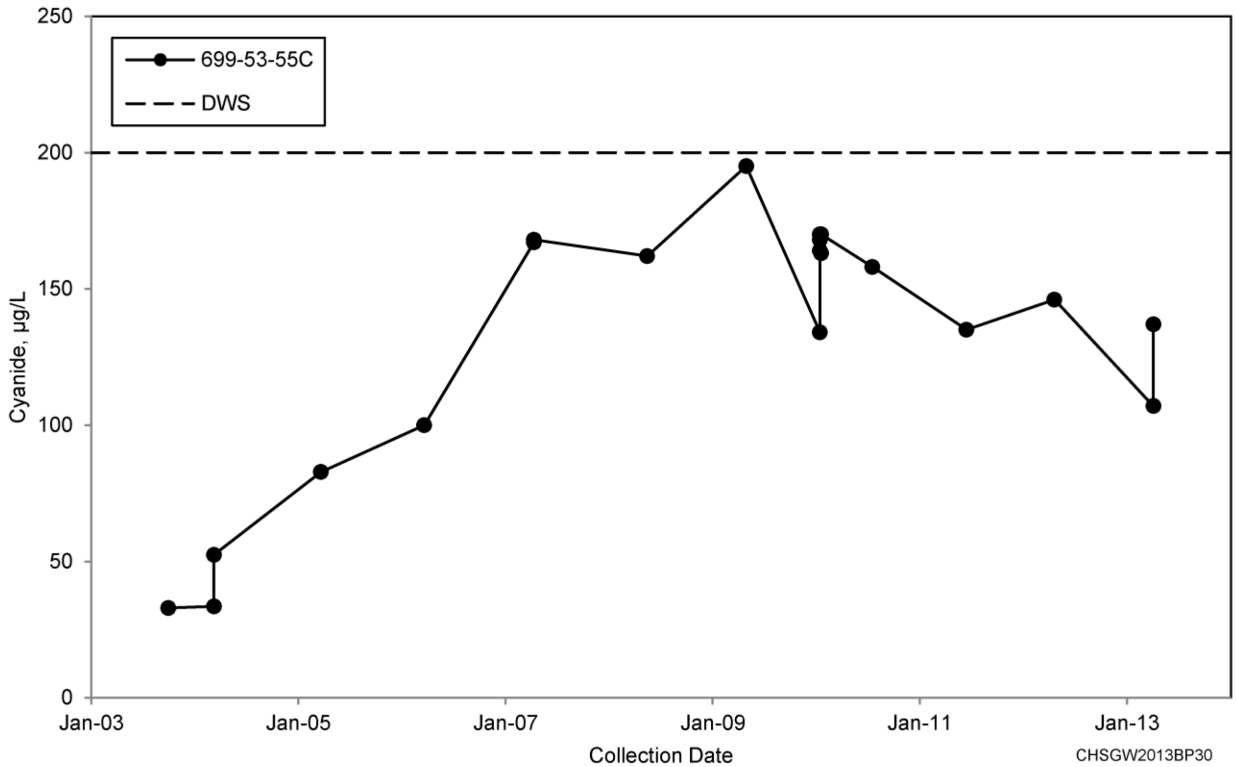

Figure BP.31 200-BP Cyanide in Well 699-53-55C

200-BP Tritium

The size of the tritium plume in the upper part of the unconfined aquifer within 200-BP has decreased since 2003 (Figure BP.6). The decline is attributed with radioactive decay, dispersion, and possibly diminishing levels of drainage from the vadose zone at certain locations. In 2013, tritium results exceeding DWS were detected at 4 locations; beneath the 216-B-50 and 216-B-57 Cribs (located in the B Complex), beneath the 241-B tank farm, and beneath the former 216-B-3 Pond. The greatest activity measured in 2013 was beneath the former 216-B-3 Pond. Another location which exhibited greater activity during depth discrete sampling in 2010 is near the 216-B-12 Crib and B Plant. This location is discussed although not portrayed in Figure BP.32 because current wells do not extend to depth to record the elevated activity at these locations. New wells have been planned in this area to depict the extent of the tritum at depth in this area.

216-B-50 and 216-B-57 Cribs. Past tritium found in B Complex above DWS originated primarily from large inventories disposed to the 216-B-50 and 216-B-57 Cribs from the mid- to late 1960s to the early to mid-1970s. The 216-B-50 Crib received approximately 126.3 Ci and 216-B-57 Crib received approximately 194.6 Ci, which is over 100 Ci of tritium than most of the other site inventories in this area (RPP-26744). These sources are considered to be continuing to drain into the aquifer today. Due to the groundwater flow reversal in this area and wells not being sampled in the tank farms (299-E33-9 and 299-E33-205) only two wells exceeded DWS in 2013 near these sites (299-E33-3 and 299-E33-15)(Figure BP.32). The greatest 2013 tritium result associated with these cribs was at well 299-E33-15 (22,000 pCi/L). This well represents activity levels associated with migration that were beneath or nearly beneath the 216-B-50 Crib last year. As a result of elevated activity in both wells 299-E33-3 and 299-E33-15, the 2013 tritium plume from the 216-B-50 Crib extends to well 299-E33-15. Also, because wells in the 241-BX-BY tank farms (299-E33-9 and 299-E33-205) were not sampled in 2013, it was assumed, based on large increases in other wells downgradient (e.g., 299-E33-41), that the plume from the 216-B-57 Crib extended into the area near well 299-E33-41. The overall activity near the 216-B-50 Crib decreased considerably from 2012 to 2013. For example, tritium at well 299-E33-3 decreased from 31,000 pCi/L in 2012 to 16,000 pCi/L in 2013, indicating the contribution from vadose zone sources may be diminishing or the groundwater flow rate is sufficient enough to disperse the activity entering groundwater from the vadose zone.

216-BX-102 Unplanned Release. The activity from 216-BX-102 is monitored by well 299-E33-18 (Figure BP. 32). This well is screened beneath a contaminated perched water horizon. The tritium activity at this well was increasing and ranged between 25,000 and 28,000 pCi/L in 2012. This well was decommissioned in 2013 prior to another sample being taken; however, early 2014 results from well 299-E33-345, located approximately 3 meters north, returned a similar activity of 25,000 pCi/L. Well 299-E33-344, screened within the perched horizon near wells 299-E33-18 and 299-E33-345, has ranged in tritium activity from 22,000 to 43,500 pCi/L since 2011. This well has been used to remove perched water and associated contamination over the past 3 years. As of the end of December 2013, approximately 1.2×10^{-2} Ci of tritium have been removed. Since the perching horizon is considered to leach contamination to the unconfined aquifer below, the tritium plume in this area was extended from well 299-E33-41 to well 299-E33-47, where 2013 tritium levels were reported at 21,000 pCi/L.

216-B-12 Crib. A deep zone of elevated tritium, not shown in Figure BP.32, was discovered in 2010 during RI drilling of wells 299-E28-30 and 299-E29-54. Greater levels of tritium were found within the Ringold Unit A, approximately 8 meters or more below the water table. The source is likely associated with the large inventory of tritium disposed to the 216-B-12 Crib in the 1950s when the crib received contaminated process condensate from U Plant operations. Alternatively, it may be from 200-PO sources. The two wells were completed at the water table and routine samples do not represent the deeper portion of the aquifer. Three additional wells were added to the Hanford well drilling priority list in 2013 to further define the extent of the deeper contamination. These wells are planned to be screened at the discrete depth where elevated nitrate, tritium, and uranium were found in the aquifer (approximately 8 meters below the water table). Note that in near well 299-E28-30, tritium activity was 94,000 pCi/L at approximately 8 meters below the water table; near the bottom of the aquifer at well 299-E29-54, tritium activity of 150,000 pCi/L was observed.

216-B-3 Pond. East of the 200 East Area, significant inventories of tritium were discharged to the 216-B-3 Pond. Based on the 2013 tritium results, the highest tritium activity was at well 699-42-40A at 42,000 pCi/L. Contamination appears to extend to the southwest towards well 699-41-42, within 200-PO.

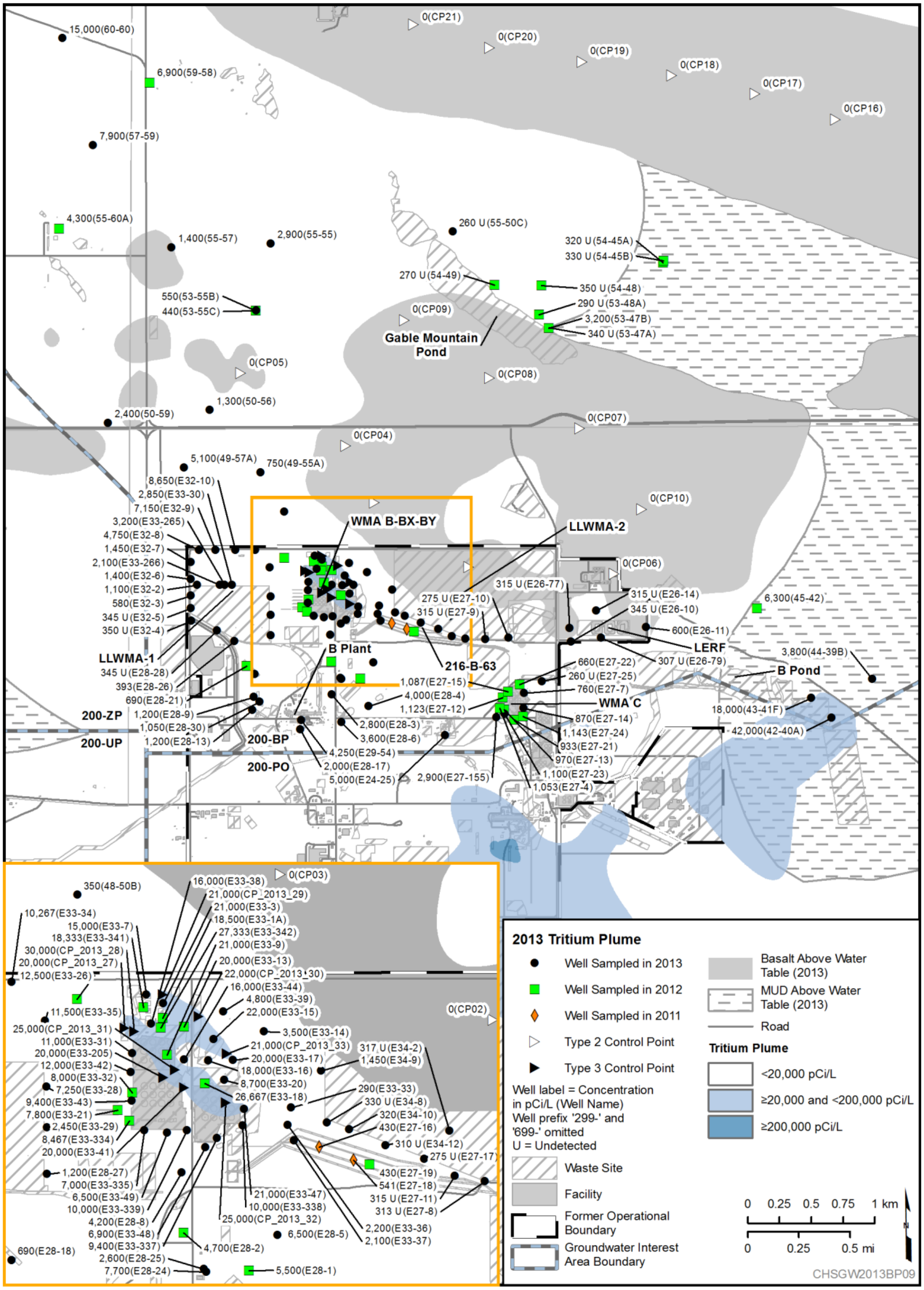

Figure BP.32 200-BP 2013 Tritium Plume

200-BP RCRA – Introduction

This section describes the results of monitoring at individual units such as treatment, storage, and disposal units. These units are monitored under RCRA requirements for dangerous waste/dangerous waste constituents and under AEA for source, special nuclear, and byproduct materials. Data from unit-specific monitoring are also integrated into CERCLA groundwater investigations. Dangerous constituents and radionuclides are occasionally discussed jointly in this section to provide comprehensive interpretations of groundwater contamination. As previously discussed and pursuant to RCRA, the source, special nuclear, and byproduct material components of radioactive mixed waste are not regulated under RCRA but are instead regulated by DOE, acting pursuant to its AEA authority. Therefore, while this report may be used to satisfy RCRA reporting requirements, the inclusion of information on radionuclides in such a context is for information only and may not be used to create conditions or other restrictions set forth in any RCRA permit.

The 200-BP groundwater interest area contains six RCRA sites with groundwater monitoring requirements: WMA B-BX-BY, WMA C, 216-B-63 Trench, LERF, LLWMA-1, and LLWMA-2 (Figure BP.4). The following discussion summarizes the results of statistical comparisons, assessment studies, and other developments for this reporting period. Groundwater data are available in the Hanford Environmental Information System (HEIS) database and in the data files accompanying this report. Appendix B provides additional information (including well and constituent lists, and statistical tables).

200-BP RCRA – WMA B-BX-BY

The WMA B-BX-BY is located in the north-northwest part of the 200 East Area (Figure BP.33). This dangerous waste management unit was constructed in stages with the 241-B Tank Farm being constructed between 1943 and 1944, 241-BX Tank Farm constructed between 1946 and 1947, and the 241-BY Tank Farm constructed between 1948 and 1949. All three farms provided interim storage of radioactive mixed waste, primarily from the bismuth-phosphate, plutonium-uranium extraction (PUREX), and uranium extraction processes. However, none of the self-boiling wastes from the PUREX or Reduction Oxidation (REDOX) Plants were sent to the B-BX-BY Tank Farms prior to removal of high-heat generating fission products. Each of the twenty-four USTs within the 241-B and BX Tank Farms were built to store a maximum capacity of 2.0 million liters of radioactive mixed waste or high level radioactive liquid wastes. Each of the twelve USTs in the 241-BY Tank Farm had a 2.9 million liter maximum capacity. Within the 241-B Tank Farm there were four additional USTs, with a maximum capacity of 208,000 liters each. Ancillary equipment at WMA B-BX-BY includes seven diversion boxes, the 244-BXR waste transfer vault, and several connecting underground lines. Twenty of the forty tanks were defined as confirmed or assumed to have leaked. Additional sources of unplanned releases within WMA B-BX-BY include waste loss from spare inlet nozzles or cascade lines, pipeline leaks, and surface releases.

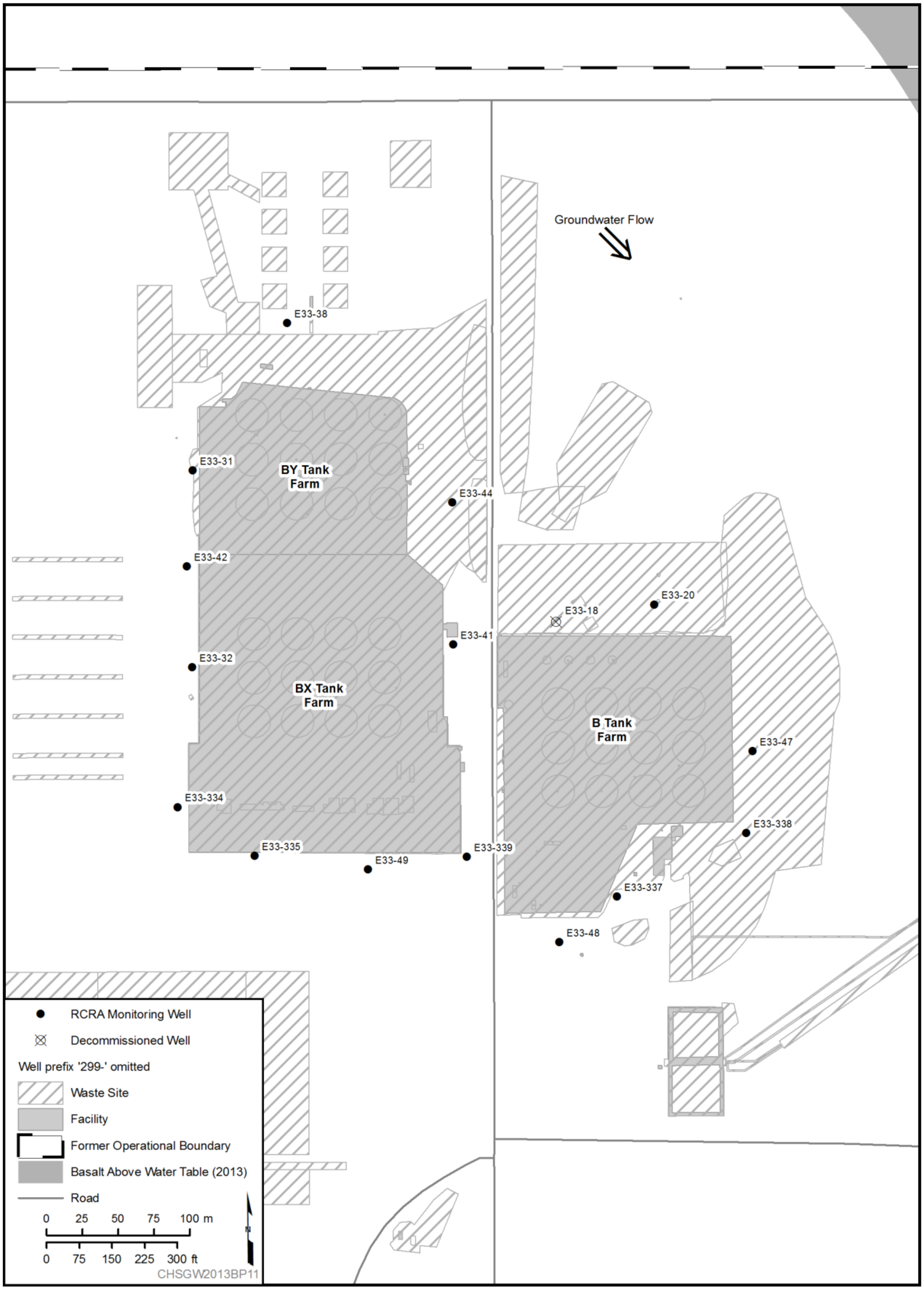

Figure BP.33 200-BP WMA B-BX-BY Well Location Map

The nonradioactive constituents of the liquid wastes conveyed and stored within WMA B-BX-BY are regulated under RCRA and its implementing requirements (WAC 173-303-400). As a result, DOE monitors the groundwater under an interim-status assessment program in accordance with 40 CFR 265.93(d)(4), as defined in Rev. 0 of DOE/RL-2012-53. This revised groundwater assessment (which included an expanded number of groundwater analytes) at WMA B-BX-BY was initiated in November 2012 and was targeted at determining those dangerous wastes/dangerous waste constituents that may be in the groundwater associated with releases at the WMA B-BX-BY in accordance with Section 3.1 of DOE/RL-2012-53. As of 2013, only one dangerous waste/dangerous waste constituent, cyanide, has been determined to be associated with WMA B-BX-BY. Per 40 CFR 265.93, a first determination report is planned to be completed providing a list of the dangerous waste/dangerous waste constituents in groundwater associated with WMA B-BX-BY and will direct future groundwater monitoring requirements. Because of the continued migration of this dangerous waste constituent an additional well is planned to be installed in 2014 to provide control of monitoring the extent as required in 40 CFR 265.93(d)(4).

All of the wells were sampled quarterly, as required, during the reporting period, except wells 299-E33-334, 299-E33-337, and 299-E33-338 (Tables B-70 and B-71, Appendix B). The sampling of these three wells was delayed because of maintenance requirements identified during the November 2013 sampling event and were not sampled until January of 2014. In addition, during the August and November 2013 sampling events other wells were delayed for maintenance requirements. However, all of the wells were sampled prior to the next quarterly sampling event and within 2013. Well 299-E33-18 was decommissioned in July 2013 for three reasons and was therefore not sampled in August or November; the well extended through the contaminated perching horizon, was not WAC compliant, and was considered an accelerated conduit for downward migration of contaminated perched water into the underlying aquifer. A replacement well is planned in 2014.

Estimations of groundwater flow rates are required by 40 CFR 265.94(d)(4), *Recordkeeping and Reporting*, because of the presence of the dangerous waste constituent cyanide. The water level measurements defining the gradient magnitude and flow direction for WMA B-BX-BY were collected monthly which meets the quarterly requirement of 40 CFR 265.94(d)(7)(i). Because the water table is so flat in 200 East Area, a select network of monitoring wells has been established to reduce errors and uncertainty in the data and improve the accuracy of measurements. Data are corrected for borehole deviation from vertical, barometric changes, and have been precision surveyed. The network includes wells in the northwestern 200 East Area (Figure BP.34).

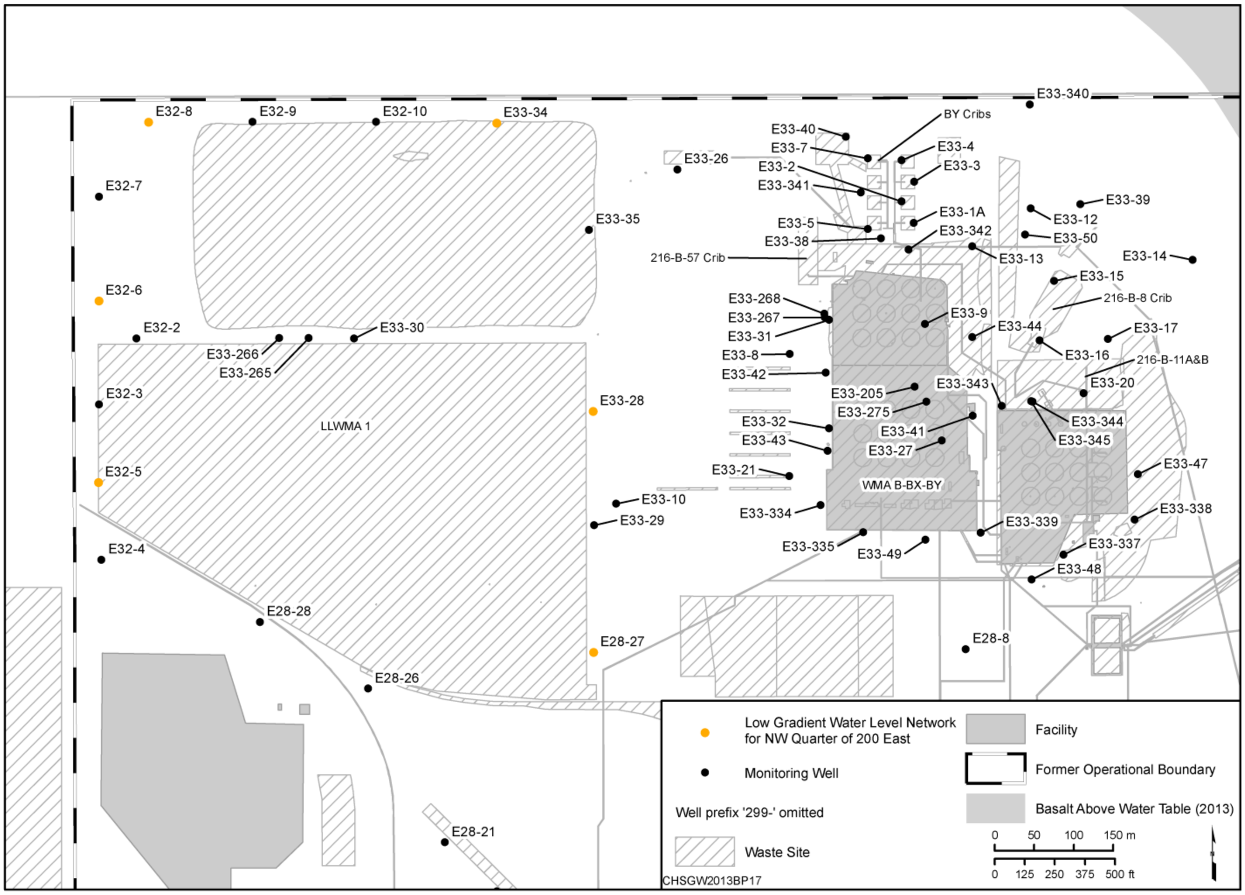

Figure BP.34 Low Gradient Water Level Network for the Northwest Quarter of the 200 East Area

Since 2011, the continued decline of the water table in the 200 East Area and seasonally high Columbia River spring stage have resulted in a southeast groundwater flow direction into the northwest corner of the 200 East Area (Figure BP.35). The temporal fluctuations of the Columbia River stages result in an increasing gradient until October/November, followed by a decreasing gradient until the next June. The gradient decreased from 2.75×10^{-5} in December 2012 to 1.48×10^{-5} in June 2013. Between June and October 2013 the gradient increased to 3.42×10^{-5}. Finally, the gradient decreased in November and December 2013. The lowest gradient in 2013 was in December at 1.19×10^{-5}. The average gradient magnitude for 2013 was 1.93×10^{-5}. The 2013 groundwater flow direction also varied between east and southeast. The average flow direction was 129 degrees from north (i.e., southeast). This flow direction is consistent with plume migration as discussed in previous contaminant sections. Using an average gradient magnitude of 1.93×10^{-5} for 2013, the groundwater flow rate at WMA B-BX-BY was estimated to be 0.3 meters per day (1.0 feet per day) or 110 meters [365 feet] per year (Table B.1, Appendix B). This average flow rate agrees with the nitrate and technetium-99 plume movement between the summer of 2012 and 2013.

The depth of the water column in WMA B-BX-BY monitoring wells ranges from 0.99 to 6.12 meters into the aquifer (Table B.72, Appendix B). The least amount of water available for sampling is at well 299-E33-20. There have not been any previous issues with groundwater collection in this well. However, this well is not WAC compliant and will be put on the well priority list.

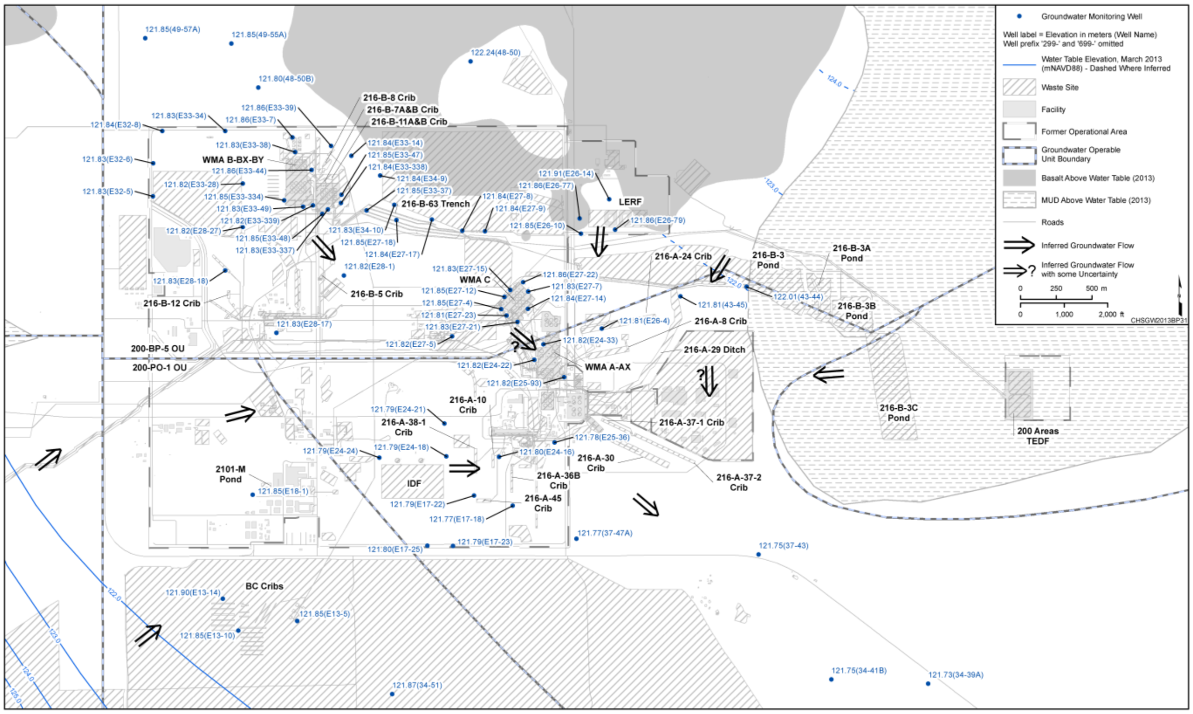

Figure BP.35 Groundwater Flow within the 200 East Area

200-BP RCRA – WMA C

The WMA C is located in the east central part of the 200 East Area. This dangerous waste management unit was constructed in 1943 and 1944 and provided interim storage of radioactive mixed waste, primarily from the bismuth-phosphate, PUREX, and uranium extraction processes. The high level liquid wastes from these processes were stored in twelve USTs, each with an approximate capacity of 1.9 million liters. Four additional USTs, with an approximate capacity of 208,000 liters each, were also used to store high level liquid waste. Ancillary equipment at WMA C includes seven diversion boxes, the 244-CR vault with four permitted tanks, the 241-C-301 catch tank, and several connecting underground lines. Seven of the sixteen underground tanks were confirmed or assumed to have leaked and retrieval processes have been employed since 1998 to remove the liquid waste from these tanks. Additional sources of unplanned releases include waste loss from spare inlet nozzles or cascade lines, pipeline leaks, and surface releases.

The liquid waste is regulated under RCRA and its implementing requirements (WAC 173-303-400). As a result, DOE monitors the groundwater under an interim-status assessment program in accordance with 40 CFR 265.93(d)(4), as defined in Rev. 0 of DOE/RL-2009-77 (Figure BP.36). As of 2013, cyanide is the only dangerous waste constituent determined as impacting groundwater from the 241-C Tank Farm. More specifically, cyanide only exceeded the detection limit in three wells in 2013 (299-E27-14, 299-E27-23, and 299-E27-24). The concentrations were significantly less than the 200 µg/L DWS. By the end of 2013 the cyanide concentrations in two of the wells were below the detection limit. The highest concentration, 13.9 µg/L, in 2013 was in well 299-E27-24, which is screened across the bottom of the aquifer, in December 2013. During 2013 the cyanide concentration in this well ranged between 8.64 and 13.9 µg/L. Figure BP.37 provides the estimated extent and trend results at select WMA C wells of the cyanide plume as required by 40 CFR 265.93(d)(4). In addition, all of the wells were sampled quarterly, as required, during the reporting period (Table B.73, Appendix B).

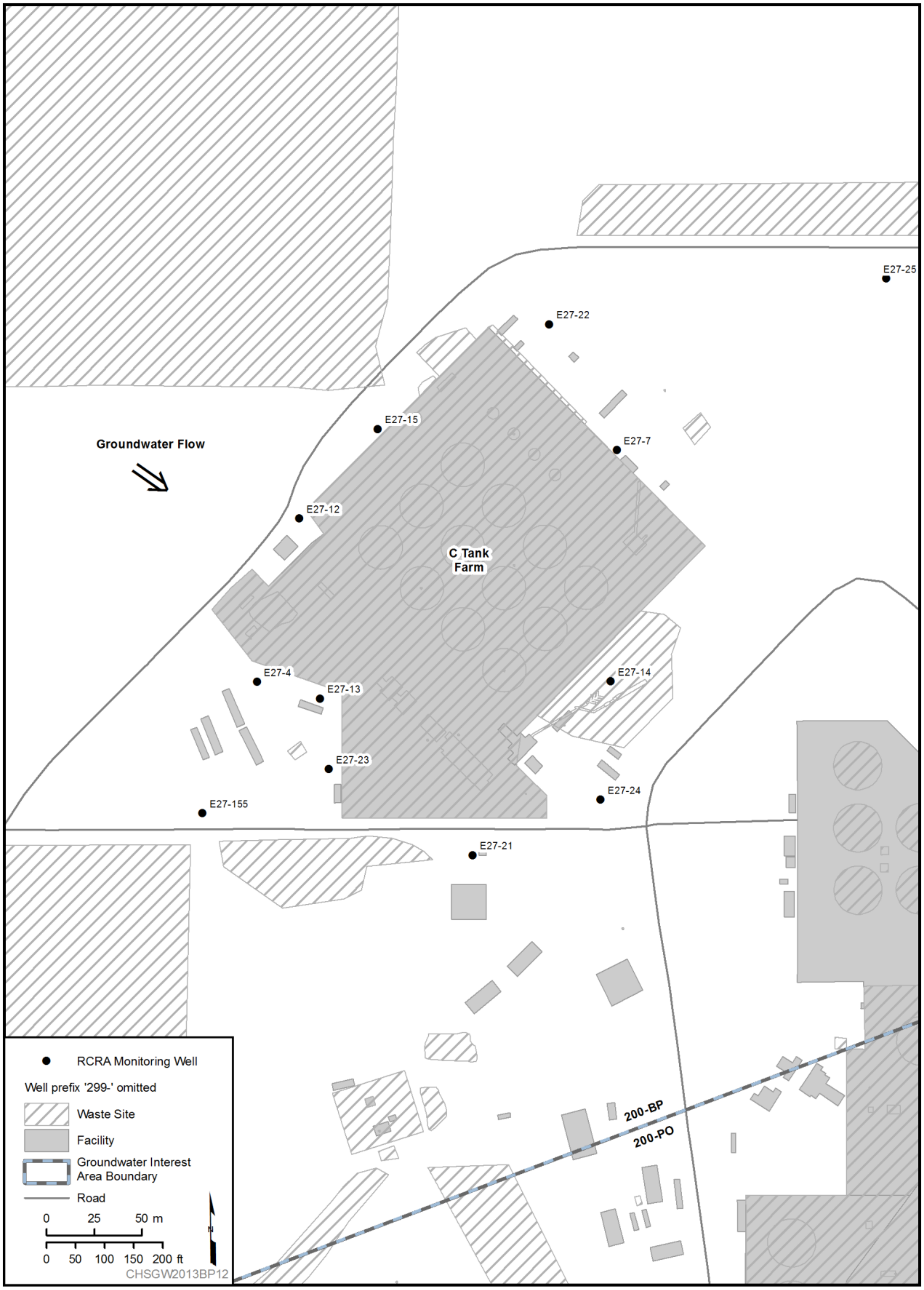

Figure BP.36 200-BP RCRA WMA C Monitoring Well Locations

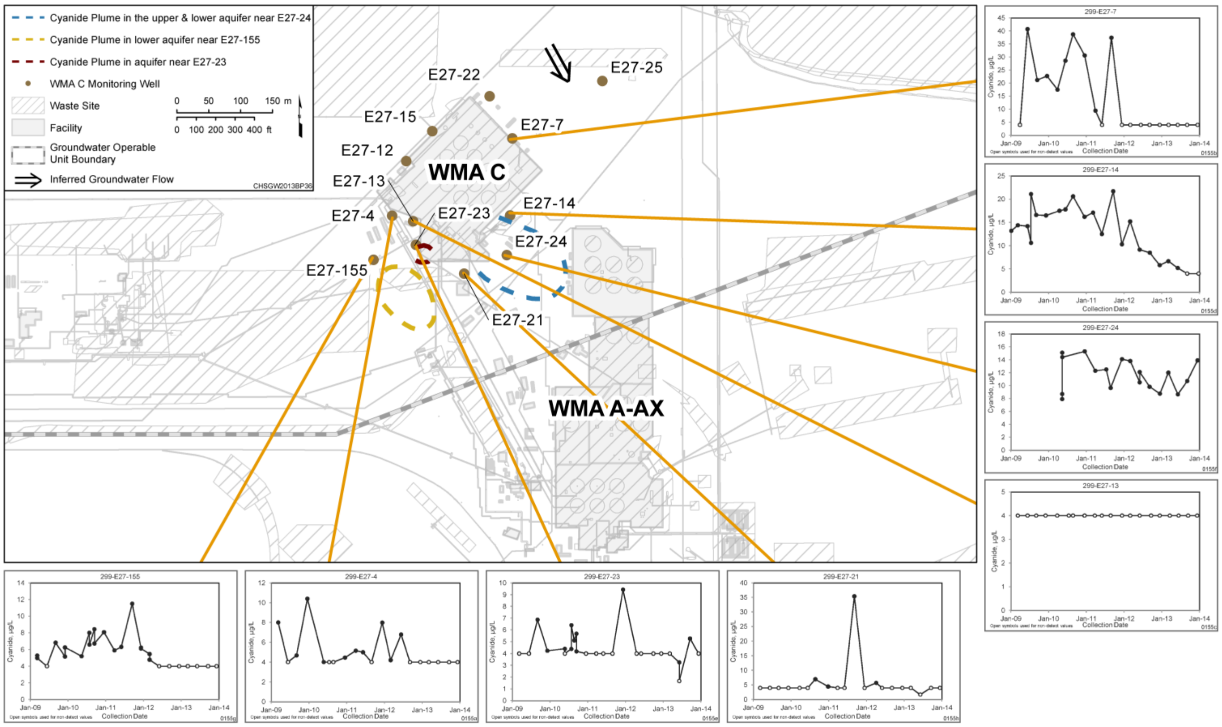

Figure BP.37 Interpretation of the 4 µg/L Cyanide Isopleth in the Upper 4 M and Lower 4 M of the Aquifer at Waste Management Area C and Cyanide Trend Results at Select Waste Management Area C Wells

Estimations of groundwater flow rates are required by 40 CFR 265.94(d)(4) because of the presence of the dangerous waste constituent cyanide. The water level measurements defining the gradient magnitude and flow direction at WMA C were collected quarterly, as required by 40 CFR 265.94(d)(7)(i), from two different water level networks in the 200 East Area during 2013. Detailed reasoning for using the two networks is provided in SGW-54508. Thus, the flow rate beneath WMA C ranged between 0.02 and 0.4 meters per day (0.07 and 1.3 feet per day) or 7.3 to 146 meters per year (26 to 475 feet per year) (based on the parameters in Table B.1, Appendix B). The average groundwater flow direction in 2013 at WMA C was 147 degrees from north or southeast (with a range during the year of 132 to 171 degress from north). Details of the flow direction for each quarter are provided in the quarterly reports provided below:

- *WMA C January Through March 2013 Quarterly Groundwater Monitoring Report*, SGW-55572
- *WMA C April Through June 2013 Quarterly Groundwater Monitoring Report*, SGW-56195
- *WMA C July Through September 2013 Quarterly Groundwater Monitoring Report*, SGW-56515
- *WMA C October Through December 2013 Quarterly Groundwater Monitoring Report*, SGW-56777

In addition to RCRA monitoring, WMA C is also monitored by AEA requirements in accordance with *Agreement on Content of Tank Waste Retrieval Work Plans* (04-TPD-083). Under this agreement gross beta, low-level gamma scans, technetium-99, and total uranium are monitored quarterly at each well location in accordance with TPA-CN-578 and DOE/RL-2001-49 Rev 1.

In 2013, the low-level gamma results were less than detection limits, except for one false positive result for cesium-137 and two false positive potassium-40 results. The cesium-137 result was initially reported at well 299-E27-14, but the reanalysis of the original sample was less than the detection limit. Detected potassium-40 results were reported by the laboratory at wells 299-E27-12 and 299-E27-15. The results were near the detection limit and statistically out of trend with past and present results at these wells. Thus, the results were flagged “Y,” indicating a suspect result.

The gross beta and technetium-99 results correlate, indicating only the presence of technetium-99. See the “200-BP Technetium-99” section for a discussion of technetium-99 results.

Uranium concentrations in 2013 were less than regional background levels of 4 µg/L (DOE/RL-96-61), except at four wells (299-E27-4, 299-E27-14, 299-E27-24, and 299-E27-155). The detected uranium concentrations were all below the 30 µg/L DWS. In 2013, the greatest uranium concentrations were in wells 299-E27-14 and 299-E27-155 (10.8 and 9.93 µg/L, respectively). At well 299-E27-155, located to the southwest of WMA C, uranium concentrations have been increasing since March 2011 and were 10.8 µg/L in December 2013. Conversely, at well 299-E27-14 the uranium concentrations have been decreasing from 10.8 µg/L in March and in December were 8.7 µg/L.

The depth of the water column in WMA C monitoring wells ranges from 1.61 to 13.47 meters (Table B.74, Appendix B). These wells all have adequate water columns in the screened interval for sampling through the next decade or more.

200-BP RCRA – 216-B-63 Trench

The 216-B-63 Trench is located in the north central portion of the 200 East Area. The trench was constructed by 1970 as an emergency percolation trench for radioactively contaminated cooling water from B Plant. Through 1985, acidic and caustic treatments were completed to neutralize the waste. The actual corrosive portion from the demineralizers was less than 1,890 liters per day, while the remainder of the 378,000 to 1,408,0000 liters per day was a combination of chemical sewer and cooling water. Discharges to this trench ceased in 1992. The corrosive waste discharges were regulated under RCRA and its implementing requirements WAC 173-303-400. DOE monitors the groundwater under an interim-status indicator evaluation (detection) program in accordance with 40 CFR 265.93(b), as defined in Rev. 1 of DOE/RL-2008-60 (Figure BP.38). The revision was completed in 2012 to realign the upgradient and downgradient monitoring network to the new southeast groundwater flow condition. Previously, there has been no evidence of contaminant effects from the 216-B-63 Trench site within the groundwater. All of the wells were sampled semiannually, as required, during the reporting period (Table B.31, Appendix B).

Determining the groundwater gradient magnitude and flow direction from water-level data is not possible at this time due to the flat water table and minimal spatial geometry of the monitoring network. However, contaminant migration from the north of the 216-B-63 Trench provides a means to estimate the flow rate and is considered to be approximately 0.3 meters per day based on the nitrate and technetium-99 plume movement from summer of 2012 to summer of 2013.

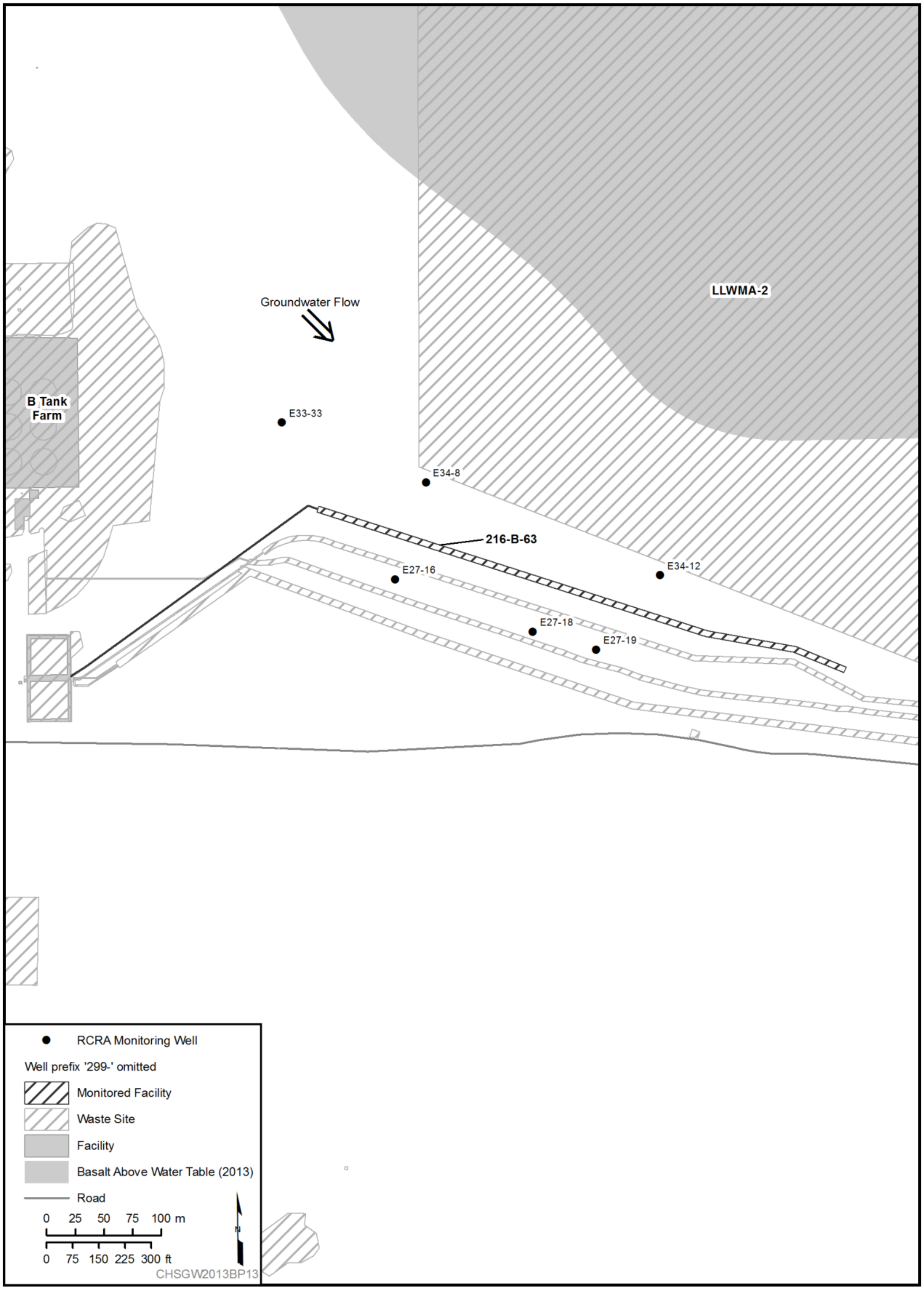

Figure BP.38 200-BP RCRA 216-B-63 Monitoring Well Locations

The only indicator parameter that exceeded the critical mean in 2013 was total organic carbon (TOC). The TOC concentrations reported by the Waste Sampling and Characterization Facility (WSCF) at Hanford, Washington exceeded the critical mean in both the upgradient and downgradient wells in the October 2013 sampling event. By regulation, verification samples were collected in December 2013 to determine if laboratory error may be related to the exceedence. Split samples were collected December 17, 2013 and sent to WSCF and TestAmerica in St. Louis, Missouri. The TestAmerica results, received in mid-January 2014, were at concentrations just above the detection limit of 270 µg/L (i.e., below the critical mean value); however, the WSCF verification results, received at the beginning of January 2014, were more than twice the concentrations received from TestAmerica laboratory and continued to exceed the critical mean value.

Investigation of recent TOC results from WSCF found that CH2M Hill Plateau Remediation Company (CHPRC) August blinds were biased high by approximately 1.5 to 2 times the expected value. WSCF began working on correcting the issue in January 2014, after the 216-B-63 verification samples had been collected. Independent of CHPRC's notification, vendor routine maintenance on the TOC instrumentation was performed in mid-January. Some of the preliminary data indicated the problem may have been resolved by the vendor's visit.

Another verification sample was collected January 30, 2014 to re-evaluate TOC. TOC from both laboratories were below the critical mean value; therefore, the initial WSCF results were flagged as suspect, and the 216-B-63 Trench remains in interim status detection monitoring.

The current 216-B-63 Trench detection monitoring plan, DOE/RL-2008-60, was revised in 2012 to account for the 2011 southeast flow direction change. The depth of the water column in network wells ranges from 1.32 to 3.18 meters. These groundwater wells all have adequate water columns in the screened interval available for sampling for the next decade or more.

While the alignment of the revised well network allows for statistical measures for determining whether the 216-B-63 Trench is impacting groundwater under stationary conditions over time, contaminant plumes migrating towards this site from the northwest are anticipated to affect both the upgradient and downgradient wells in 2014 and beyond. An increasing trend in specific conductance is expected and may require the background comparison values to be recalculated as recommended in the unified guidance (EPA 530-R-09-007) and 40 CFR 265.91(a)(1). The unified guidance stance on trending background concentrations is that it violates the assumption of stationary concentrations over time, which is a key assumption for the statistical interim Student *t*-test approach used to derive background levels in accordance with 40 CFR 265.93(b). Furthermore, 40 CFR 265.91(a)(1) requires upgradient wells that are representative of background ground-water quality; thus, background levels will be recalculated as necessary to ensure representative comparisons with the changing background groundwater quality.

200-BP RCRA – LERF

Located on the eastern boundary of the 200 East Area, the LERF consists of three lined surface impoundment basins (Basin 42, 43, and 44) (Figure BP.39). Construction of the complex was completed in 1991, utilizing a dual confinement barrier concept (i.e., dual basin liners and pipe-in-a-pipe transfer piping system) to minimize human exposure and potential for accidental releases to the environment. A leachate detection, collection, and removal system and basin covers were also added to reduce possible environmental or personnel exposure. The basins are arranged side by side, with 18.2 meters of separation between each basin. The dimensions of each basin (cell) are 100.5 meters by 82.2 meters, with a maximum fluid depth of 6.7 meters.

The LERF was constructed for interim storage and treatment for aqueous waste streams prior to final treatment in the 200 Area Effluent Treatment Facility (ETF). Treatment at LERF consists of flow and pH equalization. The flow equalization allows for several smaller waste streams that are intermittently received at the LERF basins to accumulate for continuous higher volume campaign processing at ETF.

LERF has and continues to receive liquid waste from a number of on-site facilities with the most prominent volumes being received from the 242-A Evaporator, Environmental Restoration Disposal Facility (ERDF) leachate, and purge water from groundwater monitoring. Several of the liquid wastes contain metals and organics, which are regulated under RCW 70.105 and subject to groundwater monitoring requirements pursuant to WAC 173-303-645. It is a final-status facility included in RCRA permit WA78900008967.

In 2013, DOE prepared a class 2 modification of the permit including a new groundwater monitoring plan in accordance with WAC 173-303-645(9), as defined in DOE/RL-2013-46, *Groundwater Monitoring Plan for the Liquid Effluent Retention Facility*. The new detection monitoring plan identifies RCRA indicator parameters for statistically based comparisons. In addition, the monitoring network was modified, based on statistical evaluations of the water table gradient magnitude and flow direction. The flow direction provided in Figure BP.39 is the average of monthly statistical derived flow directions between December 2011 and January 2013 using deviation and barometrically corrected measurements from wells 299-E26-10, 299-E26-14, 299-E26-77, and 299-E26-79. The new plan requires the addition of one new downgradient well to complete the detection monitoring network (299-E26-15), which is scheduled to be drilled. The other two wells used for detection monitoring are 299-E26-14 (upgradient well) and 299-E26-79 (downgradient well). All three of the detection monitoring wells plus two other wells (299-E26-10 and 299-E26-77) will be used to derive the groundwater flow direction and gradient magnitude. This plan is going through public comment in early 2014 and may be implemented in later 2014.

Previously, there has been no evidence of contaminant effects from the LERF site within the groundwater; however, since 2001, inter-well statistical evaluations of LERF groundwater monitoring data have not been performed. In 2013, five wells (299-E26-10, 299-E26-11, 299-E26-14, 299-E26-77, and 299-E26-79) were sampled semi-annually (Table B.44, Appendix B). Samples were collected for volatile organics, semi-volatile organics, alkalinity, anions, cations, and trace metals. The organics were less than detect and the trace metals were at or near regional background levels based on DOE/RL-96-61. The trace metals that exceeded background were flagged "B", meaning the value was detected lower than the contract required detection limit, and indicate high variability. This is reflected by many results being both below and above the regional background level. The anions and cations are greater to the west, in wells 299-E26-10 and 299-E26-77, than closer to the basins. The increased results to the west reflect migration of elevated anions and cations, possibly related to unplanned releases associated with the 216-B-2 Ditches.

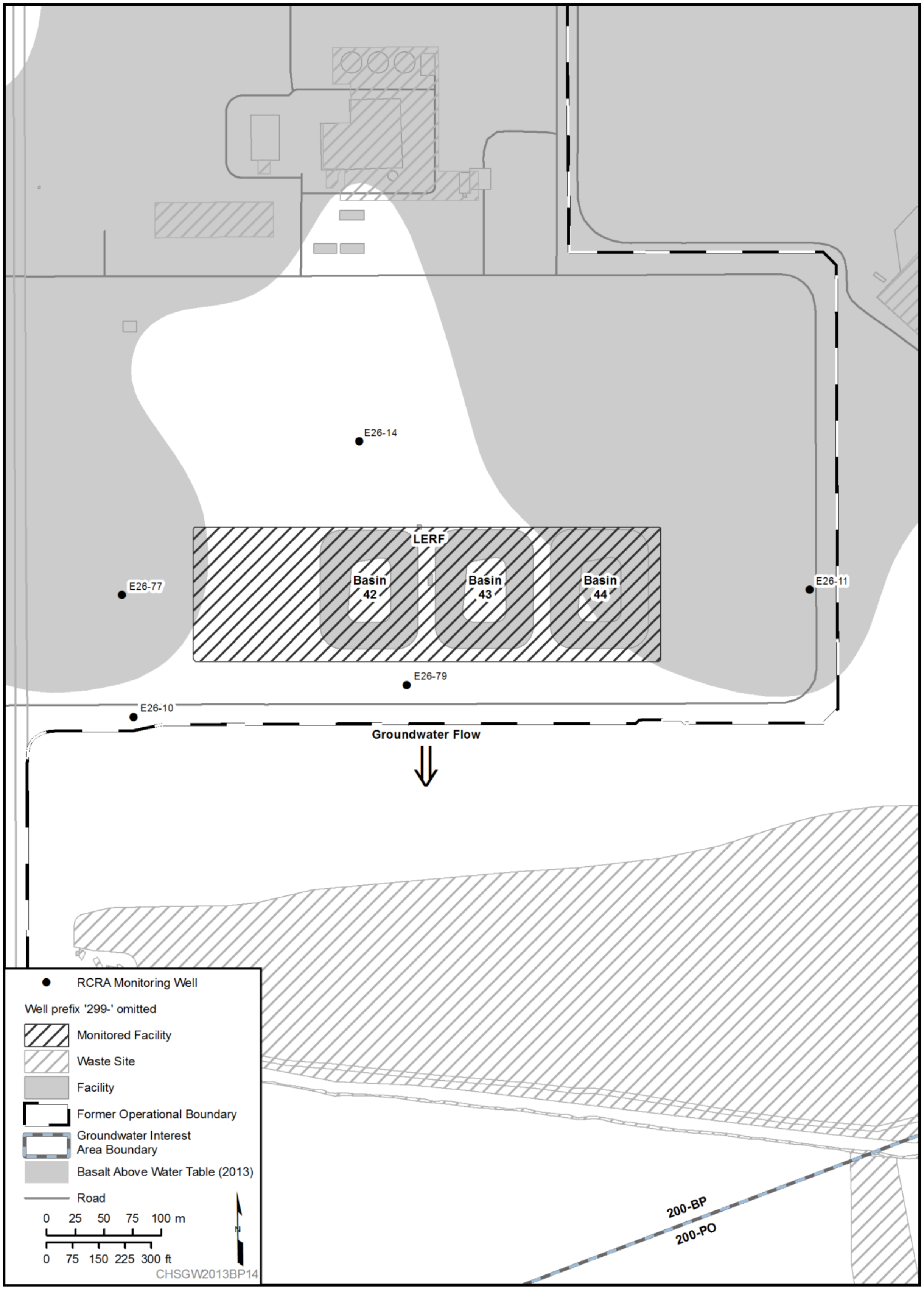

Figure BP.39 200-BP RCRA LERF Monitoring Well Locations

Although statistical evaluations are not performed at LERF currently, the parameters generally associated with detection monitoring were analyzed. Two parameters that have and continue to show variability across the LERF network are specific conductance and TOC. The greatest specific conductance and TOC results were from well 299-E26-10. The levels in this well and well 299-E26-77 were consistent with levels to the west at well 299-E27-10 and much lower than previous levels at well 299-E34-7, located to the northwest. The specific conductance values at wells 299-E26-10 and 299-E26-77 are consistent with the elevated levels of chloride, nitrate, and sulfate from these same wells. These constituents are also elevated to the west and were greatest in the past at well 299-E34-7. An example of the chloride correlation between wells 299-E26-10, 299-E27-10 and 299-E34-7 is provided in Figure BP.40. In addition, the nitrate and sulfate concentrations exceed DWS and secondary DWS in wells 299-E26-10 and 299-E26-77; however, are lower than concentrations previously seen at well 299-E34-7. Although the TOC is elevated in wells 299-E26-10 and 299-E26-77 there were no volatile organic analytes (VOA) or semi-VOA results above the detection limits. It has been postulated that the source of the elevated TOC and anions may be associated with migration of the unplanned release UPR-200-E-138, located within the 216-B-2-2 Ditch. Figure BP.41 provides a comparative view of TOC levels near this release in wells 299-E26-10, 299-E27-10, and 299-E34-7.

The depth of the water column in LERF network wells ranges from 1.1 to 6.6 meters into the aquifer. These groundwater wells all have adequate water columns in the screened interval available for sampling for the next decade or more.

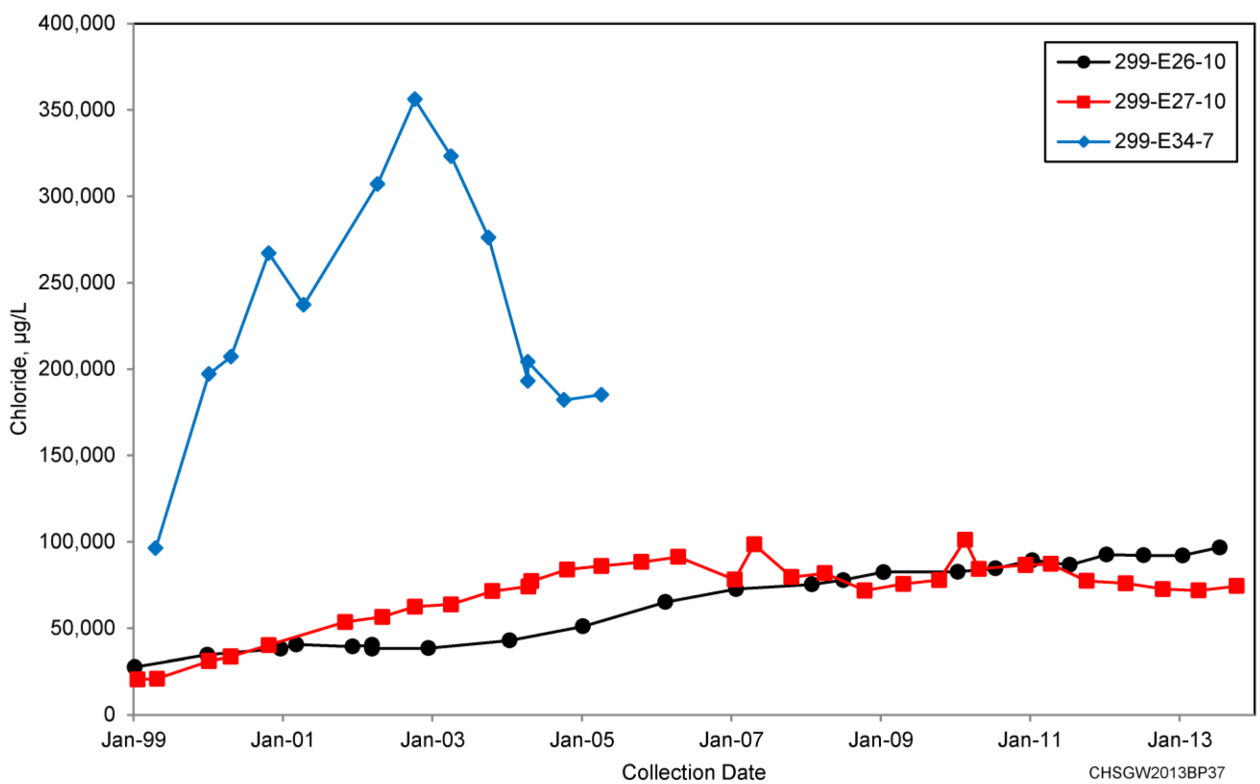

Figure BP.40 200-BP Comparison of Chloride Concentrations at Wells 299-E26-10, 299-E27-10, and 299-E34-7

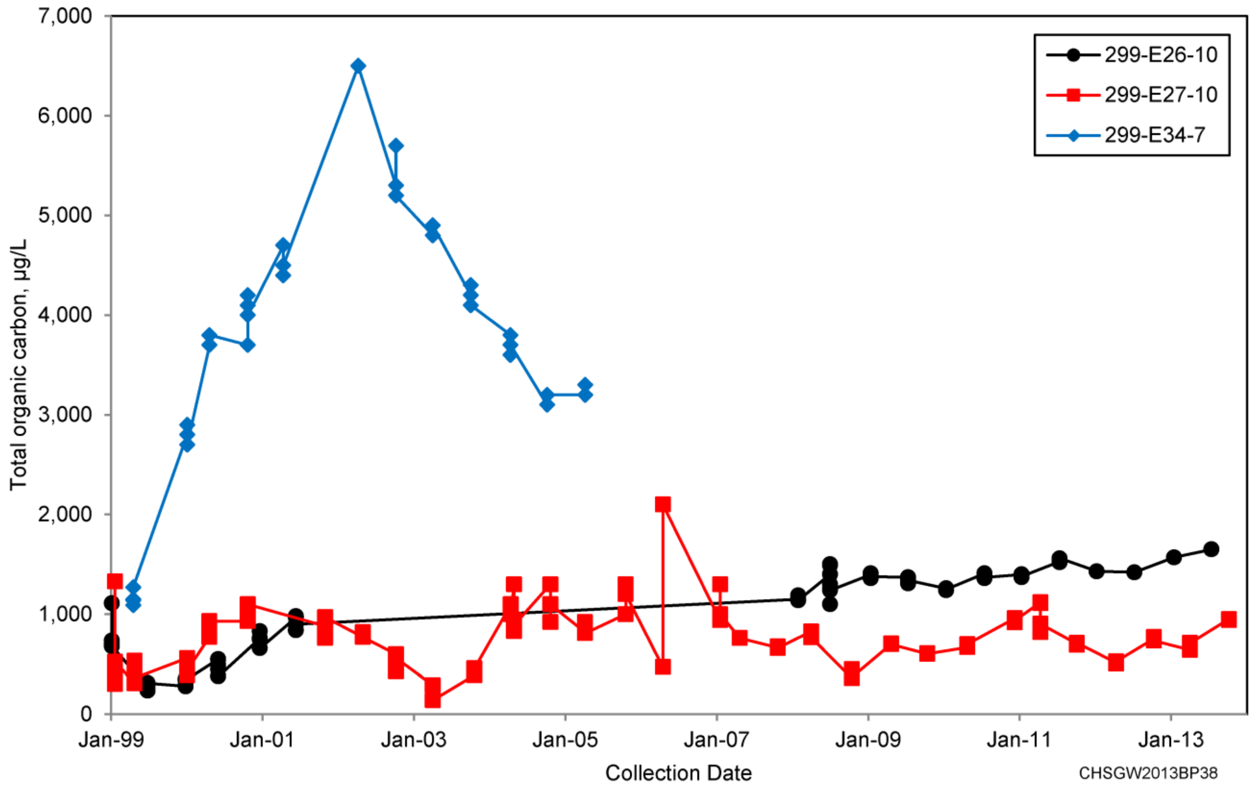

Figure BP.41 200-BP Comparison of Total Organic Carbon at Wells 299-E26-10, 299-E27-10, and 299-E34-7

200-BP RCRA – LLWMA-1

The LLWMA-1 is located in the northwest corner of the 200 East Area (Figure BP.42). The LLWMA-1 monitoring network is designed for detection of dangerous waste/dangerous waste constituents affecting groundwater from the 218-E-10 Burial Ground, which consists of 14 unlined trenches. The 218-E-10 Burial Ground received low-level radiological waste and low-level mixed wastes beginning in 1955. The dangerous chemicals in the low-level mixed waste portions of 218-E-10 Burial Ground are regulated under RCRA and its implementing requirements WAC 173-303-400. DOE monitors the groundwater in accordance with 40 CFR 265.93(b), as defined in DOE/RL-2009-75. The monitoring network currently consists of eighteen wells (Figure BP.42). Previously, there has been no evidence of contaminant effects from the 218-E-10 Burial Ground site within the groundwater. All of the wells were sampled semiannually, as required, during the reporting period (Table B.47, Appendix B).

The groundwater gradient magnitude and flow direction varied during 2013. The water level measurements defining the gradient magnitude and flow direction are derived from a 6 well network that is corrected for deviation and barometric pressure fluctuations. The wells include the following: 299-E28-27, 299-E32-5, 299-E32-6, 299-E32-8, 299-E33-28, and 299-E33-34. The groundwater gradient magnitude changes at LLWMA-1 are associated with yearly Columbia River spring stages. Since July 2011, declining water levels in the 200 East Area along with propagating Columbia River spring stages into the northwest corner of the 200 East Area have caused a groundwater flow direction change to the southeast. The temporal fluctuations of the Columbia River stages have caused an increasing gradient from June/July until October/November since 2011, followed by a decreasing gradient until next June. The gradient magnitude decrease from December 2012 to June 2013 was 2.75×10^{-5} to 1.48×10^{-5}, respectively. Between June and October the gradient magnitude increased to 3.42×10^{-5}. Finally, the gradient decreased in November and December. The lowest gradient in 2013 was in December at 1.19×10^{-5}. The average gradient magnitude for 2013 was 1.93×10^{-5}. Using an average gradient magnitude of 1.93×10^{-5}, for 2013, the groundwater flow rate at LLWMA-1 was estimated to range between 0.03 and 0.3 meters per day (0.1 to 1.0 feet per day) or 11 to 110 meters (37 to 365 feet) per year (Table B.1, Appendix B). The greater flow rate is along the north and east side of LLWMA-1 where greater hydraulic conductivity values were derived and the slower flow rate pertains to the southwest and south boundary of LLWMA-1 were lower hydraulic conductivity values were derived. The greater flow rate values are consistent with the paleochannel of unconsolidated Hanford and Cold Creek sediments as discussed in the introduction of the BP-5 OU. The 2013 groundwater flow direction also varied, between east and southeast. The average flow direction was 129 degrees from north or southeast. This flow direction is consistent with plume migration a discussed below.

In 2012, TOC was confirmed to exceed the critical mean in downgradient well 299-E33-265. The elevated TOC at this well was coincident with a flow reversal. As a result, a draft of DOE/RL-2012-35 was submitted to Ecology in May, 2012. Evaluation of the assessment results were reported in the *First Determination RCRA Groundwater Quality Assessment Report for Low-Level Burial Grounds Low-Level Waste Management Area-1*, DOE/RL-2013-25, which was submitted to the Administrative Record on May 10, 2013. The conclusion of the report was that no dangerous waste/dangerous waste constituents in groundwater were associated with the 216-E-10 Burial Ground; however, the TOC values remained elevated at well 299-E33-265. The most likely reason for the elevated TOC is an upgradient source of natural organic material near the well. This conclusion stemmed from the non-detect organic results throughout the well network and the low TOC in neighboring wells 299-E33-30 and 299-E33-266, located to 58 meters to the east and 37 meters to the west, respectively. Thus, interim detection monitoring was reinstated in 2013 as defined by DOE/RL-2009-75.

The detection monitoring plan, DOE/RL-2009-75, is designed for a northwest flow direction and was planned to be updated for the current southeast flow direction in 2013, but was delayed as the unused north portion of the burial ground is planned to be administratively closed prior to modifying the monitoring plan. The depth of the water column in monitoring wells ranges from 1.72 to 3.36 meters into the aquifer. These groundwater wells all have adequate water columns in the screened interval available for sampling for the next decade or more.

Radionuclide performance assessment monitoring at LLWMA-1 (in accordance with AEA authority) is designed to complement RCRA detection monitoring and specifically at monitoring radionuclides not regulated under RCRA. The current monitoring plan (DOE/RL-2000-72) requires iodine-129, technetium-99, tritium, and uranium for assessing the groundwater. Based on observations at the LLWMA-1 wells and other 200-BP monitoring wells, the 218-E-10 Burial Ground did not impact the groundwater. Results for each of these constituents are discussed below and can be found on the site map in the respective sections above.

Elevated iodine-129 activities found predominantly in the northeast portion of LLWMA-1 are from sources to the east-southeast, as discussed in the “200-BP Iodine-129” section. The highest level was in well 299-E33-35 (4.06 pCi/L). Levels decrease across the LLWMA to the southwest.

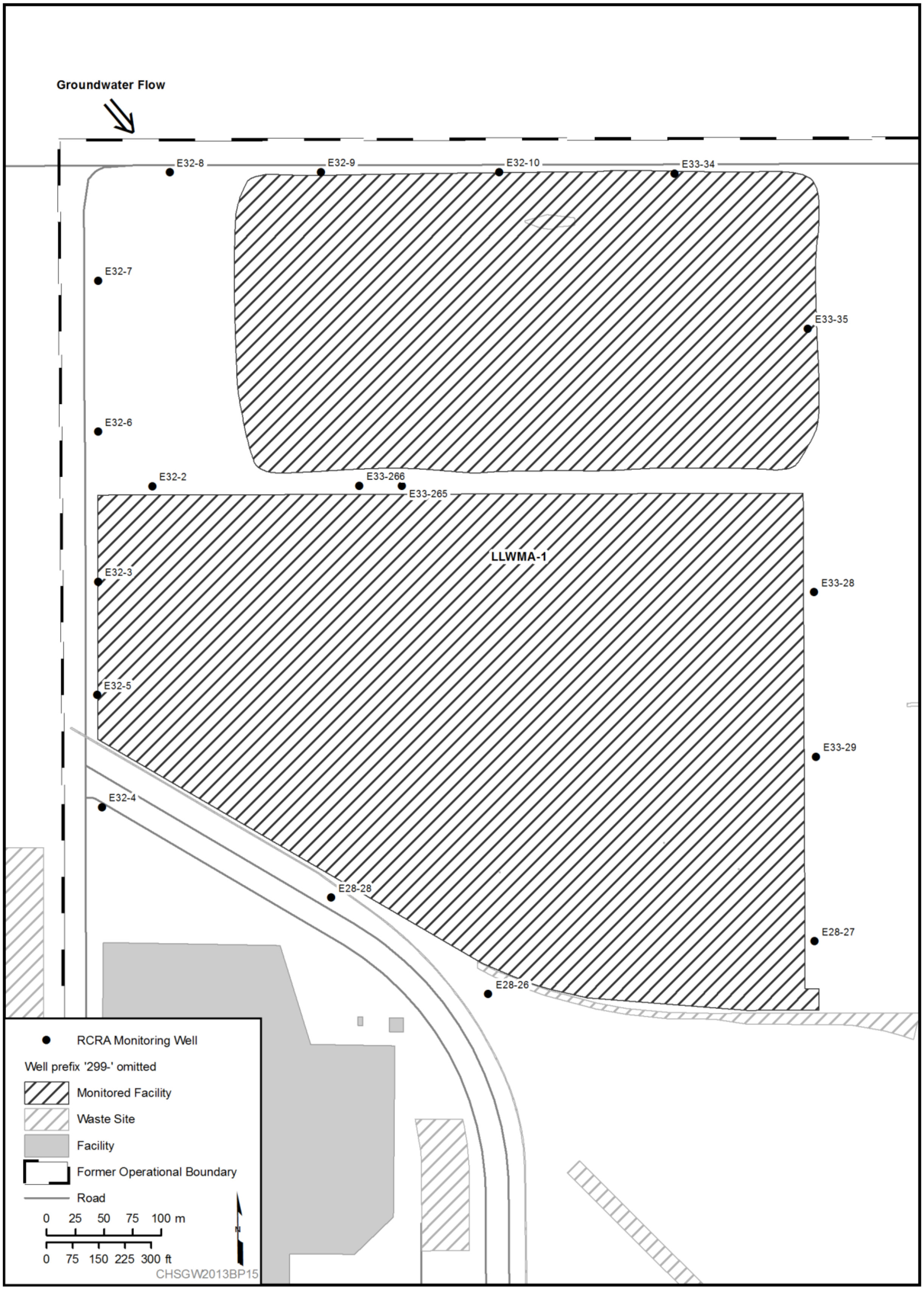

Figure BP.42 200-BP RCRA LLWMA-1 Monitoring Well Locations

Technetium-99 concentrations exceed DWS in wells monitoring the north and east portion of the LLWMA. The technetium-99 groundwater activity in the north and east wells (299-E32-8, 299-E32-9, 299-E32-10, 299-E33-28, 299-E33-34, and 299-E33-35) is primarily associated with the technetium-99 plume migrating from the BY Cribs and the 241-BX-102 unplanned release. Technetium-99 from the B Complex is discussed further in the 200-BP technetium-99 section.

Tritium was not reported above DWS in any LLWMA-1 monitoring well in 2013. The highest activity was in well 299-E33-35, which is the result of migration from the 216-B-57 and 216-B-50 Cribs (see 200-BP Tritium section).

In 2013, uranium concentrations exceeded DWS in wells 299-E33-34 and 299-E33-35, monitoring the northwest corner of the LLWMA. The elevated concentrations are associated with the 241-BX-102 unplanned release. The highest concentration was in well 299-E33-35 at 65.6 µg/L.

200-BP RCRA – LLWMA-2

The LLWMA-2 is located in the northeast corner of the 200 East Area. It includes the 218-E-12 Burial Ground, which consists of 40 unlined trenches. The 218-E-12 Burial Ground received low-level radiological waste and low-level mixed wastes beginning in 1967. The dangerous chemicals in the low-level mixed waste portions of LLWMA-2 are regulated under RCRA and its implementing requirements WAC 173-303-400. DOE monitors the groundwater with an interim-status indicator evaluation (detection) program in accordance with 40 CFR 265.93(b), as defined in DOE/RL-2009-76. The monitoring network is illustrated in Figure BP.43.To date there has been no evidence of contaminant effects from the 218-E-12 Burial Ground within the groundwater. All of the wells were sampled semiannually, as required, during the reporting period (Table B.50, Appendix B).

Determining the groundwater gradient magnitude and flow direction from the LLWMA-2 monitoring network based on water levels is not possible at this time due to the flat water table and geometry of the monitoring network. However, because of contaminant migration into the area, the flow along the west side of LLWMA-2 is considered southeast, while the flow direction along the east side is more southward. Plume migration provides a means to estimate the flow rate and is considered to be approximately 0.3 meters per day along the west side based on the nitrate and technetium-99 plume movement from the summer of 2012 to the summer of 2013. The estimated flow rate along the east side of LLWMA-2 is considered to be equivalent to the measurements completed for LERF, 0.1 meters per day.

The detection monitoring plan, DOE/RL-2009-75, is designed for a west-southwest flow direction and was planned to be updated for the current southeast-south flow direction in 2013, but was delayed as the unused north portion of the burial ground is planned to be administratively closed prior to modifying the monitoring plan. The depth of the water column in monitoring wells ranges from 1.24 to 2.78 meters. These groundwater wells all have adequate water columns in the screened interval available for sampling for the next decade or more.

The only indicator parameter that exceeded the critical mean in 2013 was specific conductance at downgradient well 299-E34-9. The elevated specific conductance at this well was determined to be associated with nitrate migration in the groundwater from primarily the BY Cribs, as explained in Letter 13-AMRP-0192. The reason the BY Cribs are now considered an upgradient source is because of the southeast flow direction change in 2011 in this area. The letter was sent to Ecology on May 28, 2013.

Meetings were also held between DOE, Ecology, and CHPRC and as a result, a determination that the 218-E-12B Burial Ground was not associated with the elevated specific conductance was agreed to; therefore, the site did not go into assessment monitoring.

Radionuclide performance assessment monitoring at LLWMA-2 (in accordance with AEA authority) is designed to complement RCRA detection monitoring and specifically at monitoring radionuclides not regulated under RCRA. The current monitoring plan (DOE/RL-2000-72) requires iodine-129, technetium-99, tritium, and uranium for assessing the groundwater. Based on observations at the LLWMA-2 wells and other 200-BP monitoring wells, the 218-E-12 Burial Ground did not impact the groundwater. Results for each of these constituents are discussed below and can be found on the site map in their respective sections above.

Iodine-129. Elevated iodine-129 has been detected in the wells along the south side of LLWMA-2 since monitoring began in the early 1990s. The highest level was in well 299-E27-10 when sampling began, but has continued to decline and is currently near DWS. Four wells (299-E27-8, 299-E27-9, 299-E27-10, and 299-E27-11) exceeded DWS in 2013; however, activity levels are decreasing in each of these wells. Iodine-129 appears to have originally migrated into the area, occupied by these wells, after the termination of discharges to the Gable Mountain Pond from sources to the south and east. Since then activity levels have been decreasing. Activity levels appear to be decreasing more rapidly over the past couple of years and may be associated with the groundwater flow direction change. The greatest activity in 2013 was at well 299-E27-9 at 2.16 pCi/L.

Technetium-99. Technetium-99 activity beneath the west side of LLWMA-2 is increasing rapidly. The activity increase is associated with technetium-99 migration through the groundwater from the BY Cribs, similar to the nitrate discussed above. Currently, the only well exceeding DWS is 299-E34-9, where the concentration increased from 1,900 pCI/L in October 2012 to 9,800 pCi/L in October 2013. Activity levels beneath the east side of LLWMA-2 peaked at approximately 100 pCi/L in 2007 at well 299-E27-10. Activity levels in this area have been declining and the greatest activity level was 35 pCi/L at well 299-E27-10 in 2013.

Tritium. Tritium activity beneath the west side of LLWMA-2 is increasing rapidly at well 299-E34-9. The activity increase is associated with tritium migration through the groundwater from the 216-B-50 Crib, similar to the nitrate and technetium-99 discussed above. The activity level increased from 650 pCi/L, in October 2012, to 1,500 pCi/L, in October 2013. Activity levels beneath the east side of LLWMA-2 peaked at approximately 12,000 pCi/L in 1991; shortly after the termination of discharges to the Gable Mountain Pond in 1987. Activity levels in this area have been less than detect since October 2012.

Uranium. Uranium concentrations at LLWMA-2 were less than 7 µg/L, which is below regional background levels (DOE/RL-96-61).

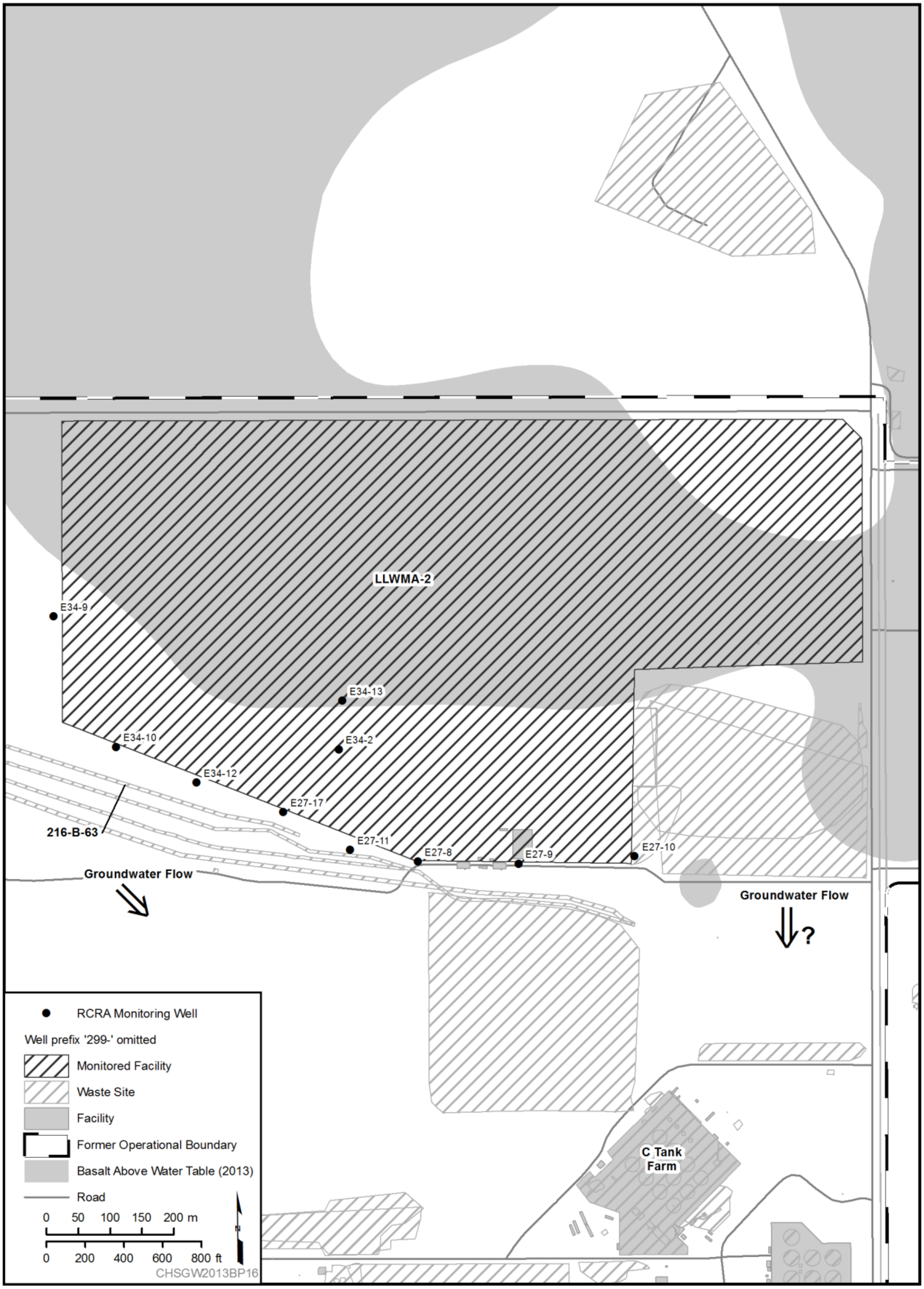

Figure BP.43 200-BP RCRA LLWMA-2 Monitoring Well Locations