There are many instances in the database of multiple results for U on the same date at the same well. These results may represent any of the following: isotopic analysis providing results in activity units, isotopic analysis providing results in mass units, total U analysis via a metals analytical method, total U via a total U analytical method, filtered sample, unfiltered sample, unvalidated result, partially validated result, validated result, and result of reanalysis. (Note that these last four result types are most common in pre-closure data.) Before trends were calculated, for each well where this applied, these multiple results were winnowed to a single result representing each unique date. Factors evaluated in selecting the result for statistical use included:

- Filtration status;
- Validation qualifiers;
- Lab qualifiers; and
- Other U results from the well.

Because most samples for U analysis were field-filtered, where both sample results are provided, the filtered result is typically preferred for reasons of consistency. Similarly, where two very different results are presented, the result closer to others from the well is retained; if the two results are similar, the higher-concentration result is retained, to be conservative.

Data from original wells are grouped with those from replacement wells to form a data set on which the statistics are based. As additional data are collected from replacement wells, most of which were installed in 2005, this may prove to be inappropriate, given that the data populations from original and replacement wells may be discontinuous, which suggests that data from the original wells should be removed from statistical assessments of the groundwater data. This determination will be made as the post-closure data set becomes large enough to allow such an evaluation. Therefore, it should be stressed that trends for some locations may be misleading in that they may be strongly affected by well replacement and do not reflect only groundwater geochemistry and hydrology.

3.1.2 Routine Monitoring

3.1.2.1 POC Monitoring

This objective deals with monitoring discharges from the terminal ponds into Woman and Walnut creeks and streamflow at the additional POCs downstream at Indiana Street to demonstrate compliance with RFLMA surface-water-quality standards (see RFLMA Attachment 2, Table 1). Water-quality data at POCs are reportable under RFLMA when the applicable compliance parameters are greater than the corresponding Table 1 values (see Appendix D). Terminal pond discharges are monitored by POCs GS11, GS08, and GS31. Walnut Creek is monitored at Indiana Street by POC GS03. Woman Creek is monitored at Indiana Street by POC GS01. These locations are shown on Figure 4. Sampling and data evaluation protocols are summarized in Table 4.

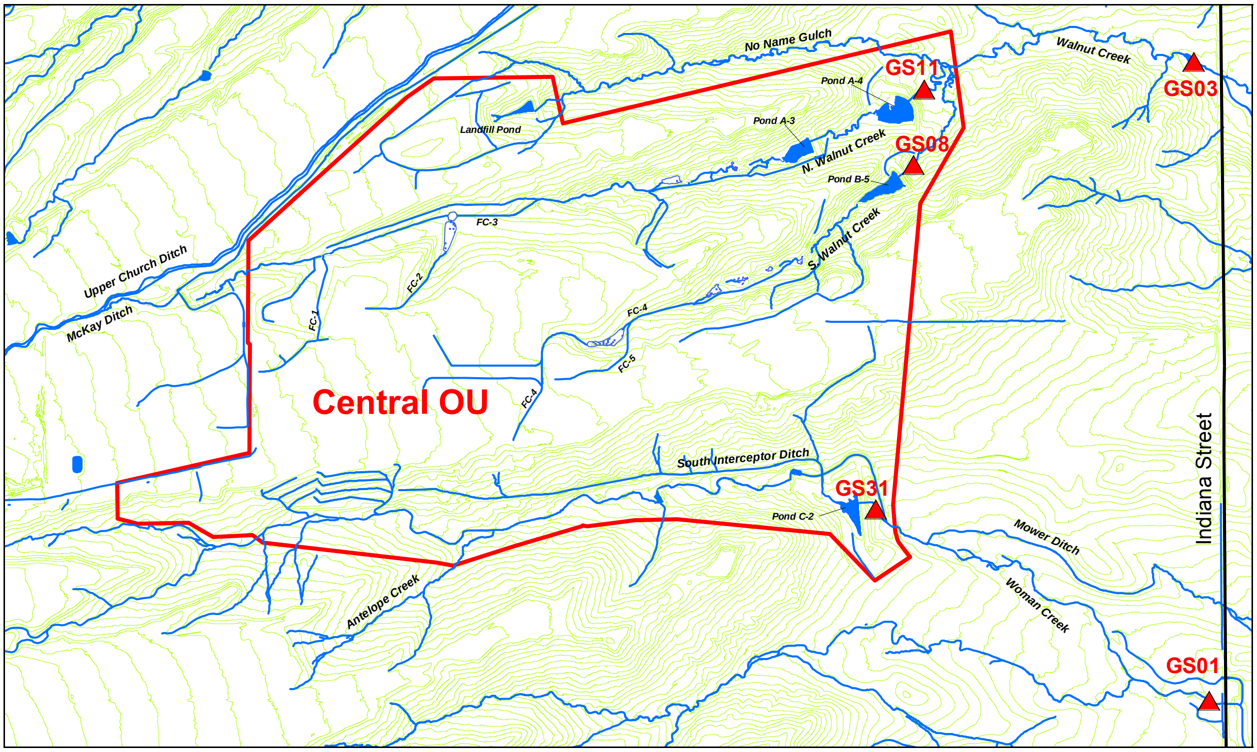

Figure 4. POC Monitoring Locations

Table 4. Sampling and Data Evaluation Protocols at POCs

Location Code	Location Description	Sample Types/Frequencies	Analytes	Data Evaluation
GS01	Woman Creek at Indiana Street	Continuous flow-paced composites; frequency varies (target is 25−35 per year)[a]	total Pu, Am, and U [TSS[c]]	See Figure 5 in Appendix D
GS03	Walnut Creek at Indiana Street	Continuous flow-paced composites; frequency varies (target is 20−35 per year)[a]	total Pu, Am, and U [TSS[c]]	See Figure 5 in Appendix D
GS08	Pond B-5 Outlet	Continuous flow-paced composites; frequency varies (target is 0−14 per year)	total Pu, Am, U, and nitrate[b]	See Figure 5 in Appendix D
GS11	Pond A-4 Outlet	Continuous flow-paced composites; frequency varies (target is 0−14 per year)	total Pu, Am, U, and nitrate[b]	See Figure 5 in Appendix D
GS31	Pond C-2 Outlet	Continuous flow-paced composites; frequency varies (target is 0−7 per year)	total Pu, Am, and U	See Figure 5 in Appendix D

Notes [a] Frequency depends on available flow; samples are segregated by water origin (baseflow or pond discharge).
[b] Collected during pond discharges only as daily grabs samples that are composited over 2–4 day periods (grab samples are collected instead of flow-paced composites to meet holding time and preservation requirements; nitrate is analyzed as nitrate+nitrite as nitrogen; this result is conservatively compared to the nitrate standard only.
[c] Total suspended solids (TSS) is analyzed when the composite sampling period is within TSS holding-time limits.

The following sections include summary tables and plots showing the applicable 30-day and 12-month rolling averages for the POC analytes. The evaluations include all results that were not rejected through the data verification and validation process. Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations, activities, and analytical errors are often greater than the precision presented. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the "real" and "duplicate" values. When a sample has multiple "real" analyses (Site-requested "reruns"), the value used in calculations is the arithmetic average of the multiple "real" analyses.[4]

Refer to Appendix B, which contains the water-quality data, for further information.

Location GS01

Monitoring location GS01 is located on Woman Creek at Indiana Street (Figure 4). The Woman Creek headwaters, the southern portion of the COU, and Pond C-2 contribute flow to GS01.

Table 5 shows that all of the annual average Pu and Am activities were well below the RFLMA standard of 0.15 picocurie per liter (pCi/L). Additionally, the long-term Pu and Am averages (1997−2010) are well below 0.15 pCi/L. The average total U concentrations are all well below the RFLMA standard of 16.8 µg/L.

Table 5. Annual Volume-Weighted Average Radionuclide Activities at GS01 for 1997−2010

Calendar Year	Volume-Weighted Average		
	Am-241 (pCi/L)	**Pu-239,240 (pCi/L)**	**Total U (µg/L)**
1997	0.003	0.007	NA
1998	0.006	0.006	NA
1999	0.005	0.008	NA
2000	0.004	0.003	NA
2001	0.004	0.006	NA
2002	0.002	0.001	NA
2003	0.002	0.004	1.60
2004	0.003	0.002	4.58
2005	0.004	0.003	3.22
2006	0.012	0.003	6.06
2007	0.002	0.007	1.40
2008	0.002	0.003	5.74
2009	0.003	0.007	2.75
2010	0.005	0.010	2.39
Total (1997−2010)	0.004	0.006	2.33

Notes: Collection of total U data began on February 3, 2003. NA = not applicable.

[4] Significant differences in values for a data pair are an indication of potential problems with sample preparation or analysis. Under these circumstances, an applicable value to be used for comparison cannot be determined with sufficient confidence to make compliance decisions. Thus, an evaluation of the duplicate error ratio (DER) or relative percent difference (RPD), depending on the analyte, is required to assess the representativeness of the sample and its usability for compliance decisions (see Section 8.2.3 of the RFSOG for discussion).

Figure 5 and Figure 6 show no occurrences of reportable 30-day averages for the year.

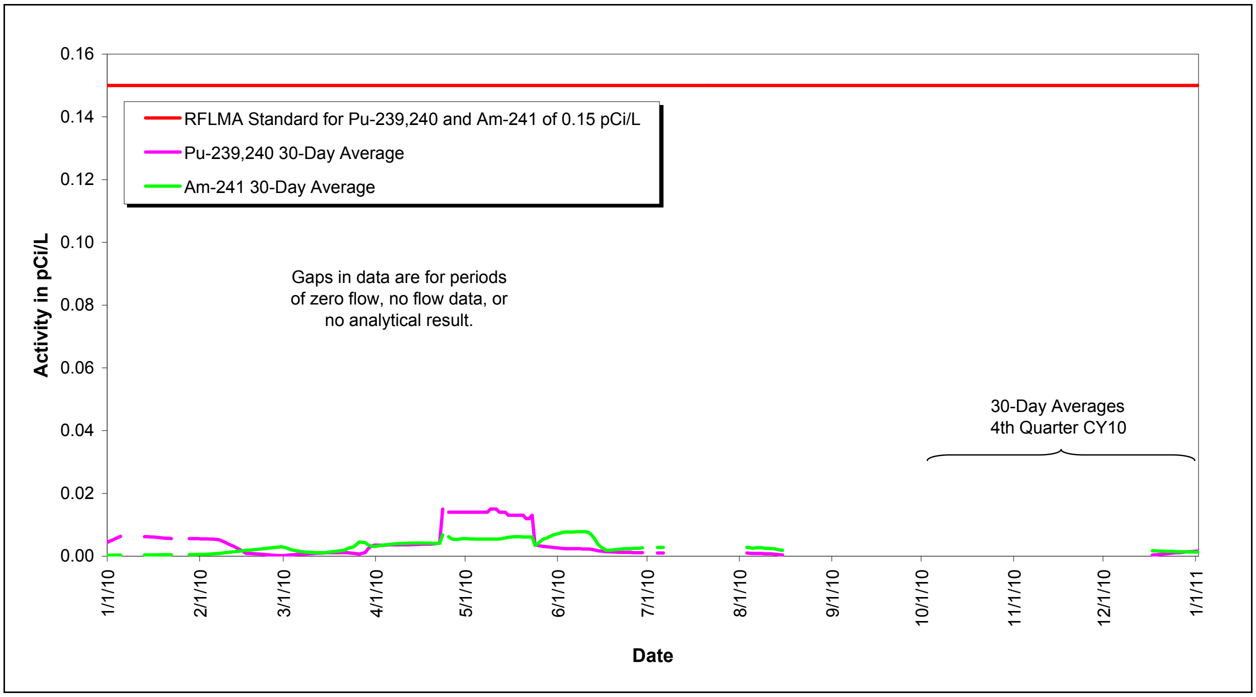

Figure 5. Volume-Weighted 30-Day Average Pu and Am Activities at GS01: Calendar Year Ending Fourth Quarter CY 2010

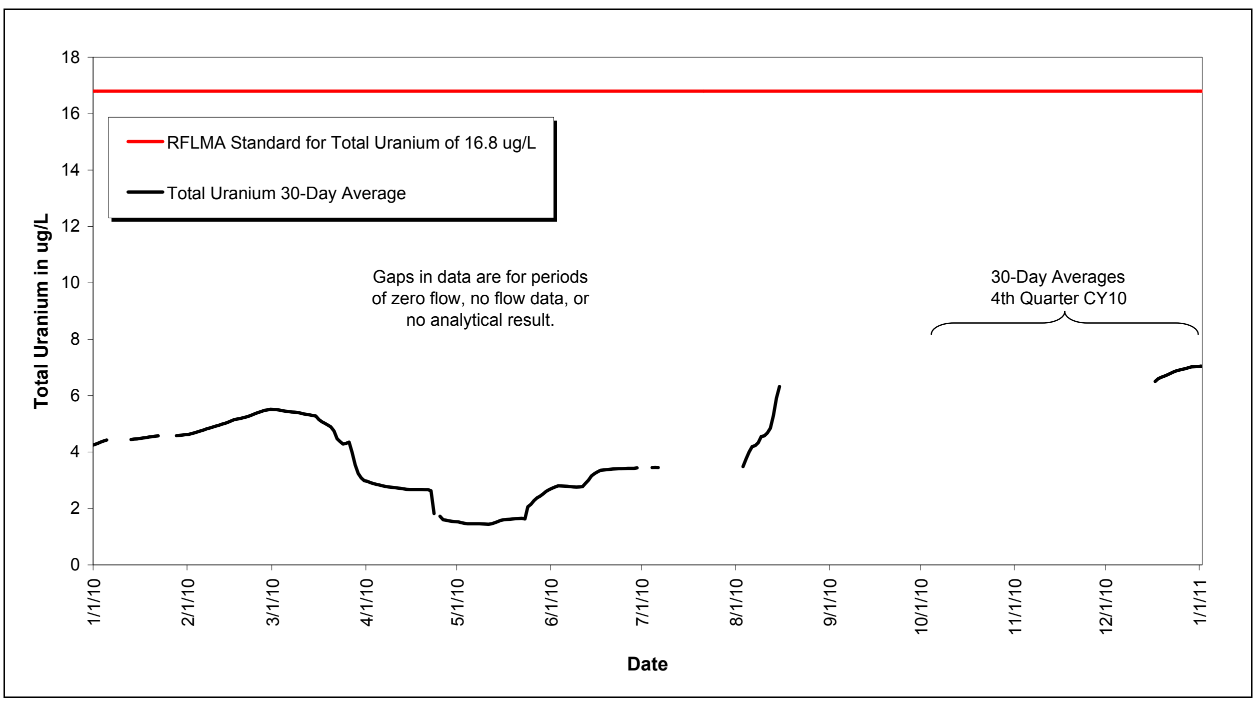

Figure 6. Volume-Weighted 30-Day Average Total U Concentrations at GS01: Calendar Year Ending Fourth Quarter CY 2010

Figure 7 and Figure 8 show similar data for the entire post-closure period.

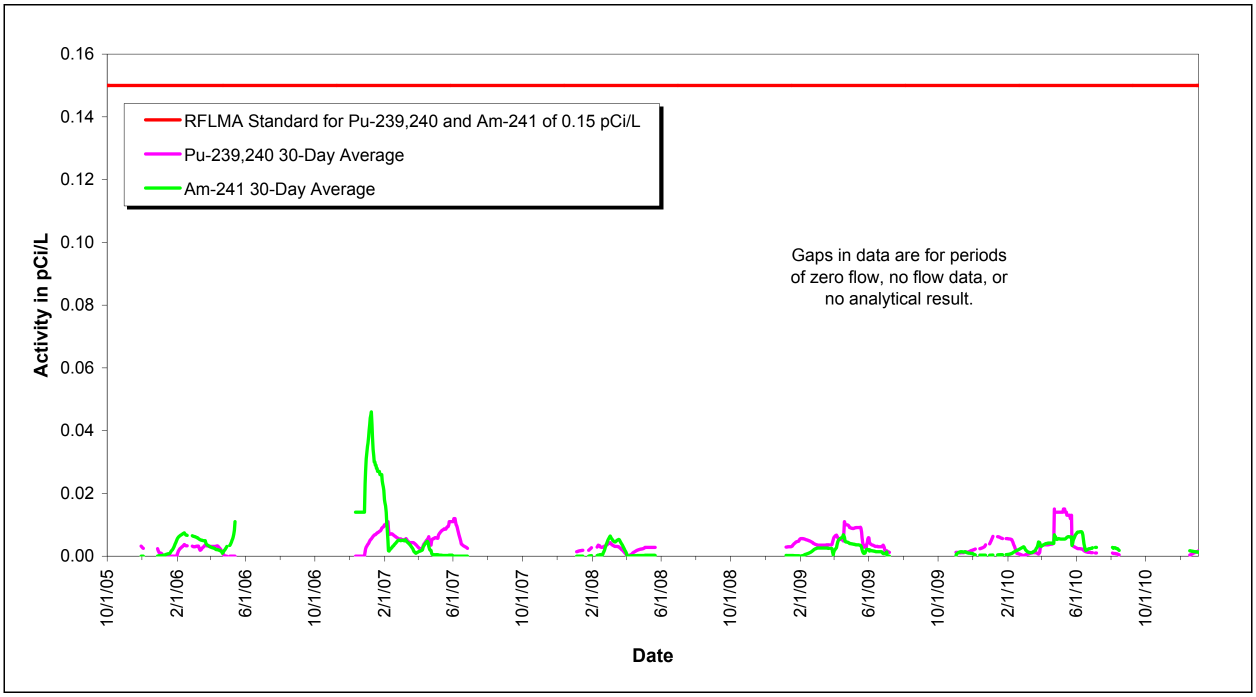

Figure 7. Volume-Weighted 30-Day Average Pu and Am Activities at GS01: Post-Closure Period

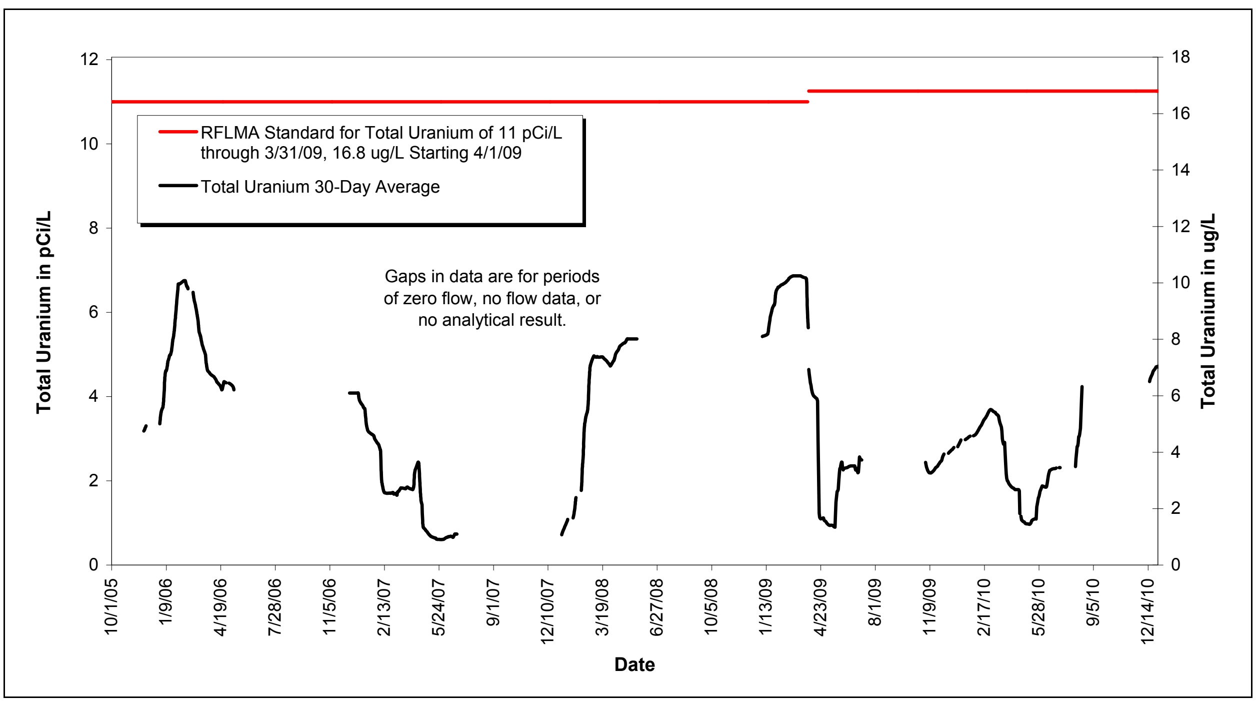

Figure 8. Volume-Weighted 30-Day Average Total U Concentrations at GS01: Post-Closure Period

Location GS03

Monitoring location GS03 is located on Walnut Creek at Indiana Street (Figure 4). The Walnut Creek headwaters, the majority of the COU, Pond A-4, and Pond B-5 contribute flow to GS03.

Table 6 shows that all of the annual average Pu and Am activities were well below 0.15 pCi/L. Additionally, the long-term Pu and Am averages (1997−2010) are well below 0.15 pCi/L. The average total U and nitrate+nitrite as N concentrations are all well below the RFLMA standard of 16.8 µg/L and 10 milligrams per liter (mg/L), respectively.

Table 6. Annual Volume-Weighted Average Radionuclide Activities and Nitrate+Nitrite as Nitrogen Concentrations at GS03 for 1997−2010

Calendar Year	Volume-Weighted Average			
	Am-241 (pCi/L)	Pu-239,240 (pCi/L)	Total U (µg/L)	Nitrate+Nitrite as N (mg/L)[a]
1997	0.014	0.026	NA	NA
1998	0.010	0.014	NA	NA
1999	0.009	0.015	NA	NA
2000	0.007	0.005	NA	NA
2001	0.005	0.009	NA	NA
2002	0.006	0.012	NA	NA
2003	0.005	0.006	2.38	NA
2004	0.008	0.008	2.44	NA
2005	0.022	0.008	5.68	NA (no pond discharge after 10/13/05)
2006	NA (no flow)	NA (no flow)	NA (no flow)	NA (no pond discharge)
2007	0.002	0.006	5.13	2.34
2008	NA (no flow)	NA (no flow)	NA (no flow)	NA (no pond discharge)
2009	0.003	0.004	4.29	0.34
2010	0.005	0.007	4.81	1.88
Total (1997−2010)	0.008	0.012	3.74	1.65

Notes: Collection of total U data began on November 5, 2002. NA = not applicable.
[a] For pond discharge periods only; nitrate+nitrite as nitrogen sampling began on October 13, 2005.

Figure 9, Figure 10, and Figure 11 show no occurrences of reportable 30-day averages for the year.

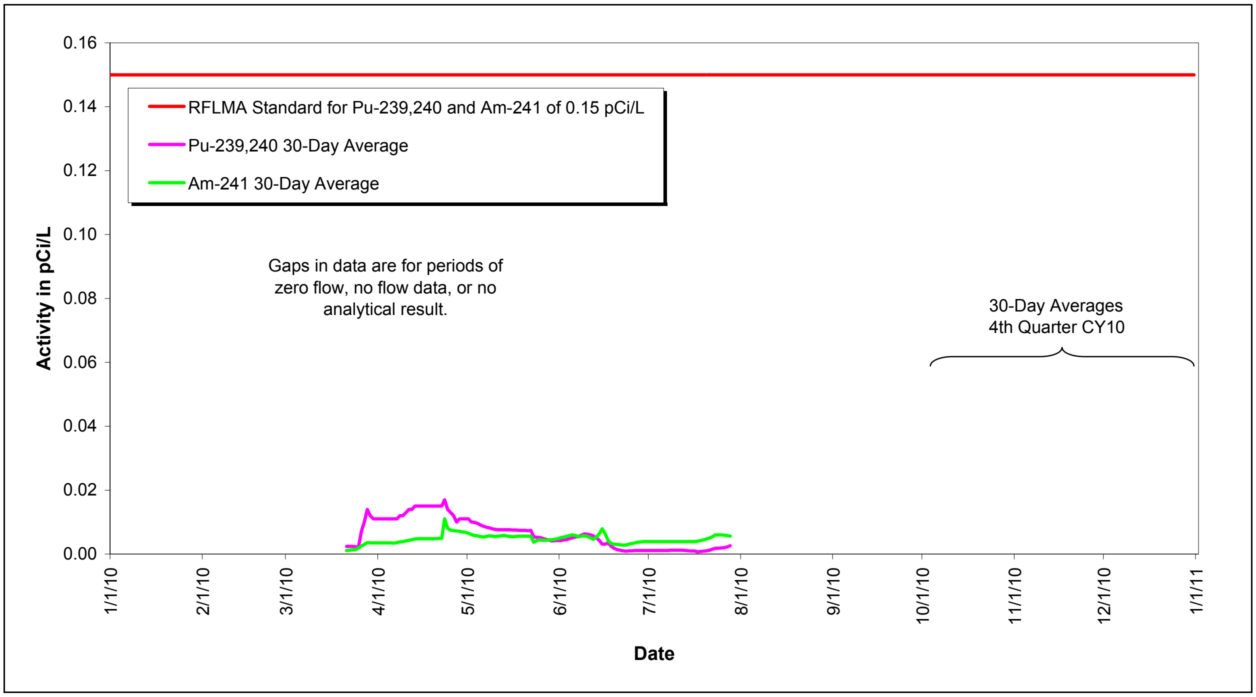

Figure 9. Volume-Weighted 30-Day Average Pu and Am Activities at GS03: Calendar Year Ending Fourth Quarter CY 2010

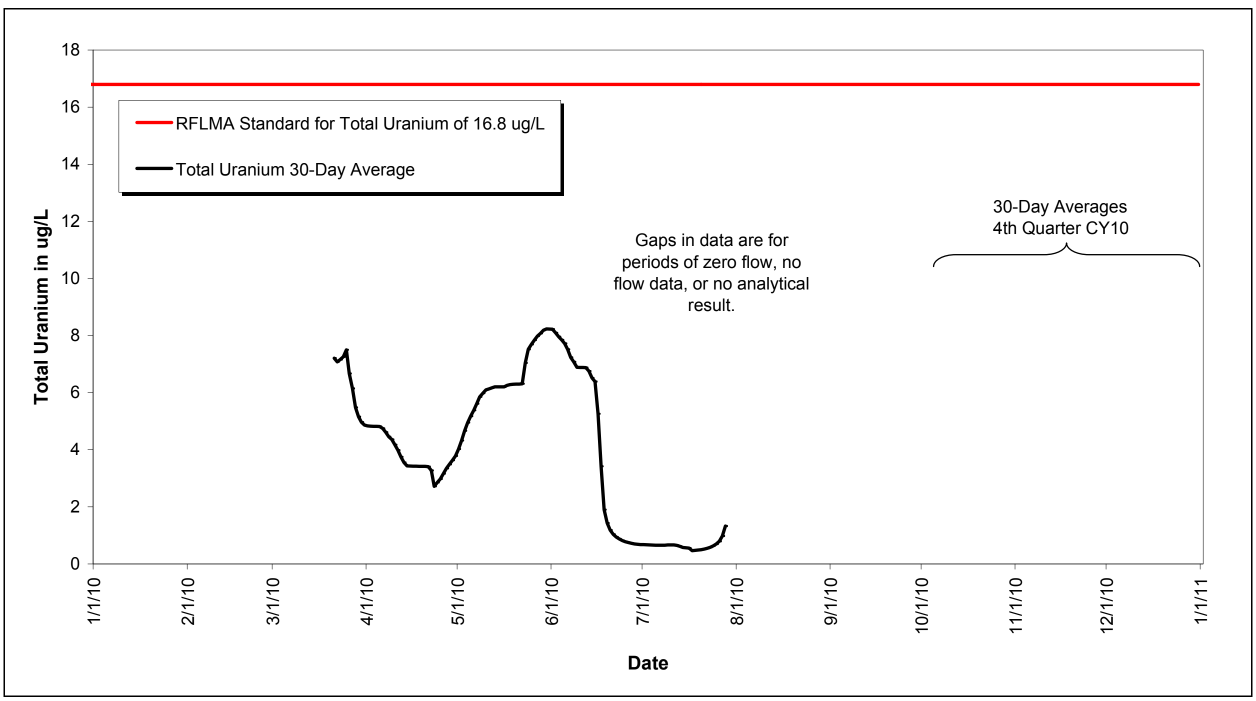

Figure 10. Volume-Weighted 30-Day Average Total U Concentrations at GS03: Calendar Year Ending Fourth Quarter CY 2010

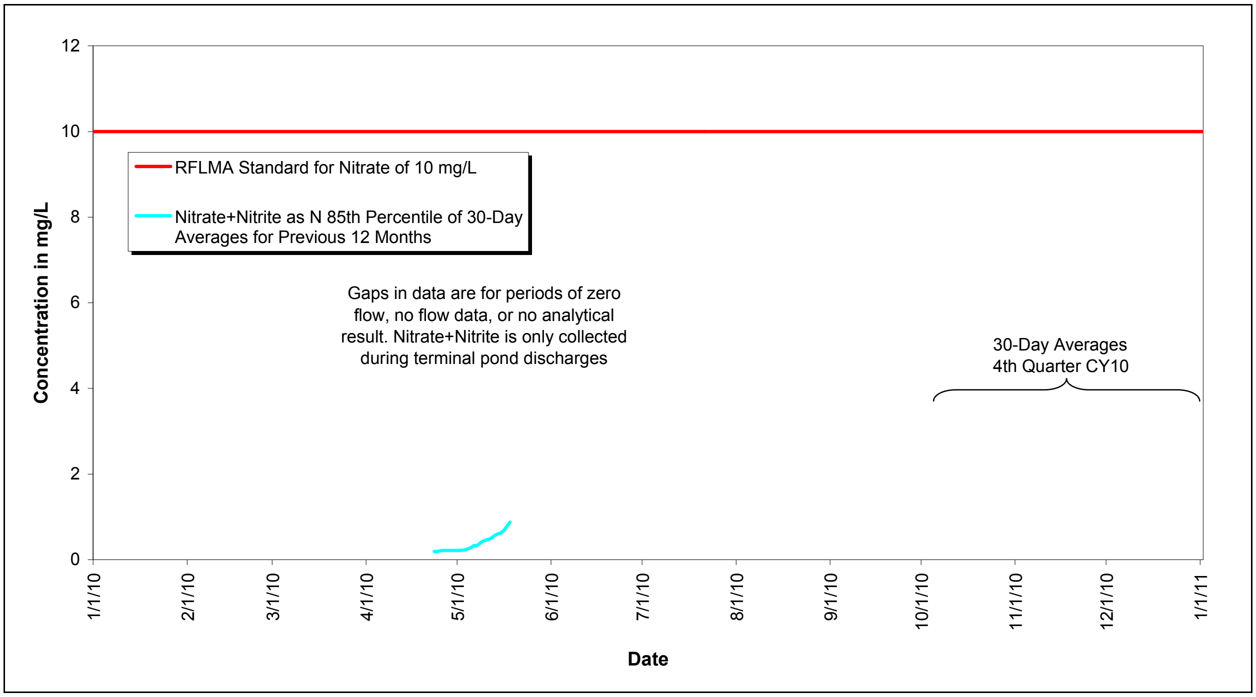

Figure 11. Volume-Weighted 30-Day Average Nitrate+Nitrite as N Concentrations at GS03: Calendar Year Ending Fourth Quarter CY 2010

Figure 12, Figure 13, and Figure 14 show similar data for the entire post-closure period.

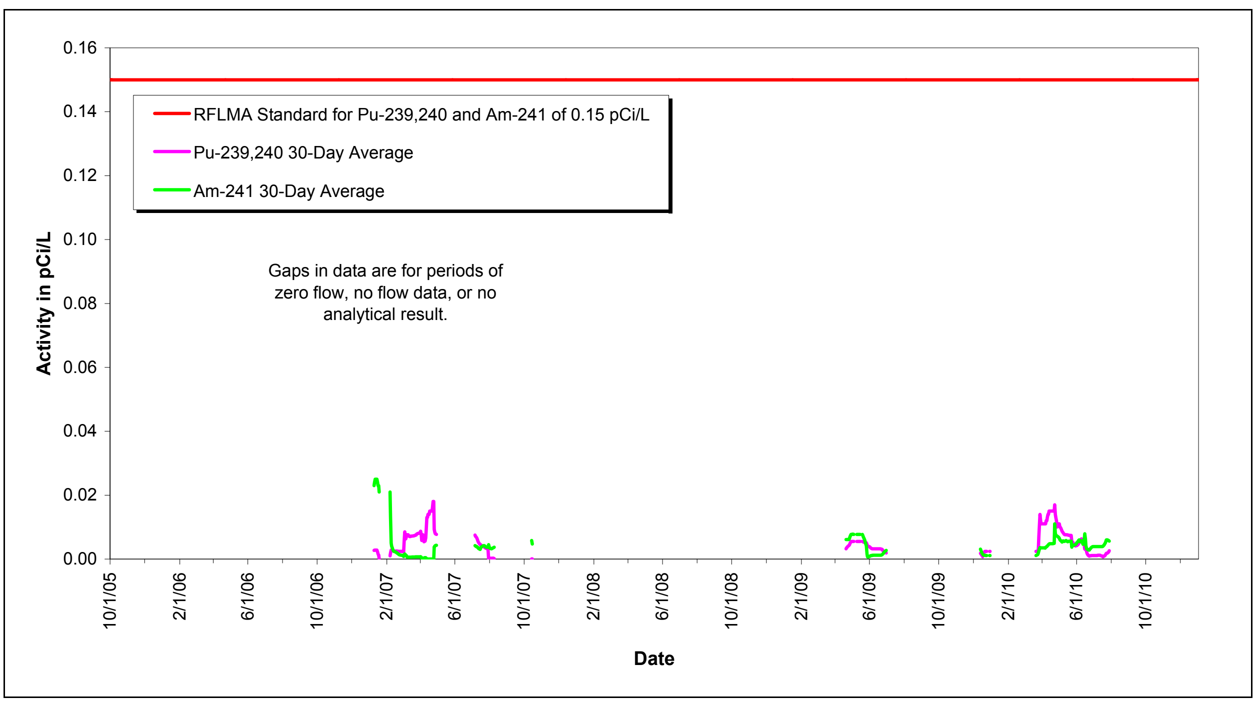

Figure 12. Volume-Weighted 30-Day Average Pu and Am Activities at GS03: Post-Closure Period

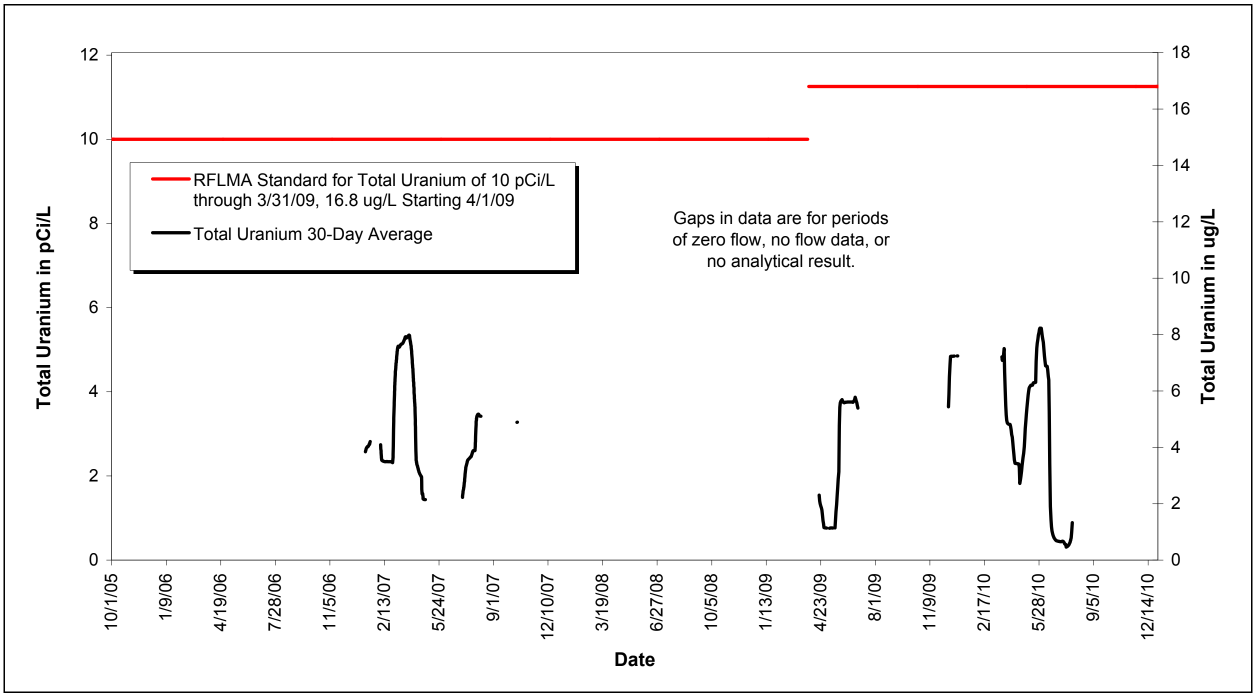

Figure 13. Volume-Weighted 30-Day Average Total U Concentrations at GS03: Post Closure-Period

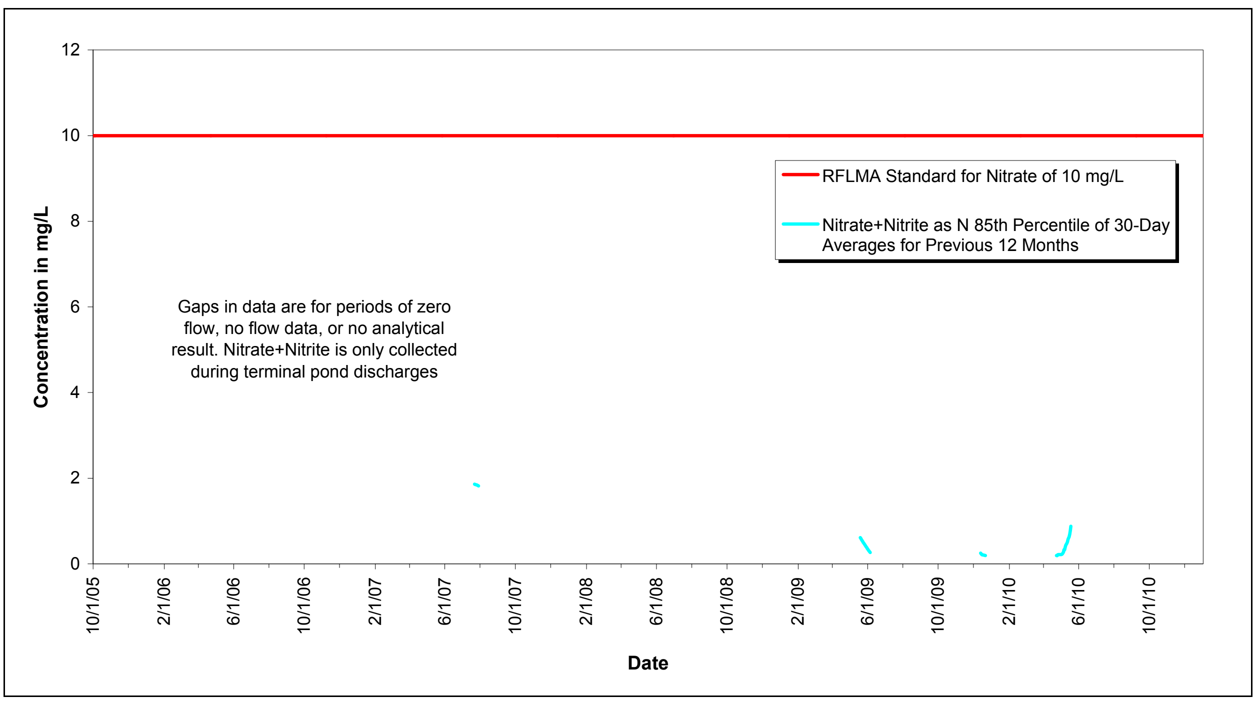

Figure 14. Volume-Weighted 30-Day Average Nitrate+Nitrite as N Concentrations at GS03: Post-Closure Period

Location GS08

Monitoring location GS08 is located on South Walnut Creek at the outlet of Pond B-5 (Figure 4). The central portion of the COU contributes flow to Pond B-5.

Table 7 shows that all of the annual average Pu and Am activities were well below 0.15 pCi/L. Additionally, the long-term Pu and Am averages (1997−2010) are well below 0.15 pCi/L. The average total U concentrations have shown recent increases due to contributions from GS10 (see Section 3.1.2.2) but are all still below the RFLMA standard of 16.8 µg/L. Nitrate+nitrite as N concentrations are well below 10 mg/L.

Table 7. Annual Volume-Weighted Average Radionuclide Activities and Nitrate+Nitrite as Nitrogen Concentrations at GS08 for 1997−2010

Calendar Year	Volume-Weighted Average			
	Am-241 (pCi/L)	**Pu-239,240 (pCi/L)**	**Total U (µg/L)**	**Nitrate+Nitrite as N (mg/L)[a]**
1997	0.008	0.006	2.42	NA
1998	0.006	0.008	3.30	NA
1999	0.015	0.046	2.00	NA
2000	0.029	0.047	1.26	NA
2001	0.004	0.006	1.73	NA
2002	0.003	0.002	0.96	NA
2003	0.006	0.026	1.97	NA
2004	0.009	0.009	1.80	NA
2005	0.021	0.008	8.76	NA (no pond discharge after 10/13/05)
2006	NA (no discharge)	NA (no discharge)	NA (no discharge)	NA (no discharge)
2007	0.002	0.003	12.0	0.38
2008	NA (no discharge)	NA (no discharge)	NA (no discharge)	NA (no discharge)
2009	0.001	0.004	6.74	0.01
2010	0.005	0.005	9.46	0.16
Total (1997−2010)	0.011	0.021	2.73	0.17

Notes: NA = not applicable.
[a] Nitrate+nitrite as nitrogen sampling began on October 13, 2005.

Figure 15, Figure 16, and Figure 17 show no occurrences of reportable 12-month rolling averages for the year.

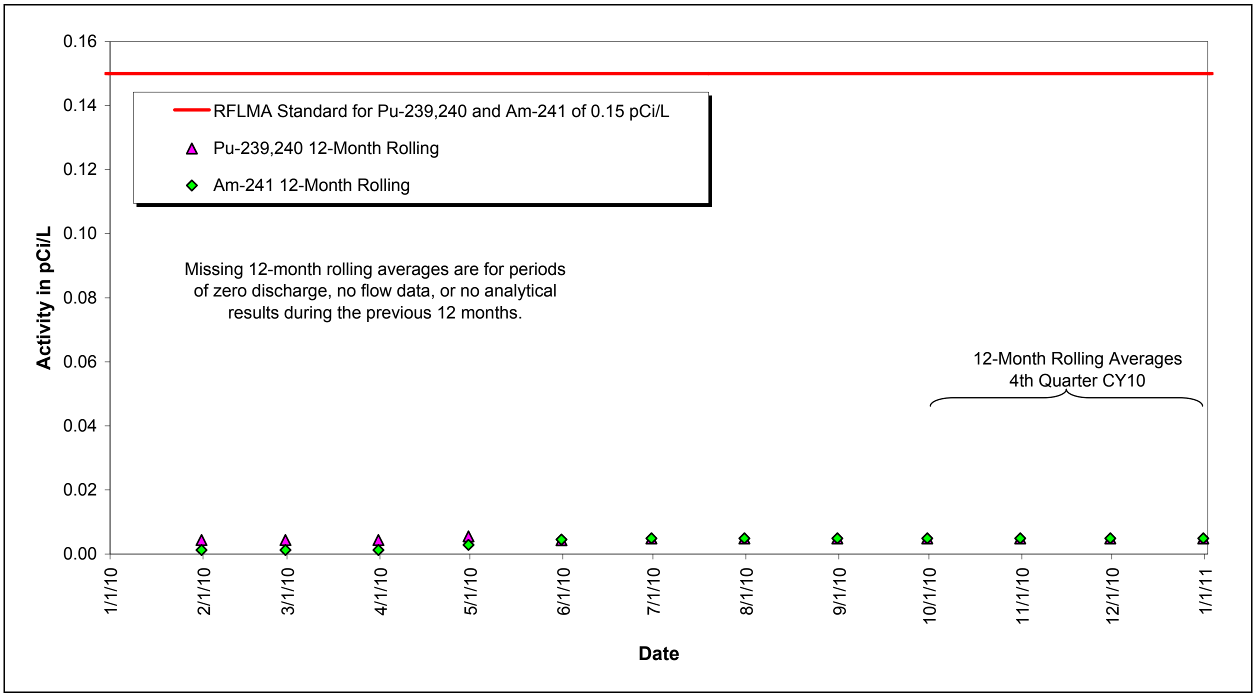

Figure 15. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at GS08: Calendar Year Ending Fourth Quarter CY 2010

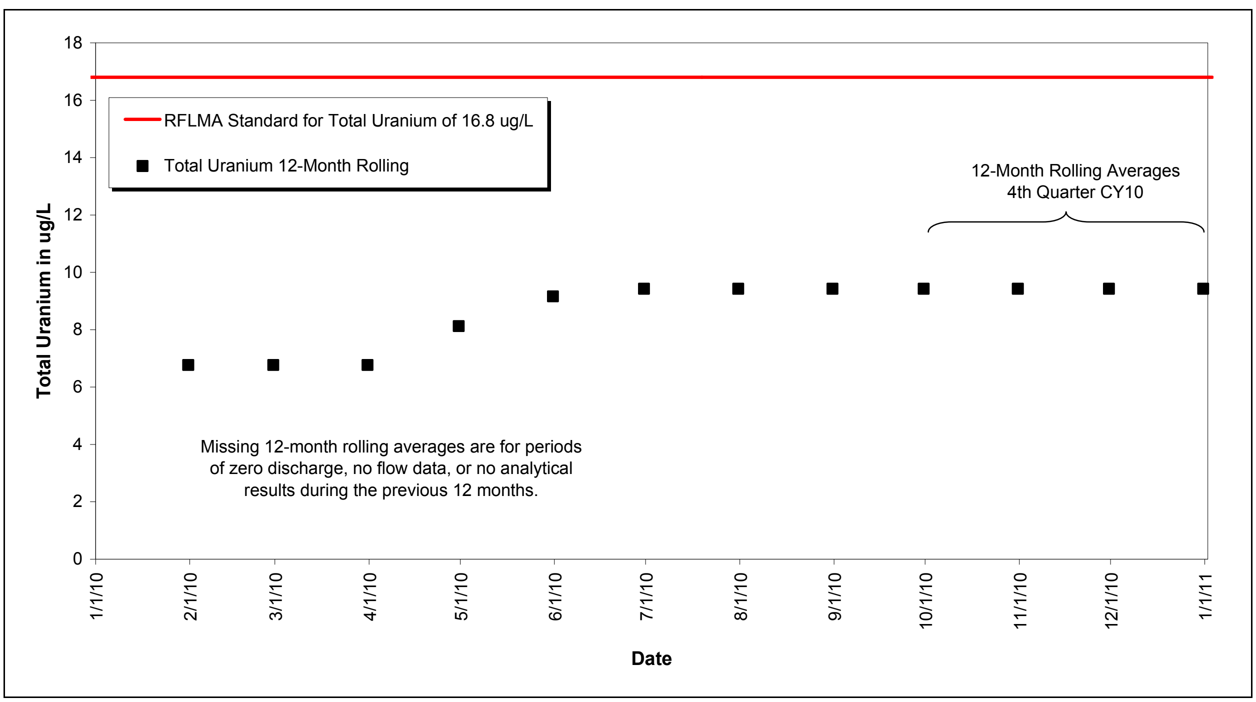

Figure 16. Volume-Weighted 12-Month Rolling Average Total U Concentrations at GS08: Calendar Year Ending Fourth Quarter CY 2010

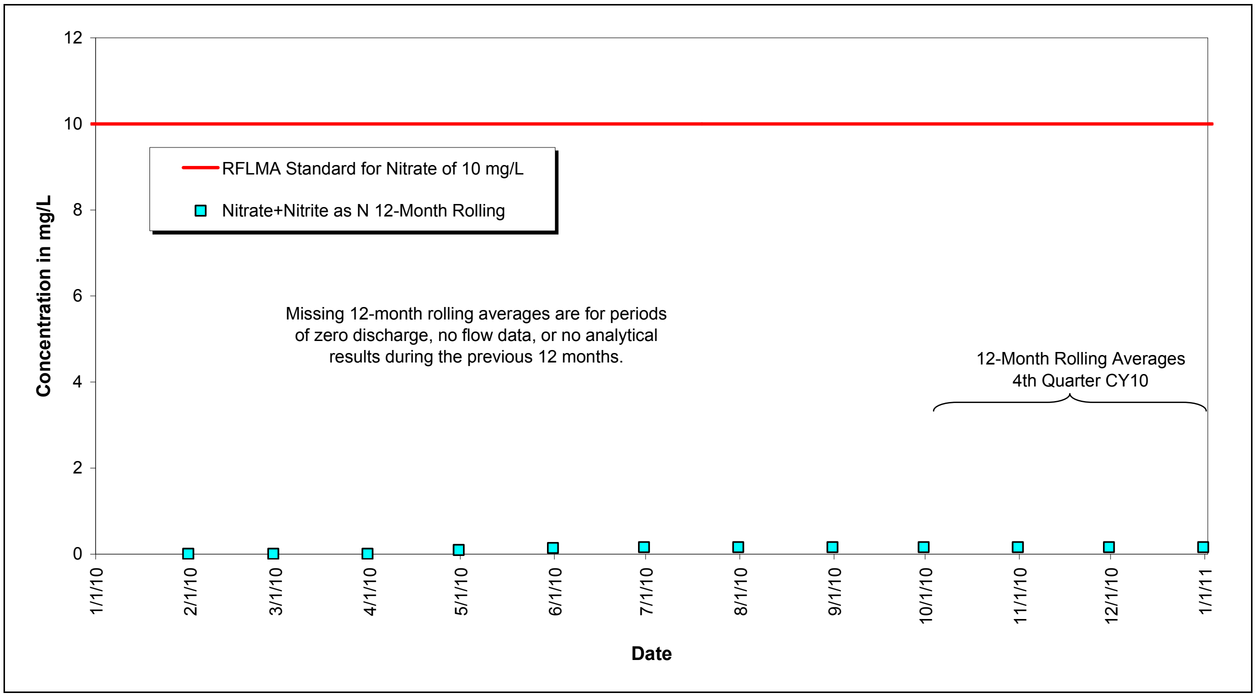

Figure 17. Volume-Weighted 12-Month Rolling Average Nitrate+Nitrite as N Concentrations at GS08: Calendar Year Ending Fourth Quarter CY 2010

Figure 18, Figure 19, and Figure 20 show similar data for the entire post-closure period.

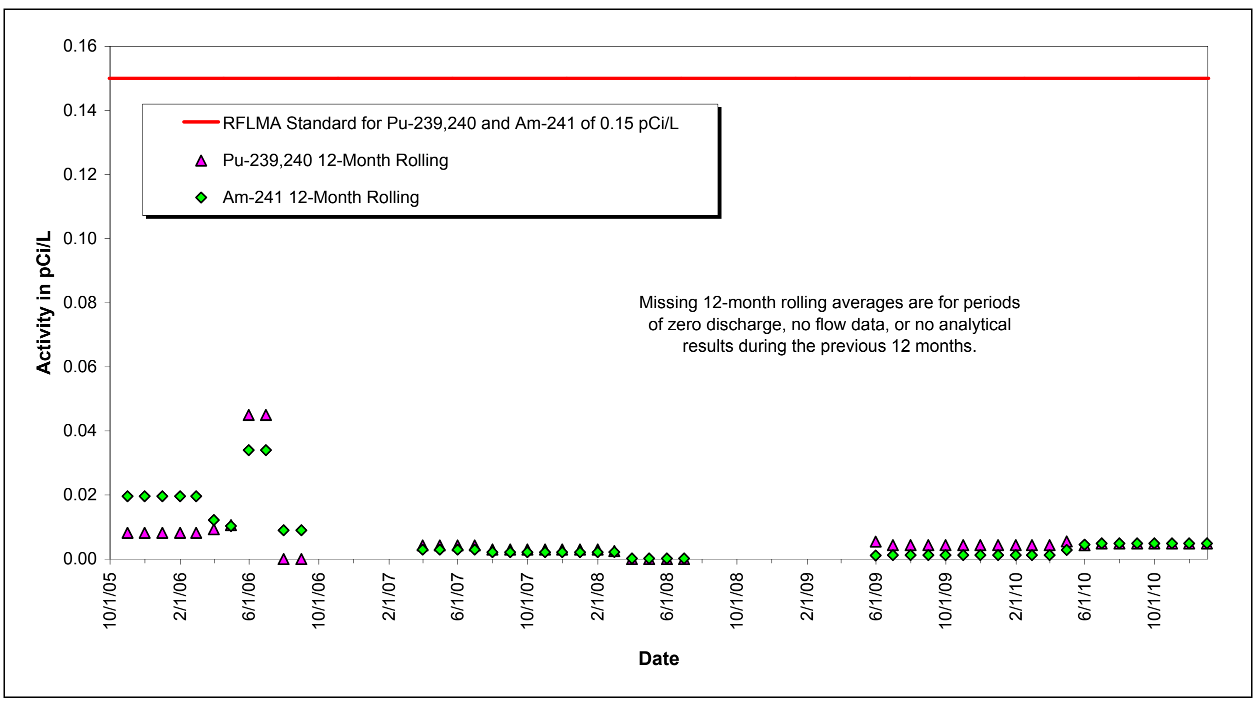

Figure 18. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at GS08: Post-Closure Period

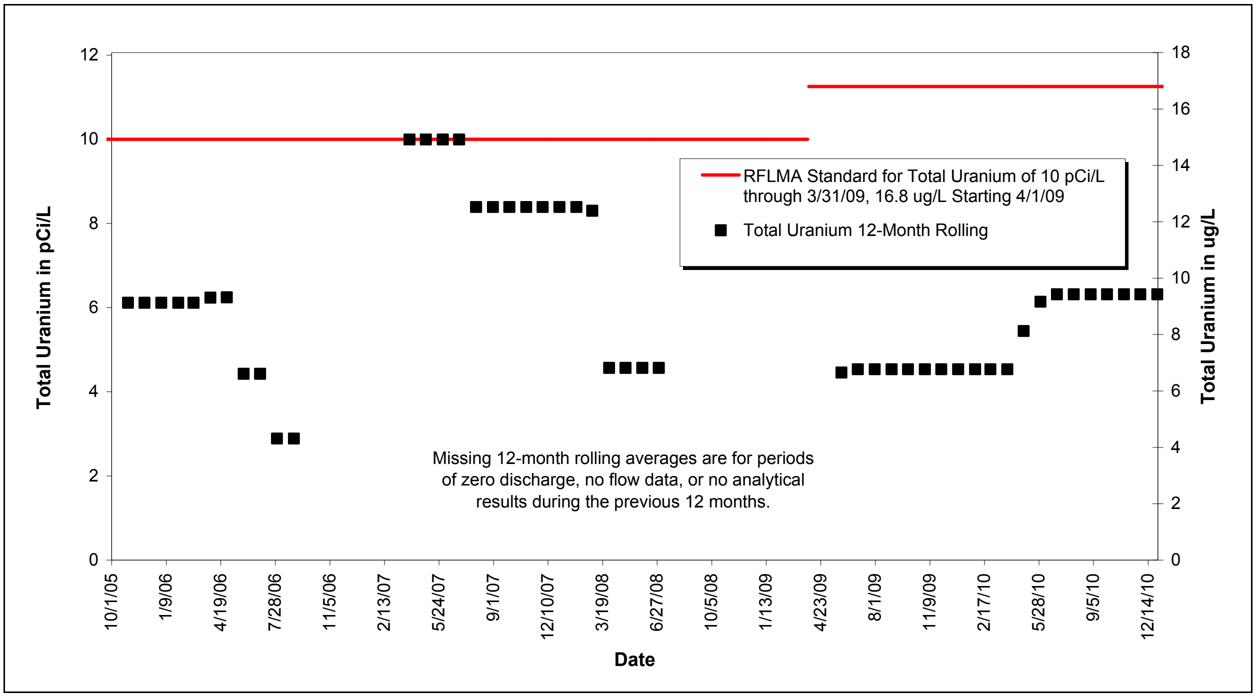

Figure 19. Volume-Weighted 12-Month Rolling Average Total U Concentrations at GS08: Post-Closure Period

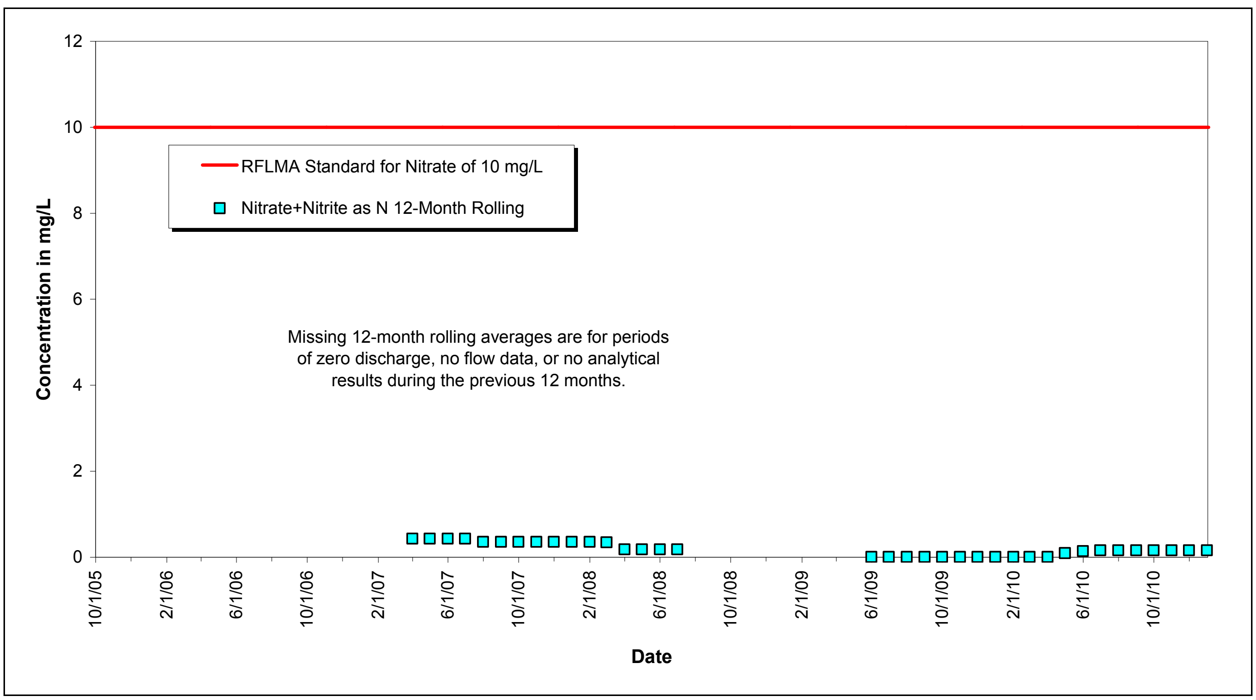

Figure 20. Volume-Weighted 12-Month Rolling Average Nitrate+Nitrite as N Concentrations at GS08: Post-Closure Period

Location GS11

Monitoring location GS11 is located on North Walnut Creek at the outlet of Pond A-4 (Figure 4). The northern portion of the COU contributes flow to Pond A-4.

Table 8 shows that all of the annual average Pu and Am activities were well below 0.15 pCi/L. Additionally, the long-term Pu and Am averages (1997−2010) are well below 0.15 pCi/L. The average total U and nitrate+nitrite as N concentrations are all below the RFLMA standard of 16.8 µg/L and 10 mg/L, respectively.

Table 8. Annual Volume-Weighted Average Radionuclide Activities and Nitrate+Nitrite as Nitrogen Concentrations at GS11 for 1997−2010

Calendar Year	**Volume-Weighted Average Activity (pCi/L)**			
	Am-241 (pCi/L)	**Pu-239,240 (pCi/L)**	**Total U (µg/L)**	**Nitrate+Nitrite as N (mg/L)[a]**
1997	0.005	0.008	2.70	NA
1998	0.011	0.004	3.23	NA
1999	0.003	0.007	2.60	NA
2000	0.001	0.018	3.51	NA
2001	0.003	0.002	4.14	NA
2002	0.003	0.000	3.29	NA
2003	0.003	0.002	3.98	NA
2004	0.006	0.002	3.63	NA
2005	0.022	0.002	2.43	NA (no pond discharge after 10/13/05)
2006	NA (no discharge)	NA (no discharge)	NA (no discharge)	NA (no discharge)
2007	0.001	0.007	5.25	3.02
2008	NA (no discharge)	NA (no discharge)	NA (no discharge)	NA (no discharge)
2009	0.005	0.003	6.58	0.68
2010	0.004	0.004	9.76	4.70
Total (1997−2010)	0.006	0.006	3.73	3.26

Notes: NA = not applicable.
[a] Nitrate+nitrite as nitrogen sampling began on October 13, 2005.

Figure 21, Figure 22, and Figure 23 show no occurrences of reportable 12-month rolling averages for the year.

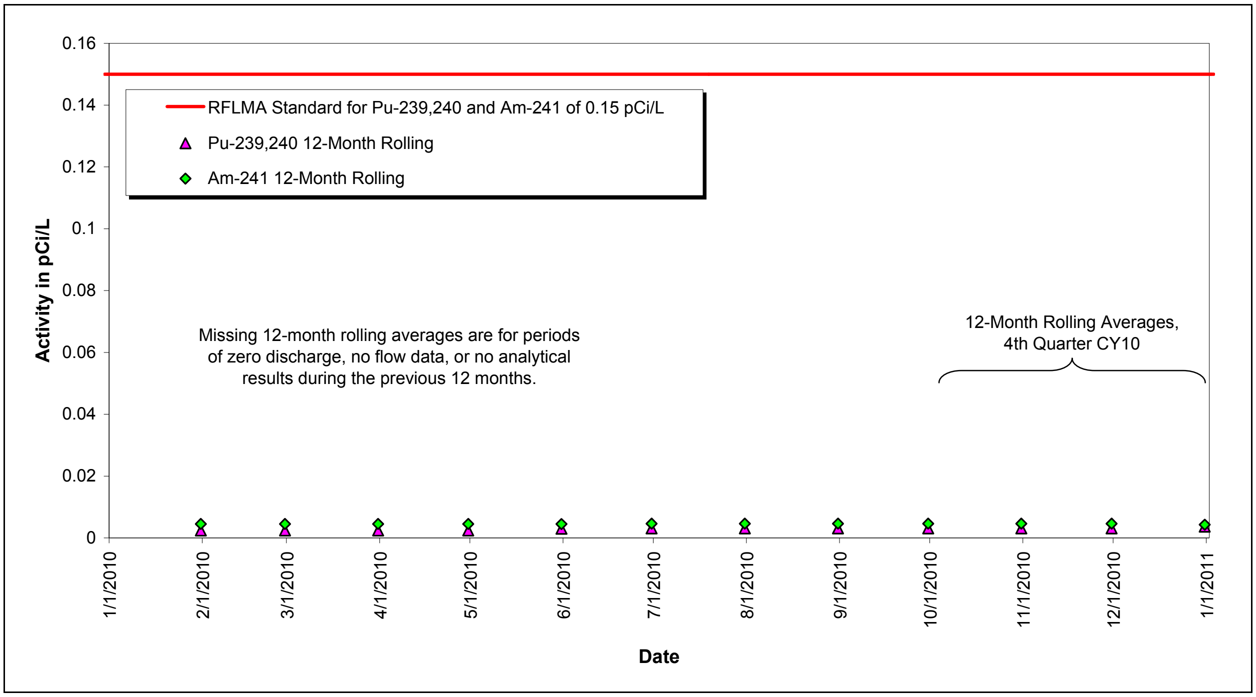

Figure 21. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at GS11: Calendar Year Ending Fourth Quarter CY 2010

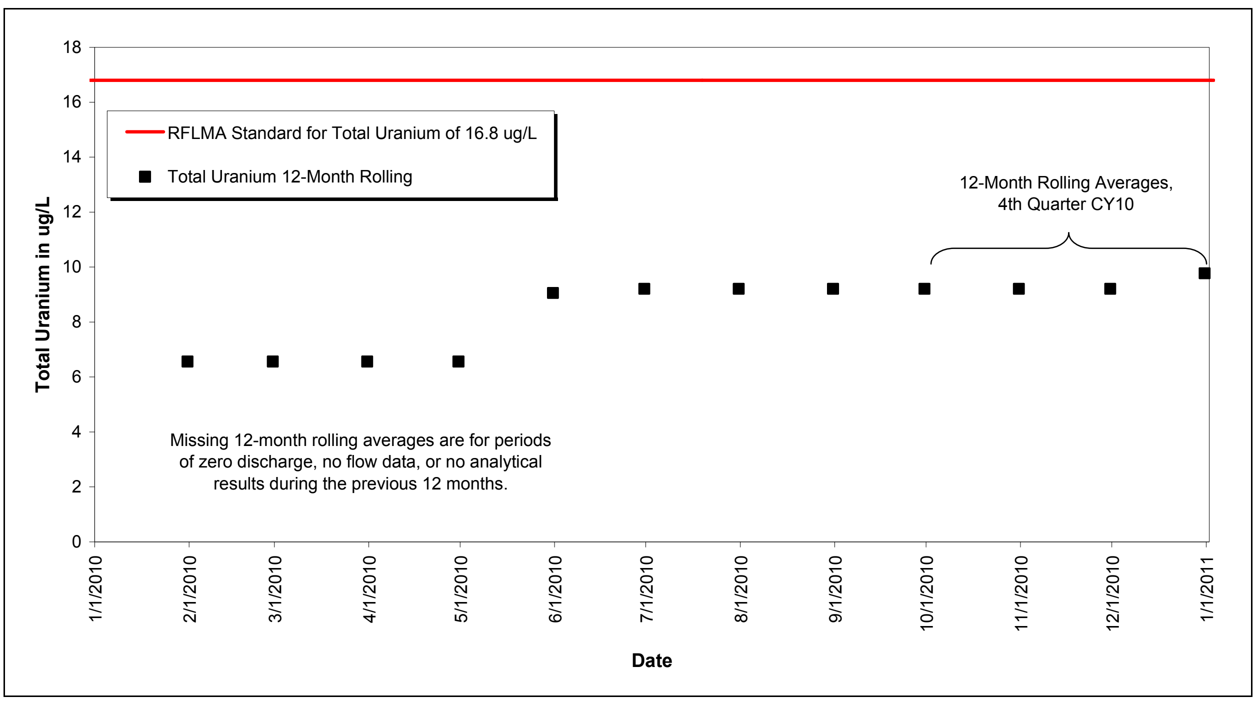

Figure 22. Volume-Weighted 12-Month Rolling Average Total U Concentrations at GS11: Calendar Year Ending Fourth Quarter CY 2010

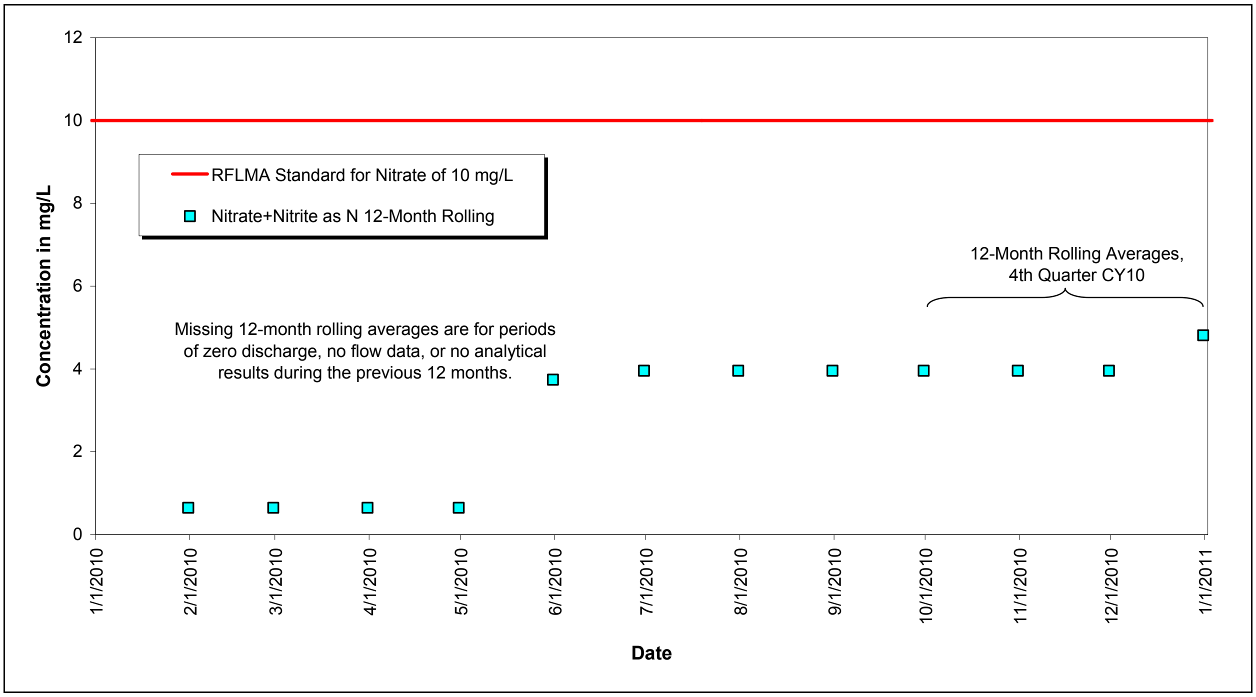

Figure 23. Volume-Weighted 12-Month Rolling Average Nitrate+Nitrite as N Concentrations at GS11: Calendar Year Ending Fourth Quarter CY 2010

Figure 24, Figure 25, and Figure 26 show similar data for the entire post-closure period.

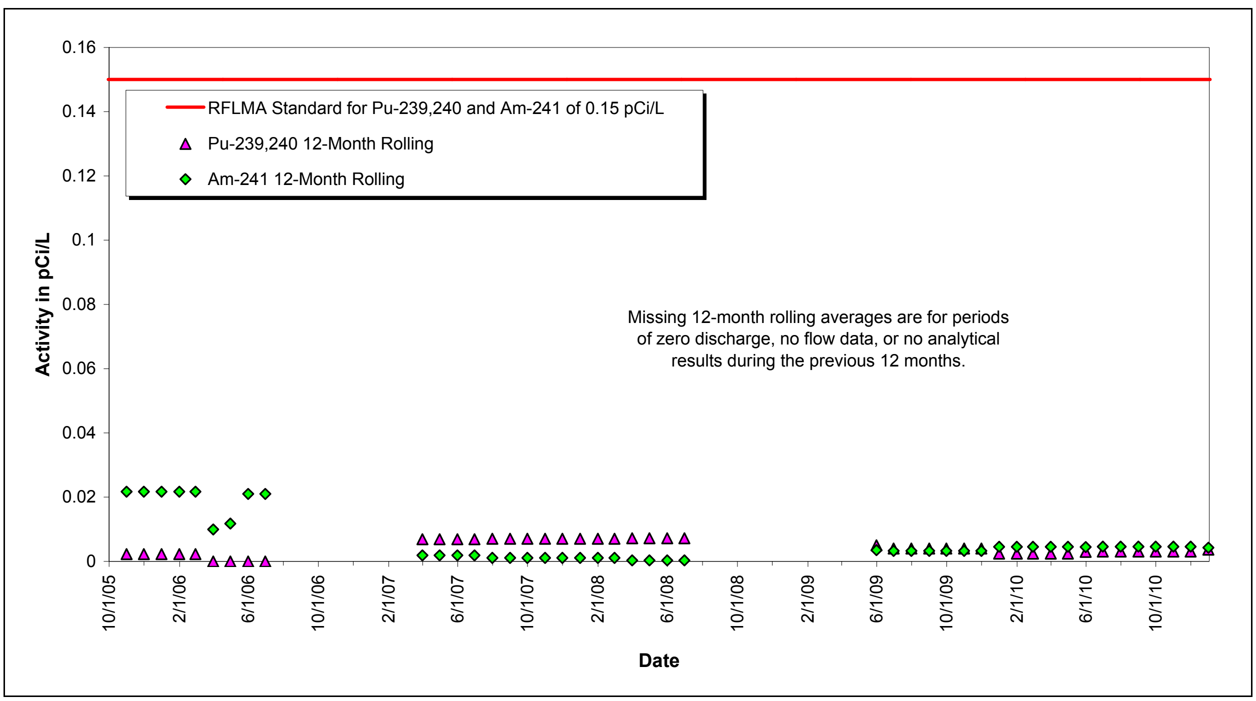

Figure 24. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at GS11: Post-Closure Period

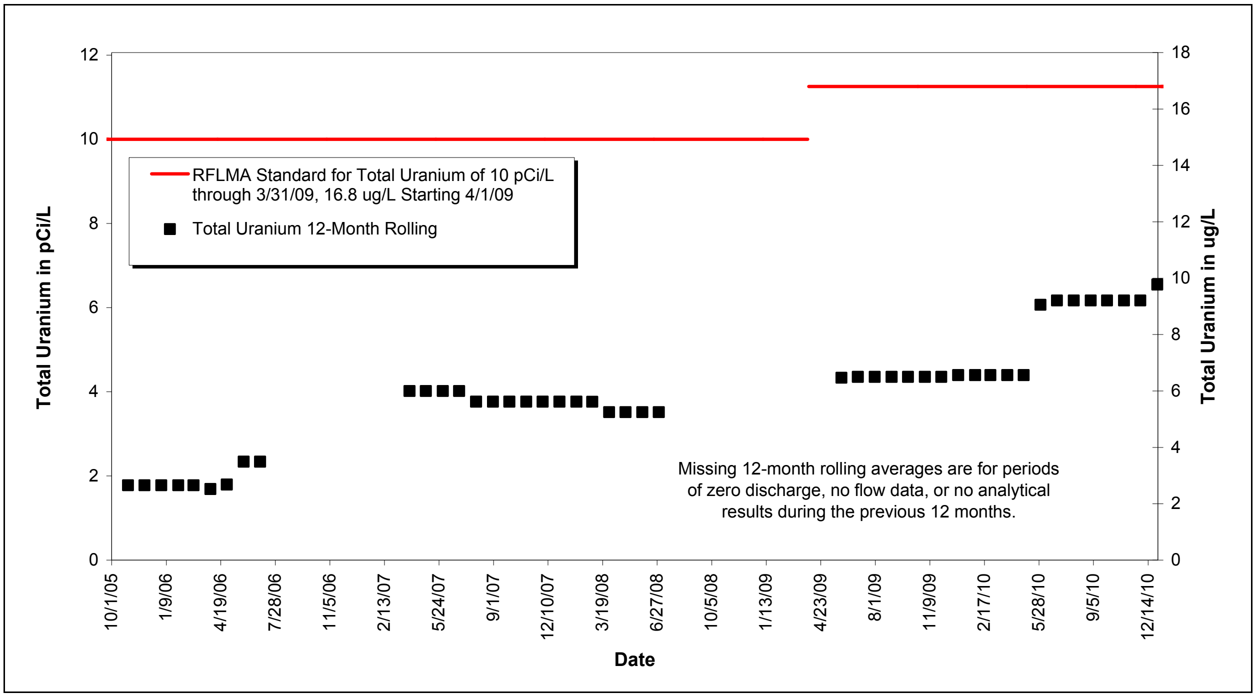

Figure 25. Volume-Weighted 12-Month Rolling Average Total U Concentrations at GS11: Post-Closure Period

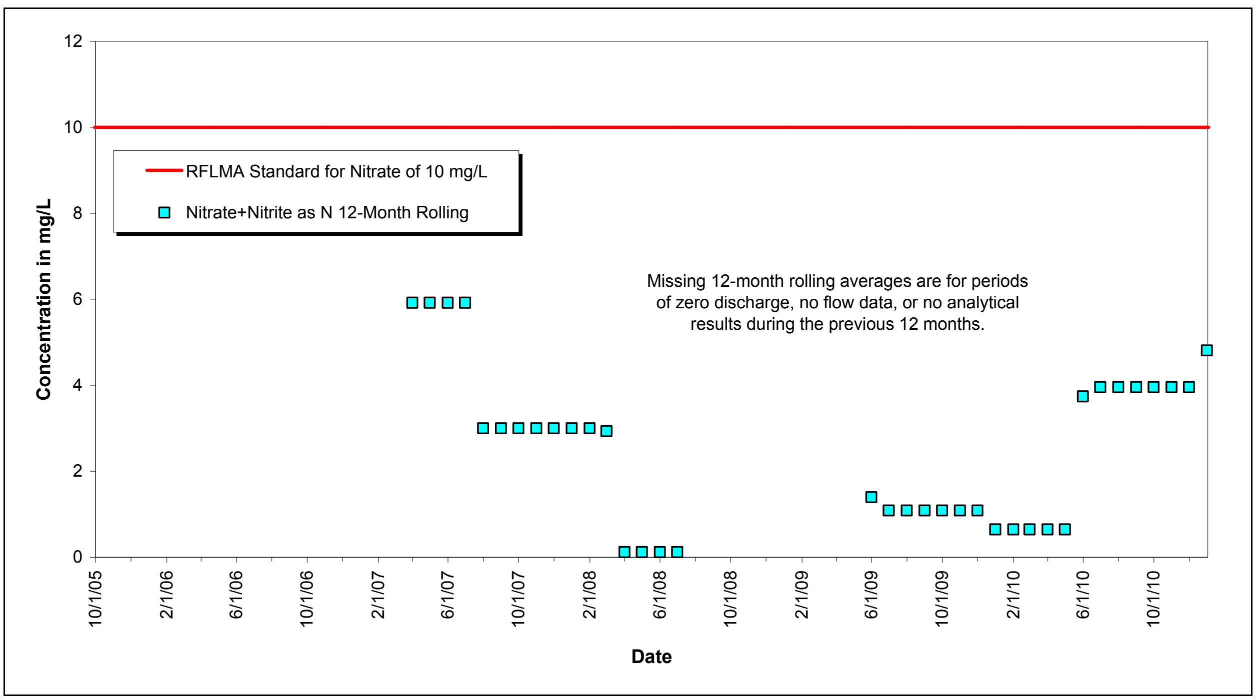

Figure 26. Volume-Weighted 12-Month Rolling Average Nitrate+Nitrite as N Concentrations at GS11: Post-Closure Period

Location GS31

Monitoring location GS31 is located on Woman Creek at the outlet of Pond C-2 (Figure 4). The southern portion of the COU contributes flow to Pond C-2.

Table 9 shows that the annual and long-term (1997–2010) average Pu and Am activities were all below 0.15 pCi/L. Additionally, the annual and long-term total U concentrations were all below the RFLMA standard of 16.8 µg/L.

Table 9. Annual Volume-Weighted Average Radionuclide Activities at GS31 for 1997−2010

Calendar Year	Volume-Weighted Average Activity		
	Am-241 (pCi/L)	**Pu-239,240 (pCi/L)**	**Total U (µg/L)**
1997	0.008	0.017	3.32
1998	0.018	0.003	4.31
1999	0.010	0.043	4.22
2000	No C-2 discharge	No C-2 discharge	No C-2 discharge
2001	0.013	0.021	1.84
2002	0.015	0.089	3.54
2003	0.006	0.015	2.43
2004	0.010	0.021	2.36
2005	0.008	0.020	6.27
2006	No C-2 discharge	No C-2 discharge	No C-2 discharge
2007	No C-2 discharge	No C-2 discharge	No C-2 discharge
2008	No C-2 discharge	No C-2 discharge	No C-2 discharge
2009	0.006	0.016	5.17
2010	0.002	0.001	2.33
Total (1997−2010)	0.010	0.018	3.36

Figure 27 and Figure 28 show no occurrences of reportable 12-month rolling averages for the year.

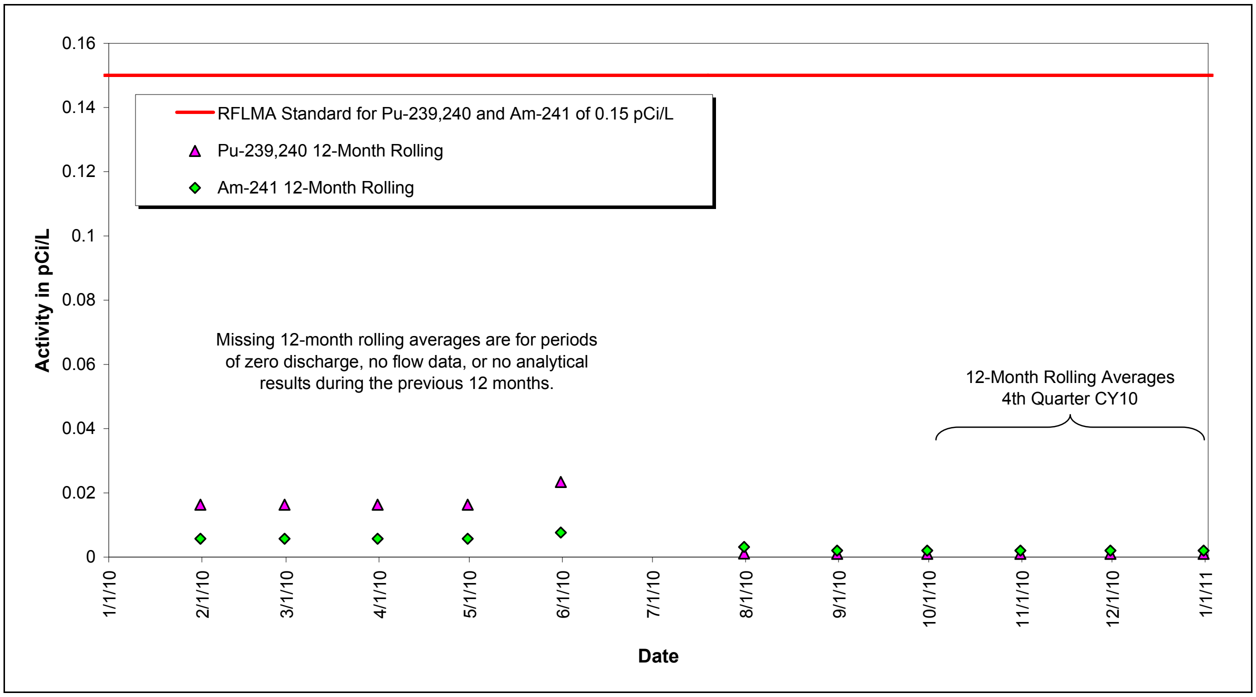

Figure 27. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at GS31: Calendar Year Ending Fourth Quarter CY 2010

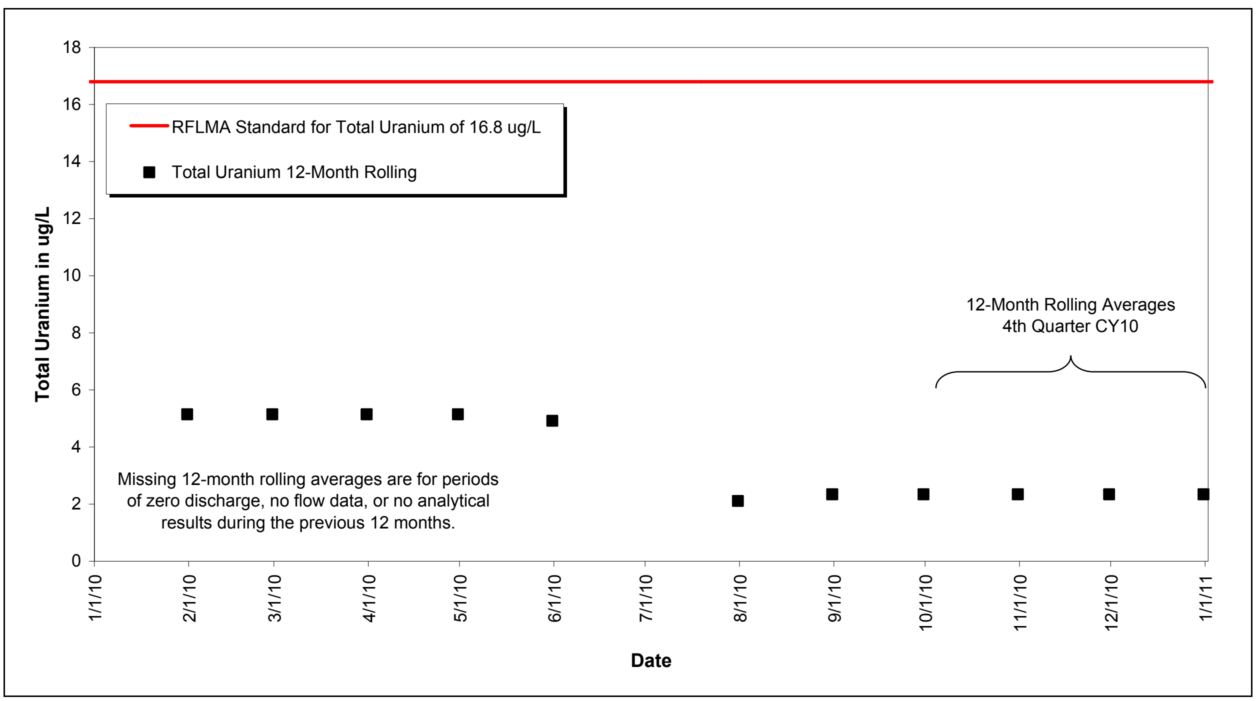

Figure 28. Volume-Weighted 12-Month Rolling Average Total U Concentrations at GS31: Calendar Year Ending Fourth Quarter CY 2010

Figure 29 and Figure 30 show similar data for the entire post-closure period.

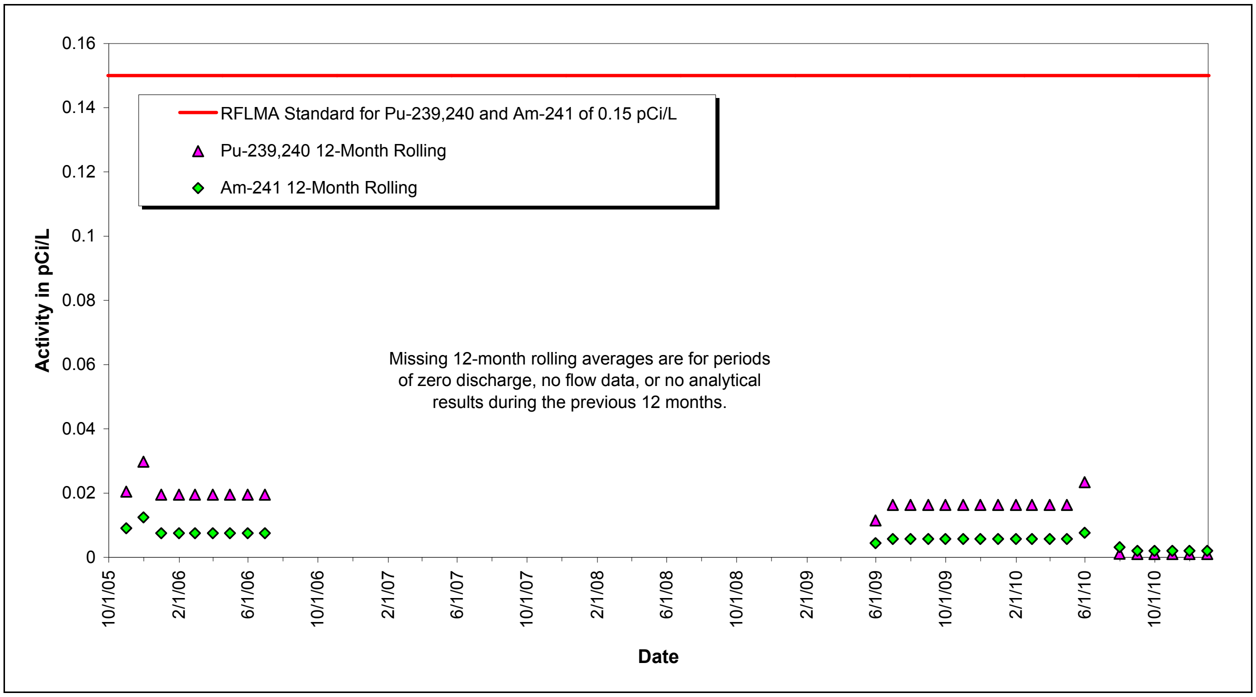

Figure 29. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at GS31: Post-Closure Period

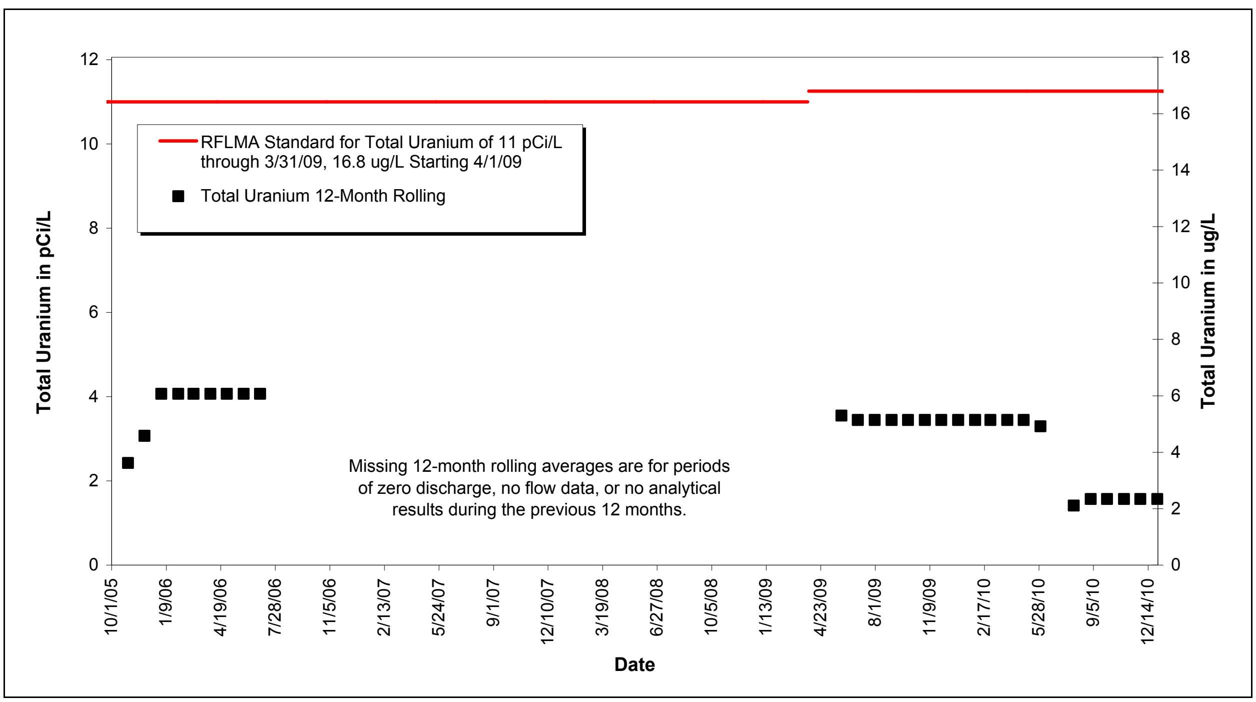

Figure 30. Volume-Weighted 12-Month Rolling Average Total U Concentrations at GS31: Post-Closure Period

3.1.2.2 POE Monitoring

This objective deals with monitoring runoff and baseflow from the interior of the COU to the A-, B-, and C-series ponds to demonstrate compliance with surface-water-quality standards (see Table 1 of RFLMA Attachment 2). Water quality data are reportable under RFLMA when the applicable compliance parameters are greater than the corresponding Table 1 values (see Appendix D). Surface water is monitored by POEs SW093, GS10, and SW027 on North Walnut Creek, South Walnut Creek, and the SID, respectively. These locations are shown on Figure 31. Sampling and data evaluation protocols are summarized in Table 10.

Table 10. Sampling and Data Evaluation Protocols at POEs

Location Code	Location Description	Sample Types/Frequencies	Analytes	Data Evaluation
GS10	South Walnut Creek at Outfall of FC-4	Continuous flow-paced composites; frequency varies (target is 14 per year)[a]	Total hardness, Be, Cr, Pu, Am, and U; dissolved Ag and Cd; [TSS[b]]	See Figure 6 in Appendix D
SW027	SID at Pond C-2	Continuous flow-paced composites; frequency varies (target is 20 per year)[a]	Total hardness, Be, Cr, Pu, Am, and U; dissolved Ag and Cd; [TSS[b]]	See Figure 6 in Appendix D
SW093	North Walnut Creek at Outfall of FC-3	Continuous flow-paced composites; frequency varies (target is 20 per year)[a]	Total hardness, Be, Cr, Pu, Am, and U; dissolved Ag and Cd; [TSS[b]]	See Figure 6 in Appendix D

Notes: [a] Frequency depends on available flow.
[b] Total suspended solids (TSS) is analyzed when the composite sampling period is within TSS holding-time limits.
Ag = silver
Be = beryllium
Cd = cadmium
Cr = chromium
FC = Functional Channel

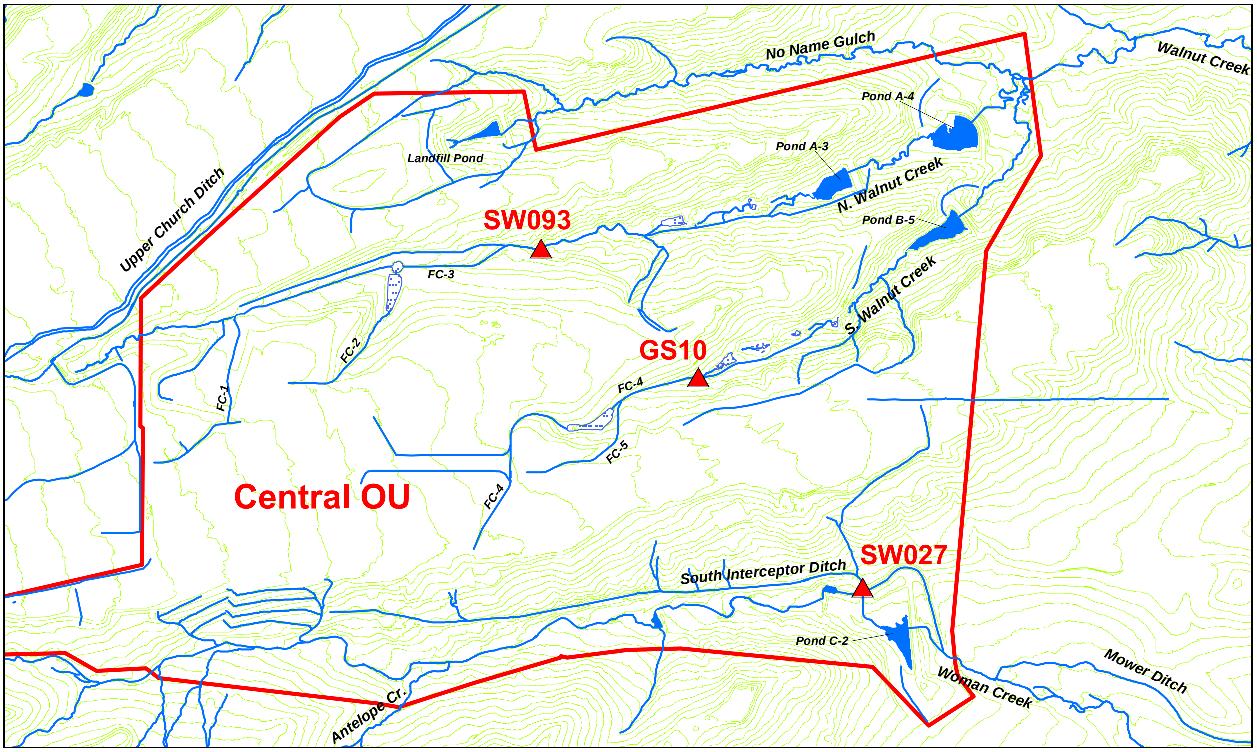

Figure 31. POE Monitoring Locations

The following sections include summary tables and plots showing the applicable 30-day and 12-month rolling averages for the POE analytes. The evaluations include all results that were not rejected through the data verification and validation process. Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations, activities, and analytical errors are often greater than the precision presented. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the "real" and "duplicate" values. When a sample has multiple "real" analyses (Site-requested "reruns"), the value used in calculations is the arithmetic average of the multiple "real" analyses.[5]

Refer to Appendix B, which contains the water-quality data, for further information.

Location GS10

Monitoring location GS10 is located on South Walnut Creek just upstream of the B-series ponds (Figure 31). The central portion of the COU contributes flow to GS10 through Functional Channel 4 (FC-4) and FC-5.

[5] Significant differences in values for a data pair are an indication of potential problems with sample preparation or analysis. Under these circumstances, an applicable value to be used for comparison cannot be determined with sufficient confidence to make compliance decisions. Therefore, an evaluation of the DER or RPD, depending on the analyte, is required to assess the representativeness of the sample and its usability for compliance decisions (see Section 8.2.3 of the RFSOG for discussion).

Table 11 shows that many of the annual average Pu and Am activities at GS10 were greater than 0.15 pCi/L during active Site closure. However, a significant reduction in both Pu and Am activities continues to be observed following Site closure. With the completion of the FCs, implementation of enhanced erosion controls, revegetation, soil stabilization, and lack of substantial runoff, transport of Pu and Am has been virtually eliminated.

Table 11. Annual Volume-Weighted Average Radionuclide Activities at GS10 for 1997−2010

Calendar Year	Volume-Weighted Average		
	Am-241 (pCi/L)	**Pu-239,240 (pCi/L)**	**Total U (µg/L)**
1997	0.266	0.260	4.05
1998	0.109	0.158	4.28
1999	0.274	0.139	3.76
2000	0.421	0.195	3.20
2001	0.075	0.080	4.14
2002	0.087	0.061	4.03
2003	0.117	0.113	3.86
2004	0.136	0.314	3.64
2005	0.185	0.238	11.95
2006	0.010	0.014	19.31
2007	0.010	0.020	16.54
2008	0.025	0.020	22.87
2009	0.009	0.019	13.36
2010	0.007	0.012	14.38
Total (1997−2010)	0.163	0.150	6.19

Surface-water data from GS10 show higher post-closure U concentrations. The higher concentrations are generally associated with lower flow rates during periods of extended baseflow sustained by groundwater contributions. Groundwater data within South Walnut Creek show naturally occurring U concentrations considerably higher than the surface-water standard. Baseflow at GS10 is sustained by groundwater expressions in the form of both localized seeps and distributed flow to the streambed. As the amount of impervious surface at the Site was reduced, direct runoff to GS10 was also reduced. Similarly, removal of Site infrastructure likely resulted in reduced baseflow contributions from domestic and sanitary water leakage. Therefore, groundwater contributions to South Walnut Creek now make up a larger portion of the flows monitored at GS10. Without the attenuation of U groundwater sources by direct runoff and infrastructure leakage, increases in surface-water U concentrations would be expected.

Figure 32 and Figure 33 show no reportable Pu, Am, or U values during the year.

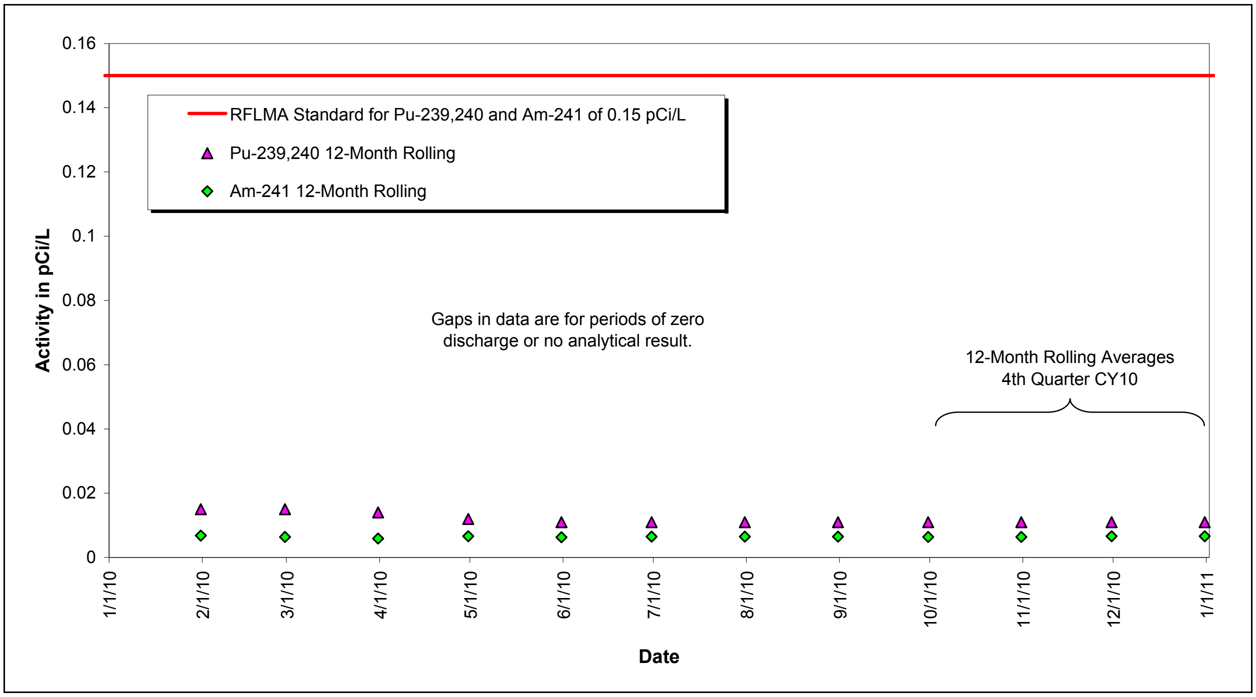

Figure 32. Volume-Weighted Average Pu and Am Compliance Values at GS10: Calendar Year Ending Fourth Quarter CY 2010

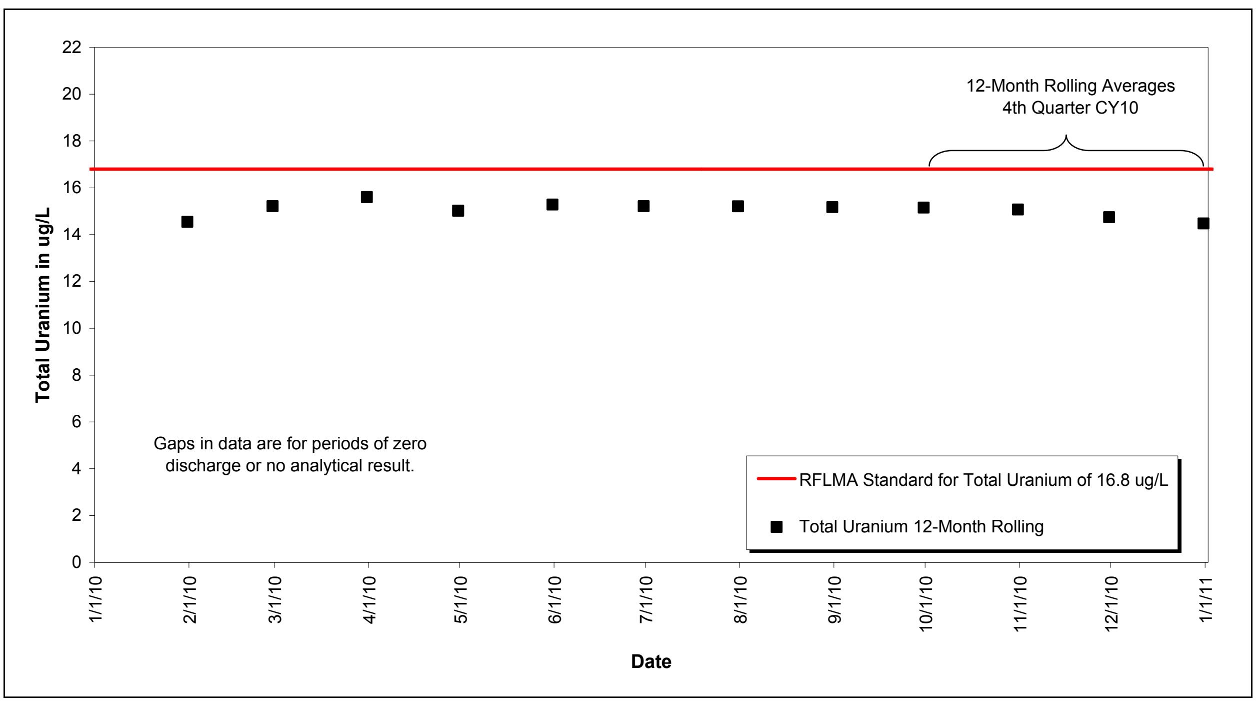

Figure 33. Volume-Weighted Average Total U Compliance Values at GS10: Calendar Year Ending Fourth Quarter CY 2010

Figure 34 and Figure 35 show similar data for the entire post-closure period.

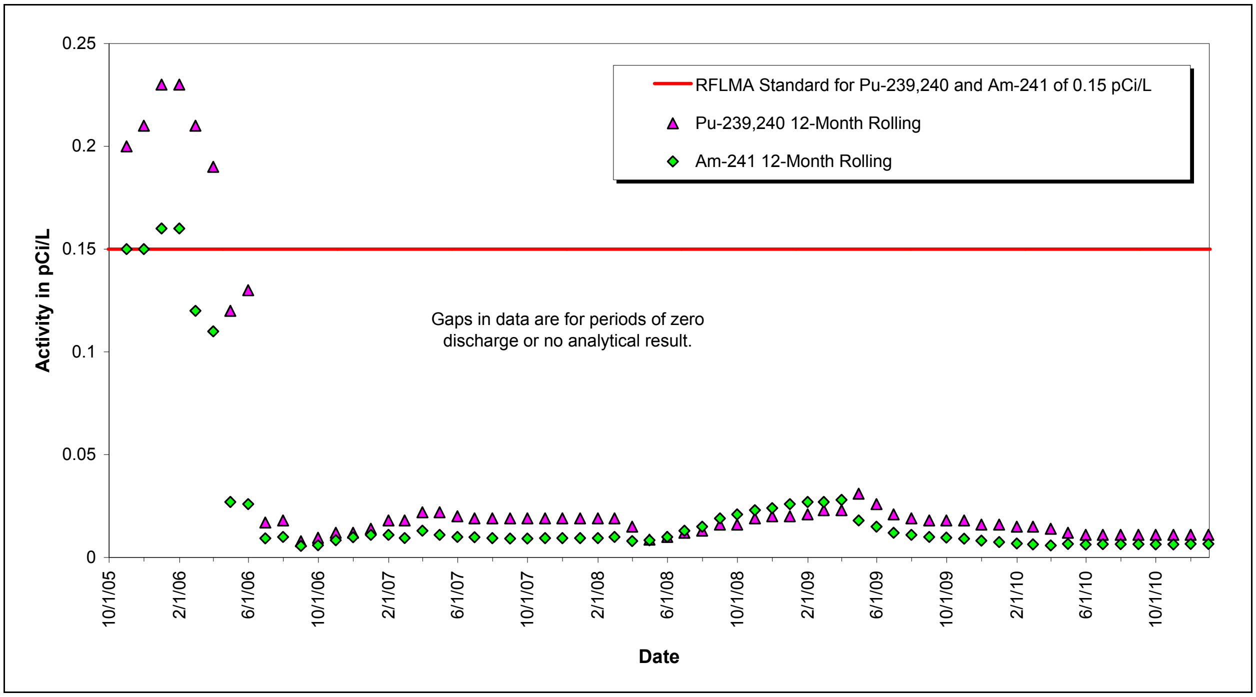

Figure 34. Volume-Weighted Average Pu and Am Compliance Values at GS10: Post-Closure Period

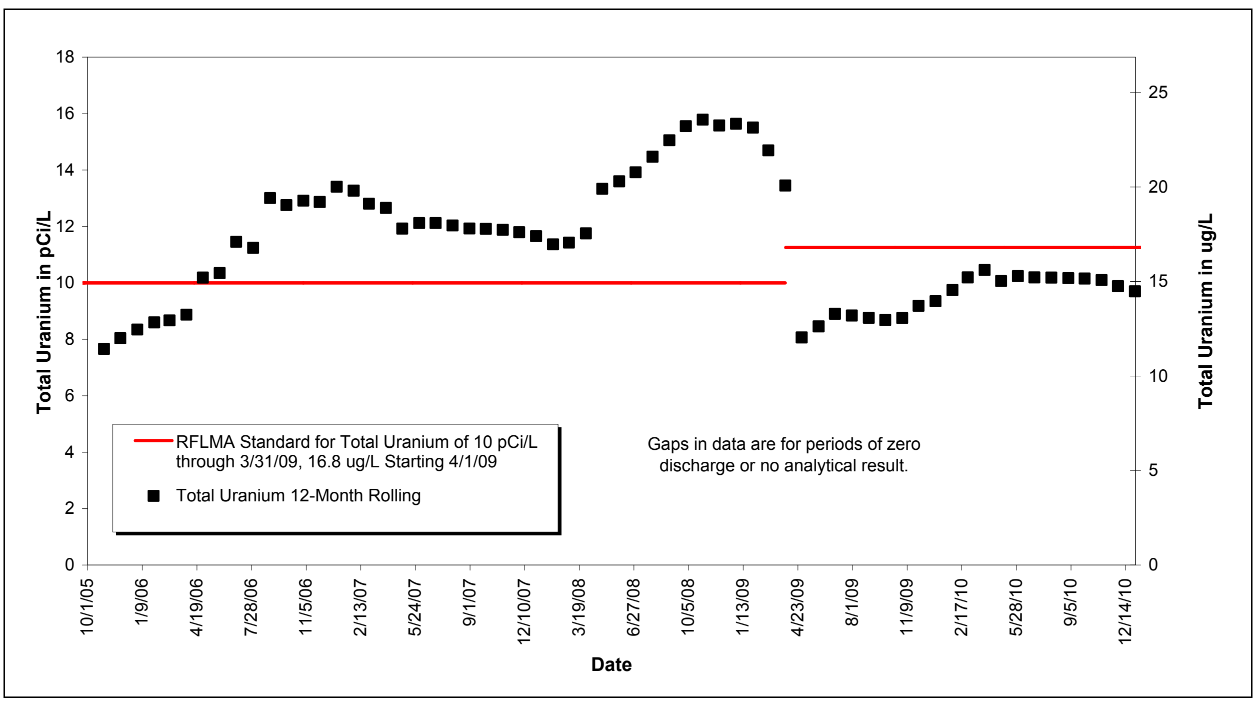

Figure 35. Volume-Weighted Average Total U Compliance Values at GS10: Post-Closure Period

Table 12 shows that all of the annual average metals concentrations were less than the standards/PQLs. Additionally, the long-term metals averages (1997−2010) were all less than the RFLMA standards/PQLs. Figure 36 shows that none of the 85th percentile 30-day average metals concentrations were reportable for the year.

Table 12. Annual Volume-Weighted Average Hardness and Metals Concentrations at GS10 for 1997−2010

Calendar Year	Volume-Weighted Average Concentration (µg/L)				
	Hardness (mg/L)	Total Be	Dissolved Cd	Total Cr	Dissolved Ag
1997	138	0.50	0.09	4.05	0.11
1998	162	0.15	0.13	3.32	0.20
1999	139	0.16	0.07	4.08	0.15
2000	181	0.21	0.11	3.65	0.11
2001	222	0.32	0.11	5.95	0.11
2002	277	0.24	0.09	5.38	0.10
2003	228	0.22	0.10	6.91	0.12
2004	227	0.60	0.10	13.1	0.13
2005	401	0.88	0.06	17.5	0.15
2006	604	0.50	0.05	0.74	0.10
2007	383	0.50	0.10	0.89	0.10
2008	517	0.45	0.07	1.20	0.09
2009	351	0.50	0.06	1.69	0.10
2010	314	0.50	0.06	1.00	0.10
Total (1997−2010)	229	0.36	0.09	5.58	0.13

Ag = silver
Be = beryllium
Cd = cadmium
Cr = chromium

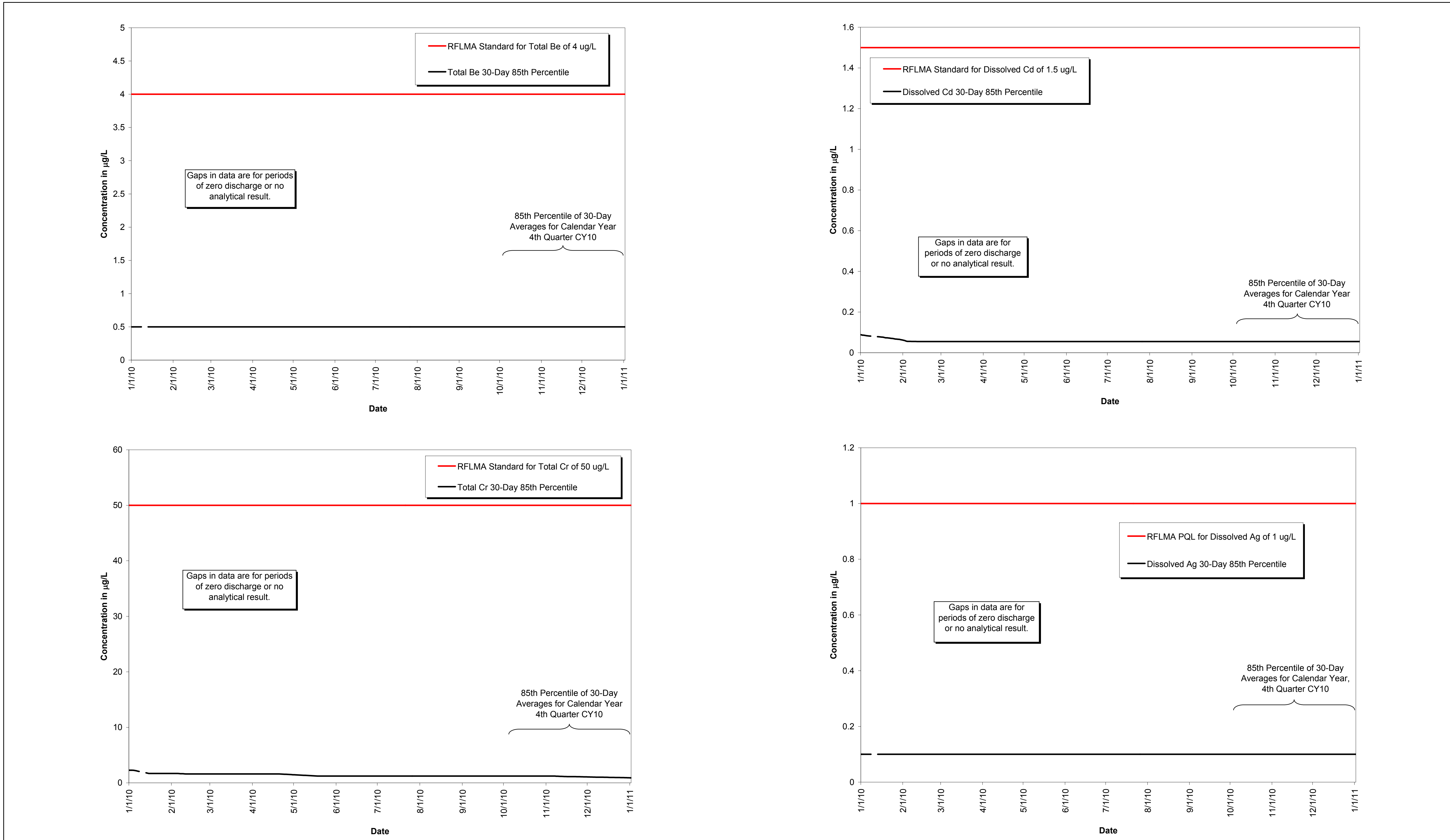

Figure 36. Volume-Weighted Average Metals Compliance Values at GS10: Calendar Year Ending Fourth Quarter CY 2010

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Location SW027

Monitoring location SW027 is located at the end of the SID at the inlet to Pond C-2 (Figure 31). The southern portion of the COU contributes flow to SW027 through the SID.

Table 13 shows that the majority of the annual average Pu and Am activities are less than 0.15 pCi/L. The significant increase in 2004 was the result of increased solids transport from disturbed areas associated with the 903 Pad/Lip accelerated actions. However, a measurable reduction in both Pu and Am activities has been observed following completion of accelerated actions in the drainage. With the completion of the 903 Pad/Lip actions, implementation of enhanced erosion controls, revegetation, soil stabilization, and lack of substantial runoff, transport of Pu and Am has been significantly reduced. The total U annual average concentrations are well below 16.8 µg/L.

Table 13. Annual Volume-Weighted Average Radionuclide Activities at SW027 for 1997−2010

Calendar Year	Volume-Weighted Average		
	Am-241 (pCi/L)	Pu-239,240 (pCi/L)	Total U (µg/L)
1997	0.008	0.036	2.46
1998	0.021	0.156	5.99
1999	0.019	0.066	3.15
2000	0.060	0.348	1.62
2001	0.006	0.025	2.17
2002	0.001	0.003	0.87
2003	0.011	0.080	2.80
2004	0.413	2.273	1.55
2005	0.022	0.156	3.91
2006	NA (no flow)	NA (no flow)	NA (no flow)
2007	0.040	0.092	2.78
2008	NA (no flow)	NA (no flow)	NA (no flow)
2009	0.015	0.092	3.07
2010	0.027	0.155	4.73
Total (1997−2010)	0.056	0.305	3.11

Note: NA = not applicable.

Figure 37 shows that the 12-month rolling average for plutonium exceeds the RFLMA standard of 0.15 pCi/L. The composite sampling results for plutonium at SW027 collected during CY 2010 are given in Table 14. All other analytes were not reportable during the quarter.

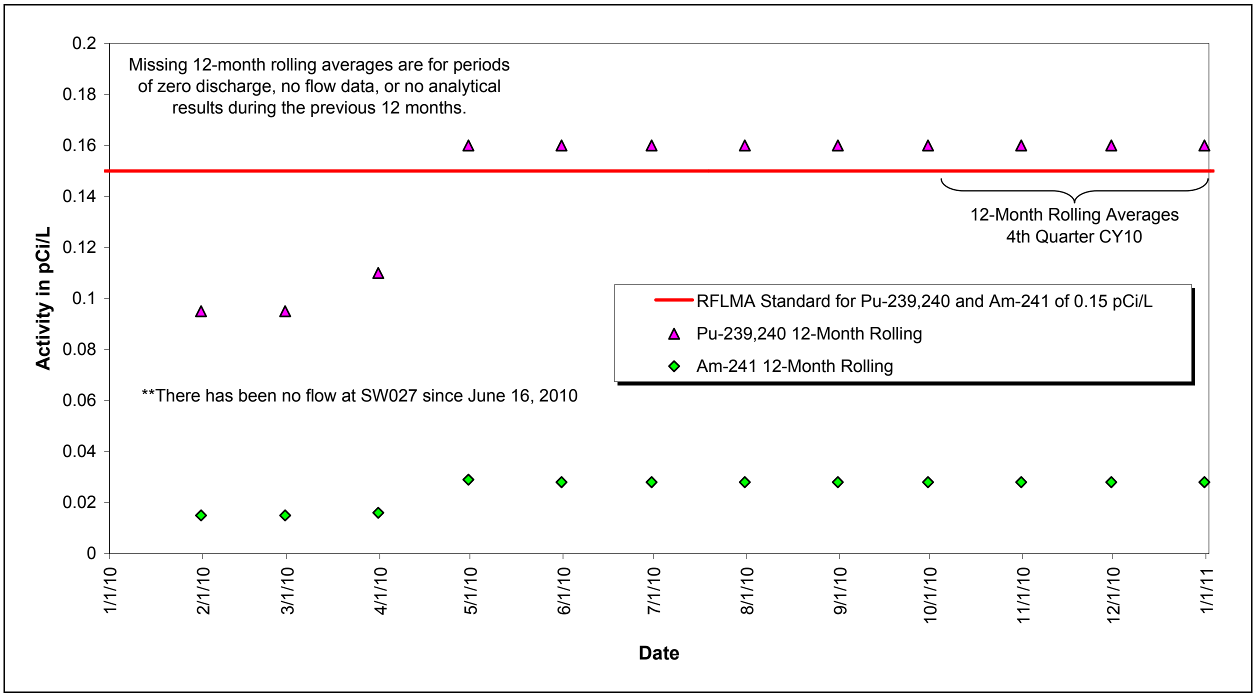

Figure 37. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at SW027: Calendar Year Ending Fourth Quarter CY 2010

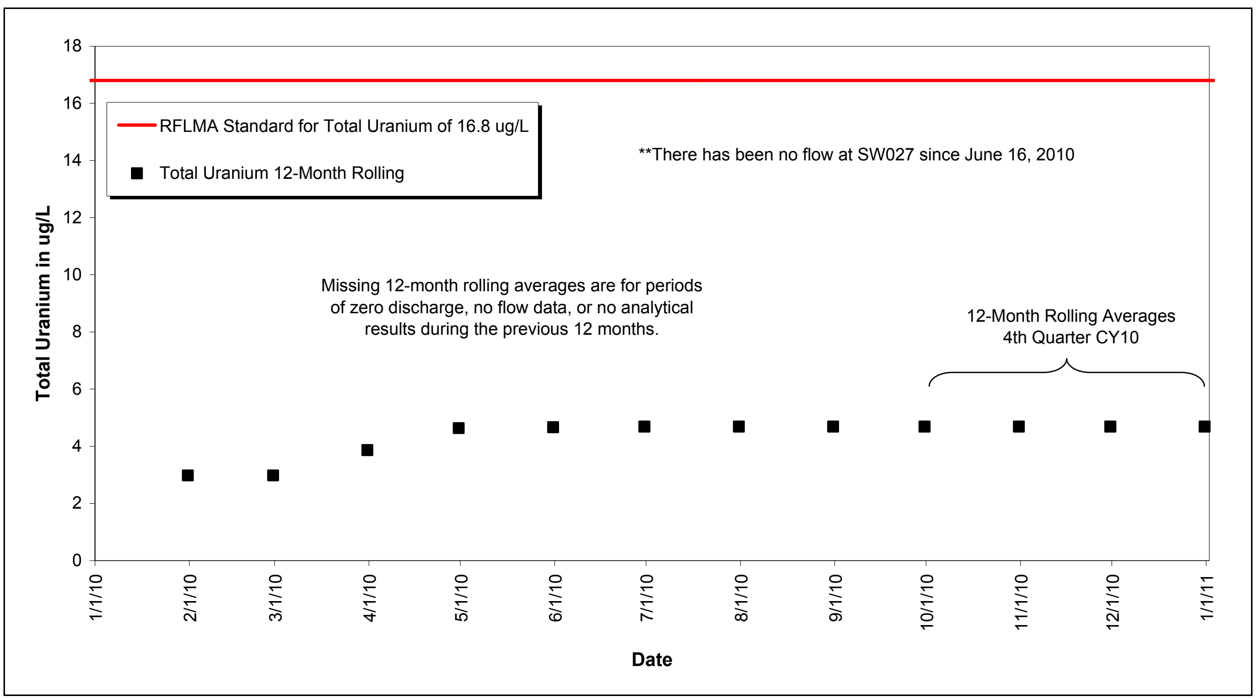

Figure 38. Volume-Weighted 12-Month Rolling Average Total U Activities at SW027: Calendar Year Ending Fourth Quarter CY 2010

Table 14. CY 2010 Composite Sampling Results for Plutonium for SW027

Date—Time Start	Date—Time End	Plutonium Result (µg/L)
1/13/10—11:11	3/29/10—11:55	0.122
3/29/10—11:55	4/23/10—11:11	0.300
4/23/10—11:11	4/23/10—19:12	0.294
4/23/10—19:12	4/27/10—12:07	0.029
4/27/10—12:07	10/4/10—12:39	0.040
10/4/10—12:39	2/17/11—9:23	NSQ

Notes: There was no flow at SW027 during the 10/4/10–2/17/11 composite sampling period; therefore there are no analytical results.

While the 12-month rolling average values could not be formally calculated until complete analytical results were available for the April 27–October 4, 2010, sample, DOE initiated preemptive consultation with CDPHE on June 2, 2010. RFLMA Contact Record 2010-06, "Monitoring Results at Surface Water Point of Evaluation (POE) SW027," provides a discussion of the monitoring results and recaps the outcome of the RFLMA Parties' consultation regarding steps to be taken to evaluate the SW027 drainage area. Contact Record 2010-06 is available on the Rocky Flats website, http://www.lm.doe.gov/Rocky_Flats/ContactRecords.aspx.

Subsequent to Contact Record 2010-06, the *Report of Steps Taken Regarding Monitoring Results at Surface Water Point of Evaluation (POE) SW027* was completed on August 31, 2010. This report provides data evaluation and an update on the steps taken in accordance with Contact Record 2010-06. Recommendations beyond the actions already taken and discussed in the Contact Record are also provided. The August 31, 2010, report on the status of actions related to evaluation of the conditions is included in Appendix G with Contact Record 2010-02. This report is also available on the Rocky Flats website, http://www.lm.doe.gov/Rocky_Flats/ContactRecords.aspx.

The recommendations in the evaluation included installing additional erosion control wattles in locations along the hillside north of the SID, installing permanent erosion blankets, and reseeding three areas in the SID. This work was successfully completed on December 20, 2010. Approximately 2,560 linear feet of Filtrexx wattles and 8,452 square feet of permanent erosion matting were installed.

Figure 39 and Figure 40 show similar data for the entire post-closure period.

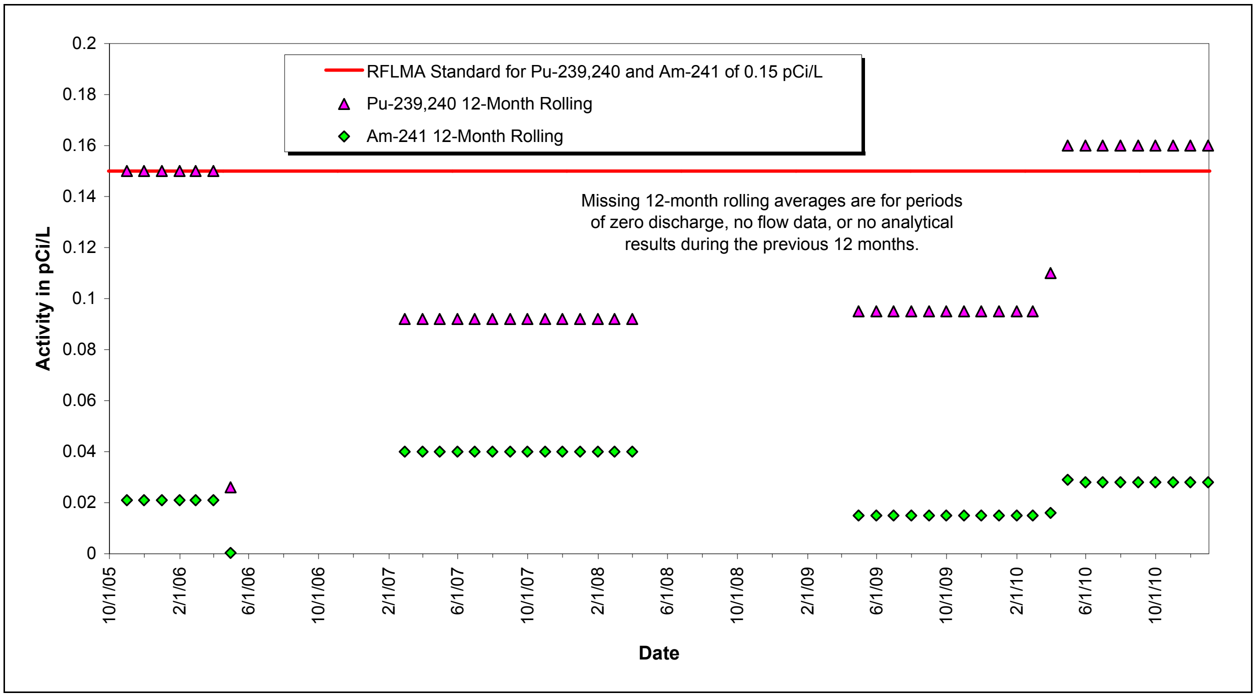

Figure 39. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at SW027: Post-Closure Period

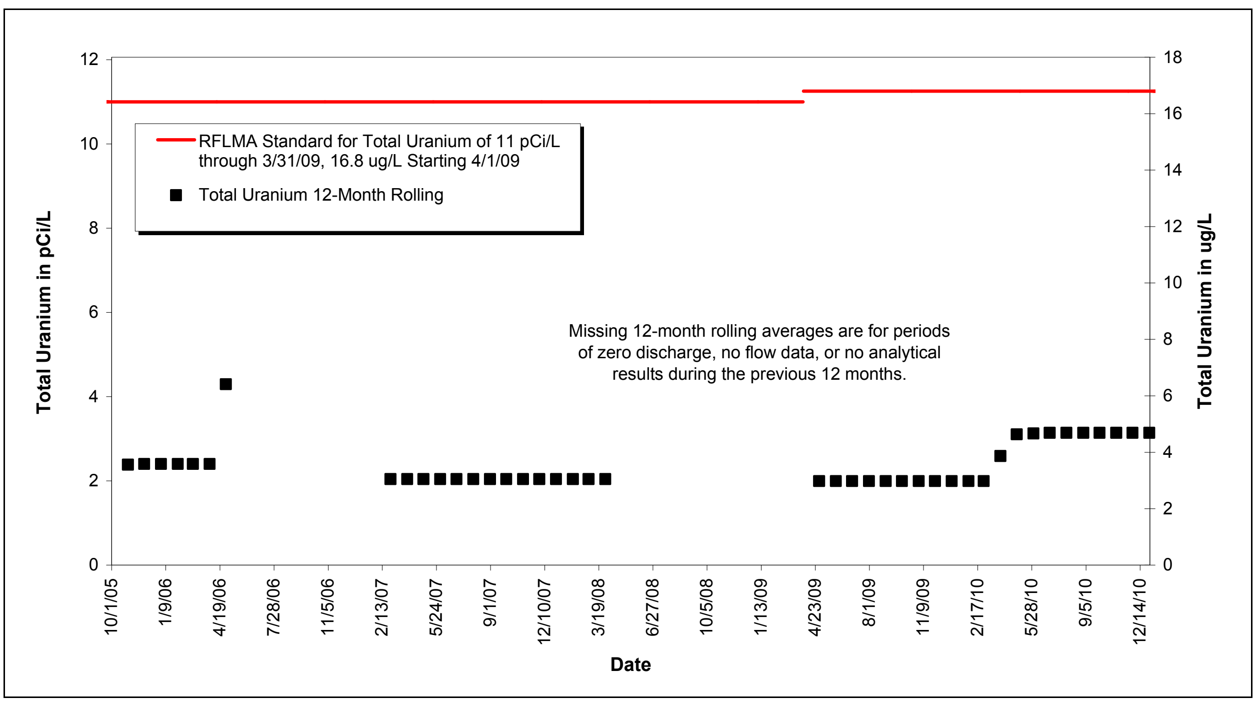

Figure 40. Volume-Weighted 12-Month Rolling Average Total U Activities at SW027: Post-Closure Period

Table 15 shows that all of the annual average metals concentrations are less than the standards/PQLs. Additionally, the long-term metals averages (1997−2010) are less than the standards/PQLs. Figure 41 shows that none of the 85th percentile 30-day average metals concentrations were reportable for the year.

Table 15. Annual Volume-Weighted Average Hardness and Metals Concentrations at SW027 for 1997−2010

Calendar Year	Volume-Weighted Average Concentration (µg/L)				
	Hardness (mg/L)	Total Be	Dissolved Cd	Total Cr	Dissolved Ag
1997	112	0.44	0.09	1.71	0.10
1998	152	0.14	0.15	0.91	0.21
1999	111	0.03	0.10	1.55	0.24
2000	150	0.27	0.05	4.14	0.09
2001	145	0.23	0.07	1.82	0.12
2002	114	0.12	0.05	2.88	0.11
2003	148	0.06	0.06	1.75	0.15
2004	133	0.32	0.06	7.36	0.19
2005	236	0.08	0.07	2.03	0.19
2006	NA (no flow)	NA (no flow)	NA (no flow)	NA (no flow)	NA (no flow)
2007	133	0.50	0.05	0.50	0.10
2008	NA (no flow)	NA (no flow)	NA (no flow)	NA (no flow)	NA (no flow)
2009	139	0.50	0.06	1.15	0.10
2010	154	0.50	0.06	1.16	0.10
Total (1997−2010)	138	0.23	0.08	2.19	0.16

NA = not applicable.
Ag = silver Be = beryllium Cd = cadmium Cr = chromium

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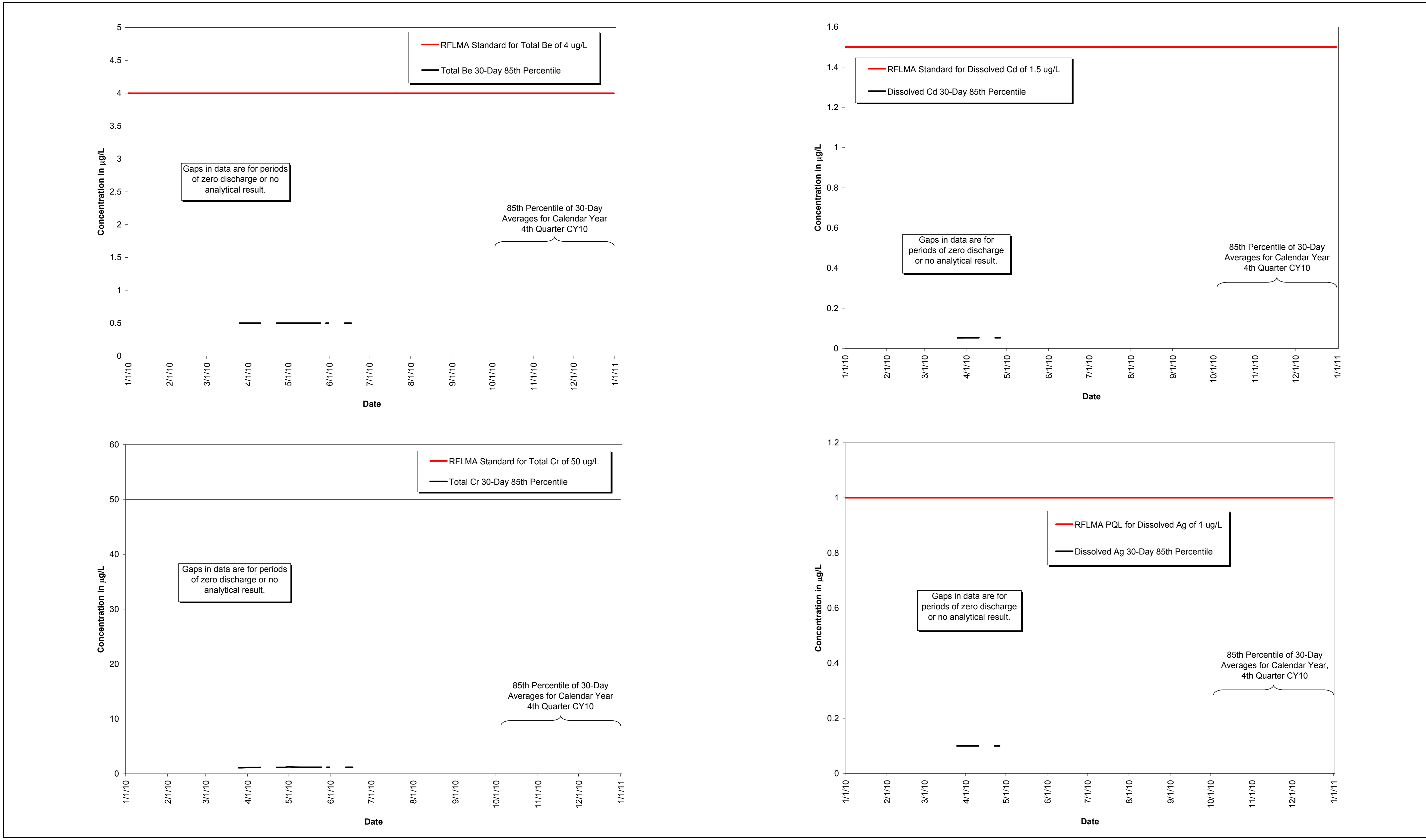

Figure 41. Volume-Weighted Average Metals Compliance Values at SW027: Calendar Year Ending Fourth Quarter CY 2010

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Location SW093

Monitoring location SW093 is located on North Walnut Creek 1,300 feet upstream of the A-Series Ponds (Figure 31). The northern portion of the COU contributes flow to SW093 through FC-2 and FC-3.

Table 16 shows that the majority of the annual average Pu and Am activities are below 0.15 pCi/L. Additionally, the long-term Pu and Am averages (1997−2010) are below 0.15 pCi/L. The total U annual average concentrations are well below 16.8 µg/L.

Table 16 indicates an increase in Pu and Am activities during 2004. However, a significant reduction in both Pu and Am activities has been observed following Site closure. With the completion of the FCs, implementation of enhanced erosion controls, revegetation, soil stabilization, and lack of substantial runoff, transport of Pu and Am has been virtually eliminated. Figure 42 and Figure 43 show no reportable Pu, Am, or total U values during the year.

Table 16. Annual Volume-Weighted Average Radionuclide Activities at SW093 for 1997−2010

Calendar Year	**Volume-Weighted Average**		
	Am-241 (pCi/L)	**Pu-239,240 (pCi/L)**	**Total U (µg/L)**
1997	0.035	0.052	3.84
1998	0.020	0.022	3.51
1999	0.025	0.038	3.02
2000	0.022	0.040	3.12
2001	0.011	0.015	3.12
2002	0.017	0.006	4.24
2003	0.039	0.056	3.19
2004	0.622	0.603	3.67
2005	0.029	0.022	5.55
2006	0.004	0.008	8.00
2007	0.009	0.011	4.85
2008	0.034	0.061	10.06
2009	0.007	0.016	5.67
2010	0.008	0.008	7.28
Total (1997−2010)	0.069	0.074	4.10

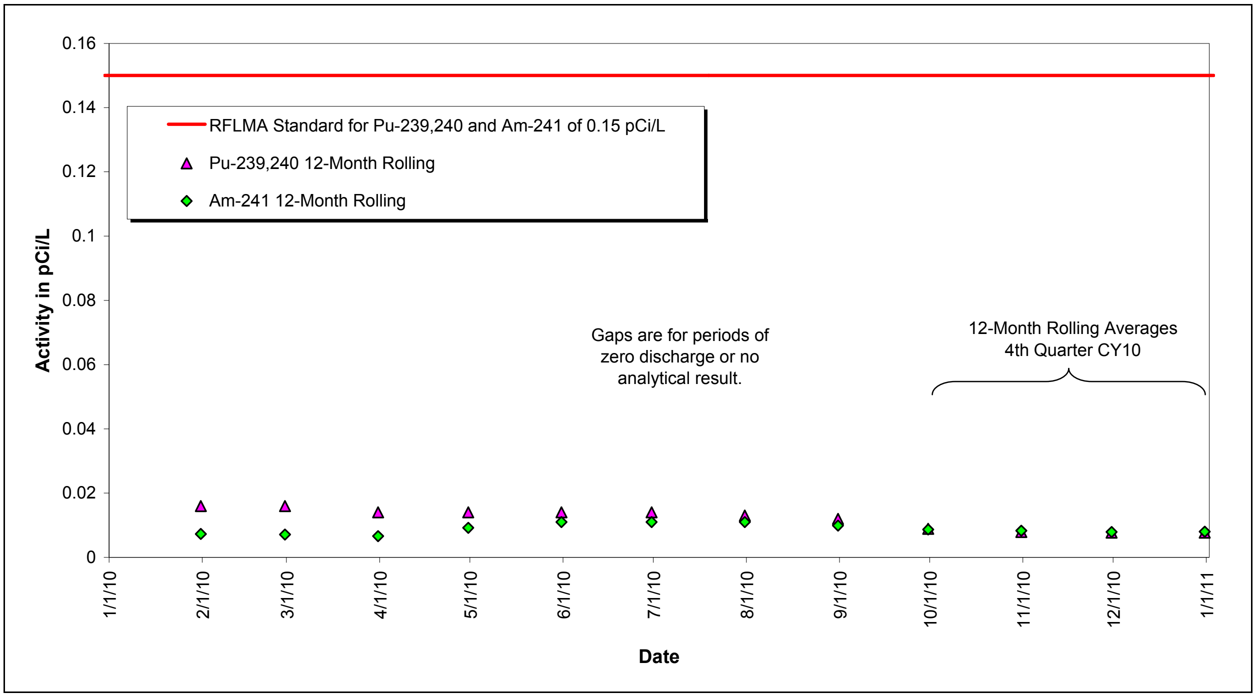

Figure 42. Volume-Weighted Average Pu and Am Compliance Values at SW093: Calendar Year Ending Fourth Quarter CY 2010

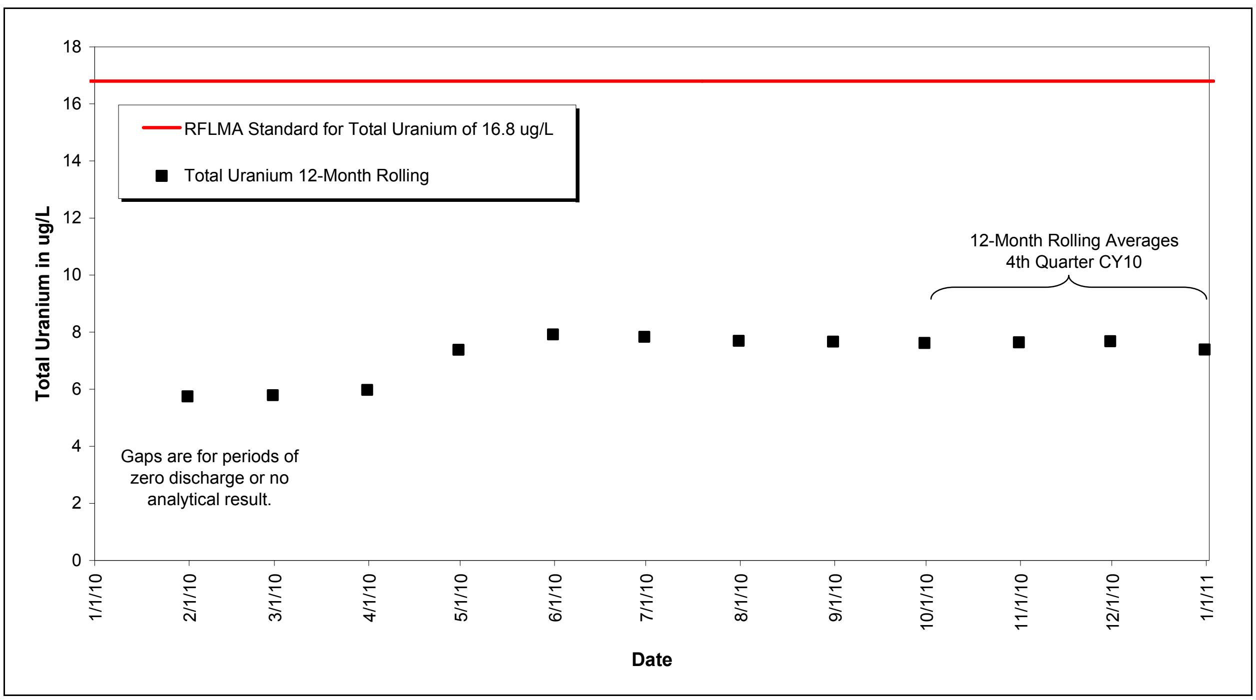

Figure 43. Volume-Weighted Average Total U Compliance Values at SW093: Calendar Year Ending Fourth Quarter CY 2010

Figure 44 and Figure 45 show similar data for the entire post-closure period.

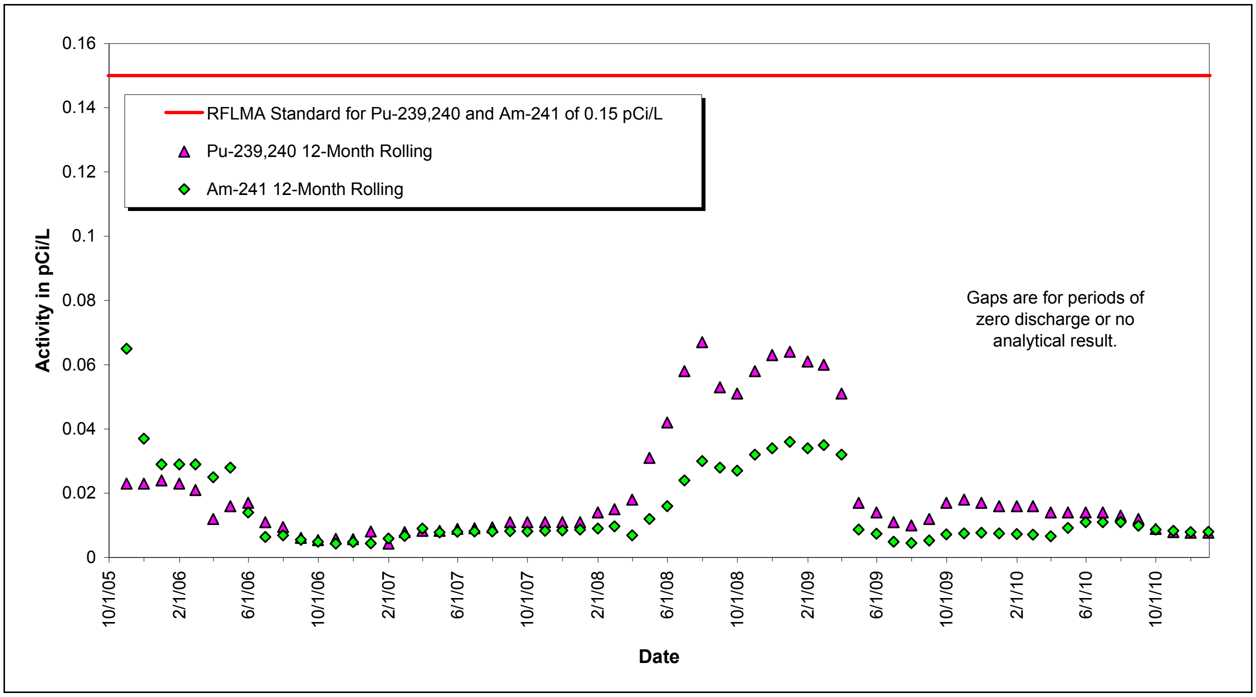

Figure 44. Volume-Weighted Average Pu and Am Compliance Values at SW093: Post-Closure Period

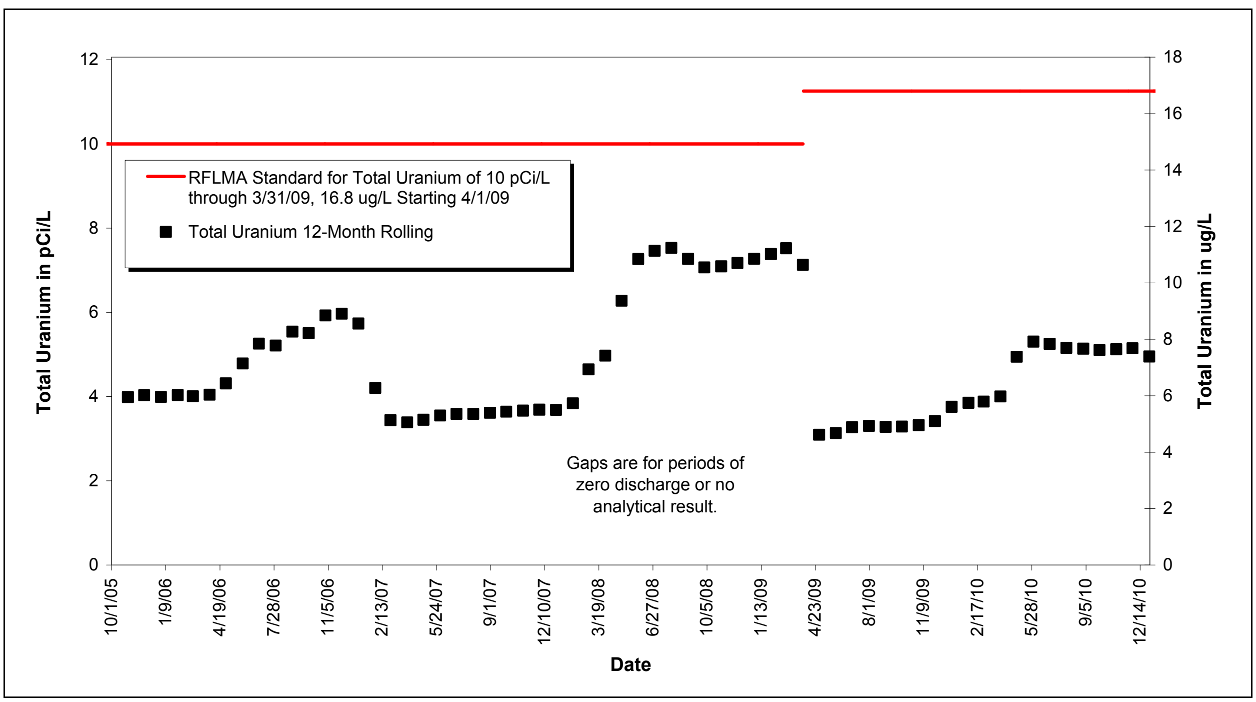

Figure 45. Volume-Weighted Average Total U Compliance Values at SW093: Post-Closure Period

Table 17 shows that all of the annual average metals concentrations are less than the standards/PQLs. Additionally, the long-term metals averages (1997−2010) are less than the standards/PQLs. Figure 46 shows that none of the 85th percentile 30-day average metals concentrations were reportable for the year.

Table 17. Annual Volume-Weighted Average Hardness and Metals Concentrations at SW093 for 1997–2010

Calendar Year	Volume-Weighted Average Concentration (µg/L)				
	Hardness (mg/L)	Total Be	Dissolved Cd	Total Cr	Dissolved Ag
1997	168	0.43	0.07	2.36	0.12
1998	184	0.14	0.23	2.22	0.22
1999	152	0.20	0.13	5.08	0.16
2000	231	0.21	0.08	3.94	0.11
2001	247	0.36	0.07	6.49	0.11
2002	365	0.30	0.08	5.95	0.11
2003	257	0.29	0.09	6.88	0.16
2004	315	0.57	0.09	12.05	0.12
2005	337	0.11	0.05	1.92	0.11
2006	564	0.50	0.05	0.82	0.10
2007	287	0.50	0.06	0.82	0.10
2008	552	0.50	0.07	1.84	0.10
2009	295	0.50	0.06	2.23	0.10
2010	231	0.50	0.06	1.15	0.10
Total (1997−2010)	245	0.33	0.10	4.37	0.13

Ag = silver Cd = cadmium Be = beryllium Cr = chromium

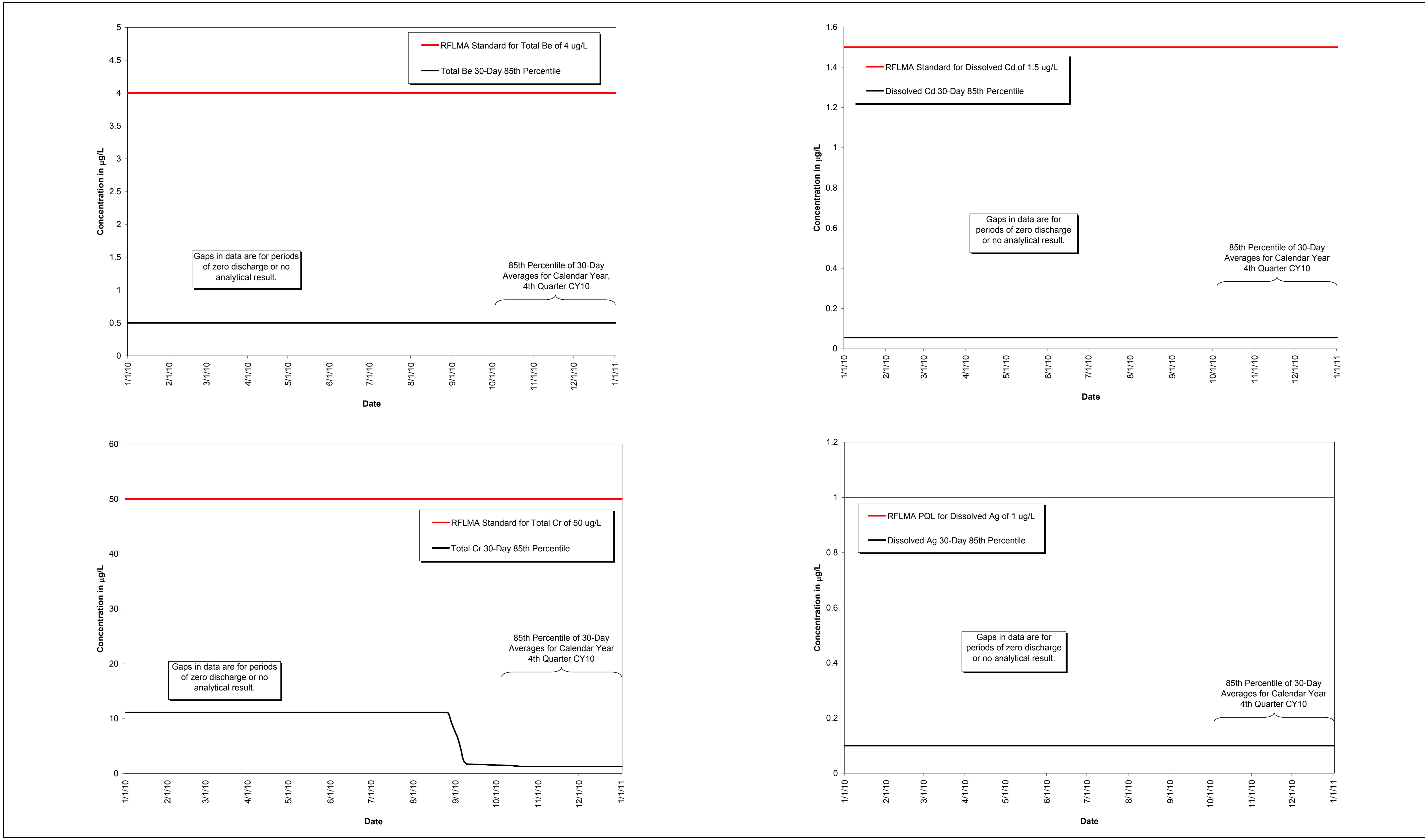

Figure 46. Volume-Weighted Average Metals Compliance Values at SW093: Calendar Year Ending Fourth Quarter CY 2010

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3.1.2.3 AOC Wells and SW018

AOC wells (Table 18 and Figure 47) are located to evaluate potential groundwater impacts to surface water. Surface Water Support location SW018 is located to assess groundwater impacts from specific source areas on surface water. Impacts are based on a minimum of two routinely scheduled sampling events in a row, not on a single data point. Analytical results from AOC wells are compared directly against the appropriate surface-water standards in Table 1 of RFLMA Attachment 2 or the RFLMA U groundwater threshold value of 120 µg/L. Analytical data from surface-water performance location SW018, where grab samples for volatile organic compounds (VOCs) are collected to support groundwater objectives, are assessed in a manner similar to data from AOC wells.

Table 18. Sampling and Data Evaluation Protocols at AOC Wells and SW018

Location Code	Location Description	Sample Types/Frequencies	Analytes[a]	Data Evaluation
00193	Woman Creek upstream of Pond C-2	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 7 in Appendix D
00997	South Walnut Creek upstream of Pond B-5	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 7 in Appendix D
10304	Southeast of 903 Pad/Ryan's Pit Plume at Woman Creek	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 7 in Appendix D
10594	North Walnut Creek downstream of Pond A-1	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 7 in Appendix D
11104	Downgradient, downstream	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 7 in Appendix D
4087	Below Landfill Pond	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 7 in Appendix D
42505	Terminus of FC-2	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 7 in Appendix D
89104	Downgradient at Woman Creek	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 7 in Appendix D
B206989	Below Landfill Pond	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 7 in Appendix D
SW018	FC-2 west of former Building 771 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 7 in Appendix D

Notes: [a] Samples for the analysis of U are field-filtered using a 0.45-micrometer in-line filter.
Nitrate is analyzed as nitrate+nitrite as nitrogen; this result is conservatively compared to the nitrate standard only (standard is also nitrate+nitrite as N).

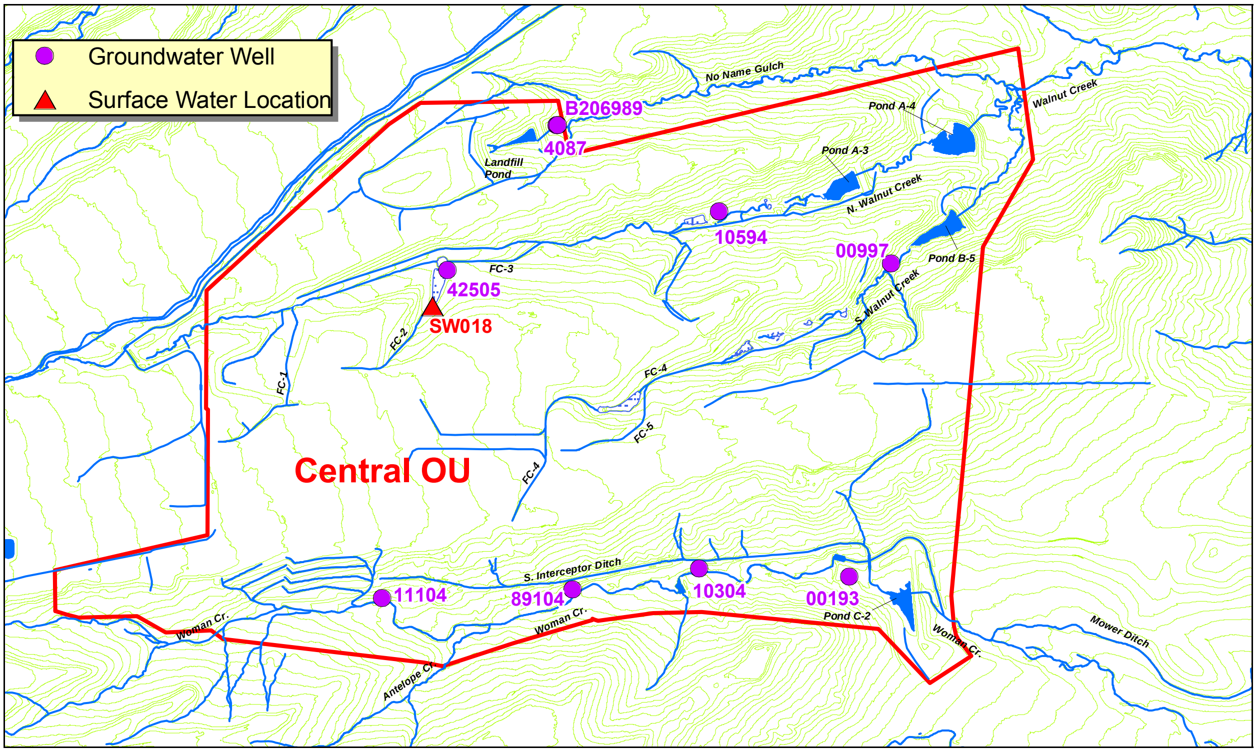


Figure 47. AOC Well and SW018 Locations

Data Evaluation

All AOC wells and SW018 were scheduled for routine monitoring in the fourth quarter of CY 2010. No decision criteria were triggered by the associated analytical results (Appendix B), which were generally consistent with previous data save for the exception discussed below for well B206989. Monitoring will continue as prescribed in RFLMA (DOE 2007a).

A reportable condition was encountered for AOC well B206989 in August 2007 (see corresponding RFLMA Contact Record 2007-06) due to elevated concentrations of nitrate in groundwater samples from this well. The fourth-quarter 2010 result was 5.7 mg/L. Updated S-K trend calculations for this well are provided in Appendix B and summarized in Section 3.1.5.3. Consistent with the results obtained in 2009, the 2010 analytical data continue to support a decreasing trend in nitrate concentrations at well B206989 that has a 95 percent level of significance. Refer to Section 3.1.5.3 for additional discussion.

3.1.2.4 Boundary Wells

Boundary wells (Table 19and Figure 48) are located at the Walnut Creek/Indiana Street and Woman Creek/Indiana Street intersections. These locations are far from contaminant source areas and well outside the actual Site (as defined by the COU). They meet no technical monitoring objectives.

Monitoring the Boundary wells is not required by the CAD/ROD. However, they have been retained in the monitoring network to provide additional assurance to local stakeholders that groundwater quality at the downgradient edge of federal government property does not pose a significant threat to human health and the environment. These wells are included in the network as part of the operational monitoring in RFLMA.

Table 19. Sampling and Data Evaluation Protocols at Boundary Wells

Location Code	Location Description	Sample Types/Frequencies	Analytes[a]	Data Evaluation
10394	Woman Creek at Indiana Street	Annual grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 7 in Appendix D
41691	Walnut Creek at Indiana Street	Annual grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 7 in Appendix D

Notes: [a] Samples for the analysis of U are field-filtered using a 0.45-micrometer in-line filter.
Nitrate is analyzed as nitrate+nitrite as nitrogen; this result is conservatively compared to the nitrate standard only.

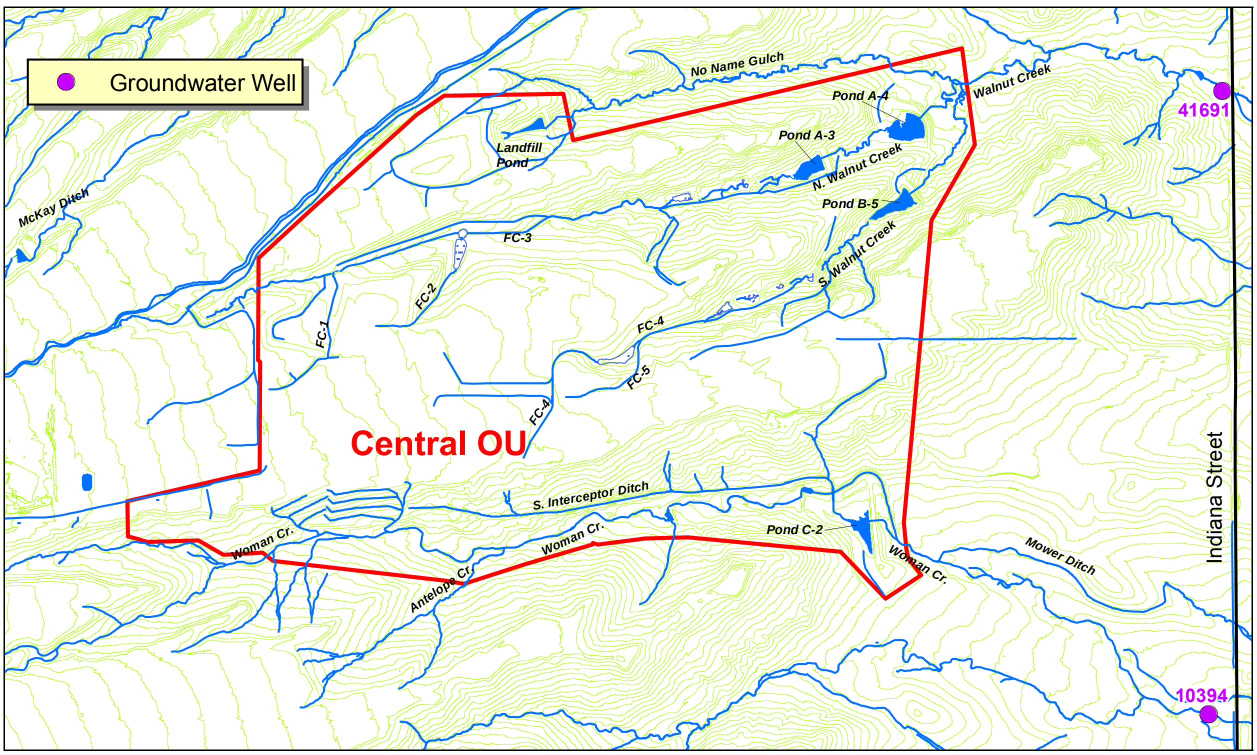


Figure 48. Boundary Well Locations

Data Evaluation

Boundary wells were not scheduled for sampling in the fourth quarter of CY 2010.

3.1.2.5 Sentinel Wells

Sentinel wells (Table 20 and Figure 49) are located near downgradient edges of contaminant plumes, in drainages, at groundwater treatment systems, and along contaminant pathways to surface water. These wells are monitored to determine whether concentrations of contaminants are increasing, thereby providing advance warning of potential groundwater-quality impacts to the downgradient AOC wells. Confirmation of a potential impact to downgradient wells will require an analytical record that consistently indicates an impact, not a single data point that indicates that a contaminant has been detected.

Sentinel wells are used to monitor the performance of an accelerated action (including soil and source removals, in situ contaminant plume treatment, groundwater intercept components of treatment systems, and facility demolitions) and assess contaminant trends at important locations. Data from Sentinel wells are supplemented by those from Evaluation wells and are used to determine when monitoring may cease or additional remedial work should be considered.

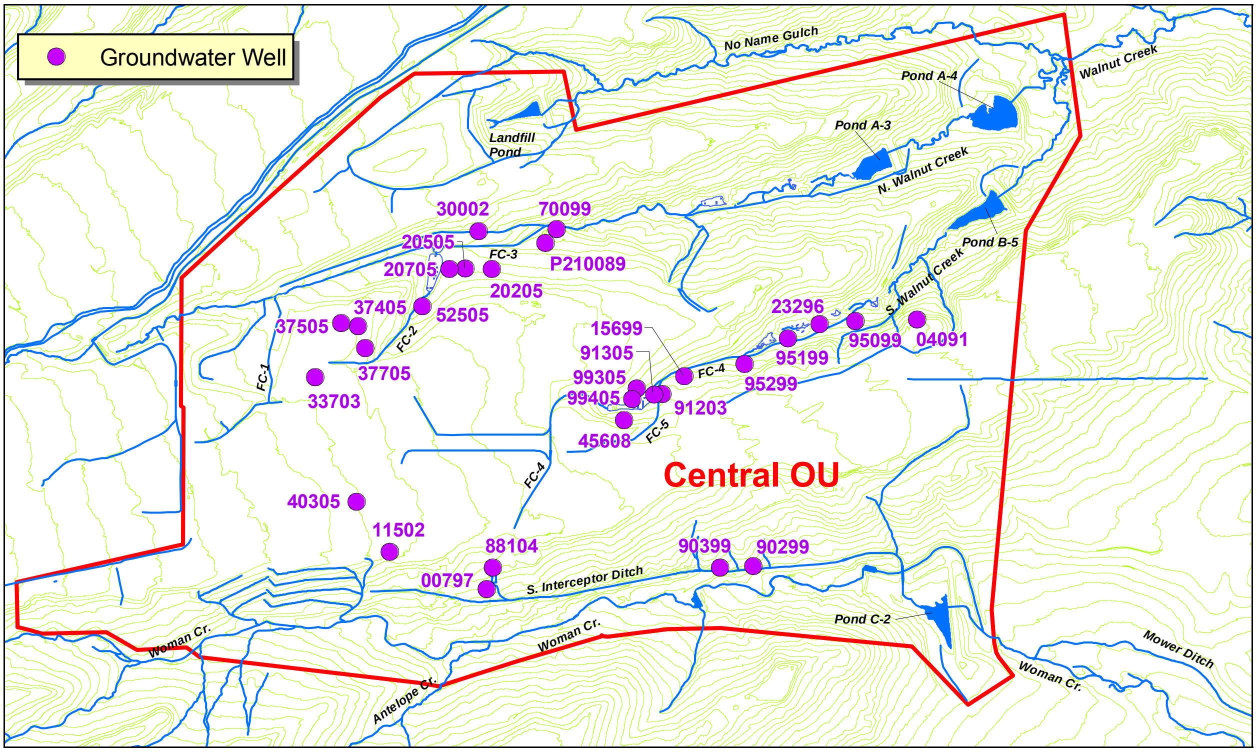
Table 20. Sampling and Data Evaluation Protocols at Sentinel Wells

Location Code	Location Description	Sample Types/Frequencies	Analytes[a]	Data Evaluation
00797	South of former Building 881 (B881) area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 8 in Appendix D
04091	East of source area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
11502	Southeast of former B444 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 8 in Appendix D
15699	Downgradient of MSPTS intercept trench	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
20205	North/northeast of former B771/774 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, Pu, Am	See Figure 8 in Appendix D
20505	North of former B771/774 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, Pu, Am	See Figure 8 in Appendix D
20705	North/northwest of former B771 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate, Pu, Am	See Figure 8 in Appendix D
23296	Downgradient of ETPTS intercept trench	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 8 in Appendix D
30002	Downgradient at North Walnut Creek	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
33703	Downgradient of source area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
37405	North/northeast part of former B371/374 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate, Pu, Am	See Figure 8 in Appendix D
37505	North part of former B371 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 8 in Appendix D
37705	East/southeast of former B371/374 area at foundation drain confluence	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate, Pu, Am	See Figure 8 in Appendix D
40305	East part of former B444 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 8 in Appendix D

Table 20 (continued). Sampling and Data Evaluation Protocols at Sentinel Wells

Location Code	Location Description	Sample Types/Frequencies	Analytes[a]	Data Evaluation
45608	Adjacent to remnants of SW056 French drain and drain interruption	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
52505	West of former IHSS 118.1 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
70099	Northwest (side-gradient) of SPPTS intercept trench	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	U, nitrate	See Figure 8 in Appendix D
88104	South part of former B881 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U	See Figure 8 in Appendix D
90299	Southeast part of 903 Pad/Ryan's Pit Plume at SID	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
90399	Southeast part of 903 Pad/Ryan's Pit Plume at SID	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
91203	Downgradient of Oil Burn Pit (OBP) #2 source area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
91305	South of confluence of FC-4 and FC-5	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 8 in Appendix D
95099	Downgradient of ETPTS intercept trench	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
95199	Downgradient of ETPTS intercept trench	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
95299	Downgradient of ETPTS intercept trench	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 8 in Appendix D
99305	East part of former B991 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 8 in Appendix D
99405	Southeast part of former B991 area	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 8 in Appendix D
P210089	Downgradient (north) portion of SPP	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs, U, nitrate	See Figure 8 in Appendix D

Notes: [a] Samples for the analysis of U, Pu, and Am are field-filtered using a 0.45-micrometer in-line filter.
Nitrate is analyzed as nitrate+nitrite as nitrogen; this result is conservatively compared to the nitrate standard only.
IHSS = Individual Hazardous Substance Site



Note: Well 45608 replaces the slump-damaged 45605, which was abandoned in the fourth quarter of CY 2007; refer to the 2007 Annual Report (DOE 2008c) for more information.

Figure 49. Sentinel Well Locations

Data Evaluation

All Sentinel wells were monitored in the fourth quarter of CY 2010 (refer to Appendix B for analytical results). Analytical data are generally consistent with previous results except for well 91203, which reported significantly higher concentrations of several VOCs in the fourth quarter of 2010. Although not required, for proactive reasons a confirmatory sample was collected in the same quarter and analyzed for VOCs. Results from this second sample were consistent with those from the first.

A result for trichloroethene (TCE) from well 23296 was called out in the 2007 Annual Report (DOE 2008c) because it was unusually low (8.5 µg/L) with respect to other data from this well. This condition has been repeated each year since, with the concentration of TCE in the fourth-quarter sample lower than that in the preceding, second-quarter sample. A similar pattern applies for other VOCs, such as tetrachloroethene (PCE), though the differences are generally not as marked.

Refer to Section 3.1.5.3 for additional discussion of these and other Sentinel well data, including statistical results, and Appendix B for trend plots.

3.1.2.6 Evaluation Wells

Evaluation wells (Table 21 and Figure 50) are located within groundwater contaminant plumes and near plume source areas, and within the interior of the COU at the Site. As such, they may monitor the effects of accelerated actions that have been performed (e.g., source removal and in situ treatment). Data from these Evaluation wells are therefore appropriate to determine whether the monitoring of a particular plume and source area may cease, and provide data to support the determination of whether corresponding groundwater plume treatment systems may be decommissioned. In addition, Evaluation wells are used to support any groundwater evaluations that may be needed as a result of changing contaminant characteristics in downgradient Sentinel or AOC wells. Data from these wells also assist evaluations of predictions made through groundwater modeling efforts.

Table 21. Sampling and Data Evaluation Protocols at Evaluation Wells

Location Code	Location Description	Sample Types/Frequencies	Analytes[a]	Data Evaluation
00191	East of former 903 Pad area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
00203	Downgradient (south) portion of SPP	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
00491	Southeast of former 903 Pad area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
00897	Mound Site source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
3687	East Trenches source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
03991	East of East Trenches source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
05691	East Trenches source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
07391	Ryan's Pit source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
18199	North of former IHSS 118.1 source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
20902	Northwest of former IHSS 118.1 source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
21505	West of former B776/777 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
22205	Downgradient (north) portion of SPP	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
22996	East/northeast part of former B886 area	Biennial grabs; second calendar quarter (high-water conditions)	U, nitrate	See Figure 9 in Appendix D
30900	PU&D Yard Plume source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
33502	OBP#1 source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
33604	OBP#1 source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
33905	North of former 231 Tanks area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
40005	West part of former B444 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
40205	South part of former B444 end	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
50299	East of former 903 Pad area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
51605	Downgradient, adjacent to GS13	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
55905	North part of former B559 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D

Table 21 (continued). Sampling and Data Evaluation Protocols at Evaluation Wells

Location Code	Location Description	Sample Types/Frequencies	Analytes[a]	Data Evaluation
56305	West part of former B559 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
70705	East part of former B707 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
79102	SPP source area—north	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
79202	SPP source area—north	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
79302	SPP source area—northeast	Biennial grabs; second calendar quarter (high-water conditions)	U, nitrate	See Figure 9 in Appendix D
79402	SPP source area—northeast	Biennial grabs; second calendar quarter (high-water conditions)	U, nitrate	See Figure 9 in Appendix D
79502	SPP source area—east	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
79605	SPP source area—east	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
88205	South part of former B881 area	Biennial grabs; second calendar quarter (high-water conditions)	U, nitrate	See Figure 9 in Appendix D
891WEL	OU 1 Plume source area	Biennial grabs; second calendar quarter (high-water conditions)	U, nitrate	See Figure 9 in Appendix D
90402	Southeast of former 903 Pad area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
90804	Southeast part of 903 Pad/Ryan's Pit Plume	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
91105	OBP#2 source area	Biennial grabs; second calendar quarter (high-water conditions)	U, nitrate	See Figure 9 in Appendix D
B210489	Downgradient of SPPTS	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
P210189	SEP-area VOC plume source area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
P208989	SPP source area—north	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U, nitrate	See Figure 9 in Appendix D
P114689	Southwest of former B559 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
P115589	West part of former B551 Warehouse area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs, U	See Figure 9 in Appendix D
P419689	Southeast of former B444 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D
P416889	Southeast of former B444 area	Biennial grabs; second calendar quarter (high-water conditions)	VOCs	See Figure 9 in Appendix D

Notes: [a] Samples for the analysis of U are field-filtered using a 0.45-micrometer in-line filter.
Nitrate is analyzed as nitrate+nitrite as nitrogen; this result is conservatively compared to the nitrate standard only.
IHSS = Individual Hazardous Substance Site
OBP = Oil Burn Pit
PU&D = Property Utilization and Disposal
SEP = Solar Evaporation Pond

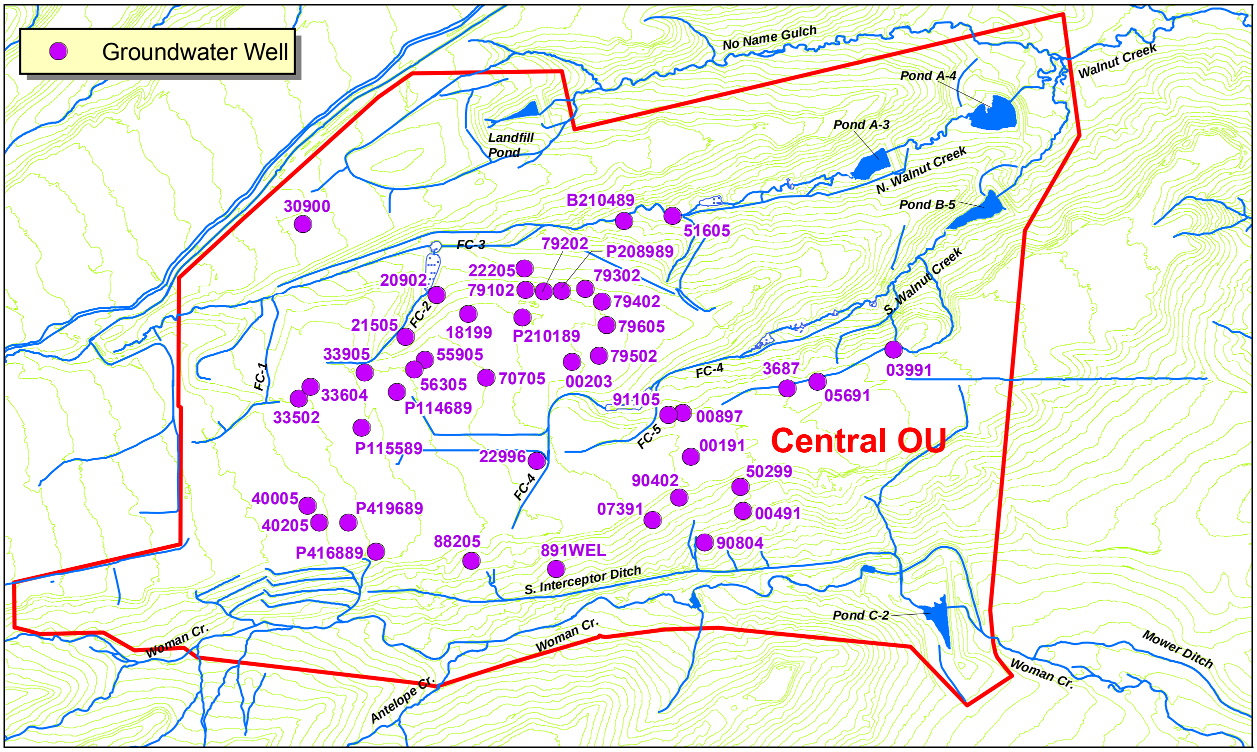


Figure 50. Evaluation Well Locations

Data Evaluation

Evaluation wells were not scheduled for in the fourth quarter of 2010.

3.1.2.7 Investigative Monitoring

When reportable water quality measurements are detected by surface-water monitoring at POEs or POCs, additional monitoring may be required to identify[6] the source and evaluate for mitigating action. Although not required by RFLMA, this investigative monitoring objective is intended to provide upstream water quality information if reportable water quality values are detected at POEs or POCs. Data collection is generally limited to POE and POC analytes and is intended to be discontinued once acceptable water quality has been demonstrated at POEs and POCs for an extended period.

Data collection is currently implemented at the locations listed in Table 22 and shown on Figure 51. The majority of these locations are sampled primarily to satisfy other monitoring objectives, though the data are used for this investigative objective. The current locations were not chosen in response to a specific source evaluation; they were chosen preemptively as a BMP immediately following cleanup and closure work and are intended to be discontinued under this monitoring objective based on data evaluation. Any future data collection upstream of POEs and POCs, subject to the consultative process, is not limited to the locations in Table 22. The parties may also elect to collect data using other methods, subject to the characteristics of the reportable water quality values and through the consultative process.

[6] Note that the term "identify" is used here to mean "locate." Characterization is also implied.

Table 22. Sampling and Data Evaluation Protocols at Investigative Monitoring Locations

Location Code	Location Description	Sample Types/Frequencies	Analytes	Data Evaluation
GS05	Woman Creek at western Refuge boundary	Continuous flow-paced composites; frequency varies (target is 8 per year)[a]	total U	See Figure 6−15 in Appendix D
GS13	North Walnut Creek just upstream of A-Series Bypass	Continuous flow-paced composites; frequency varies (target is 8 per year)[a]	total U	See Figure 6−15 in Appendix D
GS51	Drainage area tributary to the SID and south of former 903 Pad/Lip	Continuous flow-paced composites; frequency varies (target is 8 per year)[a]	total Pu and Am; [TSS[b]]	See Figure 6−15 in Appendix D
GS59	Woman Creek 800 feet east of OLF	Continuous flow-paced composites; frequency varies (target is 8 per year)[a]	total U	See Figure 6−15 in Appendix D
SW018	FC-2 west of former Building 771 area	Continuous flow-paced composites; frequency varies (target is 8 per year)[a]	total Pu and Am; [TSS[b]]	See Figure 6−15 in Appendix D

Notes: [a] Frequency depends on available flow.
[b] Total suspended solids (TSS) is analyzed when the composite sampling period is within TSS holding-time limits.

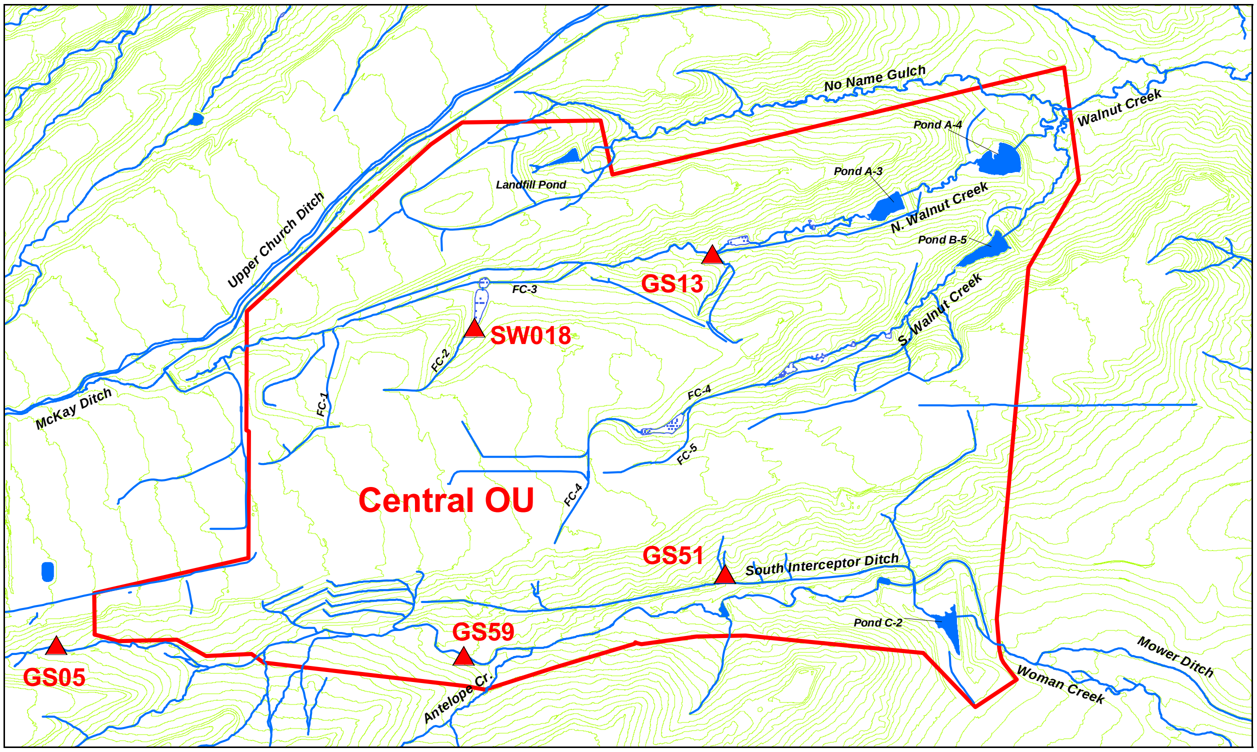


Figure 51. Investigative Monitoring Locations

Data Evaluation

During CY 2010, five investigative locations were operational (Table 22). As of November 26, 2007, analysis of composite samples collected at SW018 for Pu and Am has been discontinued. This action has been taken in accordance with the "Investigative Monitoring" flowchart (see Appendix D) for upstream locations where no reportable compliance values have been observed at a downstream POE or POC. Composite samples for Pu and Am will continue to be collected at SW018, but analysis will not be routinely conducted. These samples will be archived for 6 months and will only be analyzed if required by a source evaluation triggered by reportable compliance values observed at a downstream POE or POC.

No routine data evaluation for the investigative objective is presented in this report. Refer to Appendix B, which contains the water-quality data, for additional information.

3.1.2.8 PLF Monitoring

The PLF is located in the COU just north of the former Industrial Area (IA). This objective deals with monitoring surface water and groundwater at the PLF to determine the short- and long-term effectiveness of the remedy. These requirements were initially identified in the *Final Interim Measures/Interim Remedial Action for IHSS 114 and RCRA Closure of the RFETS Present Landfill*, Appendix B: "Post-Accelerated Action Monitoring and Long-Term Surveillance and Monitoring Considerations" (DOE 2004), and finalized in the PLF M&M Plan (DOE 2008a).

Water monitoring locations for the PLF are shown on Figure 52. The surface-water and treatment system monitoring requirements deal specifically with the PLFTS and are discussed in detail in Section 3.1.2.10. Details regarding general groundwater monitoring are provided below.

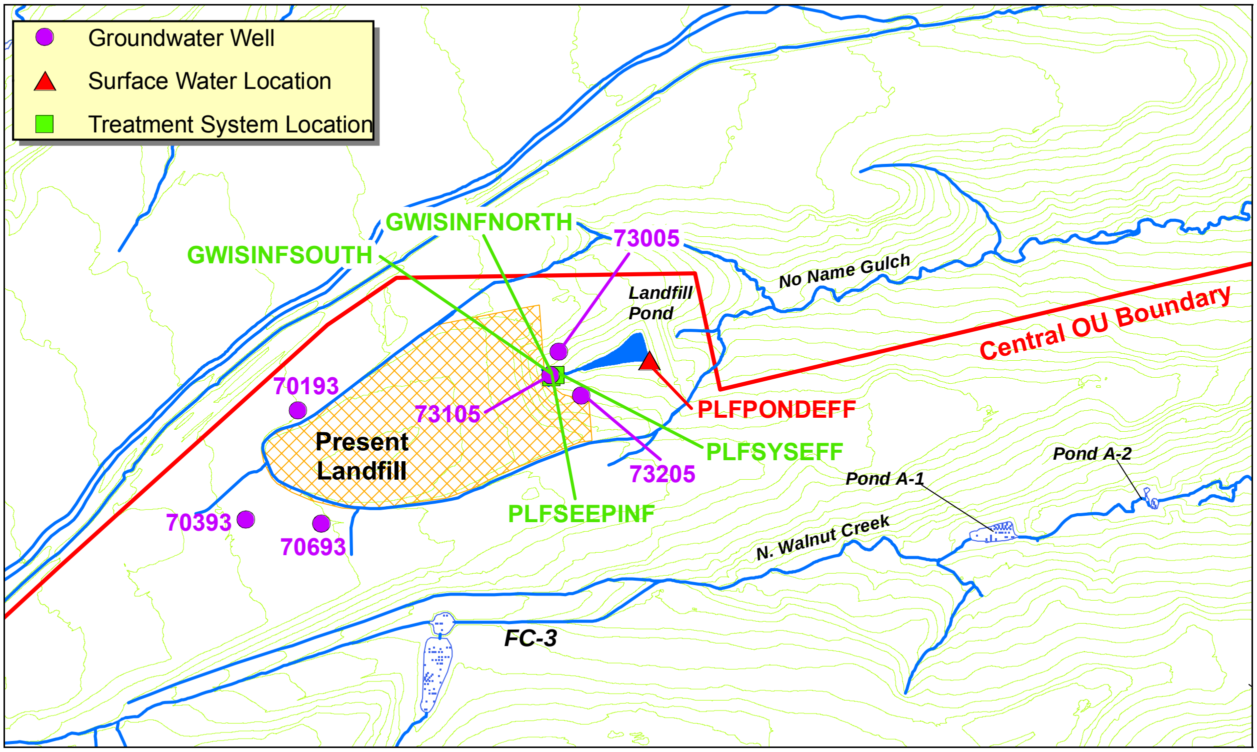
The RCRA monitoring network at the PLF comprises six wells: three are located upgradient of the landfill, and three are downgradient of the landfill but upgradient of the Landfill Pond. The RCRA wells are monitored in accordance with RFLMA. Decision rules are also set forth in that document; see Appendix D for the RFLMA decision flowcharts. Additional monitoring wells are present in the general vicinity of the PLF; however, they do not contribute to the RCRA monitoring of the landfill and are discussed in other sections of this report.

Sampling and data evaluation protocols for the RCRA wells at the PLF are provided in Table 23.

Table 23. Sampling and Data Evaluation Protocols at PLF RCRA Monitoring Wells

Location Code	Location Description	Sample Types/ Frequencies	Analytes[a]	Data Evaluation
70193	Upgradient (northwest) of the upgradient end of the PLF	Quarterly each calendar quarter	VOCs, metals	See Figure 10 in Appendix D
70393	Upgradient (west/southwest) of the upgradient end of the PLF	Quarterly each calendar quarter	VOCs, metals	See Figure 10 in Appendix D
70693	Upgradient (southwest) of the upgradient end of the PLF	Quarterly each calendar quarter	VOCs, metals	See Figure 10 in Appendix D
73005	Downgradient (northeast) of the downgradient end of the PLF	Quarterly each calendar quarter	VOCs, metals	See Figure 10 in Appendix D
73105	Downgradient (east) of the downgradient end of the PLF at the PLFTS	Quarterly each calendar quarter	VOCs, metals	See Figure 10 in Appendix D
73205	Downgradient (southeast) of the downgradient end of the PLF	Quarterly each calendar quarter	VOCs, metals	See Figure 10 in Appendix D

Notes: [a] Samples for the analysis of metals are field-filtered using a 0.45-micrometer in-line filter.
Laboratory analytes are limited to those based on the analytical methods listed in the PLF M&M Plan.



Note: PLFSYSEFF serves as both the treatment system effluent monitoring location and a performance surface-water location.

Figure 52. PLF Monitoring Locations

Data Evaluation

All RCRA wells at the PLF were sampled in the fourth quarter of CY 2010. Results are included in Appendix B.

This section presents the evaluation of the PLF groundwater quality data for all of CY 2010. Monitoring performed in 2010 at the PLF RCRA wells is summarized in Table 24.

Table 24. RCRA Groundwater Sampling Performed in 2010 at the PLF

Well	Location	Q1	Q2	Q3	Q4
70193	Upgradient	VOCs, metals	VOCs, metals	VOCs, metals	VOCs, metals
70393	Upgradient	VOCs, metals	VOCs, metals	VOCs, metals	VOCs, metals
70693	Upgradient	VOCs, metals	VOCs, metals	VOCs, metals	VOCs, metals
73005	Downgradient	VOCs, metals	VOCs, metals	VOCs, metals	VOCs, metals
73105	Downgradient	VOCs, metals	VOCs, metals	VOCs, metals	VOCs, metals
73205	Downgradient	VOCs, metals	VOCs, metals	VOCs, metals	VOCs, metals

Notes: Q = quarter. Metals include U. Only RFLMA-defined (DOE 2007a) RCRA wells supporting the PLF are listed; other wells in the area (such as Sentinel and Evaluation wells) are omitted because they are not part of the RCRA monitoring network.

Downgradient water quality (as represented by analytical data from wells 73005, 73105, and 73205) was statistically compared against upgradient water quality (as represented by analytical data from wells 70193, 70393, and 70693). Generally, water quality in the upgradient wells continues to be more impacted than that in the downgradient wells, because upgradient wells 70393 and 70693 are within the margins of the Property Utilization and Disposal (PU&D) Yard Plume, an area of groundwater contaminated with VOCs.

Statistical evaluation of the analytical data from the PLF was performed using all nonrejected data for upgradient and downgradient RCRA wells. An interwell comparison was made (i.e., comparing upgradient wells against downgradient wells) in accordance with RFLMA and the PLF M&M Plan, using the Analysis of Variance (ANOVA) procedure as performed using the Sanitas software package (Sanitas Technologies 2009). The data were also assessed for trends, again using Sanitas and the S-K trending method in keeping with the findings of previous studies indicating this method to be most appropriate for Rocky Flats groundwater data (K-H 2004a).

RFLMA-required consultation with the regulators is required if both of two conditions are true of PLF groundwater: (1) concentration of a constituent is statistically higher in downgradient than upgradient groundwater (per ANOVA results), and (2) the constituent is also calculated to be on an increasing trend. In 2010, both of these conditions were true for B in groundwater from well 73105. Consultation was conducted in early 2011 as reported in a Contact Record issued in early 2011. (Note that this same outcome was the result of the statistical evaluations performed for the 2009 Annual Report, as reported in Contact Record 2010-05 and DOE 2010d). These groundwater conditions and statistical evaluations are described in greater detail below.

The ANOVA evaluation of the groundwater analytical data from PLF RCRA wells indicates that groundwater sample results from some of the downgradient wells are statistically higher in the concentration of certain constituents, all metals. As summarized in Table 25, one or more downgradient wells produce groundwater samples with statistically significant higher concentrations of boron (B), cadmium (Cd), selenium (Se), uranium (U), or zinc (Zn) than upgradient wells. With the exception of Cd in well 73205 and Zn in well 73005 (data sets for both of which contain numerous nondetects), these results are unchanged from those reported in the annual report for 2009 (DOE 2010d).

Table 25. Results of Groundwater ANOVA Evaluation for 2010 at the PLF

Analyte	73005	73105	73205
B	x	x	x
Cd			x
Se	x		x
U	x	x	x
Zn	x	x	

Note: x = analyte is present in groundwater at a statistically significant higher concentration in the indicated downgradient well compared to upgradient wells.

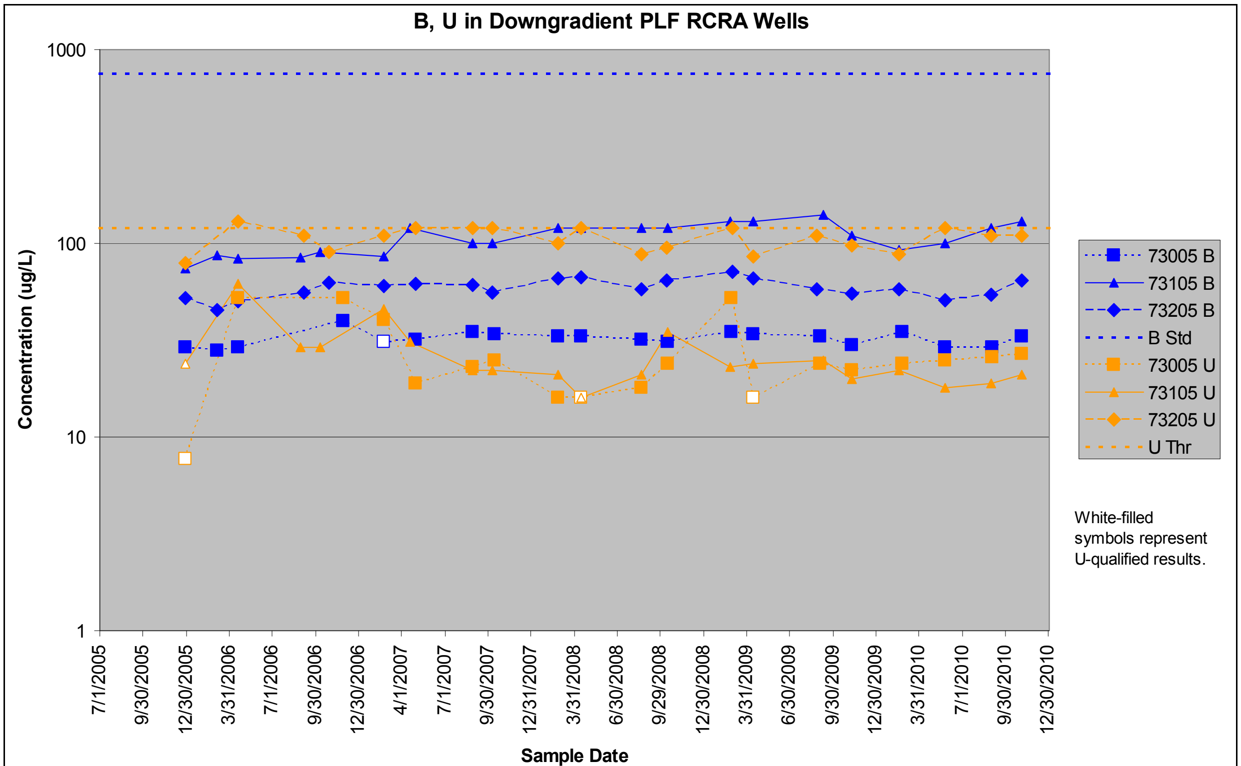
Concentrations of B in downgradient groundwater remain well under the RFLMA Table 1 standard of 750 µg/L; the highest concentration observed in 2010 from a downgradient PLF well was 130 µg/L (well 73105, November 2010). The same applies to concentrations of Zn (RFLMA standard = 141 µg/L), which in 2010 was consistently reported either as a nondetect or J-qualified concentration. The highest concentration of Zn reported in 2010 was in a sample from well 73205 (13 µg/L in February).

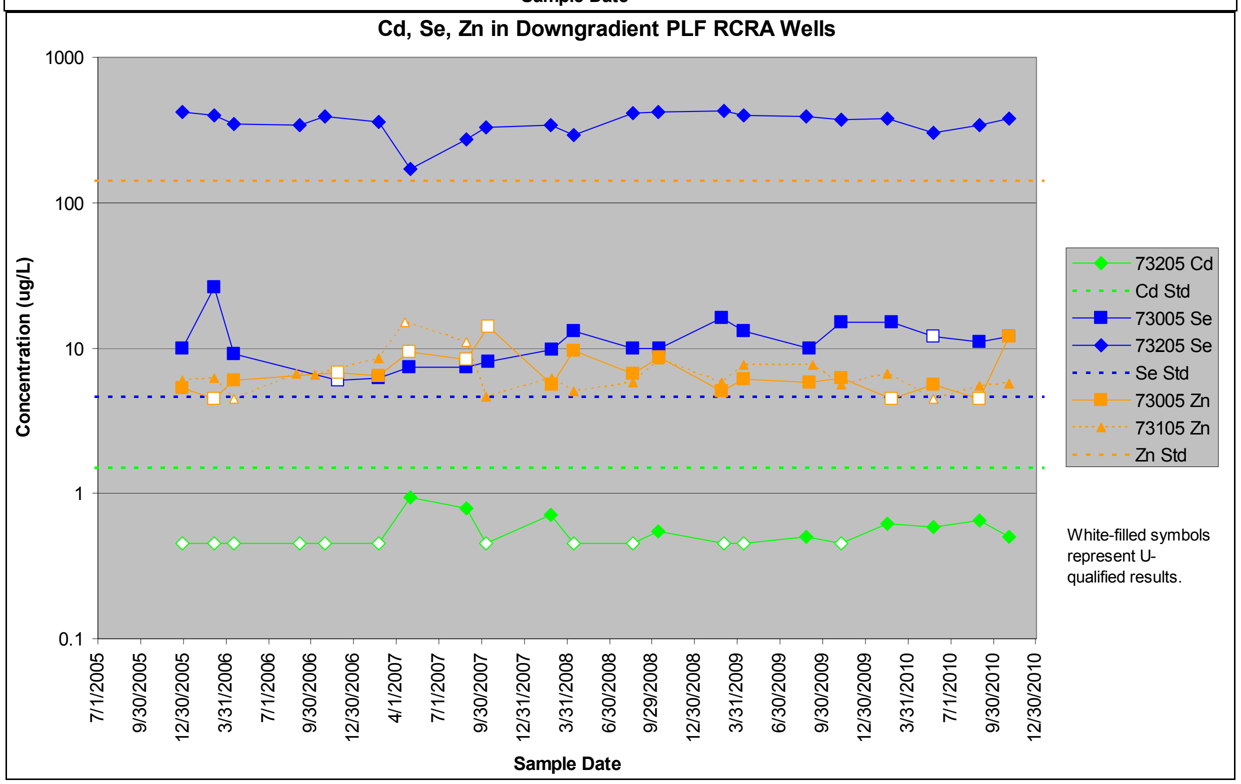
Concentrations of Se in groundwater samples from downgradient well 73005 were most often above the 4.6 µg/L RFLMA standard in 2010, ranging from nondetect to three J-qualified detections reported at 11 µg/L to 15 µg/L. These concentrations are consistent with previous data collected since this well was first installed. Similarly, as in previous years, concentrations of Se in samples from well 73205 are consistently well above the corresponding standard, ranging in 2010 from 300 µg/L to 380 µg/L.

Reported concentrations of Cd in samples collected in 2010 from well 73205 ranged from 0.5 µg/L to 0.65 µg/L. Each result was "J"-qualified.

Although all three downgradient wells produce samples with concentrations of U that are statistically higher than in upgradient wells, only well 73205 produces samples with concentrations that are close to the U threshold of 120 µg/L. To date, U data from this well include one result (from a sample collected in 2006) exceeding that concentration; in 2010, concentrations ranged from 88 µg/L to, on one occasion, 120 µg/L. (This is consistent with conditions in previous years: in 2008, concentrations of uranium in this well varied from 88 µg/L to 120 µg/L; and in 2009, the range was 85 µg/L to 120 µg/L.) The other downgradient wells produce groundwater samples with U concentrations that are much lower than the threshold.

Figure 53 provides time-series plots of the ANOVA-identified constituents summarized in Table 25. Note the frequent nondetects reported for some constituents, particularly Cd in samples from well 73205, but also Zn from 73005, as indicated above. The relatively consistent concentrations of these constituents from 2005 through 2010 are evident on this figure.





Notes: Only those analyte-well combinations identified in the ANOVA evaluation of PLF groundwater data as having statistically significant higher concentrations in downgradient RCRA wells (as listed in Table 25) are shown. RFLMA action levels are published in DOE 2007a. Note that the uranium data are compared to the uranium threshold. In addition to the nondetects ("U"-qualified results), numerous other results were qualified ("B," "J" [estimated]), but are not shown differently for the sake of simplicity. Note logarithmic concentration scales.

Figure 53. Constituents Determined Through ANOVA to be Statistically Elevated in Samples from Downgradient Wells Relative to Upgradient Wells at the PLF

One VOC was detected in downgradient wells. 1,3-dichlorobenzene (DCB) was reported at estimated (i.e., J-qualified) concentrations ranging from 0.21 µg/L to 0.87 µg/L in groundwater samples collected in the first and second quarters from wells 73105 and 73205. J-qualified detections of 1,3-DCB were also reported in one or both of these downgradient PLF wells in 2006 and 2008. Similar concentrations were reported in samples collected in 2010 from the upgradient wells (70193, 70393, and 70693) and are typically reported in one or more of these wells at least once annually, although concentrations in 2009 at the upgradient wells were as high as 3.4 µg/L. The RFLMA Table 1 standard for 1,3-DCB is 94 µg/L. This compound is used as an insecticide and fungicide, as well as a space deodorizer.

The constituents identified via the ANOVA statistical evaluation are all found in natural settings, and the statistical results summarized above may not reflect the presence of contaminants related to the PLF. For example, B is incorporated in evaporite minerals (such as ulexite, or "TV rock," and the more common borax), metamorphic minerals (such as tourmaline), and perhaps most notably in coals and similar deposits of carbonaceous fossilized organic matter. Two of the upgradient wells are screened in alluvial materials, and one is screened in weathered bedrock. The three downgradient wells are all screened in the weathered bedrock, and lithologic logs from these wells note the presence of fossilized organics (i.e., substances akin to lignite or coal) at the depth corresponding to the screened interval. Thus, these wells may produce waters with higher concentrations of B as an artifact of the geology and variations in screened materials.

Similarly, the presence of Se at elevated concentrations may be related to regional mineralization and the prevalence of coals and organic-rich sediments, clays, and iron oxides in the geologic intervals screened by PLF wells (and most monitoring wells at Rocky Flats). The sulfide mineralization that drew prospectors to Colorado and is evident in the mountains west of the Site would be a source of Se, as might shales that are closer to the Site. Se would be liberated as those rocks and minerals weather. Clays, coals, and iron oxides could then act to sorb the mobile Se and may be present in the screened interval of these wells.

According to RFLMA, if downgradient concentrations are significantly greater than upgradient concentrations (as indicated by the ANOVA statistics summarized in Table 25) *and* if downgradient concentrations show a statistically significant increasing trend (as discussed and summarized in Section 3.1.5.3), the consultative process is initiated to determine the appropriate response. Increasing concentration trends meeting the required level of significance are determined for B in PLF downgradient well 73105. This trend is visually apparent on Figure 53 and was also reported in the 2009 Annual Report (DOE 2010d). The consultative process was initiated in response to that determination and is summarized in Contact Record 2010-05. Increasing trends for B are also indicated for two of the three upgradient PLF RCRA wells, and a decreasing trend is calculated for the third well; however, these trends do not meet the 95 percent level of statistical significance. An increasing trend is also reported for chromium (Cr) in downgradient well 73005, but this analyte is not identified as being present at higher concentrations in groundwater from downgradient wells than from upgradient wells. Therefore, the trend in Cr concentrations at well 73005 does not represent a condition requiring consultation. (In addition, the Cr data for this well include numerous nondetects, suggesting this calculated trend may not be real.)

According to RFLMA, calculated 85th percentile concentrations from downgradient PLF wells are also to be compared to the corresponding standards to support the exit strategy. However, the data to be used in this comparison are from the previous two periodic (i.e., CERCLA) reviews; these wells and their corresponding monitoring requirements have not existed long enough to support two reviews. (The first review was in 2002, before any of the downgradient wells were installed and before the current RCRA monitoring schedule was in place.) Therefore, such a comparison cannot be completed at this time.

Groundwater quality at the PLF is impacted on the upgradient side by VOCs from the PU&D Yard Plume. (Refer to the separate discussion of this plume in Section 3.1.5.3.) As noted above, data from the downgradient RCRA wells in 2010 only showed J-qualified (estimated) detections of the single VOC, 1,3-DCB.

Groundwater flow at the PLF is strongly affected by the GWIS, which diverts groundwater flow around the perimeter of the PLF rather than through the wastes. The GWIS includes a slurry wall and perforated drain around the upgradient and side-gradient perimeter of the PLF and acts to isolate groundwater within the PLF from that outside the PLF. (Refer to the previously published reports referenced earlier in this section for more detail on the GWIS and related discussions.) Previous RCRA and groundwater annual reports have confirmed the effectiveness of this isolation. Because the GWIS is located between the upgradient PLF RCRA wells and the downgradient PLF RCRA wells, estimating seepage velocities as discussed in Section 3.1.3.5 between those sets of wells is not appropriate.

3.1.2.9 OLF Monitoring

The OLF is located in the COU just south of the former IA. This objective addresses monitoring surface water and groundwater at the OLF to determine the short- and long-term effectiveness of the remedy. These requirements were initially identified in the *Final Interim Measure/Interim Remedial Action for the Original Landfill (Including IHSS Group SW-2; IHSS 115, Original Landfill and IHSS 196, Filter Backwash Pond)*, Appendix B, “Post-Accelerated Action Monitoring and Long-Term Surveillance and Maintenance Considerations” (DOE 2005a), and finalized in the OLF M&M Plan (DOE 2009a).

Four groundwater monitoring wells were identified to monitor the OLF and are classified as RCRA wells in RFLMA; three of these wells were installed in 2005. One of the OLF RCRA wells is located upgradient of the landfill, and three are downgradient of the landfill but upgradient of Woman Creek. The RCRA wells are monitored in accordance with RFLMA. Decision rules are also set forth in that document; see Appendix D for the RFLMA decision flowcharts. Additional monitoring wells are present in the general vicinity of the OLF; however, they do not contribute to the RCRA monitoring of the facility and are therefore discussed in other sections of this report.

Surface-water and RCRA groundwater monitoring locations for the OLF are shown on Figure 54. Sampling and data evaluation protocols are summarized in Table 26 and Table 27.

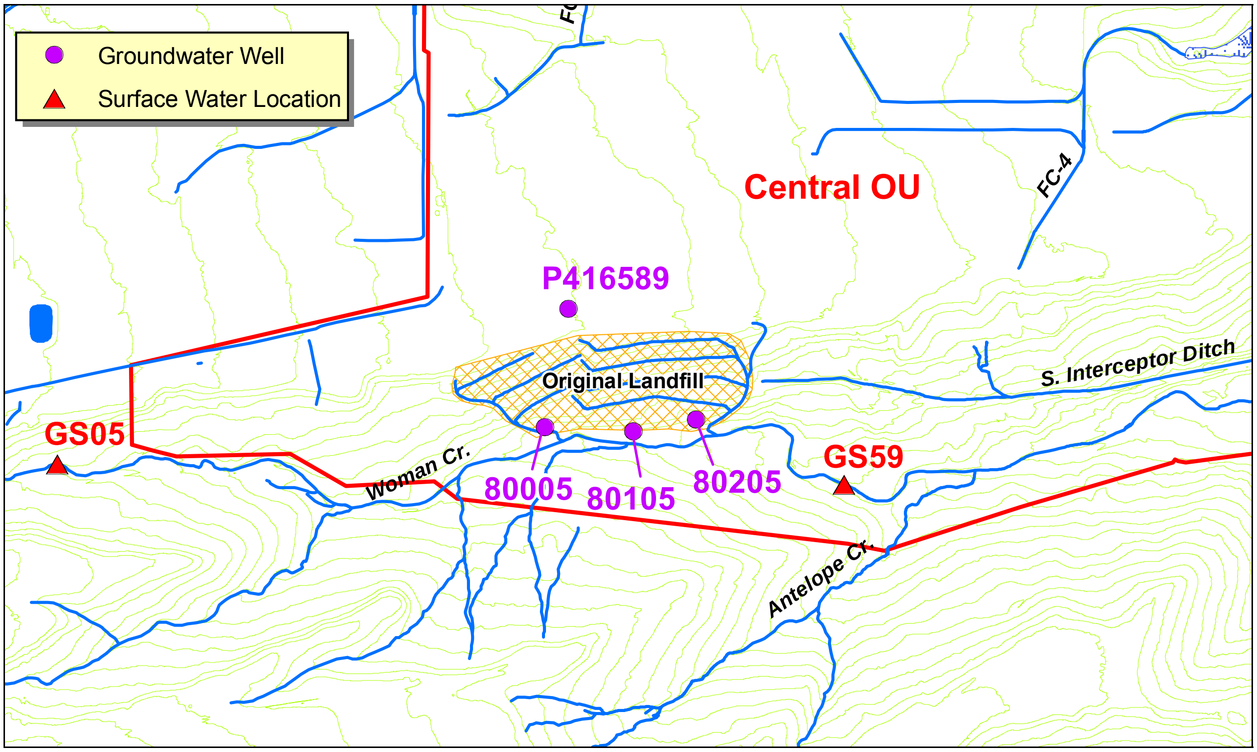


Figure 54. OLF Monitoring Locations

Table 26. Sampling and Data Evaluation Protocols at OLF Surface-Water Monitoring Locations

Location Code	Location Description	Sample Types/ Frequencies	Analytes[b]	Data Evaluation
GS05; upgradient	Woman Creek at west POU fenceline	Quarterly grab samples[a]	Total U; dissolved and total metals; VOCs; mercury	See Figure 12 in Appendix D
GS59; downgradient	Woman Creek 800 feet downstream of OLF	Quarterly grab samples[a]	Total U; dissolved and total metals; VOCs; mercury	See Figure 12 in Appendix D

Notes: [a] Samples for total U and metals are currently collected as continuous flow-paced composites in conjunction with the Investigative monitoring objective; decisions specifically for the OLF monitoring objective only require quarterly grabs.
[b] Laboratory analytes are limited to those based on the analytical methods listed in the OLF M&M Plan.

Table 27. Sampling and Data Evaluation Protocols at OLF RCRA Monitoring Wells

Location Code	Location Description	Sample Types/ Frequencies	Analytes[a]	Data Evaluation
P416589	Upgradient (north) of the OLF	Quarterly each calendar quarter	VOCs, SVOCs, metals	See Figure 10 in Appendix D
80005	Downgradient (south) of the western portion of the OLF	Quarterly each calendar quarter	VOCs, SVOCs, metals	See Figure 10 in Appendix D
80105	Downgradient (south) of the central portion of the OLF	Quarterly each calendar quarter	VOCs, SVOCs, metals	See Figure 10 in Appendix D
80205	Downgradient (south) of the eastern portion of the OLF	Quarterly each calendar quarter	VOCs, SVOCs, metals	See Figure 10 in Appendix D

Notes: [a] Samples for the analysis of metals are field-filtered using a 0.45-micrometer in-line filter.
Laboratory analytes are limited to those based on the analytical methods listed in the OLF M&M Plan.
SVOCs = semivolatile organic compounds

Data Evaluation

Analytical results for GS59 and GS05 are compared, according to Figure 12 in Appendix D, to the appropriate surface-water standard in Table 1 of RFLMA Attachment 2. During CY 2010, no analytes were detected above the applicable standards.

All RCRA wells at the OLF were sampled in the fourth quarter of CY 2010. Results are included in Appendix B.

This section presents the evaluation of the CY 2010 groundwater quality data for the OLF, previously known as OU 5. All RCRA wells are monitored quarterly. Monitoring performed in 2010 is summarized in Table 28.

Table 28. RCRA Groundwater Sampling Performed in 2010 at the OLF

Well	Location	Q1	Q2	Q3	Q4
P416589	Upgradient	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs
80005	Downgradient	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs
80105	Downgradient	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs
80205	Downgradient	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs	VOCs, metals, SVOCs

Notes: Q = quarter. SVOCs = semivolatile organic compounds. Metals include U. Only RCRA wells supporting the OLF are listed; other wells in the area (such as AOC, Sentinel, and Evaluation wells) are omitted because they are not part of the RCRA monitoring network.

In addition to being monitored and evaluated similarly to RCRA wells (i.e., sampled quarterly, and resulting analytical data evaluated by upgradient-downgradient comparisons), the three downgradient wells are also monitored and evaluated in the manner of Sentinel wells. Specifically, data from these wells are statistically evaluated using 85th percentile concentrations to compare against surface-water standards, and data trends are constructed as warranted to determine a need for action.

As with the PLF, statistical evaluation of the analytical data from the OLF was performed using all nonrejected data for upgradient and downgradient RCRA wells. An interwell comparison was made (i.e., comparing the upgradient well against downgradient wells) in accordance with RFLMA and the OLF M&M Plan (DOE 2009a), using the ANOVA procedure as performed with the Sanitas software package (Sanitas Technologies 2009). The data were also evaluated for statistical trends, again using Sanitas and the S-K trending method in keeping with the findings of previous studies indicating this method to be most appropriate for Rocky Flats groundwater data (K-H 2004a).

RFLMA-required consultation with the regulators is required if either of two conditions is true of OLF groundwater: (1) concentrations of certain constituents are statistically higher in downgradient than upgradient groundwater (per ANOVA results); or (2) concentrations of constituents in a downgradient well are on an increasing trend meeting the 95 percent level of significance. In 2010, condition (1) was true for B in all three downgradient wells and uranium in downgradient well 80205, but condition (2) did not apply because no such increasing trends were calculated. Consultation was conducted in early 2011 as reported in a Contact Record issued in early 2011. (Note that this same outcome was the result of the statistical evaluations performed for the 2009 Annual Report, as reported in Contact Record 2010-05 and DOE 2010d) These groundwater conditions and statistical evaluations are described in greater detail below.

ANOVA evaluation of the groundwater analytical data from OLF RCRA wells indicates that groundwater samples from the downgradient wells are statistically higher in the concentration of certain constituents. No VOCs were found in downgradient wells at statistically higher concentrations than in upgradient wells, but the concentrations of two metals are statistically higher in one or more downgradient wells. These results are summarized in Table 29.

Table 29. Results of Groundwater ANOVA Evaluation at the OLF

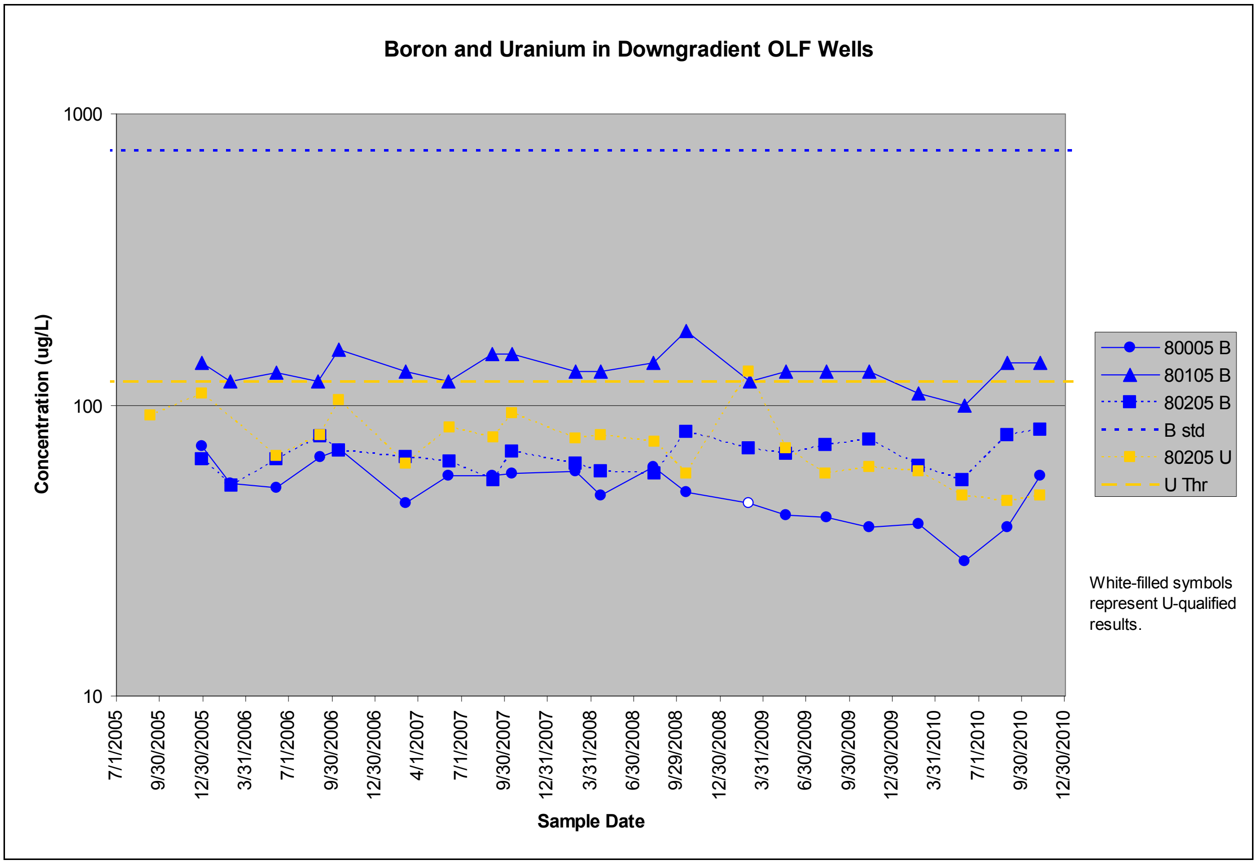
Analyte	80005	80105	80205
B	x	x	x
U			x

Note: x = analyte is present in groundwater at a statistically significant higher concentration in the indicated downgradient well compared to upgradient wells, based on ANOVA statistical analyses performed using the Sanitas software package.

RFLMA instructs that if concentrations in downgradient wells are found to be significantly higher than in upgradient, the consultative process is initiated to determine the appropriate response. All three downgradient wells produce groundwater samples with statistically higher concentrations of B than the upgradient well, and the same applies to concentrations of U in well 80205. This is identical to ANOVA results reported in the 2007, 2008, and 2009 Annual Reports (DOE 2008c, 2009d, and 2010d). Consistent with conditions reported above for the PLF, consultation regarding OLF conditions was conducted as documented in Contact Record 2010-05. Also as noted above in the discussion of the PLF groundwater results, these findings may be due to natural geological and geochemical conditions.

Figure 55 provides time-series plots of reported B and U concentrations in groundwater from the wells listed in Table 29. As this figure indicates, concentrations of B in downgradient groundwater are uniformly well under the RFLMA Table 1 standard of 750 µg/L; the highest concentrations reported in 2010 were two results of 140 µg/L from well 80105. The surface-water quality reported at downstream OLF location GS59 does not indicate that B concentrations in downgradient OLF groundwater represent a threat.

Concentrations of U in samples from downgradient well 80205 (Figure 55) were consistently below the U threshold in 2010. Given that only one result has been reported above that value (in March 2009), it follows that the 85th percentile concentration of U in samples from well 80205 also does not exceed this threshold (as described in the Sentinel well decision rules that also apply to downgradient OLF RCRA wells). Including the 2010 results, the 85th percentile concentration of U in samples from well 80205 is 94 µg/L, slightly lower than the 100 µg/L value reported in the 2009 Annual Report (DOE 2010d). Groundwater from this well was analyzed for anthropogenic content in late 2007 and found to be 100 percent natural (DOE 2008c). As with B, the surface water monitored at location GS59 has not indicated that U concentrations in downgradient OLF groundwater represent a threat to surface-water quality.



Notes: Only those analyte-well combinations identified in the ANOVA evaluation of OLF groundwater data as having statistically significant higher concentrations in downgradient RCRA wells are shown. RFLMA action levels are published in DOE 2007a. Note that the U data are compared to the U threshold. Several results were qualified ("B," "J"), but for simplicity are not shown differently. Note logarithmic concentration scale.

Figure 55. B and U in Downgradient Groundwater from OLF RCRA Wells Identified in 2010 ANOVA Data Evaluations

Data reported in 2010 from downgradient RCRA wells at the OLF include two VOC detections and three detections of semivolatile organic compounds (SVOCs); all but one qualified as estimates (Table 30). Four of the reported concentrations were beneath the applicable RFLMA standard/PQL, and one detection, representing the SVOC hexachloroethane, exceeded the corresponding PQL. This constituent was reported in the fourth quarter 2010 at a concentration of 16 µg/L in a sample from well 80005; the PQL is 1 µg/L. This represents the first detection of this constituent in a groundwater sample from the RCRA wells at the OLF: every other result, for each of the wells, is a nondetect.

Table 30. VOCs and SVOCs Detected in 2010 in Downgradient Wells at the OLF

Well	Sample Date	Analyte	Result	Units	Lab Qualifier
80005	2/23/2010	Methylene chloride	0.39	µg/L	J
80005	11/8/2010	Bis(2-ethylhexyl)phthalate	1.9	µg/L	J
80005	11/8/2010	Hexachloroethane	16	µg/L	
80105	2/23/2010	Methylene chloride	0.33	µg/L	J
80105	6/1/2010	Diethyl phthalate	0.71	µg/L	J

Note: J = analyte detected, result is estimated. No validation qualifiers were attached to these results. Applicable RFLMA standards: methylene chloride, 4.6 µg/L; bis(2-ethylhexyl)phthalate, 10 µg/L (PQL); hexachloroethane, 1 µg/L (PQL); diethyl phthalate, 5,600 µg/L.

Similar to the reported detection of hexachloroethane, the results for bis(2-ethylhexyl)phthalate and diethyl phthalate represent the first validated detections of these constituents from any of the downgradient RCRA wells at the OLF. Upgradient well P416589 likewise has reported no validated detections of hexachloroethane or diethyl phthalate, but bis(2-ethylhexyl)phthalate has been detected at low, J-qualified (estimated) concentrations on several occasions. Also, the common laboratory solvent methylene chloride has been reported in several samples from downgradient OLF RCRA wells, typically B-qualified (signifying the blank was contaminated with this constituent) and always J-qualified (estimated concentration). Three detections are not B-qualified: one in August 2008 from well 80105 (estimated at 0.43 µg/L) and two in February 2010 from wells 80005 (estimated at 0.39 µg/L) and 80105 (estimated at 0.33 µg/L). Detections of this constituent have not been confirmed in samples from upgradient OLF RCRA well P416589.

According to RFLMA, downgradient OLF wells are also assessed in a manner consistent with that used for Sentinel wells (DOE 2007a); concentrations are evaluated for statistically-significant (95 percent) trends, and 85th percentile concentrations are assessed in comparison with the applicable RFLMA standards or threshold. There were no increasing trends meeting the 95 percent level of significance for the downgradient wells. However, a statistically-significant (95 percent) decreasing trend was calculated for B concentrations in samples from well 80005 and U concentrations from well 80205. In addition, an increasing trend in B meeting the 95 percent level of significance was calculated for upgradient well P416589, as was an increasing trend in U that does not meet this level of significance (see trending results in Appendix B).

RFLMA instructs that calculated 85th percentile concentrations from downgradient OLF wells are to be compared against the corresponding standards to support the exit strategy. However, as with downgradient RCRA wells at the PLF, the data to be used in this comparison are from the previous two CERCLA reviews; these OLF wells have not existed long enough to support two reviews. (The first review was in 2002, before any of the downgradient wells were installed and before the current RCRA monitoring schedule was in place.) Therefore, such a comparison cannot be completed at this time.

Groundwater flow at the OLF is not affected by controls such as the GWIS at the PLF. Groundwater flows beneath the pediment surface on the north side of the OLF in a general west-to-east direction. As it nears the southern edge of the pediment, closest to the OLF, groundwater is diverted to a more south-southeasterly direction. This latter general flow direction applies to groundwater moving through the OLF.

Groundwater flow velocities were calculated (see Section 3.1.3.5) for OLF well pair P416589 (the upgradient well) and 80105 (the middle downgradient well). The resulting estimates for the travel time from the upgradient to downgradient well based on water level data collected in 2010 are slightly under 3 years. Note that this calculated velocity is simplistic and applies only to pure water; the migration of contaminants would be retarded to varying degrees.

Seeps are also present at the OLF and have been observed in this area for decades (as well as being suggested on aerial photographs taken before the Rocky Flats Plant came into existence in the 1950s). Additional discussion of seeps at the OLF is provided in Section 2.4.2.

3.1.2.10 Groundwater Treatment System Monitoring

Contaminated groundwater is intercepted and treated in four areas of the Site. Three of these systems (MSPTS, ETPTS, and SPPTS) include a groundwater intercept trench (collection trench), which is similar to a French drain with an impermeable membrane on the downgradient side. Groundwater entering the trench is routed through a drain pipe into one or more treatment cells, where it is treated and then discharged to the subsurface, and eventually reaches surface water. The fourth system (PLFTS) treats water from the north and south components of the GWIS and flow from the PLF seep.

Water monitoring at the MSPTS, ETPTS, and SPPTS includes a minimum of three sample-collection points: untreated influent entering the treatment system, treated effluent exiting the system, and a surface-water performance location. At the PLFTS, the treated effluent and surface-water sampling locations are typically the same; this is discussed in further detail below.

The fundamental questions at each system are whether (1) influent-water quality indicates that treatment is still necessary, (2) effluent-water quality indicates that system maintenance is required, and (3) surface-water quality suggests impacts from inadequate treatment of influent.

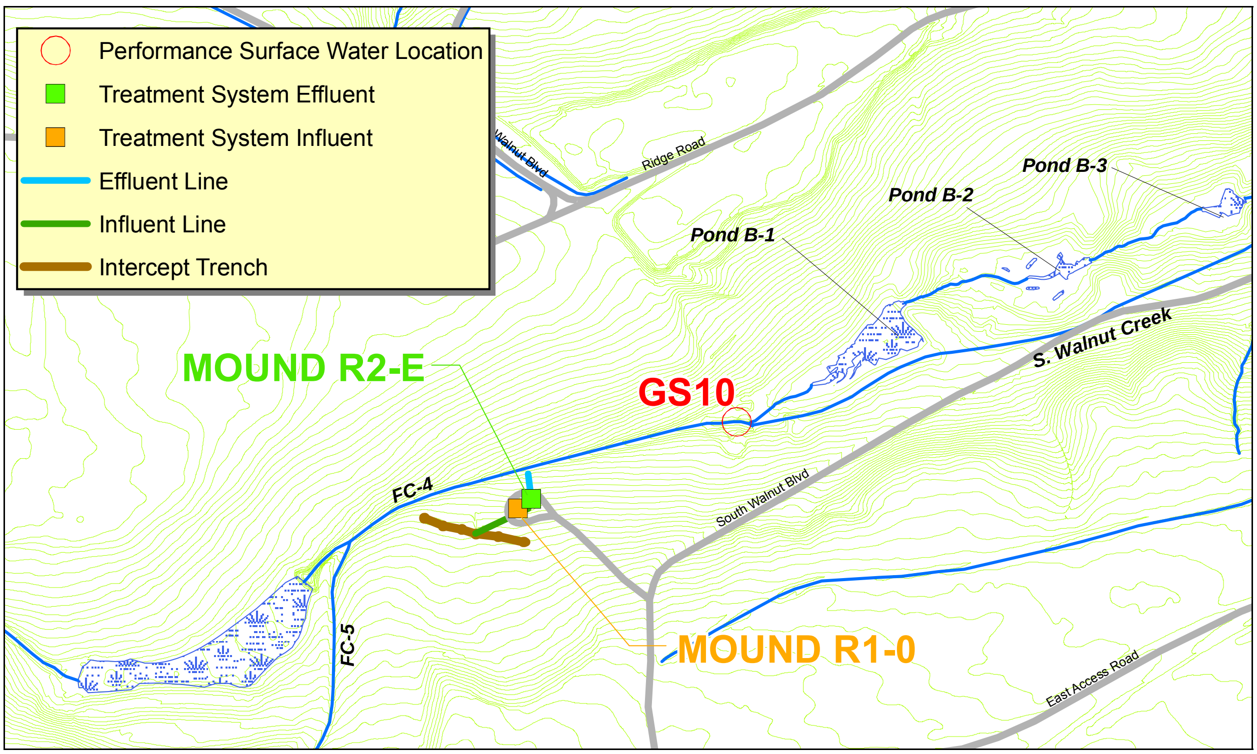
Note that groundwater monitoring wells also support the MSPTS, ETPTS, and SPPTS. (Wells are also present in the vicinity of the PLFTS, but their objectives differ as they directly support the PLF as RCRA wells.) These locations are discussed in the sections that correspond to their respective objectives (i.e., text describing Sentinel and Evaluation wells) and that discuss groundwater plume characteristics.

Mound Site Plume Treatment System

RFMLA monitoring locations specific to the MSPTS are shown on Figure 56. Sampling and data evaluation protocols are summarized in Table 31. In addition to the monitoring locations shown, one well is monitored as a Sentinel well (see related text above), and several piezometers are present within the collection trench. The piezometers are retained for troubleshooting purposes.

Table 31. RFLMA Sampling and Data Evaluation Protocols at MSPTS Monitoring Locations

Location Code	Location Description	Sample Types/Frequencies	Analytes	Data Evaluation
MOUND R1-0	Influent sampling location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 11 in Appendix D
MOUND R2-E	Effluent sampling location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 11 in Appendix D
GS10	Downgradient surface-water performance location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 11 in Appendix D



Note: The intercept trench also captures water from a former 72-inch storm drain utility corridor (not shown) that previously emptied to South Walnut Creek (shown here as FC-4). This corridor runs from south to north, approximately parallel to the dominant trend of FC-5 shown here. It was backfilled and tied into the western portion of the intercept trench during Site closure activities. See the 2006 Annual Report (DOE 2007c) for additional discussion, and subsequent sections of this 2010 report for water quality updates.

Figure 56. RFLMA MSPTS Monitoring Locations

Data Evaluation

All MSPTS locations listed above were scheduled for routine monitoring in the fourth quarter of CY 2010. Results are provided in Appendix B and are discussed in Section 3.1.5.3.

In addition to the RFLMA locations, the two locations in the nearby FC-4 were sampled in the fourth quarter to support the evaluation outlined in Contact Record 2010-07. This is also discussed in Section 3.1.5.3.

East Trenches Plume Treatment System

RFMLA monitoring locations specific to the ETPTS are shown on Figure 57. Sampling and data evaluation protocols are summarized in Table 32. In addition to the monitoring locations shown, several monitoring wells are present, and several piezometers are present within the collection trench. Each of the wells is monitored as a Sentinel well (see related text above). The piezometers are retained for troubleshooting purposes.

Table 32. RFLMA Sampling and Data Evaluation Protocols at ETPTS Monitoring Locations

Location Code	Location Description	Sample Types/Frequencies	Analytes	Data Evaluation
ET INFLUENT	Influent sampling location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 11 in Appendix D
ET EFFLUENT	Effluent sampling location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 11 in Appendix D
POM2	Downgradient surface-water performance location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	VOCs	See Figure 11 in Appendix D

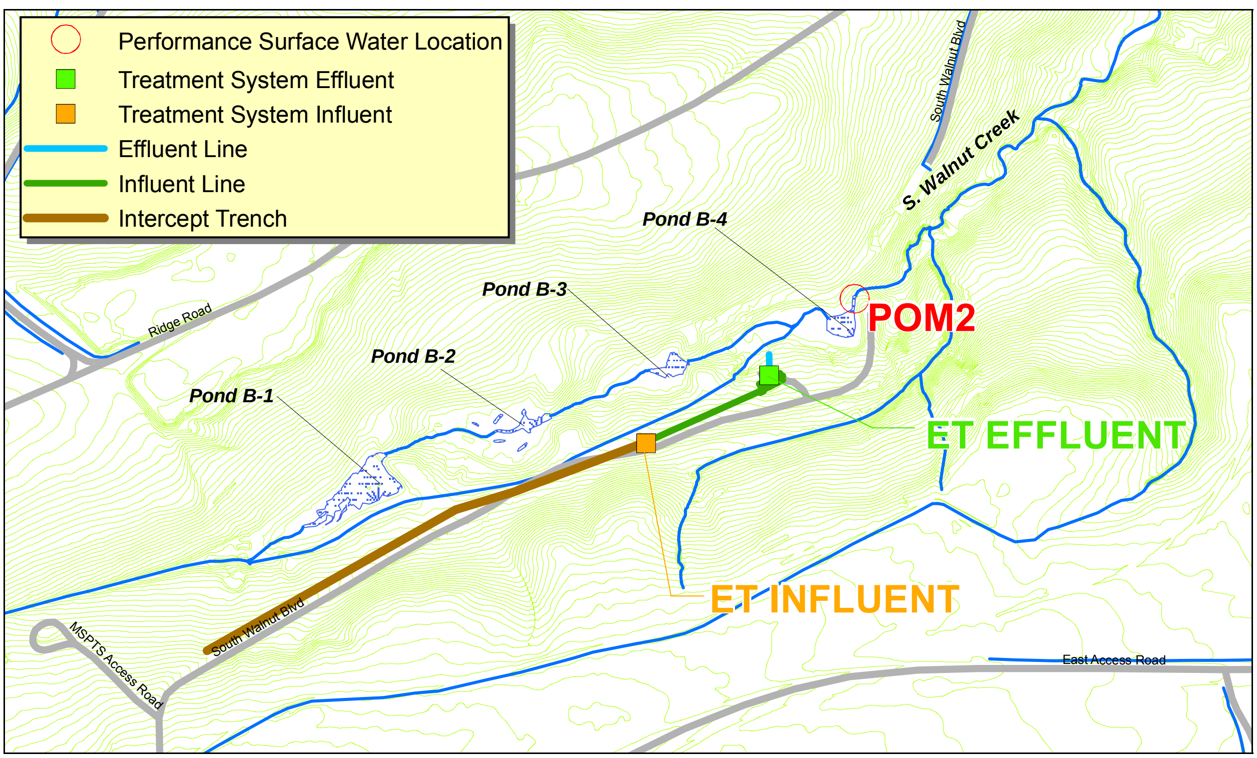


Figure 57. RFLMA ETPTS Monitoring Locations

Data Evaluation

All ETPTS locations listed above were scheduled for routine monitoring in the fourth quarter of CY 2010. Results are provided in Appendix B and are discussed in Section 3.1.5.3.

In addition to the RFLMA locations, the two locations in between the ETPTS effluent discharge gallery and performance location POM2 were sampled in the fourth quarter to support the evaluation outlined in Contact Record 2010-07. This is also discussed in Section 3.1.5.3.

Solar Ponds Plume Treatment System

RFLMA monitoring locations specific to the SPPTS are presented on Figure 58. Sampling and data evaluation protocols are summarized in Table 33. In addition to the monitoring locations shown, several monitoring wells are present, and several piezometers are present within the collection trench. The wells are monitored as either Sentinel wells or Evaluation wells (see related text above). The piezometers are retained for troubleshooting purposes.

Table 33. RFLMA Sampling and Data Evaluation Protocols at SPPTS Monitoring Locations

Location Code	Location Description	Sample Types/Frequencies	Analytes	Data Evaluation
SPIN	Influent sampling location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	U, nitrate	See Figure 11 in Appendix D
SPOUT[a]	Effluent sampling location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	U, nitrate	See Figure 11 in Appendix D
GS13[b]	Downgradient surface-water performance location	Semiannual grabs; second and fourth calendar quarters (high- and low-water conditions)	U, nitrate	See Figure 11 in Appendix D

Notes: [a] The effluent monitoring location was changed from SPPMM01 to SPOUT in 2008, as described in Contact Record 2008-09, following several rounds of sampling that showed water quality at the two locations to be equivalent.

[b] Samples collected for U at GS13 are typically flow-paced, unfiltered, and analyzed for U isotopes; however, if desired they may be collected as grab samples and field-filtered. U data at GS13 support other monitoring objectives that are not addressed here.

Nitrate is analyzed as nitrate+nitrite as nitrogen; this result is conservatively compared to the nitrate standard only.

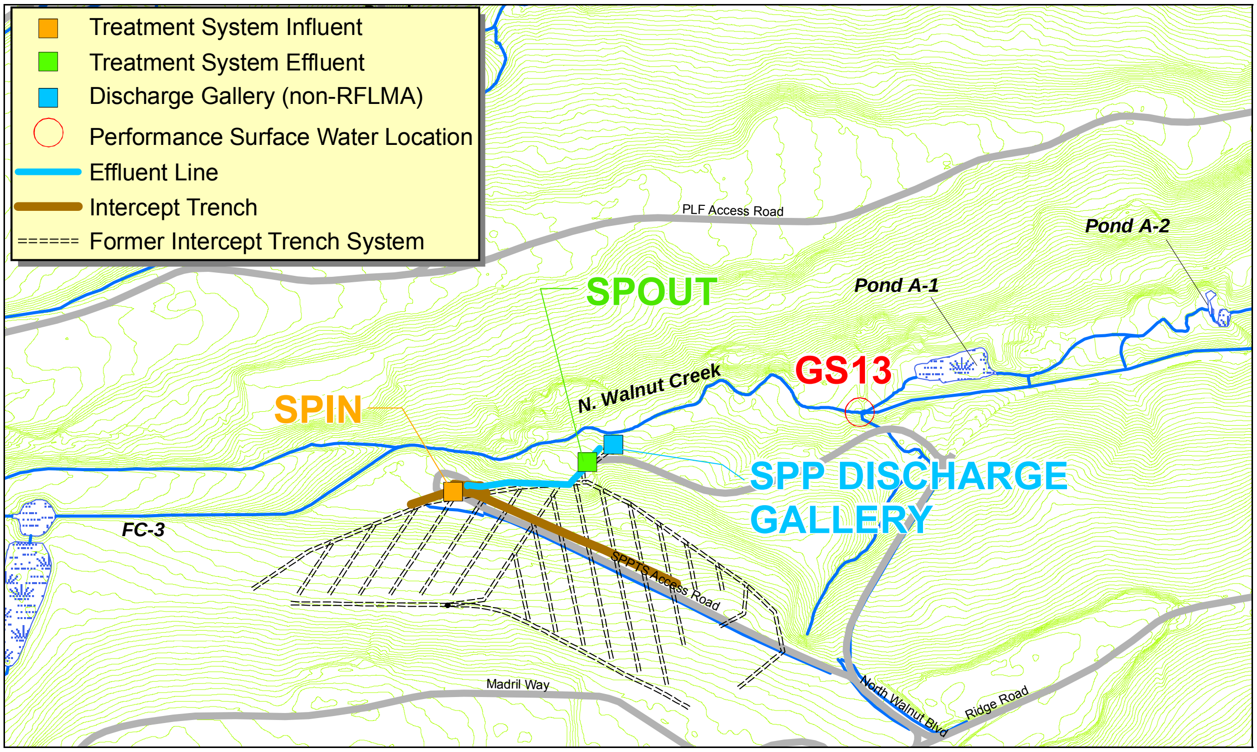


Figure 58. RFLMA SPPTS Monitoring Locations

Data Evaluation

All SPPTS locations listed above were scheduled for routine monitoring in the fourth quarter of CY 2010. Results are included in Appendix B; see Section 3.1.5.3 for discussion.

In addition to the RFLMA locations, in the fourth quarter the SPP Discharge Gallery (DG) was sampled according to the RFSOG, and all SPPTS locations plus additional locations related to system operation, optimization, and performance were also monitored to support an evaluation of the effects of Phases II and III improvements to the SPPTS (see Section 3.1.5.3).

PLF Treatment System

Water monitoring locations for the PLF are shown on Figure 59. The general groundwater monitoring requirements deal specifically with the RCRA wells and are discussed in detail in Section 3.1.2.8. Details regarding surface-water and treatment system monitoring are provided below.

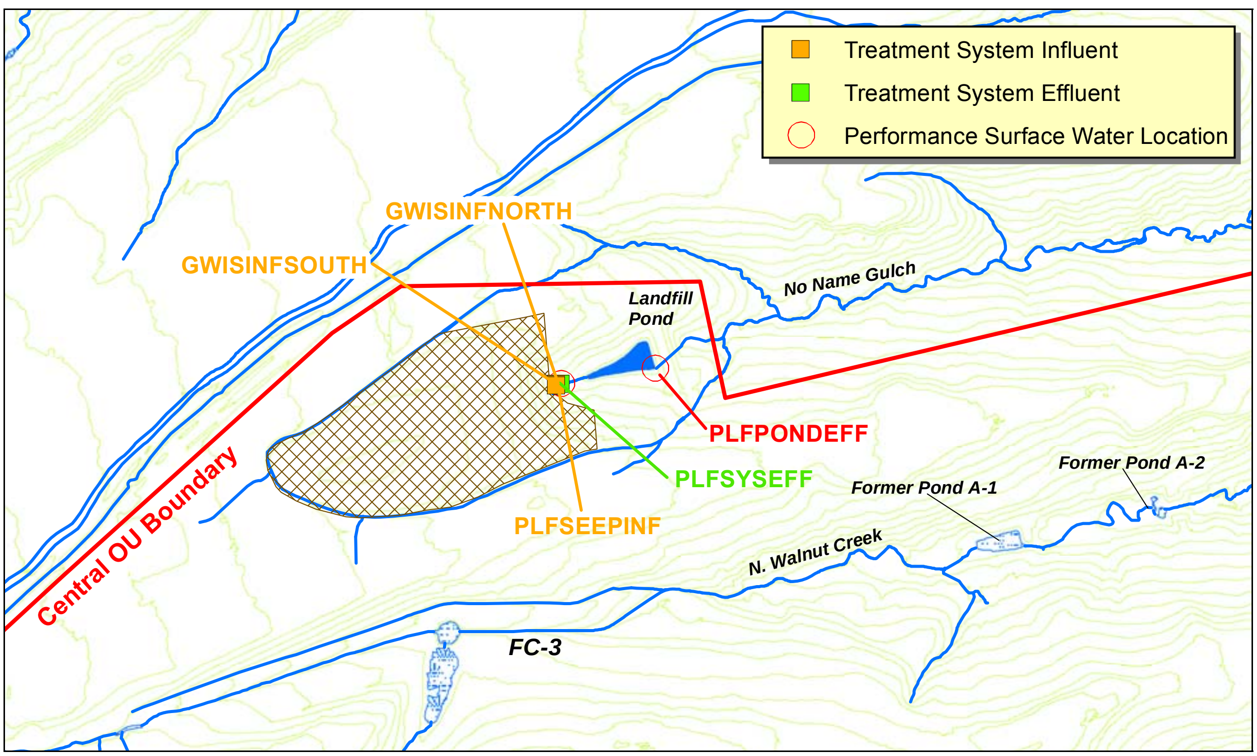
As part of PLF closure, a passive seep interception and treatment system was installed to treat landfill seep water and GWIS water. There are three sources of influent to the treatment system: two GWIS pipes and the PLF seep. Effluent for the treatment system eventually flows to the Landfill Pond. This section presents the monitoring data for the treatment system effluent as well as the Landfill Pond if the treatment system effluent exceeds surface-water standards. Details regarding PLFTS monitoring can be found in the PLF M&M Plan.

Monitoring locations for the PLFTS are shown on Figure 59. Sampling and data evaluation protocols are summarized in Table 34. As of December 21, 2007, collection of samples at the GWIS locations (GWISINFNORTH and GWISINFSOUTH) has been discontinued. This action has been taken subsequent to the consultative process in accordance with the Groundwater Treatment Systems flowchart (Appendix D) and documented in Contact Record 2007-08.

Table 34. Sampling and Data Evaluation Protocols at PLFTS Monitoring Locations

Location Code	Location Description	Sample Types/ Frequencies	Analytes	Data Evaluation
GWISINFNORTH	Northern GWIS influent to the treatment system	Discontinued	VOCs, total U, total and dissolved metals, nitrate[a]	See Figure 11 in Appendix D
GWISINFSOUTH	Southern GWIS influent to the treatment system	Discontinued	VOCs, total U, total and dissolved metals, nitrate[a]	See Figure 11 in Appendix D
PLFSEEPINF	Landfill seep influent to the treatment system	Quarterly grabs	VOCs, total U, total and dissolved metals	See Figure 11 in Appendix D
PLFSYSEFF	Effluent from the treatment system	Quarterly grabs	VOCs, total U, total and dissolved metals, SVOCs	See Figure 11 in Appendix D
PLFPONDEFF	Landfill Pond at the downstream (east) end	As needed; triggered by data evaluation	As needed; determined by decision rule	See Figure 11 in Appendix D

Notes: [a] Nitrate is analyzed as nitrate+nitrite as nitrogen.
GWISINFNORTH and GWISINFSOUTH may still be periodically sampled for investigative purposes only.



Note: PLFSYSEFF serves as both the treatment system effluent monitoring location and a performance surface-water monitoring location.

Figure 59. PLFTS Monitoring Locations

Data Evaluation

Analytical results for the treatment system effluent (PLFSYSEFF) are compared to the appropriate surface-water standards listed in Table 1 of RFLMA Attachment 2. During CY 2010, no analytes were detected above the applicable standards.

3.1.2.11 Pre-Discharge Monitoring

This monitoring objective deals with pre-discharge sampling of Ponds A-4, B-5, and C-2, or any other upstream pond functioning as a terminal pond, as a BMP to suggest compliance with surface water-quality standards (see Table 1 of RFLMA Attachment 2) at the downstream POCs. Pre-discharge samples are collected at Ponds A-4, B-5, and C-2 on North Walnut Creek, South Walnut Creek, and Woman Creek, respectively. These locations are shown on Figure 60. Sampling and data evaluation protocols are summarized in Table 35.

Table 35. Sampling and Data Evaluation Protocols at Pre-Discharge Monitoring Locations

Location Code	Location Description	Sample Types/ Frequencies	Analytes	Data Evaluation
A4 POND	Pond A-4 at east end of pond near outlet works	Prior to discharge	Pu, Am, total U, nitrate[a]	Review with regulators prior to discharge
B5 POND	Pond B-5 at east end of pond near outlet works	Prior to discharge	Pu, Am, total U, nitrate[a]	Review with regulators prior to discharge
C2 POND	Pond C-2 at east end of pond near outlet works	Prior to discharge	Pu, Am, total U	Review with regulators prior to discharge

Notes: [a] Nitrate is analyzed as nitrate+nitrite as nitrogen; the nitrate+nitrite result is conservatively compared to the nitrate standard only.

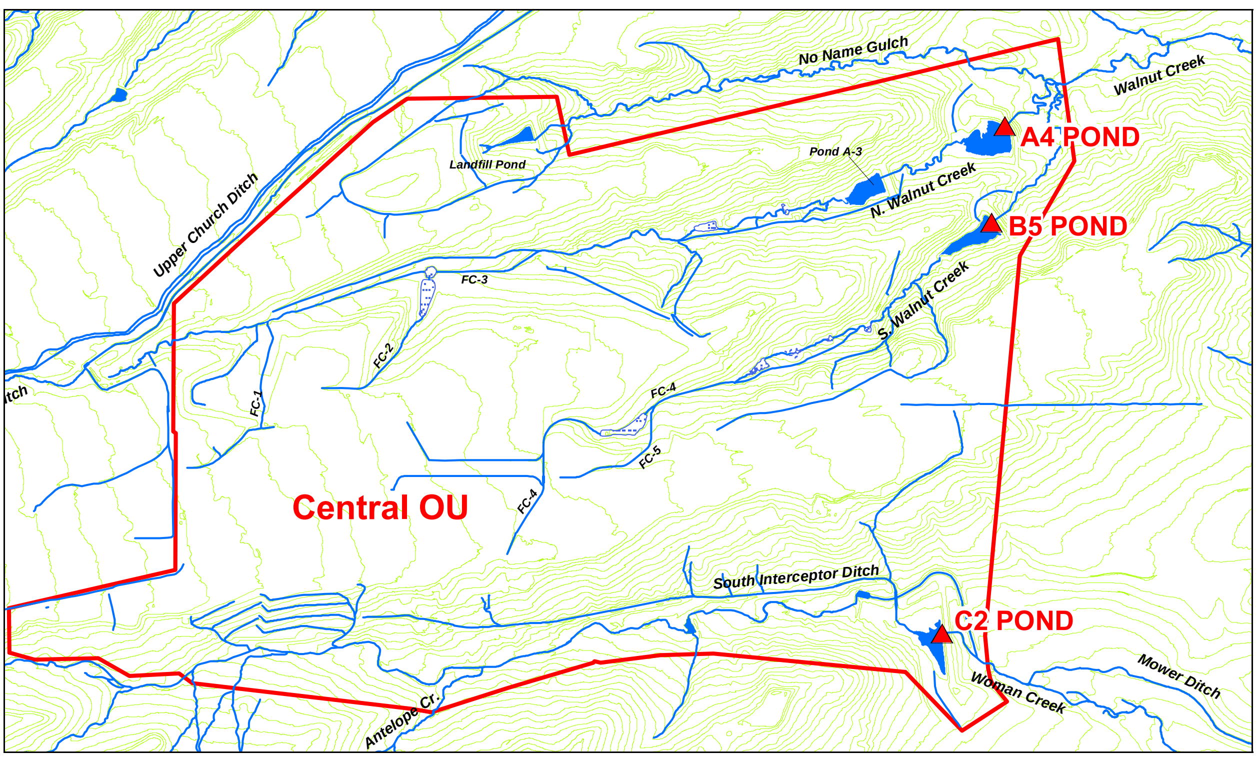


Figure 60. Pre-Discharge Sampling Locations

Data Evaluation

During CY 2010, pre-discharge samples were collected during at Ponds A-4, B-5, and C-2 prior to discharge. All predischarge sample results indicated that water quality was acceptable for discharge. Subsequent POC sampling during discharge also indicated acceptable water quality for the discharged water.

3.1.3 Rocky Flats Hydrology

The following section provides information for all automated surface-water monitoring and precipitation gage locations at the Site that operated during CY 2010. For locations with continuous flow measurement, graphical discharge summaries are provided. Graphical summaries are also provided for all precipitation gage locations. Numerical discharge and precipitation values are included in the tables in Appendix A.

Groundwater hydrology is also addressed. This includes a discussion of groundwater levels in various areas of interest via the preparation of hydrographs and potentiometric surface maps. Flow velocities are also calculated. Hydrographs for monitoring wells are included in Appendix A.

3.1.3.1 General Hydrologic Setting

Streams and seeps at the Site are largely ephemeral, with stream reaches gaining or losing flow, depending on the season and precipitation amounts. Section 3.1.3.6 discusses the 2010 efforts to document observed seeps at the site. Surface-water flow across the Site is primarily from west to east, with three major drainages traversing the Site. Five ponds within the COU collect and manage surface-water runoff.[7] The Site drainages and ponds, including their respective pertinence to this report, are described below and shown on Figure 61.

The major stream drainages leading out of the Refuge, from north to south, are Rock Creek, Walnut Creek, and Woman Creek. North Walnut Creek flows through the A-Series Ponds, and South Walnut Creek flows through the B-Series Ponds; both are tributaries to Walnut Creek. The hydrologic routing diagram (as of December 31, 2010) for the locations included in this report is shown on Figure 62.

The groundwater hydrology is generally characterized by relatively thin, shallow, saturated materials (in the COU, typically on the order of a few dozen feet thick or less, and less than 50 feet deep). This shallow saturated interval occurs within the unconsolidated Rocky Flats Alluvium, hillslope colluvium, valley-fill alluvium, artificial fill, and the weathered portion of the underlying bedrock. Collectively, these materials are referred to as the upper hydrostratigraphic unit (UHSU). Regionally, groundwater flows from west to east within the UHSU of the pediment surfaces, except where locally diverted toward the generally east-west trending drainages that bisect these pediments. Groundwater typically discharges at seeps and

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[7] Former Dams A-1, A-2, B-1, B-2, B-3, and B-4 were breached during 2008−2009.