In general, the estimated flow paths and velocities calculated for 2014 are comparable to those calculated prior to Site closure (e.g., K-H 2004b) and are also very similar to those presented in the 2013 Annual Report (DOE 2014c), as well as previous annual reports.

Based on the field data collected during 2014, it is apparent that the significant precipitation event in September 2013 continued to influence second quarter 2014 water levels. The effects of the flooding can be seen in the elevated levels, with fourth quarter water levels more closely resembling seasonal norms. Overall, the estimates of seepage velocities for 2014 are not much different from those calculated in previous post-closure years and the estimated groundwater flow paths also remain consistent with previous results.

3.1.3.6 Seeps

Seeps are common at the Rocky Flats Site. Seep distribution and occurrence are strongly controlled by geology and precipitation, and much of the discharge occurs at the contact between the Rocky Flats Alluvium and underlying claystone.

Seep locations posted on the second and fourth quarter CY 2014 potentiometric surface maps are slightly modified from those shown on the 1995 Hydrogeologic Characterization Report (EG&G 1995a). Although this 1995 depiction of seeps has been the best available map of the seeps for the Site for some time, it is no longer accurate, having been strongly affected by the removal of all artificial water sources and impermeable surfaces, as well as the overall land surface reconfiguration (e.g., excavations and placement of fill) in some areas. Thus, a new effort to identify locations of existing seeps in the COU began in 2010. Although not a rigorous investigation, this activity is designed to qualitatively establish the presence of seeps and document their general location.

One observation made during recent years is that seeps often occur where former building foundations, footer drains, and other features remain that contribute to groundwater reaching the surface. This observation supports the design of the monitoring network, which considered the anticipated post-closure groundwater flow directions.

Figure 112 presents the locations where seeps and wet areas were observed during July of CY 2014. Given that July was, by far, the wettest month of 2014, with almost 4 inches of precipitation, it is not surprising that numerous seeps and wet areas were scattered across the site during this time frame. Approximately one-third of the total precipitation for 2014 fell during July. Efforts to map seeps and wet areas across the Site will continue.

3.1.4 Surface-Water Data Interpretation and Evaluation

3.1.4.1 Surface-Water Quality Summaries

This section presents water quality summaries for selected analytes for the period January 1, 1997, through December 31, 2014 (CY 1997–2014) for the automated surface-water monitoring locations collecting flow-paced composite samples in CY 2014. Radionuclides summarized include Pu, Am,[10] and total U. Additionally, the POE metals (total beryllium [Be],

[10] In this report, "plutonium" or "Pu" refers to plutonium-239, 240; and "americium" or "Am" refers to americium-241.

dissolved Cd, total Cr, and dissolved silver [Ag]) and nitrate+nitrite as N[11] are also summarized. Additional analyses are also performed based on the specific monitoring objective. The results and evaluation for these additional analytes are presented in Section 3.1.2.1 through Section 3.1.2.9 by monitoring objective.

The summary values in this section should not be confused with the RFLMA required water-quality evaluations according to Attachment 2 in the RFLMA. The Pu, Am, and total U standards noted in this section apply only to POE (GS10, SW027, and SW093; Section 3.1.2.2) and POC (WALPOC and WOMPOC; Section 3.1.2.1) 30-day or 12-month rolling averages. Comparisons of standards to other summary statistics are noted in this section for reference only. POEs and POCs are highlighted in **bold** in the tables.

Radionuclides

The following summaries include all available results that were not rejected through the validation process.[12] 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 negative radionuclide result (e.g., –0.002 pCi/L) is reported by the laboratory due to blank correction, a value of 0.0 pCi/L is used for calculation purposes. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the "real" and "duplicate" values.[13] When a sample has multiple "real" analyses (e.g., Site requested "reruns"), the value used in calculations is the arithmetic average of the multiple "real" analyses.

The Pu/Am ratio is calculated for each sample by dividing the Pu result by the corresponding Am result. Ratios are only calculated for samples where *both* the Pu and Am results are greater than 0.015 pCi/L (generally the minimum detectable activity for Pu and Am analyses) to exclude ratios for very low results with high relative error.

Each table includes only those locations where samples were collected that were analyzed for the referenced analyte. Maps are also included showing monitoring locations and the corresponding median values of the referenced parameter. Only locations that had four or more individual results are mapped.

[11] Due to hold time requirements, the nitrate+nitrite as N summaries are based on grab sample results.
[12] Summaries do not include supplemental post-closure grab samples for uranium from GS13 that were collected to assess modifications to the SPPTS; only routine continuous flow-paced samples are included.
[13] Arithmetic averaging of radionuclide pairs is performed only when the RER is less than or equal to 5. If the RER is greater than 5, the radionuclide results are determined to be nonrepresentative. These results are not used for the calculation of summary statistics. A more thorough discussion of data management is given in Appendix B.1, "Surface-Water Analytical Data Evaluation Methods."

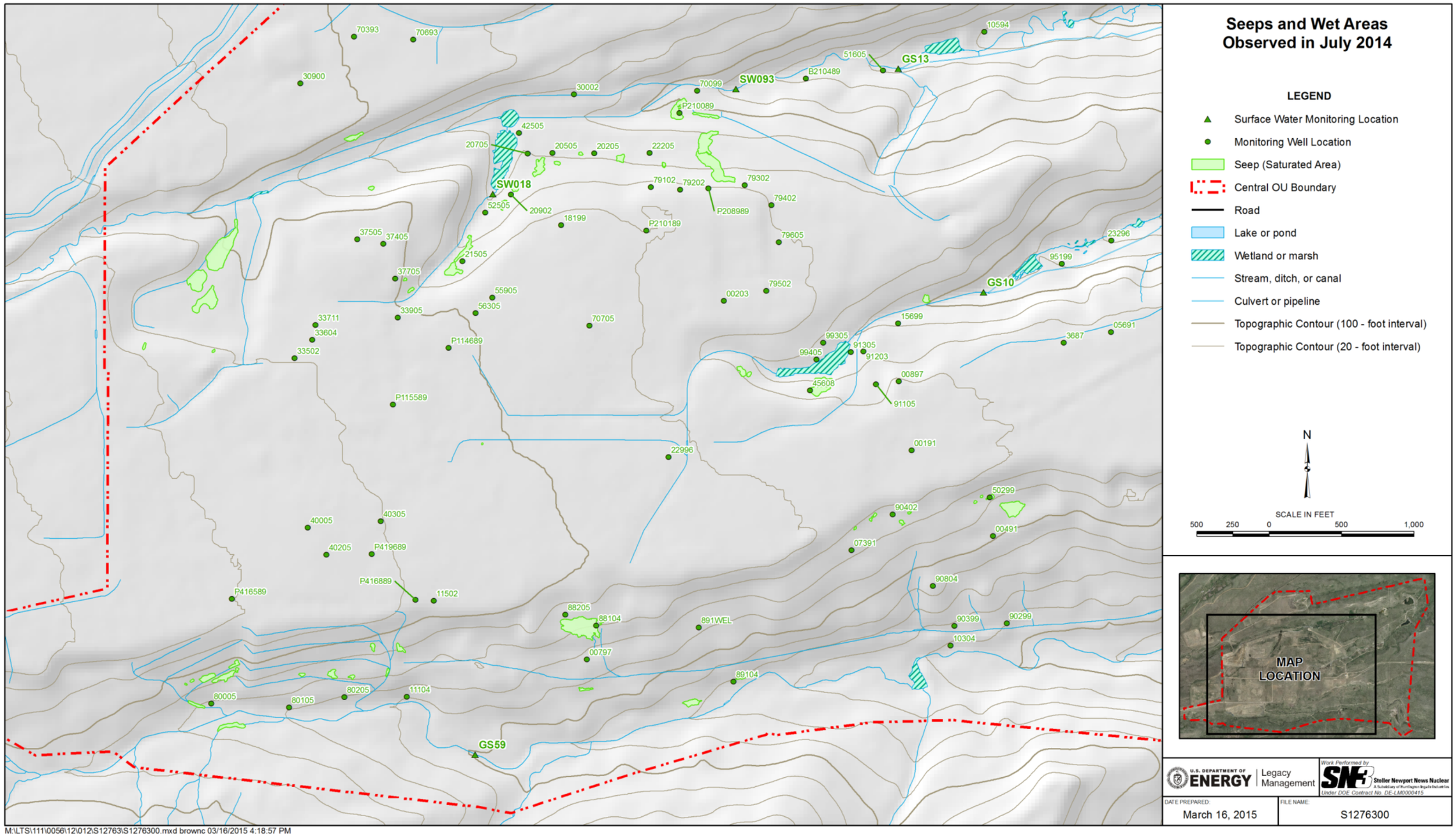

Figure 112. Seeps and Wet Areas Observed in 2014

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Table 36 shows pre-closure Pu activities. Table 37 shows that post-closure median Pu activities for all locations are below the RFLMA standard of 0.15 pCi/L. The 85th percentile activities are also below the standard for all locations except GS10. Figure 113 and Figure 114 show the pre- and post-closure median Pu activities, respectively.

Table 36. Pre-Closure Summary Statistics for Pu-239,240 Analytical Results (January 1, 1997–October 13, 2005)

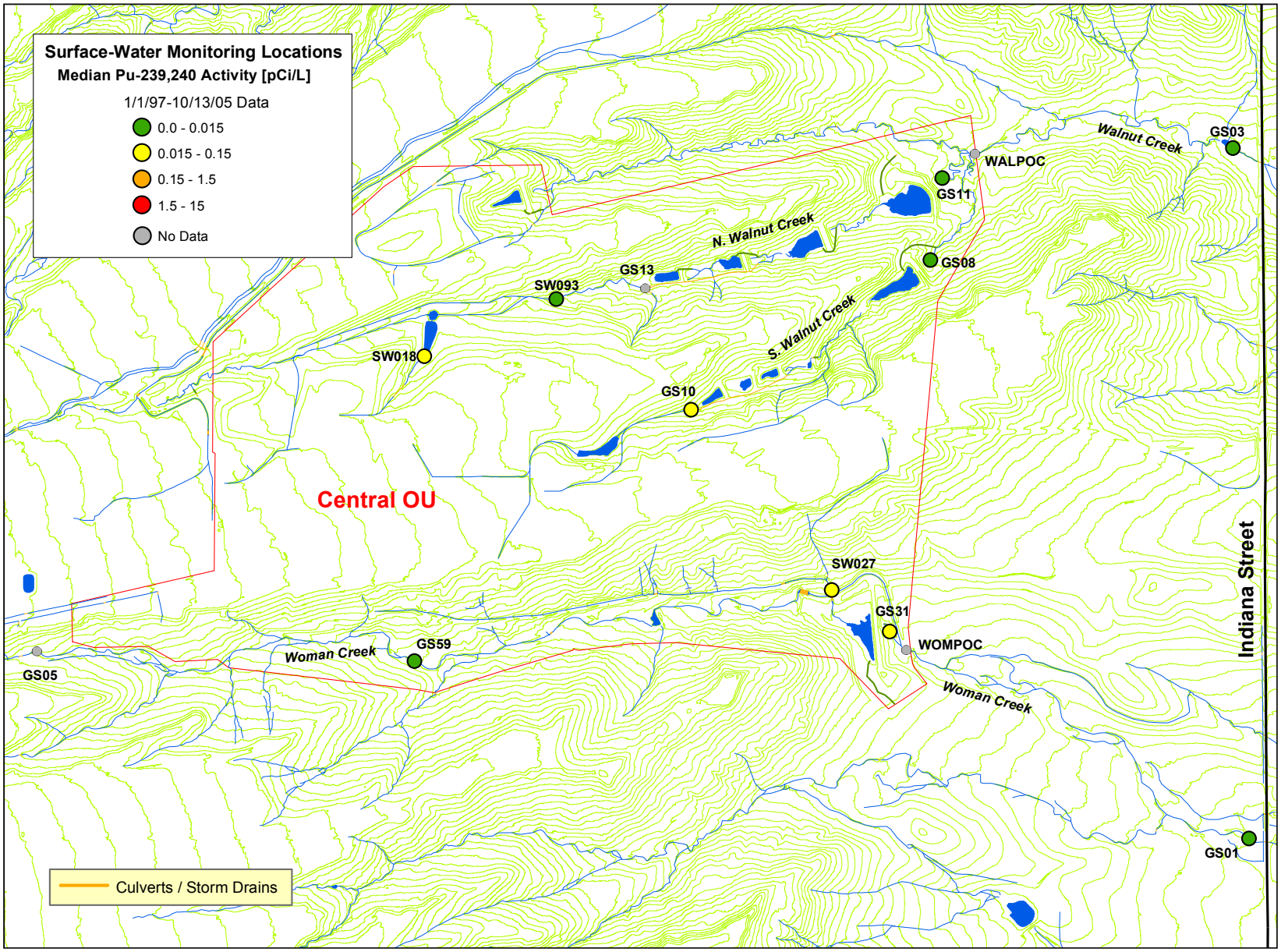
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	165	0.002	0.008	0.024
GS03	257	0.005	0.016	0.220
WOMPOC	**NA**	**NA**	**NA**	**NA**
WALPOC	**NA**	**NA**	**NA**	**NA**
GS05	NA	NA	NA	NA
GS08	118	0.004	0.013	0.864
GS10	**266**	**0.054**	**0.207**	**2.27**
GS11	89	0.002	0.009	0.070
GS13	NA	NA	NA	NA
GS31	26	0.017	0.094	0.348
GS59	30	0.000	0.004	0.020
SW027	**71**	**0.049**	**0.199**	**13.2**
SW093	**284**	**0.010**	**0.063**	**4.18**

Notes: WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
NA = analyte not sampled
Bold = POC or POE

Table 37. Post-Closure Summary Statistics for Pu-239,240 Analytical Results (October 13, 2005–December 31, 2014)

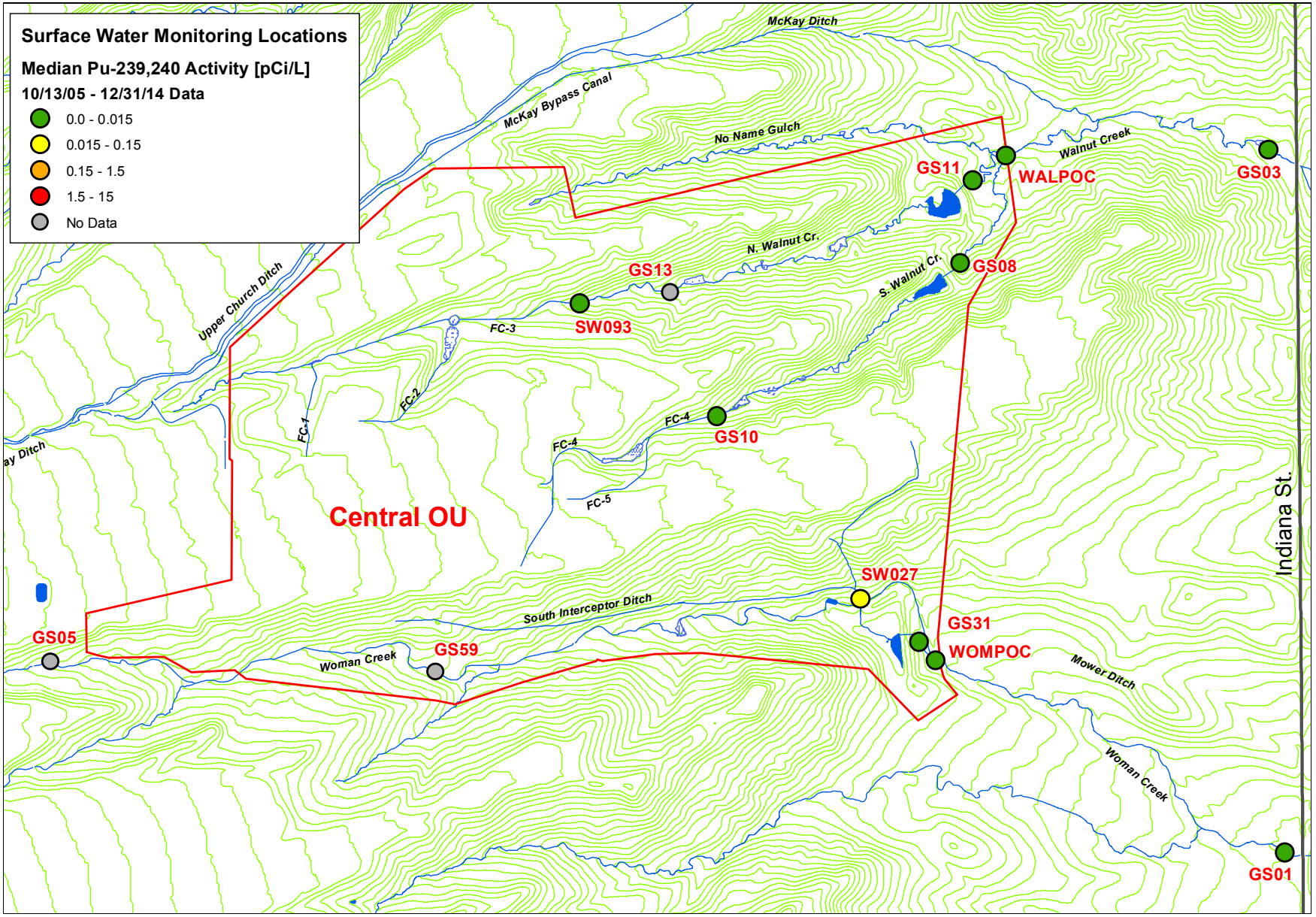
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	125	0.003	0.008	0.025
GS03	96	0.003	0.010	0.042
WOMPOC	**51**	**0.003**	**0.010**	**0.038**
WALPOC	**36**	**0.005**	**0.014**	**0.039**
GS05	NA	NA	NA	NA
GS08	57	0.004	0.014	0.074
GS10	**155**	**0.011**	**0.076**	**5.28**
GS11	54	0.003	0.009	0.046
GS13	NA	NA	NA	NA
GS31	28	0.006	0.016	0.090
GS59	NA	NA	NA	NA
SW027	**11**	**0.108**	**0.210**	**0.300**
SW093	**140**	**0.005**	**0.019**	**0.861**

Notes: WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
NA = analyte not sampled
Bold = POC or POE



Notes: Only locations with four or more results are mapped.

Figure 113. Median Pu-239,240 Activities for CY 1997–October 13, 2005



Notes: Only locations with four or more results are mapped.

Figure 114. Post-Closure Median Pu-239,240 Activities

Table 38 shows pre-closure Am activities. Table 39 shows that post-closure median and 85th percentile Am activities for all locations are below the RFLMA standard of 0.15 pCi/L. Figure 115 and Figure 116 show median Am activities for pre- and post-closure, respectively.

Table 38. Pre-Closure Summary Statistics for Am-241 Analytical Results (January 1, 1997–October 13, 2005)

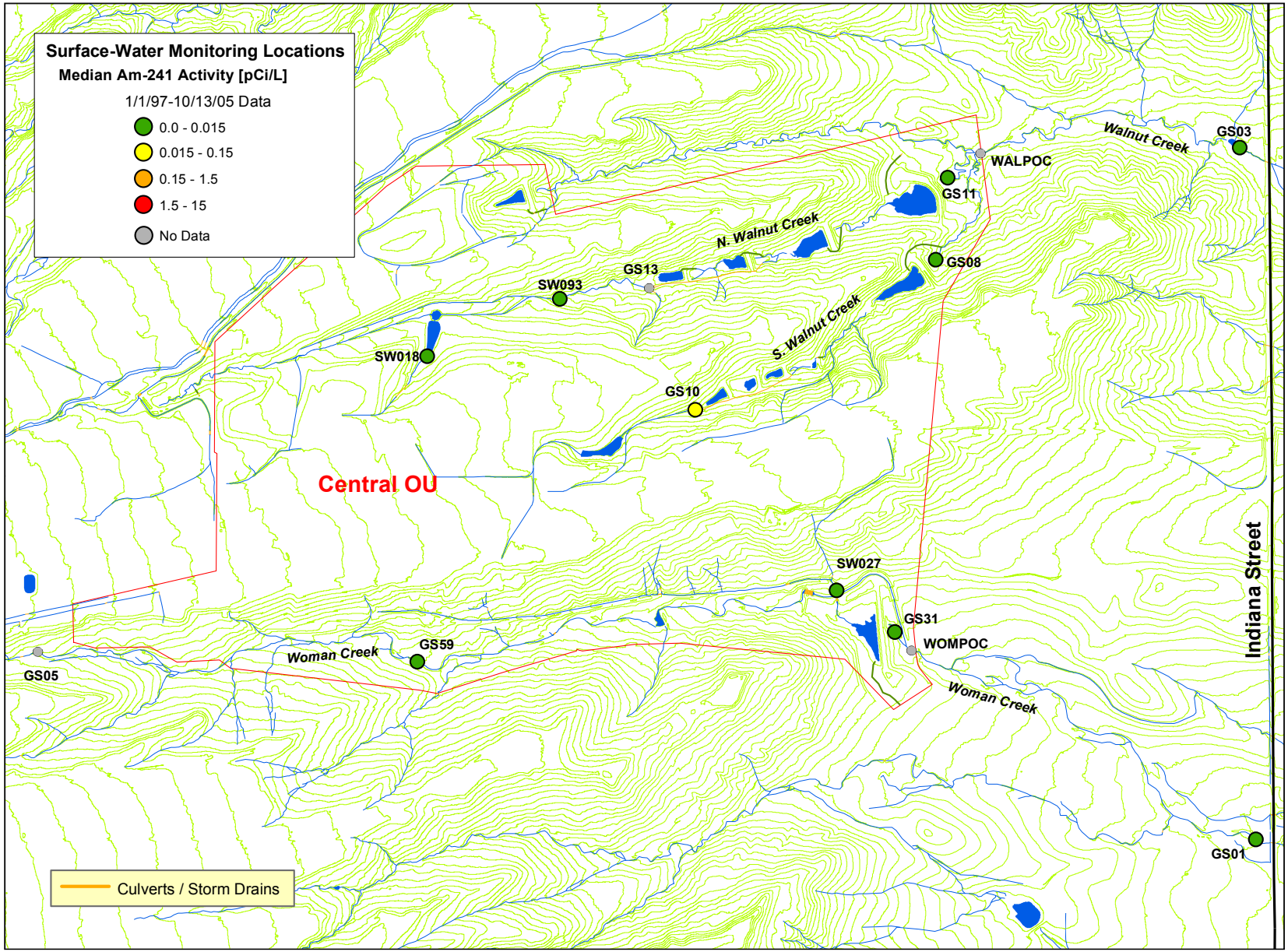
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	164	0.001	0.008	0.054
GS03	258	0.006	0.018	0.066
WOMPOC	**NA**	**NA**	**NA**	**NA**
WALPOC	**NA**	**NA**	**NA**	**NA**
GS05	NA	NA	NA	NA
GS08	118	0.006	0.015	0.275
GS10	**259**	**0.057**	**0.193**	**8.39**
GS11	88	0.003	0.010	0.047
GS13	NA	NA	NA	NA
GS31	26	0.009	0.020	0.116
GS59	30	0.001	0.004	0.015
SW027	**71**	**0.009**	**0.045**	**2.33**
SW093	**279**	**0.012**	**0.052**	**14.1**

Notes: WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
NA = Analyte not sampled
Bold = POC or POE

Table 39. Post-Closure Summary Statistics for Am-241 Analytical Results (October 13, 2005–December 31, 2014)

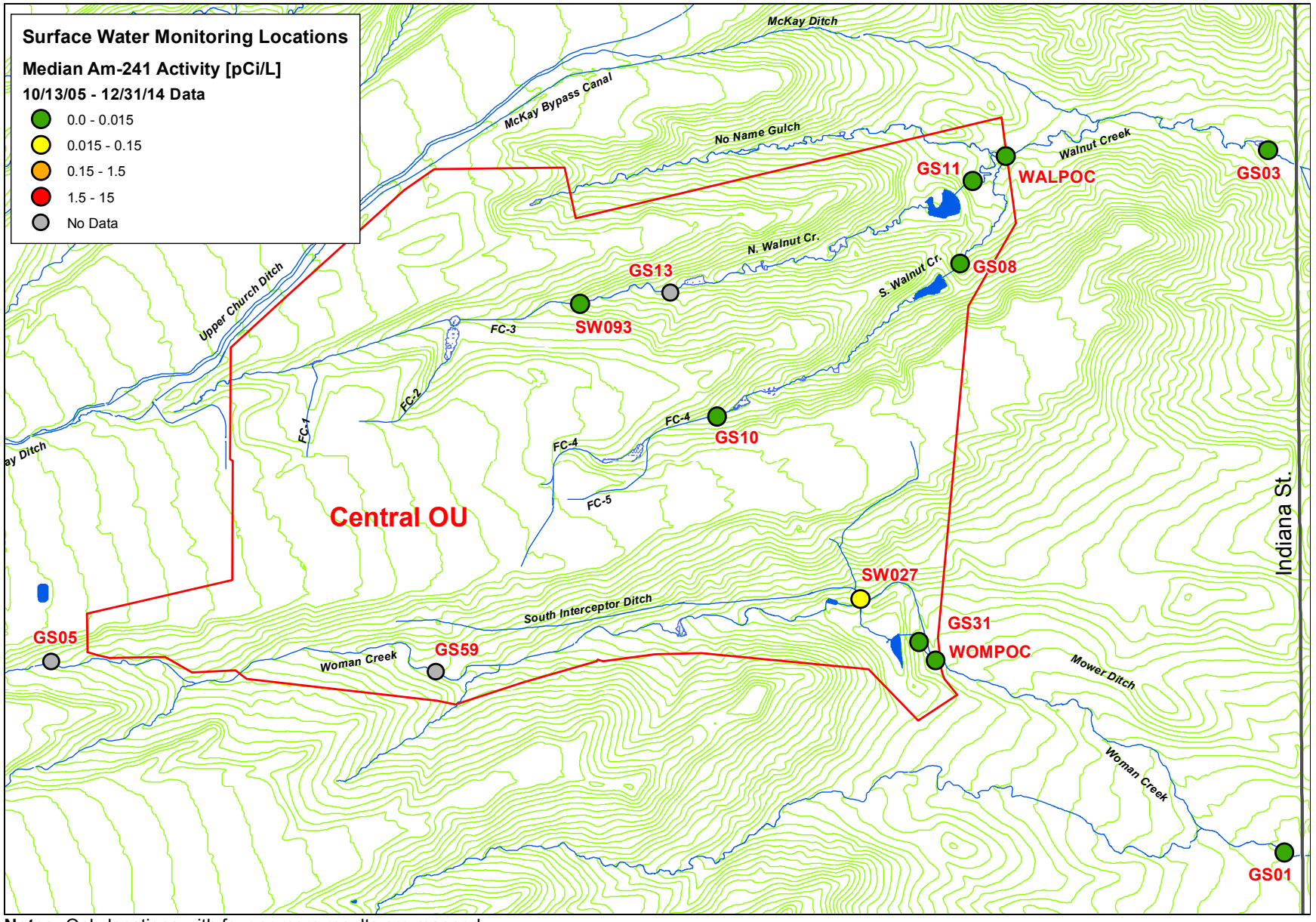
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	125	0.002	0.006	0.057
GS03	96	0.002	0.008	0.036
WOMPOC	**51**	**0.002**	**0.007**	**0.016**
WALPOC	**36**	**0.005**	**0.010**	**0.028**
GS05	NA	NA	NA	NA
GS08	57	0.002	0.015	0.065
GS10	**156**	**0.012**	**0.142**	**8.41**
GS11	54	0.003	0.008	0.027
GS13	NA	NA	NA	NA
GS31	28	0.003	0.007	0.041
GS59	NA	NA	NA	NA
SW027	**11**	**0.016**	**0.045**	**0.053**
SW093	**140**	**0.003**	**0.016**	**0.357**

Notes: WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
NA = Analyte not sampled
Bold = POC or POE



Notes: Only locations with four or more results are mapped.

Figure 115. Median Am-241 Activities for CY 1997—October 13, 2005



Notes: Only locations with four or more results are mapped.

Figure 116. Post-Closure Median Am-241 Activities

Table 40 shows pre-closure U concentrations. Table 41 shows that post-closure median total U concentrations for all locations do not exceed the RFLMA standard of 16.8 µg/L. Recent data from several locations show total U levels in excess of 16.8 µg/L. These measurements are influenced by contributions of naturally occurring U in groundwater and hydrologic changes post-closure. Although the Site standard is 16.8 µg/L, it should be noted that the drinking water standard (i.e., the MCL) is 30 µg/L. Figure 117 and Figure 118 show median total U activities for pre- and post-closure, respectively.

Table 40. Pre-Closure Summary Statistics for Total U Analytical Results (January 1, 1997–October 13, 2005)

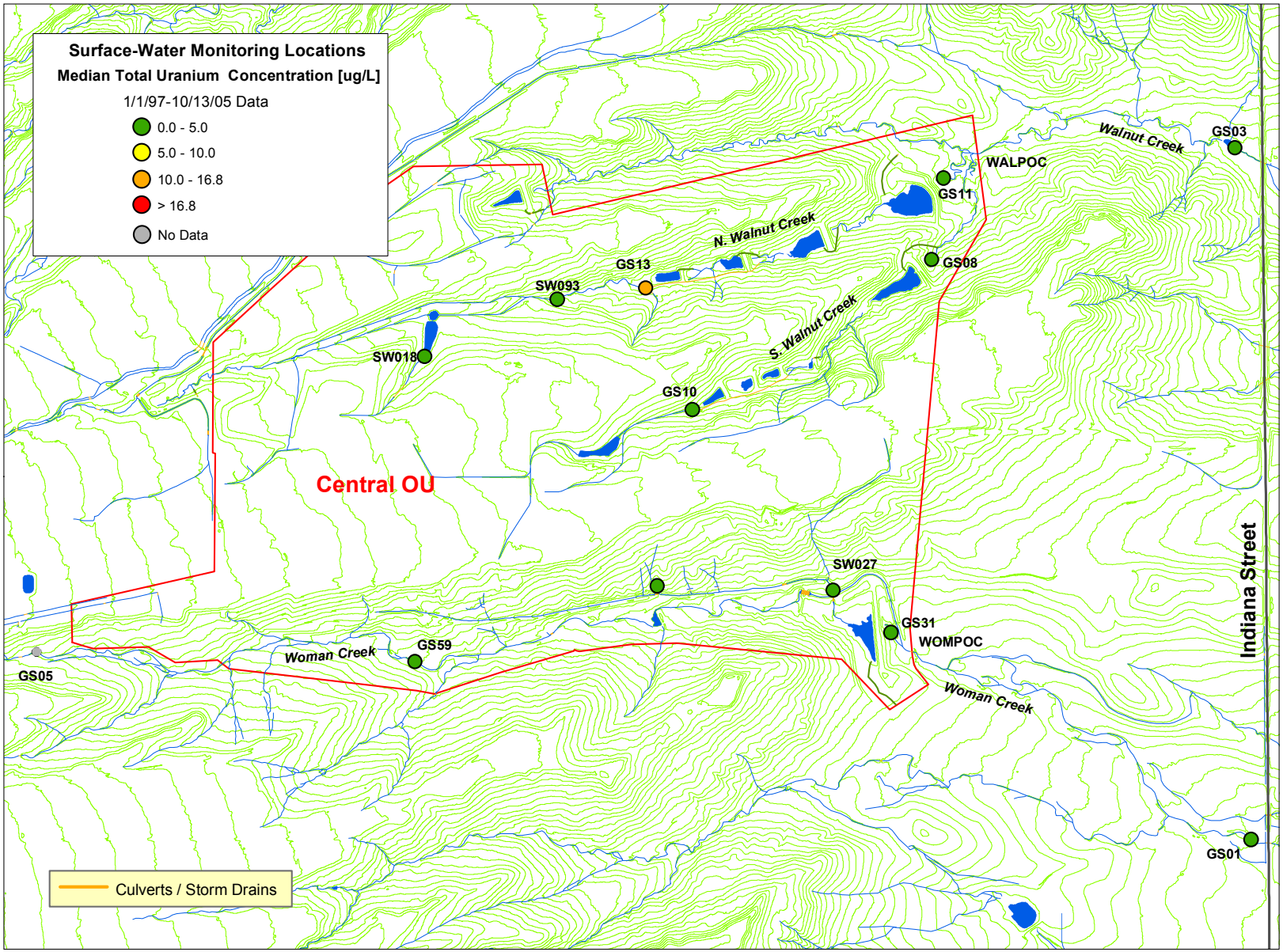
Location	Samples (N)	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
GS01	53	4.29	6.51	11.9
GS03	78	2.37	4.48	7.64
WOMPOC	**NA**	**NA**	**NA**	**NA**
WALPOC	**NA**	**NA**	**NA**	**NA**
GS05	NA	NA	NA	NA
GS08	118	1.83	3.09	9.88
GS10	**266**	**4.48**	**7.15**	**20.5**
GS11	89	3.00	4.29	5.62
GS13	68	11.7	17.2	33.0
GS31	26	3.48	4.22	6.27
GS59	31	0.93	1.74	4.66
SW027	**71**	**2.06**	**4.47**	**8.70**
SW093	**284**	**3.99**	**6.35**	**11.1**

Notes: WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
NA = Analyte not sampled
Bold type = POC or POE

Table 41. Post-Closure Summary Statistics for Total U Analytical Results (October 13, 2005–December 31, 2014)

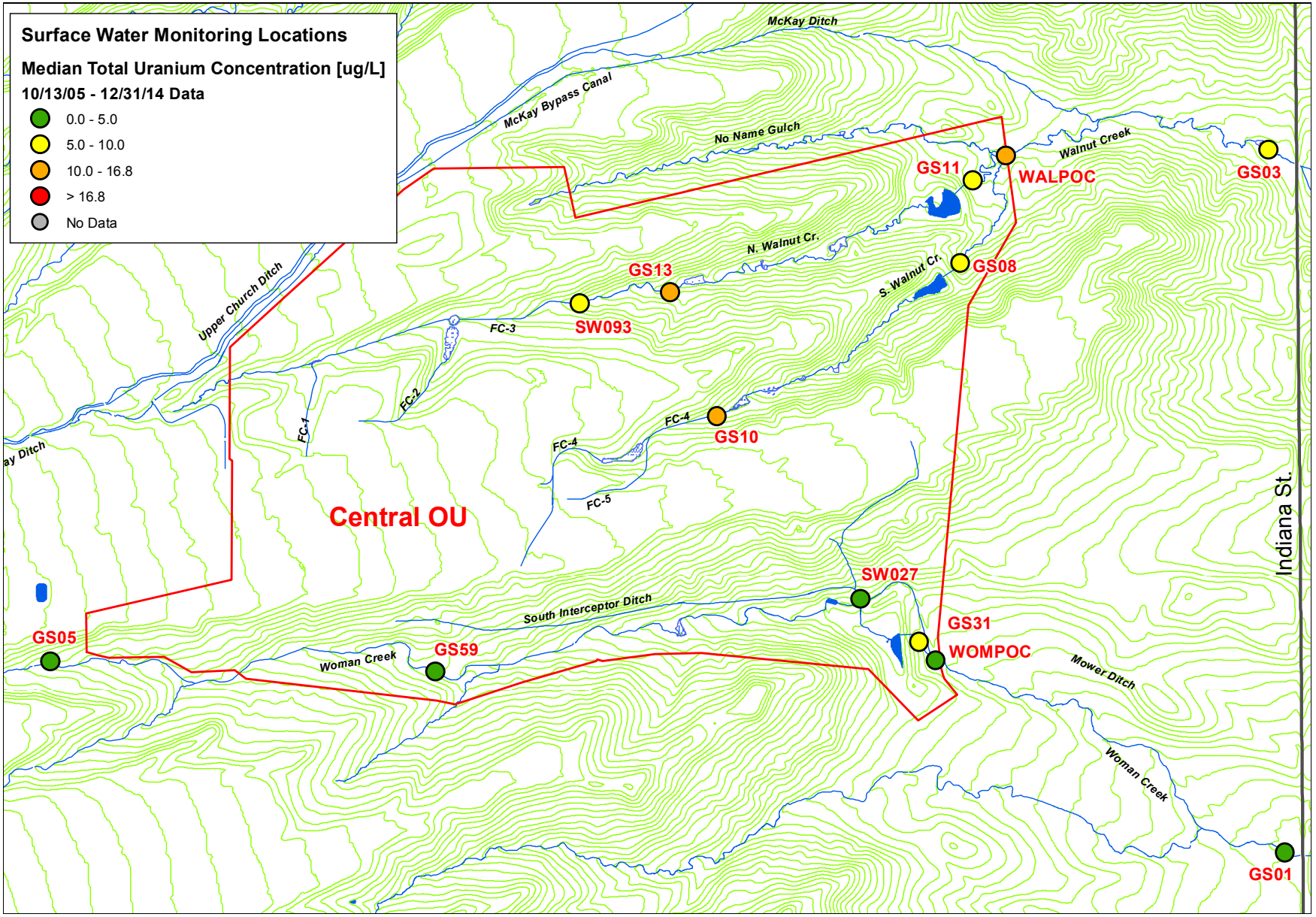
Location	Samples (N)	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
GS01	125	4.09	6.55	11.3
GS03	96	6.91	10.4	18.8
WOMPOC	**51**	**3.29**	**4.40**	**7.11**
WALPOC	**36**	**12.6**	**19.8**	**22.9**
GS05	76	0.79	1.71	4.67
GS08	57	9.01	15.1	20.4
GS10	**156**	**16.8**	**27.1**	**89.2**
GS11	54	7.84	13.7	29.0
GS13	115	14.5	36.0	63.6
GS31	30	6.17	8.17	13.3
GS59	72	1.39	2.22	9.30
SW027	**11**	**3.24**	**5.80**	**7.07**
SW093	**140**	**7.11**	**11.3**	**23.4**

Notes: WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
NA = Analyte not sampled
Bold = POC or POE



Notes: Only locations with four or more results are mapped.

Figure 117. Median Total U Concentrations for CY 1997—October 13, 2005



Notes: Only locations with four or more results are mapped.

Figure 118. Post-Closure Median Total U Concentrations

Table 42 and Figure 119 show that post-closure median nitrate concentrations for most locations are below the standard of 10 mg/L. Location GS13 clearly shows the effects of the former Solar Ponds.

Table 42. Post-Closure Summary Statistics for Nitrate+Nitrite as Nitrogen Analytical Results (October 13, 2005–December 31, 2014)

Location	Samples (N)	Median (mg/L)	85th Percentile (mg/L)	Maximum (mg/L)
GS03	70	0.92	3.74	6.70
WALPOC	**36**	**2.27**	**6.18**	**8.70**
GS11	55	1.62	7.39	16.0
GS13	143	25.0	53.4	140

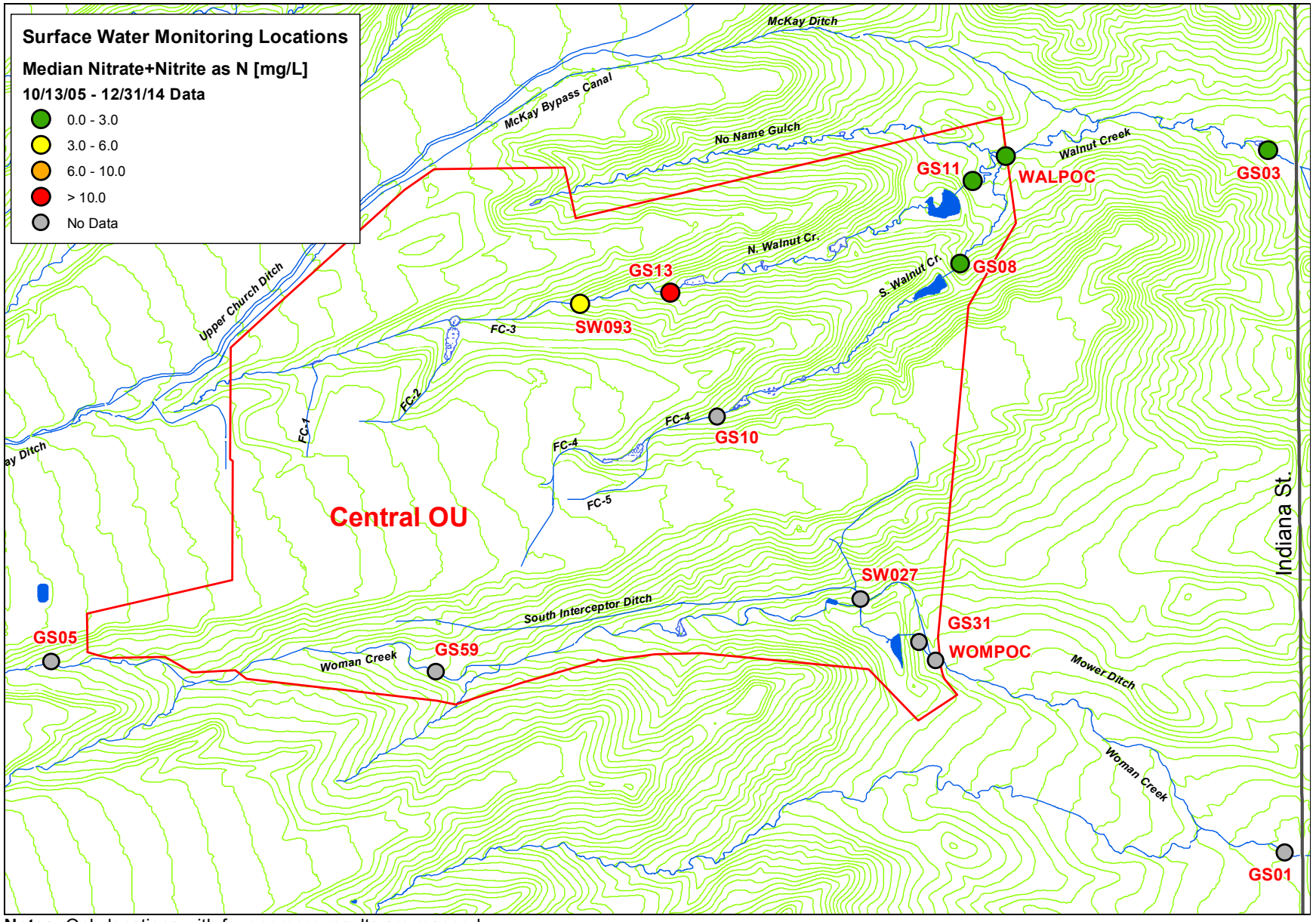
Notes: WALPOC began operation on September 9, 2011.
Bold = POC or POE

Table 43 and Table 44 list the average Pu/Am activity ratios for locations where samples are analyzed for Pu and Am. A ratio greater than one indicates Pu activity in excess of Am activity. Conversely, a ratio less than one indicates Am activity in excess of Pu activity. Generally, Pu activities are greater than Am activities in surface water at the Site. Post-closure data show patterns similar to those of pre-closure data. With the recent reportable values at GS10, the ratio there has shifted measurably towards americium. Figure 120 and Figure 121 present pre- and post-closure average Am/Pu ratios, respectively.

Table 43. Pre-Closure Average Pu/Am Ratios for Analytical Results (January 1, 1997–October 13, 2005)

Location	Samples (N)[a]	Average Pu/Am Ratio
GS01	1	1.5
GS03	14	2.1
WOMPOC	**NA**	**NA**
WALPOC	**NA**	**NA**
GS05	NA	NA
GS08	5	8.9
GS10	**196**	**1.3**
GS11	[b]	[b]
GS13	NA	NA
GS31	4	3.9
GS59	[b]	[b]
SW027	**26**	**4.9**
SW093	**95**	**1.8**

Notes:
[a] Number of samples in which both Pu and Am activities were greater than 0.015 pCi/L
[b] No results greater than 0.015 pCi/L
WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
Bold = POC or POE
NA = Analyte not sampled



Notes: Only locations with four or more results are mapped.

Figure 119. Post-Closure Median Nitrate+Nitrite as Nitrogen Concentrations

Table 44. Post-Closure Average Pu/Am Ratios for Analytical Results (October 13, 2005–December 31, 2014)

Location	Samples (N)[a]	Average Pu/Am Ratio
GS01	[b]	[b]
GS03	4	1.3
WOMPOC	[b]	[b]
WALPOC	**2**	**1.1**
GS05	NA	NA
GS08	6	1.6
GS10	**55**	**0.8**
GS11	1	1.2
GS13	NA	NA
GS31	1	2.2
GS59	NA	NA
SW027	**6**	**5.0**
SW093	**12**	**2.1**

Notes:
[a] Number of samples in which both Pu and Am activities were greater than 0.015 pCi/L
[b] No results greater than 0.015 pCi/L
WOMPOC and WALPOC began operation on September 28, 2011, and September 9, 2011, respectively.
Bold = POC or POE
NA = Analyte not sampled

POE Metals

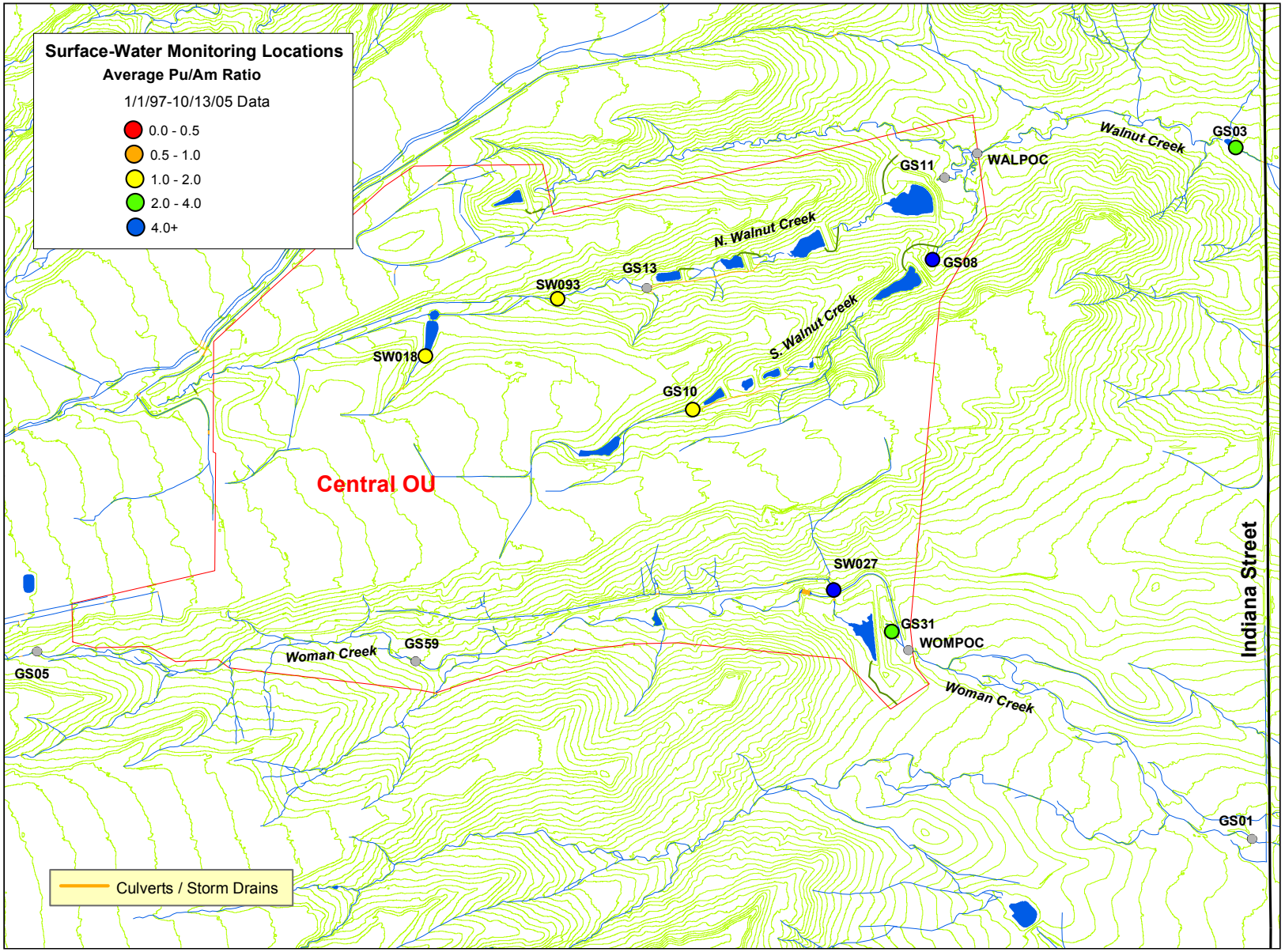
The following summaries include all results that were not rejected through the validation process. Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations and analytical errors are often greater than the precision presented. When a nondetect is returned from the laboratory for metals analyses, one-half the detection limit is used for calculations. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the "real" value and the "duplicate."[14] When a sample has multiple "real" analyses (Site-requested "reruns"), the value used in calculations is the arithmetic average of the multiple "real" analyses.

Table 45, Table 46, Table 47, Table 48, Table 49, and Table 50 present summary statistics for the POE metals. All three POEs generally show reduced metals concentrations in the post-closure period.

Table 45. Pre-Closure Summary Statistics for POE Metals Results from GS10 (January 1, 1997–October 13, 2005)

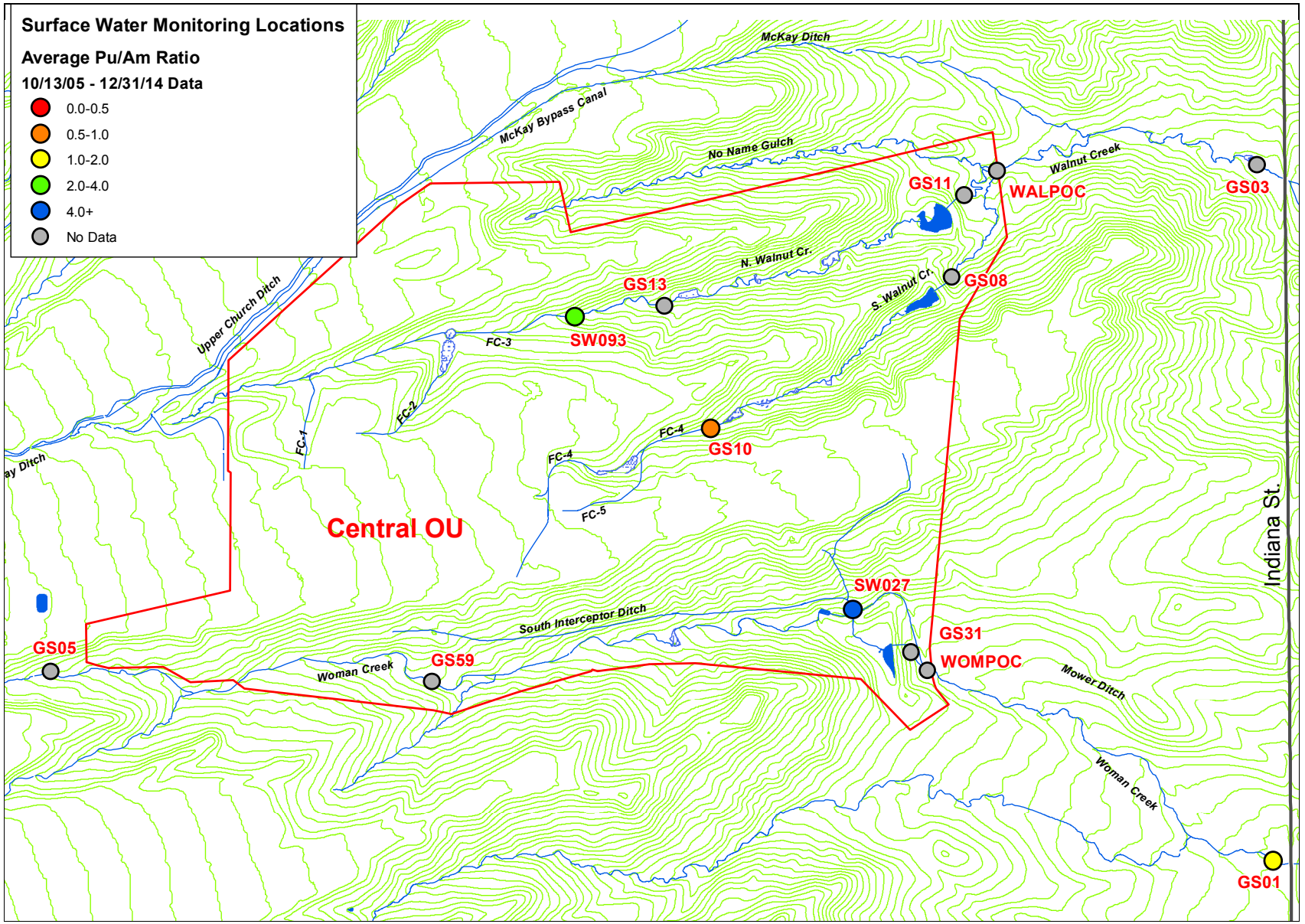
Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	263	32.3%	0.12	0.63	3.40
Dissolved Cd	259	59.1%	0.05	0.15	1.00
Total Cr	264	13.3%	2.40	9.72	80.10
Dissolved Ag	258	88.8%	0.11	0.18	1.10

[14] Arithmetic averaging of metal pairs is performed only when the relative percent difference (RPD) is less than 100 percent. If the RPD is greater than or equal to 100 percent, the metal results are determined to be nonrepresentative. The results are then not used for the calculation of summary statistics.



Notes: Only locations with four or more results are mapped.

Figure 120. Average Pu/Am Ratios for CY 1997—October 13, 2005



Notes: Only locations with four or more results are mapped.

Figure 121. Post-Closure Average Pu/Am Ratios

Table 46. Post-Closure Summary Statistics for POE Metals Results from GS10 (October 13, 2005–December 31, 2014)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	156	100.0%	0.50	0.50	0.50
Dissolved Cd	156	94.2%	0.06	0.06	0.34
Total Cr	156	78.2%	0.50	1.34	8.02
Dissolved Ag	156	98.7%	0.10	0.10	0.27

Table 47. Pre-Closure Summary Statistics for POE Metals Results from SW027 (January 1, 1997–October 13, 2005)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	70	45.7%	0.09	0.41	1.30
Dissolved Cd	70	68.6%	0.05	0.13	0.70
Total Cr	70	8.6%	1.70	4.03	31.2
Dissolved Ag	68	85.3%	0.12	0.24	0.72

Table 48. Post-Closure Summary Statistics for POE Metals Results from SW027 (October 13, 2005–December 31, 2014)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	11	100.0%	0.50	0.50	0.50
Dissolved Cd	10	100.0%	0.06	0.06	0.06
Total Cr	11	54.5%	1.00	1.72	2.15
Dissolved Ag	10	100.0%	0.10	0.10	0.10

Table 49. Pre-Closure Summary Statistics for POE Metals Results from SW093 (January 1, 1997–October 13, 2005)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	284	35.2%	0.11	0.55	2.10
Dissolved Cd	284	68.7%	0.05	0.14	2.20
Total Cr	283	16.3%	2.00	7.40	34.90
Dissolved Ag	280	89.6%	0.10	0.18	1.03

Table 50. Post-Closure Summary Statistics for POE Metals Results from SW093 (October 13, 2005–December 31, 2014)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	140	100.0%	0.50	0.50	2.50
Dissolved Cd	140	91.4%	0.06	0.06	1.40
Total Cr	140	71.4%	0.50	1.71	25.7
Dissolved Ag	140	100.0%	0.10	0.10	0.50

3.1.4.2 Surface-Water Loading Analysis

This section provides a summary of radionuclide loads (Am, Pu, and total U) for RFLMA POEs and POCs. In September 2011, the two new COU boundary POCs (WALPOC and WOMPOC) became operational. At the same time, locations GS08, GS11, and GS31 were discontinued as POCs. Locations GS01 and GS03 were operated and evaluated as POCs through September 8, 2013, and September 27, 2013, respectively. All five of these locations continue to operate to provide data for the Adaptive Management Plan, and are included in this section. The locations included in this section all collect continuous flow-paced composite samples for laboratory analysis. The nature of the continuous sampling during all flow conditions allows for more accurate load estimations compared to storm-event or grab sampling.

Due to the interruptions in automated sampling during the September 2013 precipitation event and the corresponding lack of analytical data, for comparison purposes the start of the high runoff (generally late on September 11) through September 13, 2013, is not included in the evaluation in this section. Additionally, some data are estimated for the comparisons herein; under normal RFLMA data evaluation protocols, these estimated data would not be included.

This loading analysis should not be confused with the regulatory evaluation under RFLMA for POCs and POEs. RFLMA evaluation is based on water activity or concentration (i.e., pCi/L or µg/L, respectively) in comparison to applicable surface-water standards (see Section 3.1.2.1 and Section 3.1.2.2). This loading analysis is presented to show changes in the transport of Pu, Am, and U following Site closure. These changes in load, in conjunction with the RFLMA required evaluation, can be used to support conclusions regarding the relative success and continued performance of the remedy.

To calculate load, the activity for each composite sample (pCi/L) is multiplied by the corresponding stream discharge (liters [L]) during the composite sample period, to yield the load (picocuries [pCi]). The total pCi value is then converted to micrograms (µg) using the conversion factors in Table 51.[15] A detailed description of the method for load estimation is given in Appendix B.[16]

[15] In the following tables and plots, values are rounded for presentation.
[16] Data are generally presented at varying precisions for presentation. Accuracy should not be inferred; both analytical and flow measurement error have not been quantified in this report.

Table 51. Activity to Mass Conversion Factors for Pu, Am, and U Isotopes

Analyte	Mass/Activity (grams/curie)
Pu-239,240	14.085
Am-241	0.292
U-233,234	1.6 E+02
U-235	4.63 E+05
U-238	2.98 E+06

Notes: Starting on April 1, 2009, uranium was analyzed as total uranium in μg/L.

The Pu-239,240 conversion factor was derived from Table 2.7.2-2 in the April 1980 *Final Environmental Impact Statement (Final Statement to ERDA 1545-D)*, Rocky Flats Plant Site. The conversion factors for Am-241, U-233,234, U-235, and U-238 were taken from Title 40 *Code of Federal Regulations* Part 302.4 (40 CFR 302.4), Appendix B, October 7, 2000.[17]

Overall Site and Refuge Area

This section summarizes the calculated overall Pu, Am, and U loads for selected locations. Total U data collection began at GS01 and GS03 just prior to CY 2003; therefore, only CY 2003–2014 data are shown for uranium. POC locations WALPOC and WOMPOC were installed in September 2011; averages shown for WALPOC and WOMPOC use available data. The following points are noted:

- Figure 122, Figure 123, Figure 124, and Figure 125 show a significant reduction in average annual Pu and Am loads and activities from the former IA, the terminal ponds, and Walnut Creek at Indiana Street post-closure. The load reductions are between 60 percent and 96 percent for all Walnut Creek locations affected directly by the former IA. Similarly, activity has been reduced between 25 percent and 92 percent at all locations except GS11. The post-closure Pu and Am activities at GS11 are approximately 0.002 pCi/L and <0.001 pCi/L higher, respectively, than pre-closure. Although these differences are well within the error for radionuclide analysis, these increases are attributed to slightly higher activities observed during the extremely high flows in September 2013. The highest measured activity was 0.040 pCi/L Pu and 0.018 pCi/L Am during this period.
- For lower Woman Creek (GS01), however, post-closure loads are comparable to pre-closure loads. This is likely due to transport of diffuse, low-level contamination in the much larger flow volumes measured at GS01, especially during CY 2007, 2010, and 2013; GS01 is not significantly affected by the former IA. GS01 post-closure volume-weighted average Pu and Am activities of 0.007 and 0.003 pCi/L, respectively, are significantly below the RFLMA standard of 0.15 pCi/L and within the analytical measurement error for each analyte.
- For both Pu and Am, remedial actions, removal of impervious surfaces (reducing runoff), revegetation, and erosion control efforts have measurably improved water quality.
- Figure 126 and Figure 127 show a measurable increase in average annual total U concentration in Walnut Creek post-closure (64 percent–201 percent increase). This increase

[17] The U-234 conversion factor was used to represent U-233,234 due to the small relative abundance of U-233.

is primarily due to the reduction of runoff in streamflow and the corresponding proportional increase of groundwater seepage with relatively high concentrations of naturally occurring U. Conversely, the reduction in overall streamflows has actually resulted in decreased total U loads (11 percent–61 percent reduction) in Walnut Creek at all locations except GS10 and GS11 (14 percent and 16 percent increase, respectively).

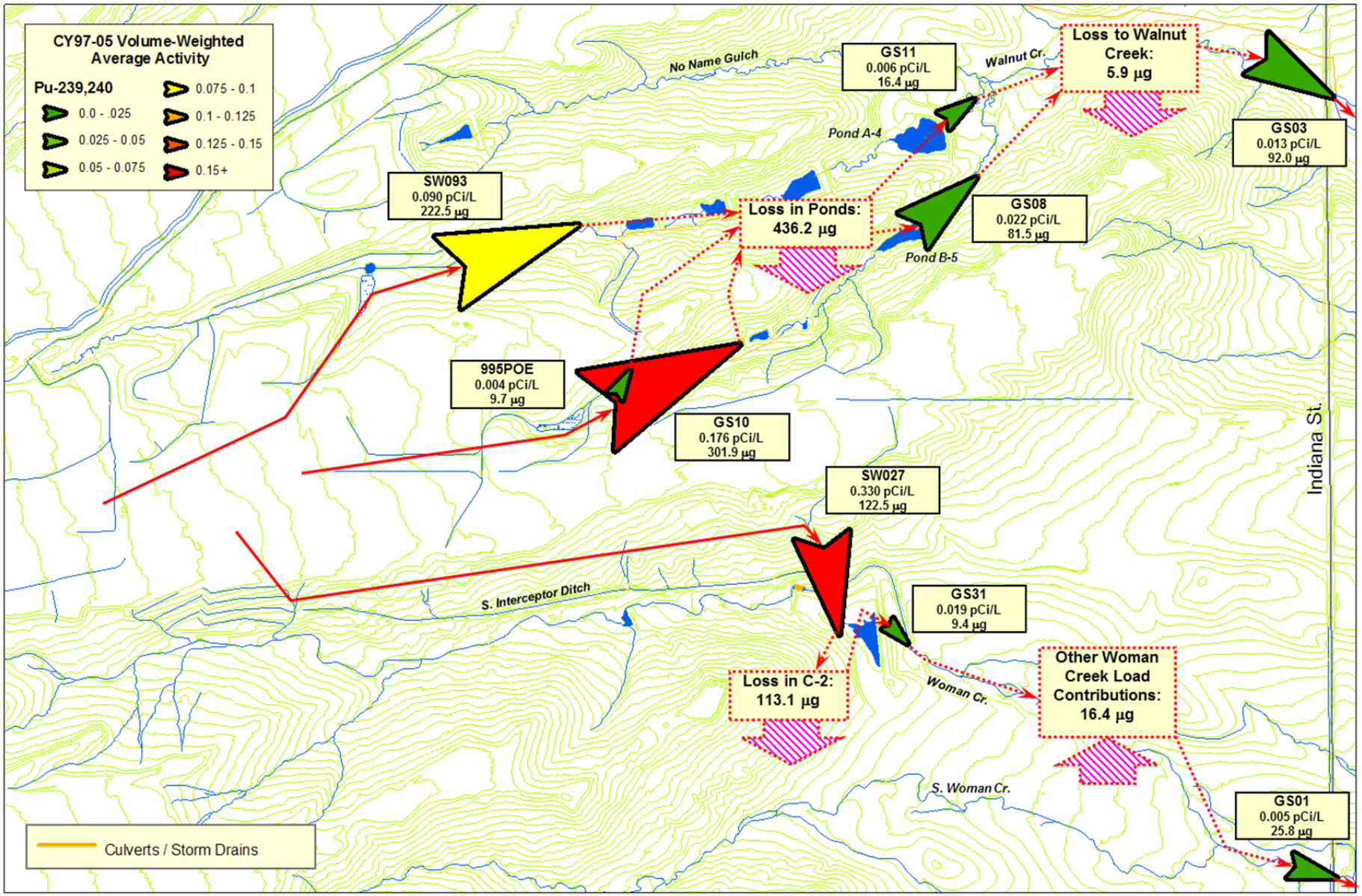
- For lower Woman Creek (GS01), U loads (typically expressed in kilograms [kg]) and concentrations have changed to a lesser extent (14 percent decrease and 4 percent increase, respectively). This is likely due to transport of naturally occurring U in the much larger flow volumes measured at GS01, a location not significantly affected by the former IA.

Walnut and Woman Creeks at Indiana Street

This section summarizes the calculated Pu, Am, and U loads from Walnut and Woman Creeks at Indiana Street. Total U data collection began at GS01 and GS03 just prior to CY 2003; therefore, only CY 2003–2014 data are shown for uranium. Figure 128, Figure 129, Figure 130, Figure 131, Figure 132, Figure 133, and Figure 134, as well as Table 52 and Table 53 present the load data. The following points are noted:

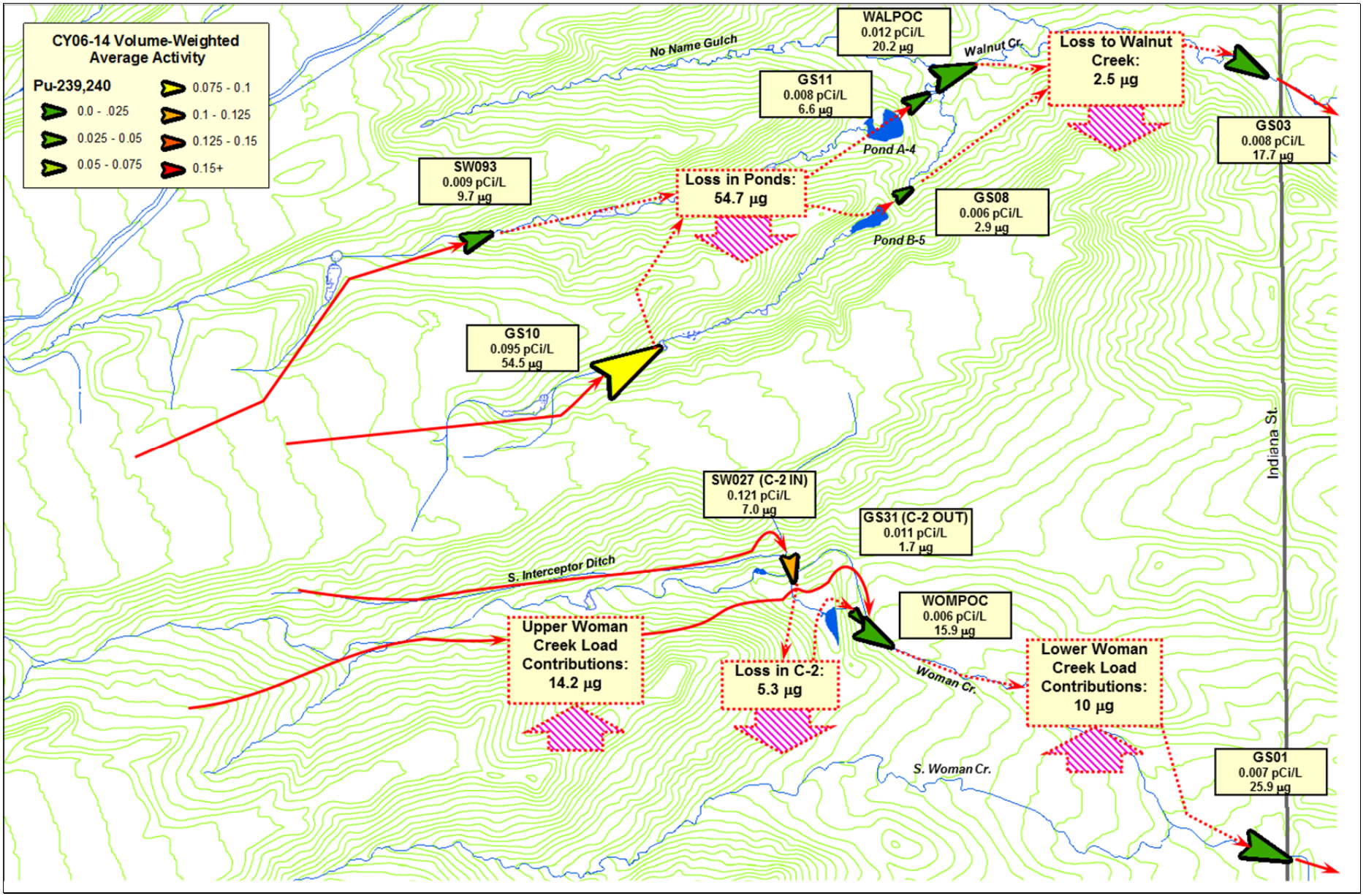
- Both Pu and Am loads have decreased in recent years as Site closure activities have reduced discharge volumes, reduced sediment transport, and eliminated source terms (Figure 128).
- The somewhat higher CY 2007 and CY 2010 Pu and Am loads in Woman Creek at Indiana Street (Figure 129 and Figure 131) can be attributed to high-flow volumes at GS01.[18] Post-closure average annual volume-weighted Pu and Am activities at GS01 are 0.007 and 0.003 pCi/L, respectively; these activities are within the analytical measurement error range.
- Similarly, the somewhat higher CY 2013 Pu and Am loads in both Woman and Walnut Creeks (Figure 129 and Figure 131) can be attributed to extremely high flow rates in September. Although measured activities did not exceed 0.15 pCi/L during this period, increases were observed as Pu and Am transport was enhanced by the high flows.
- Figure 130 and Figure 132 show a significant post-closure reduction in both Pu and Am loads in Walnut Creek at Indiana Street (81 percent and 82 percent, respectively).
- Walnut Creek accounts for nearly 80 percent of both the Pu (Figure 130) and Am (Figure 132) loads at Indiana Street pre-closure. However, post-closure Walnut Creek accounts for only 41–50 percent as a result of the reduction in runoff and transport due to the effectiveness of remedial actions, revegetation, and erosion control measures.
- Walnut Creek accounts for 61 percent of the pre-closure and 56 percent of the post-closure U loads at Indiana Street (Figure 134). Although U concentration has increased in Walnut Creek post-closure, reduced flow volumes have resulted in measurably decreased average annual loads comparable to pre-closure loads.

[18] Measured flow volumes at GS01 in CY 2007 were the highest recorded to date. These volumes are attributed to a combination of large snow events and extensive flood irrigation from Rocky Flats Lake. Volumes in CY 2010 were also well above average due to a large storm event in April 2010.



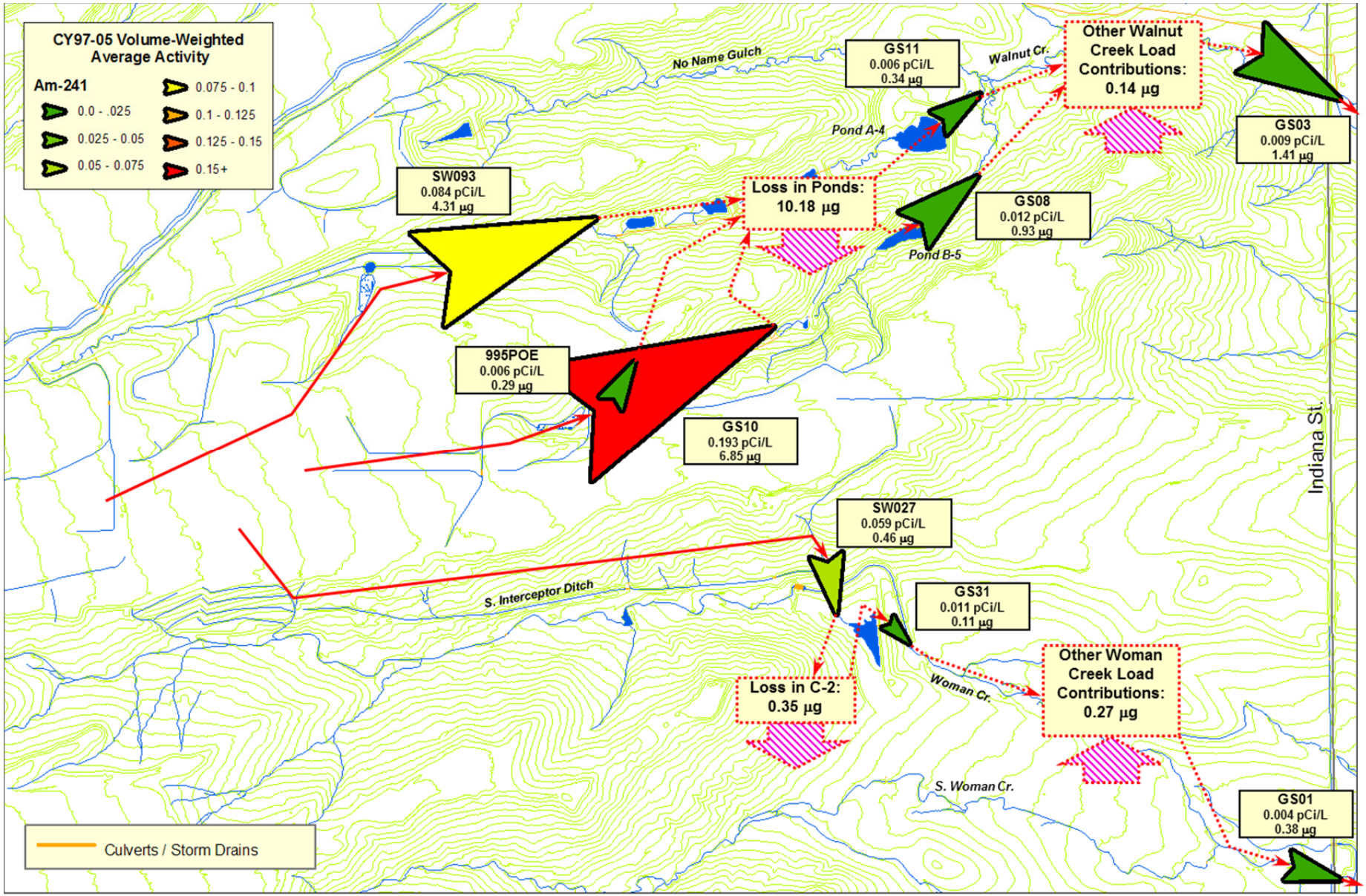
Notes: Location symbols are sized proportional to the calculated average annual load and colored according to the activity ranges in the legend.

Figure 122. Relative Average Annual Pu Loading Schematic: CY 1997–2005



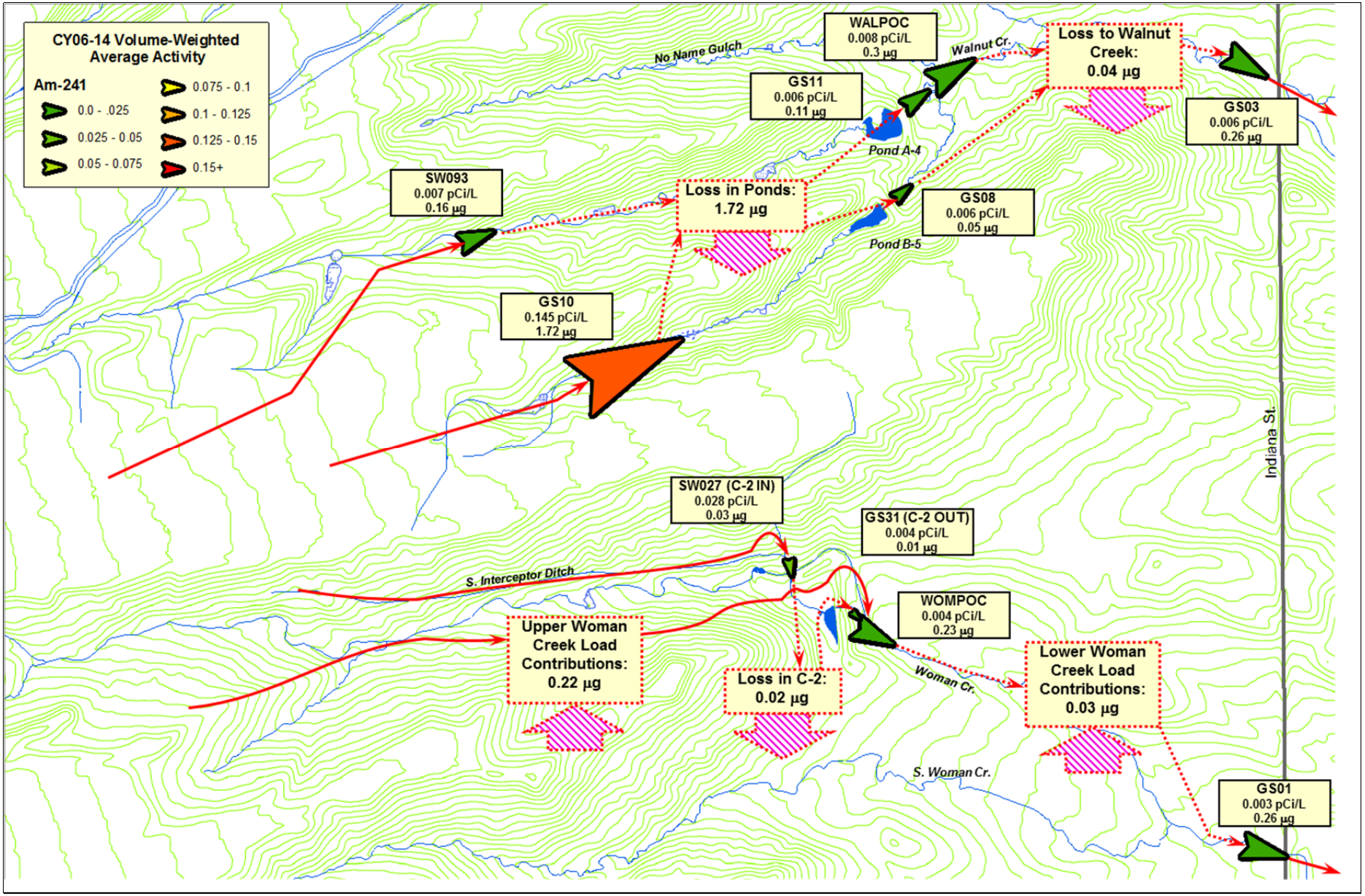
Notes: Location symbols are sized proportional to the calculated average annual load and colored according to the activity ranges in the legend.

Figure 123. Relative Average Annual Pu Loading Schematic: CY 2006–2014



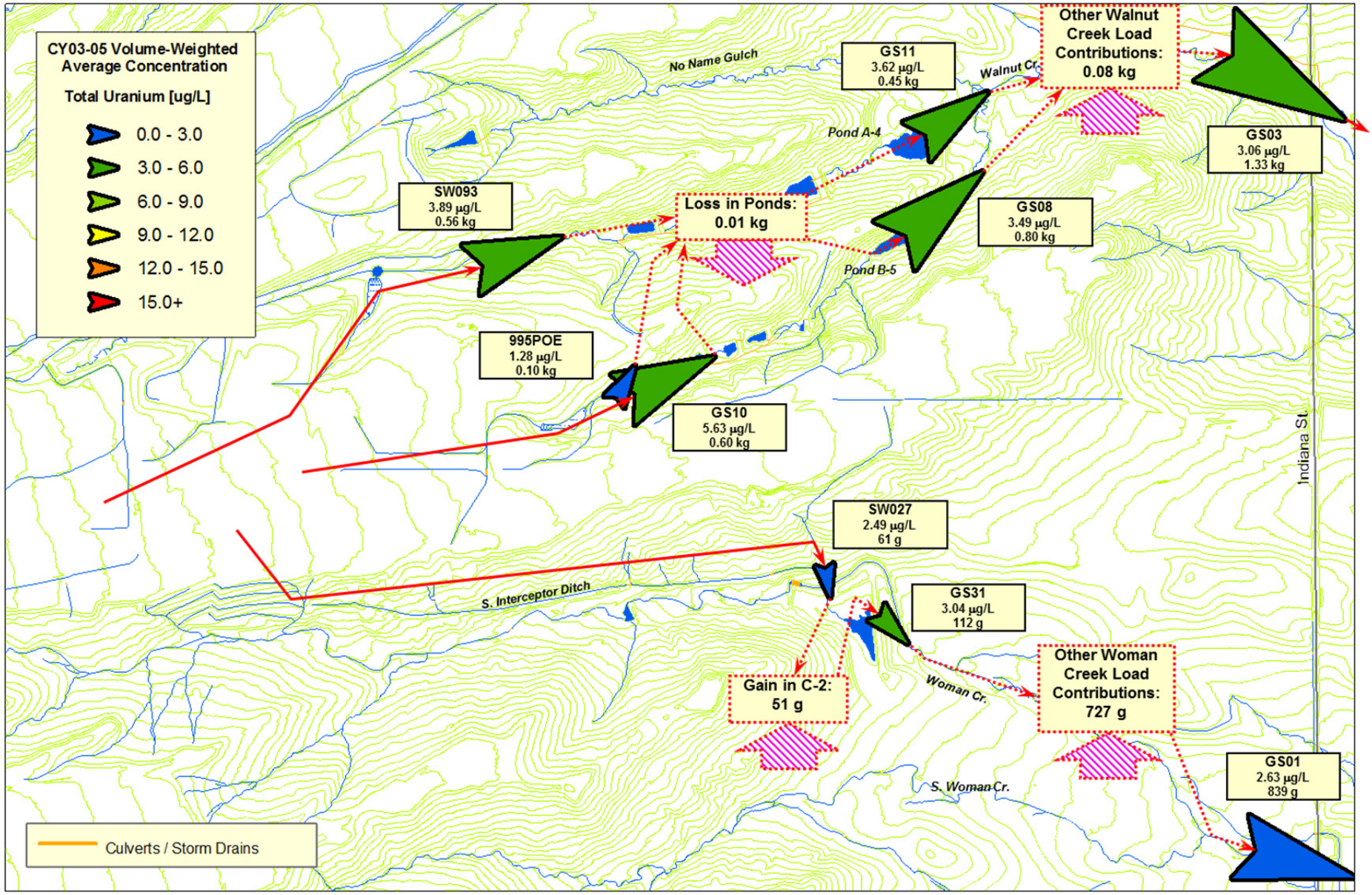
Notes: Location symbols are sized proportional to the calculated average annual load and colored according to the activity ranges in the legend.

Figure 124. Relative Average Annual Am Loading Schematic: CY 1997–2005



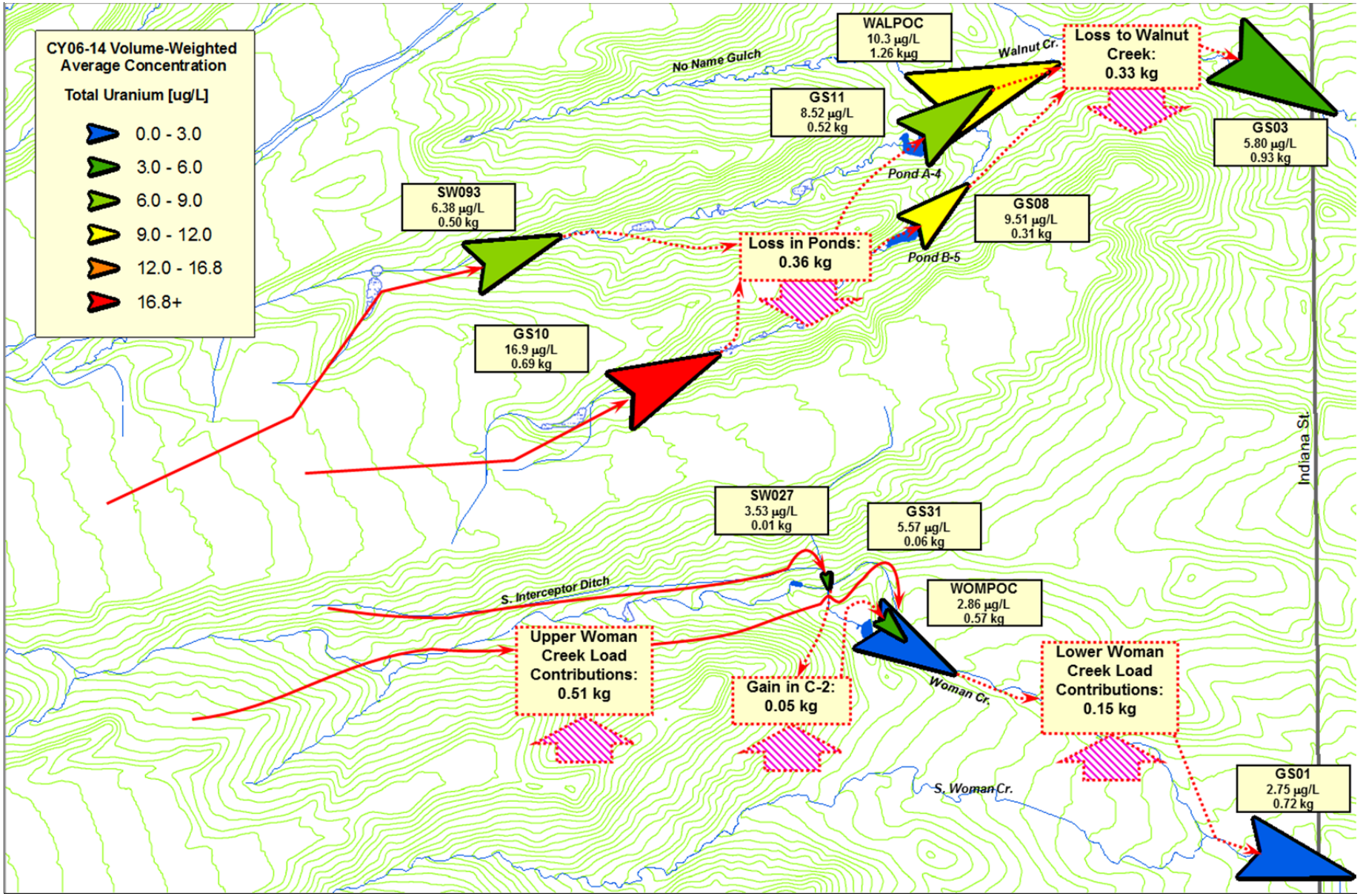
Notes: Location symbols are sized proportional to the calculated average annual load and colored according to the activity ranges in the legend.

Figure 125. Relative Average Annual Am Loading Schematic: CY 2006–2014



Notes: Location symbols are sized proportional to the calculated average annual load and colored according to the activity ranges in the legend.

Figure 126. Relative Average Annual Total U Loading Schematic: CY 2003–2005



Notes: Location symbols are sized proportional to the calculated average annual load and colored according to the activity ranges in the legend.

Figure 127. Relative Average Annual Total U Loading Schematic: CY 2006–2014

Table 52. Pu and Am Loads from Walnut and Woman Creeks at Indiana Street: CY 1997–2014

Calendar Year	Pu-239,240 (µg)			Am-241 (µg)		
	Walnut Creek [GS03]	Woman Creek [GS01]	Total	Walnut Creek [GS03]	Woman Creek [GS01]	Total
1997	262.4	47.9	310.3	2.99	0.40	3.39
1998	172.2	55.4	227.6	2.66	0.99	3.65
1999	150.2	56.7	206.9	1.83	0.75	2.57
2000	26.0	6.1	32.1	0.74	0.18	0.92
2001	58.6	22.4	81.0	0.63	0.30	0.93
2002	37.4	0.8	38.2	0.37	0.03	0.40
2003	57.6	25.9	83.5	1.07	0.34	1.41
2004	33.1	4.7	37.8	0.70	0.15	0.86
2005	30.3	12.5	42.8	1.67	0.30	1.97
2006	0.0; No Flow	1.4	1.4	0.00; No Flow	0.13	0.13
2007	17.2	68.0	85.1	0.12	0.49	0.60
2008	0.0; No Flow	1.1	1.1	0.00; No Flow	0.02	0.02
2009	9.5	26.7	36.2	0.16	0.23	0.39
2010	46.9	70.6	117.5	0.71	0.78	1.49
2011	3.2	5.2	8.4	0.08	0.12	0.20
2012	3.3	2.2	5.5	0.02	0.07	0.08
2013	73.5	38.5	111.9	1.13	0.26	1.39
2014	5.8	19.4	25.2	0.12	0.28	0.39
Total	987	465	1,452	15.0	5.8	20.8

Notes: During CY 1997, flows from Woman Creek were routinely diverted to Mower Ditch for subsequent monitoring at GS02. Therefore, the load calculated for Woman Creek at Indiana Street (GS01) includes the water that was measured at GS02. The estimated load diverted to GS02 is calculated by multiplying the CY 1997 volume-weighted activities at GS01 by the streamflow volume measured at GS02, and converting for units. This diverted load is then added to the calculated load at GS01 to obtain the total CY 1997 load at GS01. For subsequent water years, the Mower diversion structure has been upgraded and configured to prevent Woman Creek flows from entering the Mower Ditch.

Table 53. Total U Loads from Walnut and Woman Creeks at Indiana Street: CY 2003–2014

Calendar Year	Total U (kg)		
	Walnut Creek [GS03]	Woman Creek [GS01]	Total
2003	1.75	0.79	2.54
2004	0.74	0.81	1.55
2005	1.48	0.92	2.40
2006	0; No flow	0.24	0.24
2007	1.01	1.02	2.02
2008	0; No flow	0.17	0.17
2009	0.72	0.76	1.49
2010	2.31	1.16	3.47
2011	0.70	0.61	1.31
2012	0.67	0.47	1.13
2013	1.51	0.89	2.39
2014	1.45	1.19	2.63
Total	12.3	9.01	21.3

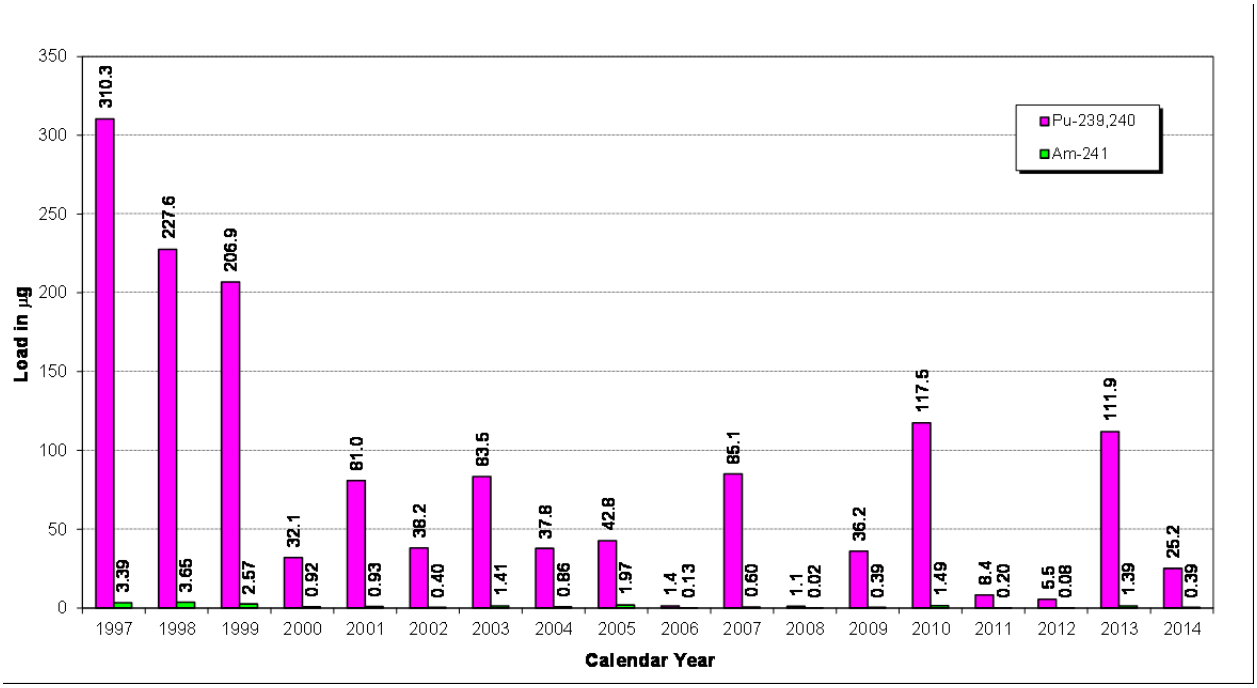


Figure 128. Combined Annual Pu and Am Loads from Walnut and Woman Creeks at Indiana Street: CY 1997–2014

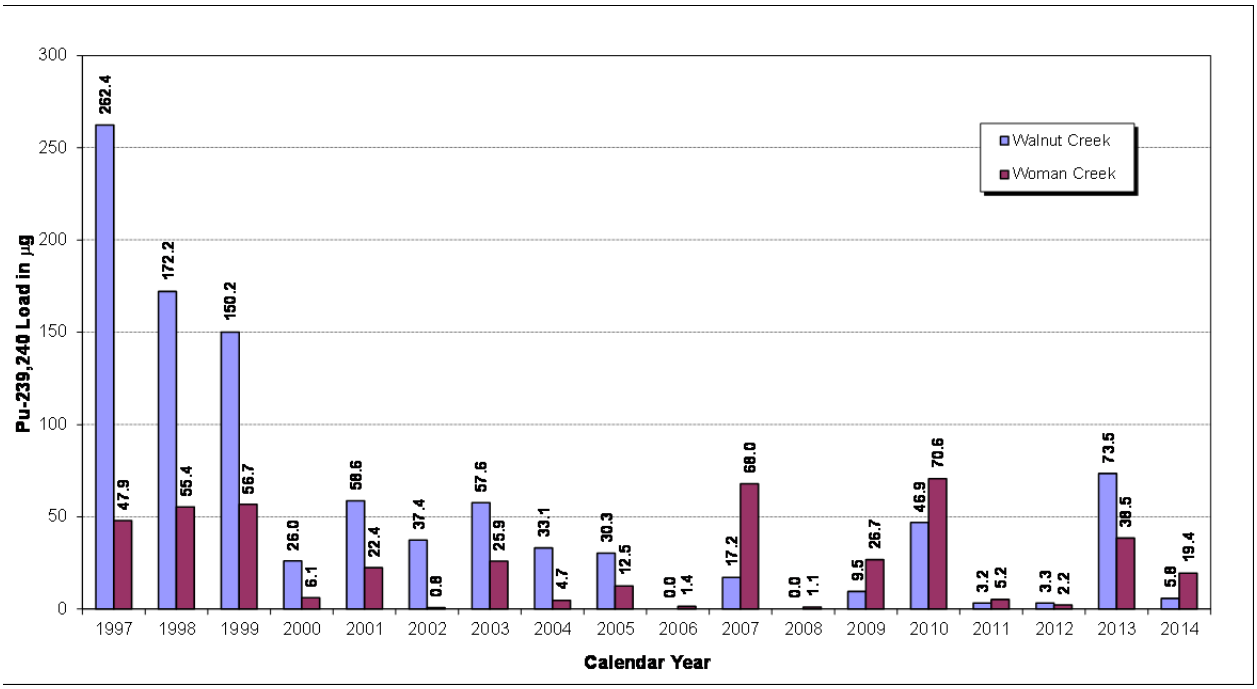
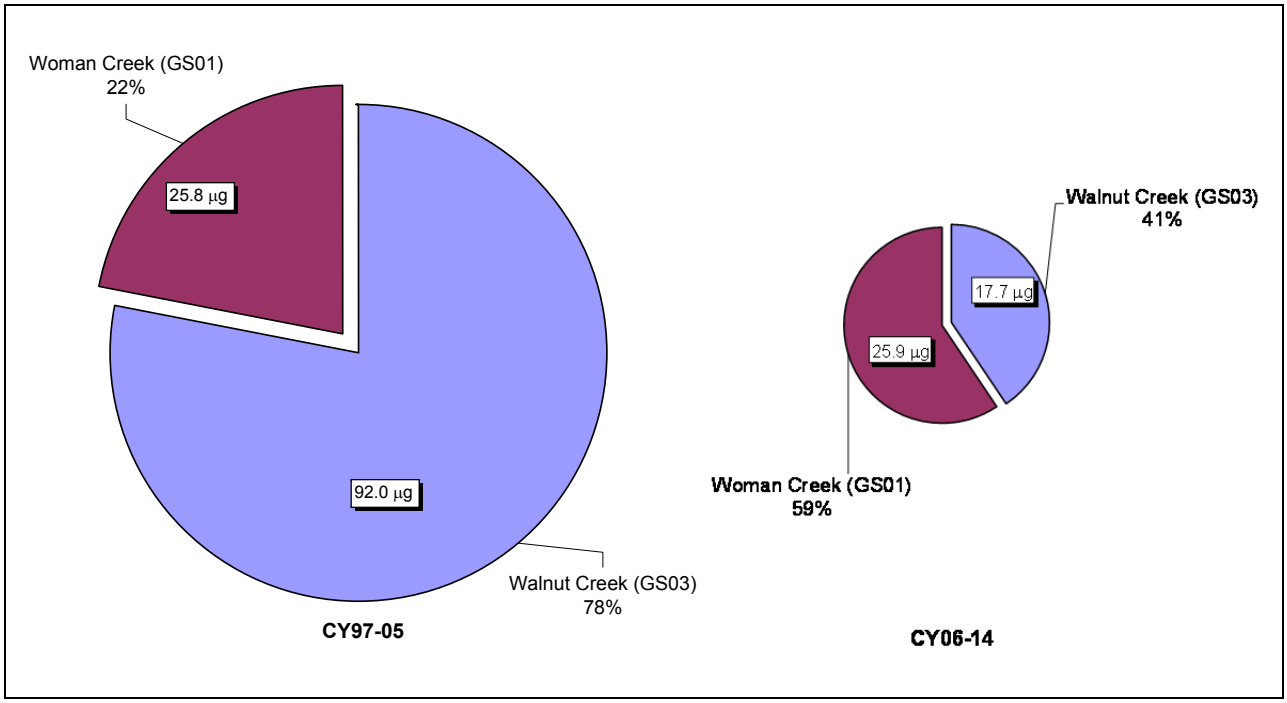


Figure 129. Annual Pu Loads from Walnut and Woman Creeks at Indiana Street: CY 1997–2014



Notes: Pie chart diameters are relative to total load.

Figure 130. Relative Average Annual Pu Load Totals from Walnut and Woman Creeks at Indiana Street

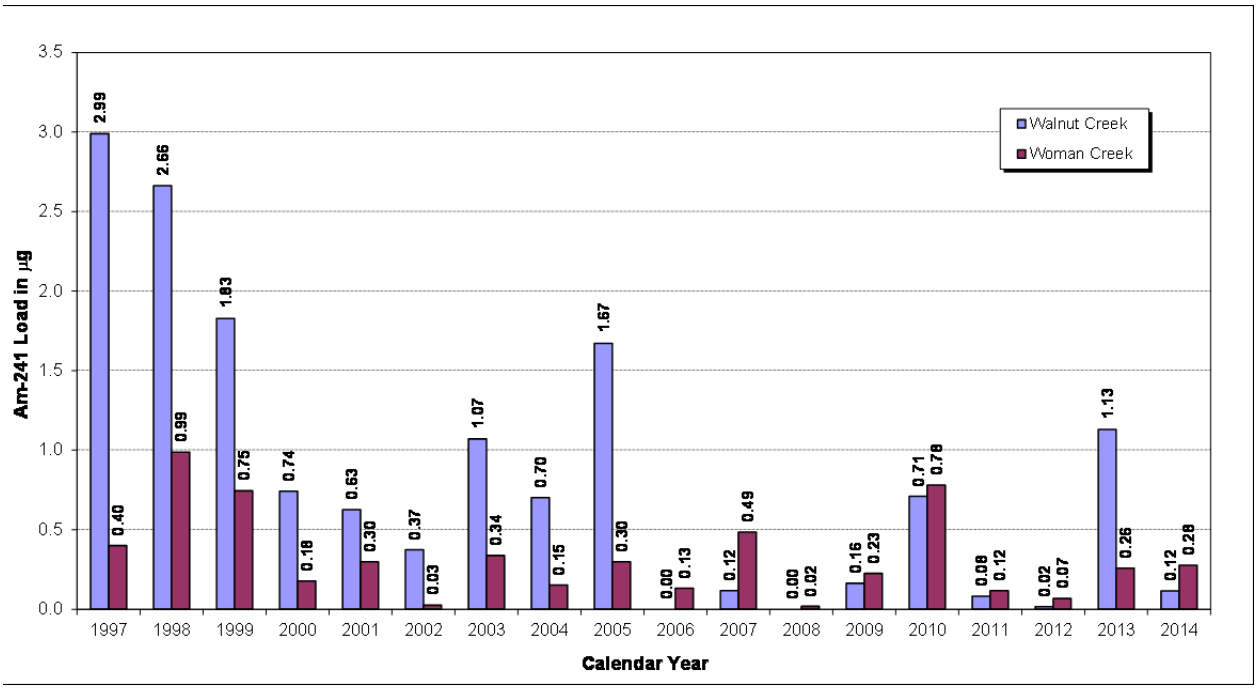
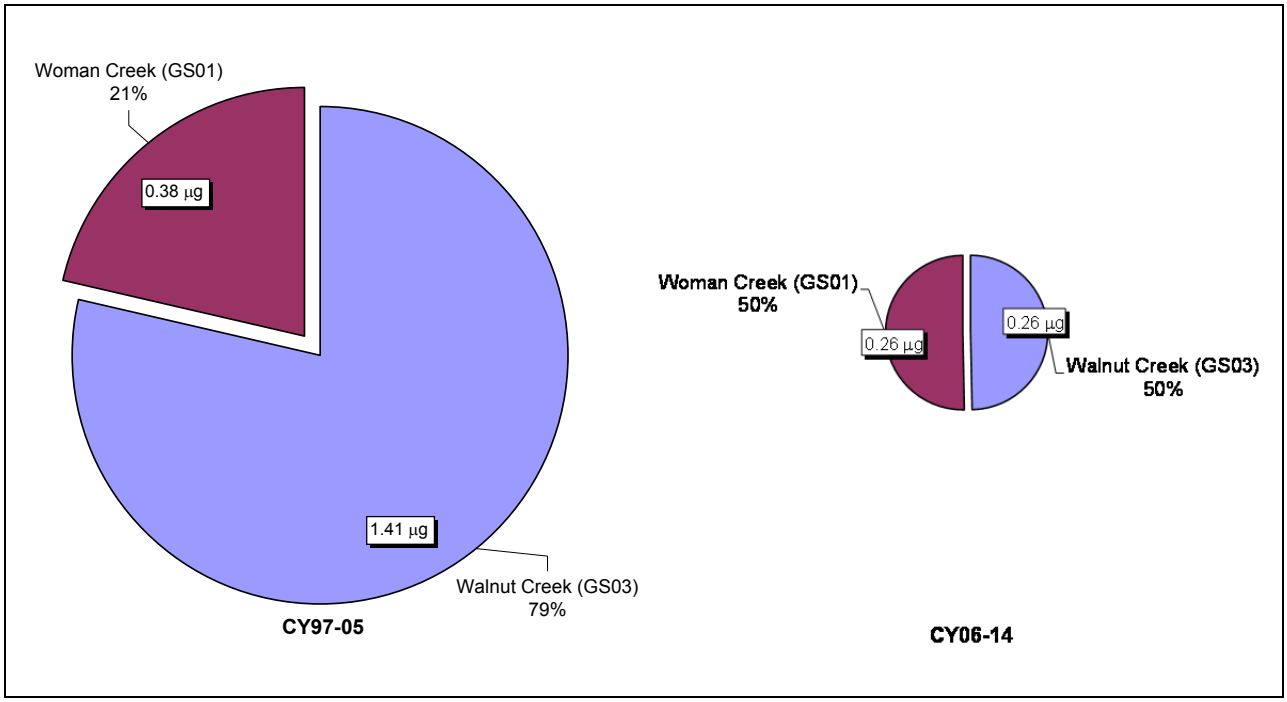


Figure 131. Annual Am Loads from Walnut and Woman Creeks at Indiana Street: CY 1997–2014



Notes: Pie chart diameters are relative to total load.

Figure 132. Relative Average Annual Am Load Totals from Walnut and Woman Creeks at Indiana Street

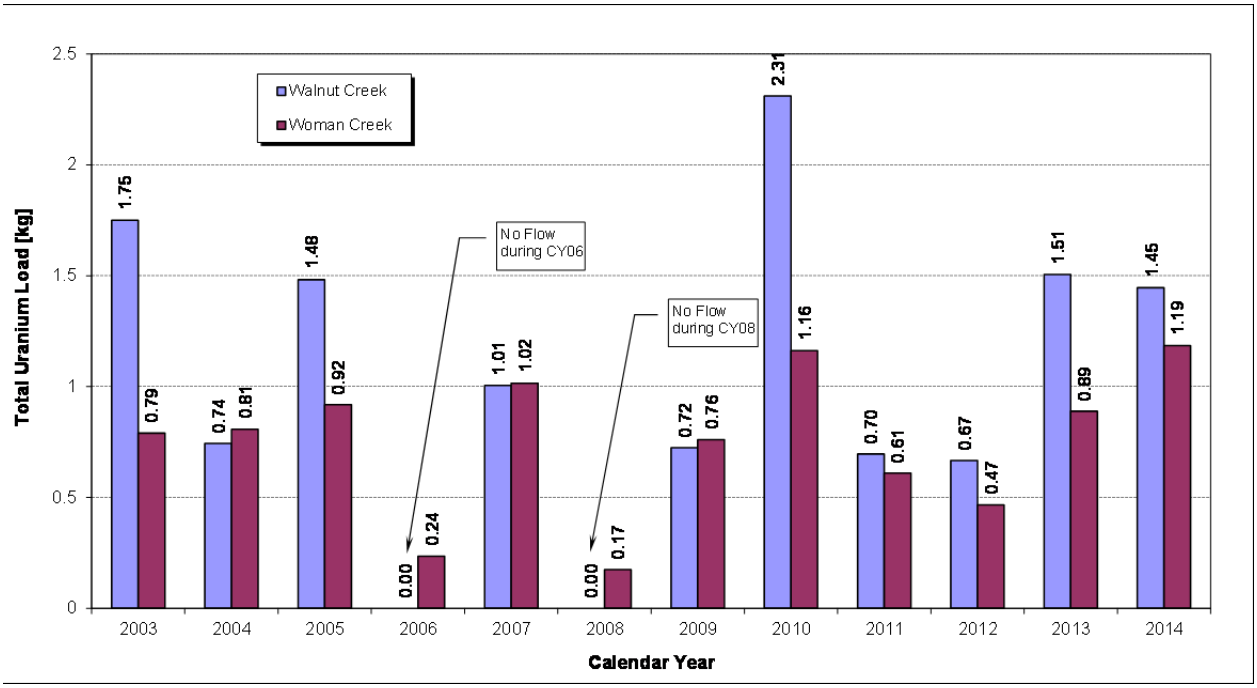
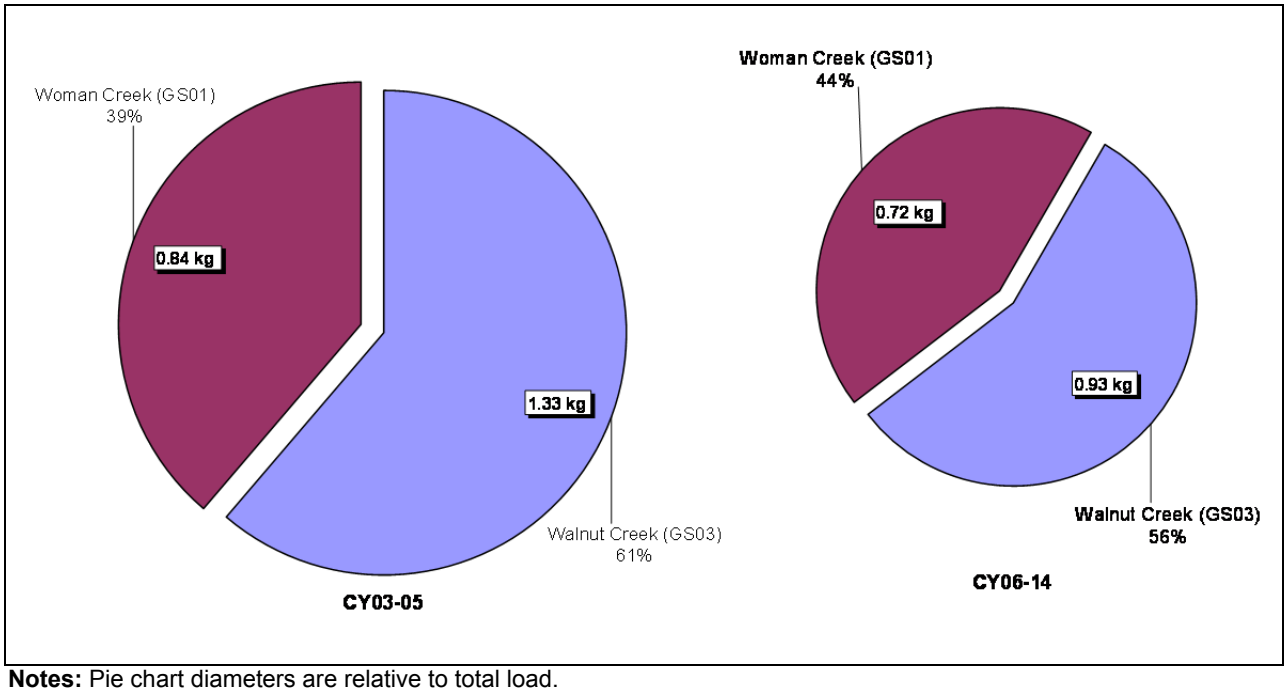


Figure 133. Annual Total U Loads from Walnut and Woman Creeks at Indiana Street: CY 2003–2014



Notes: Pie chart diameters are relative to total load.

Figure 134. Relative Average Annual Total U Load Totals from Walnut and Woman Creeks at Indiana Street

Central Operable Unit Boundary POCs (Site POCs)

This section summarizes the calculated Pu, Am, and U loads from Walnut and Woman Creeks at the eastern COU boundary. POCs WALPOC and WOMPOC began operating in September 2011. Figure 135, Figure 136, Figure 137, and Figure 138, as well as Table 54 and Table 55 present the load data. POCs WALPOC and WOMPOC show both loads and activities/concentrations that are comparable to the downstream locations at Indiana Street (GS03 and GS01; see the next two sections).

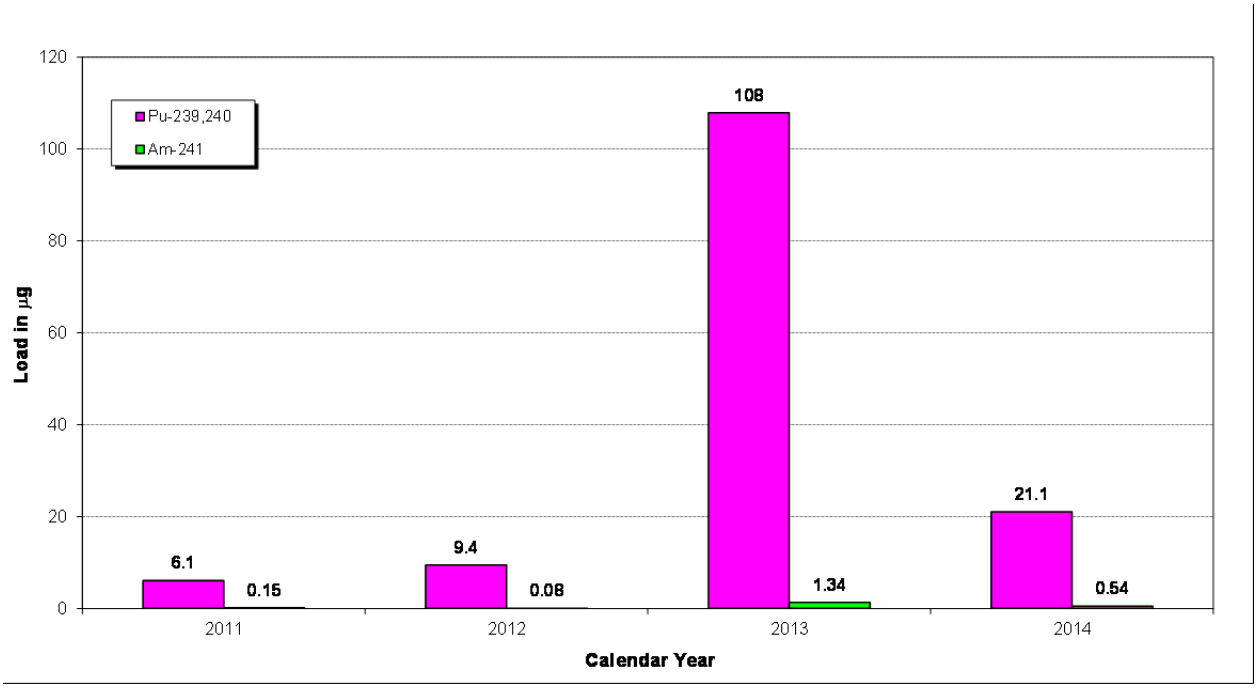


Figure 135. Combined Annual Pu and Am Loads from Walnut and Woman Creeks at Eastern COU Boundary: CY 2011–2014

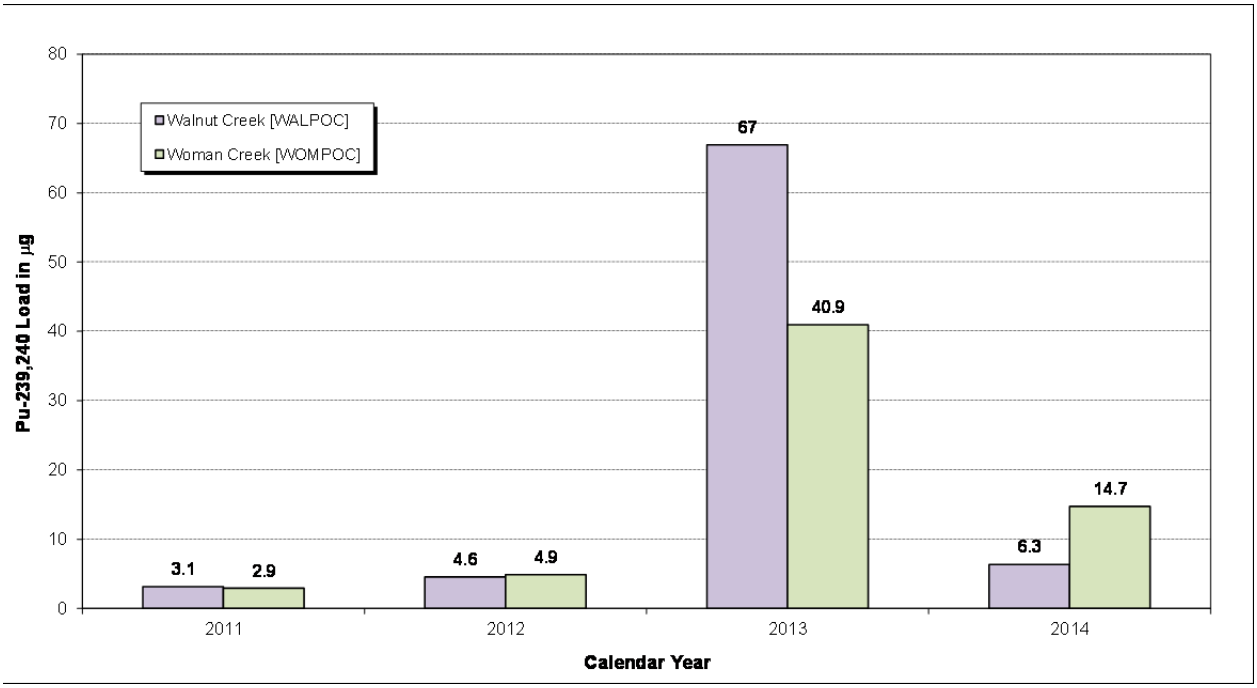


Figure 136. Annual Pu Loads from Walnut and Woman Creeks at Eastern COU Boundary: CY 2011–2014

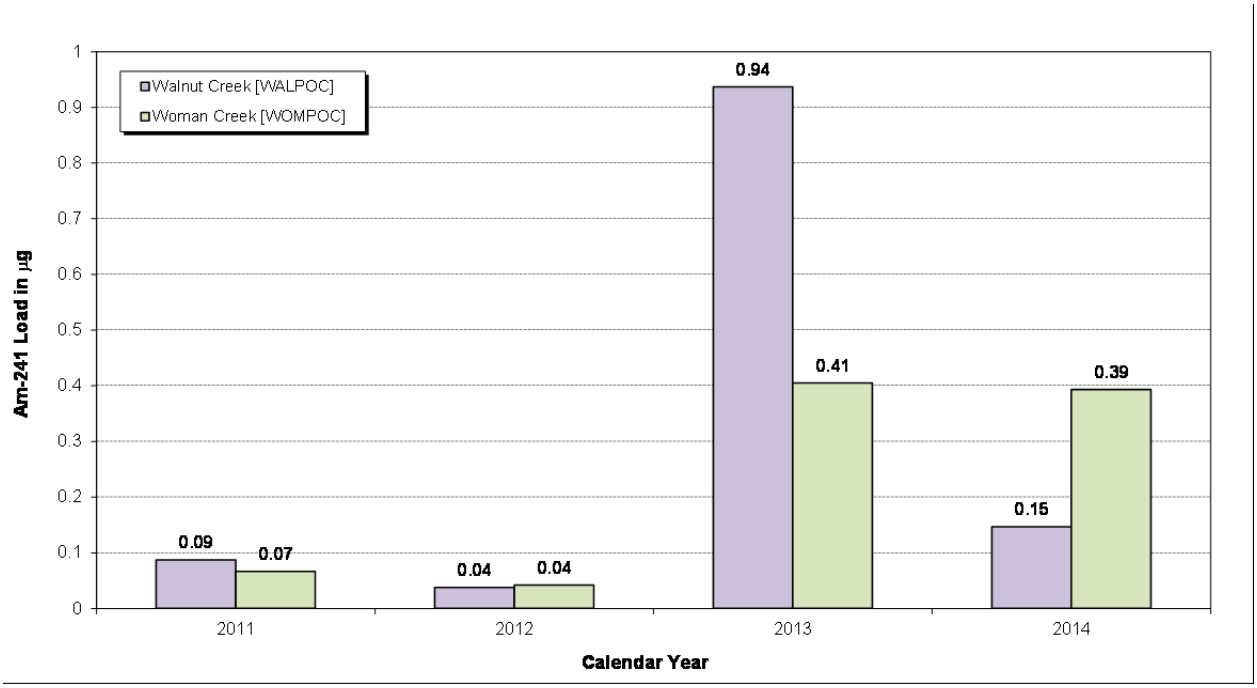


Figure 137. Annual Am Loads from Walnut and Woman Creeks at Eastern COU Boundary: CY 2011–2014

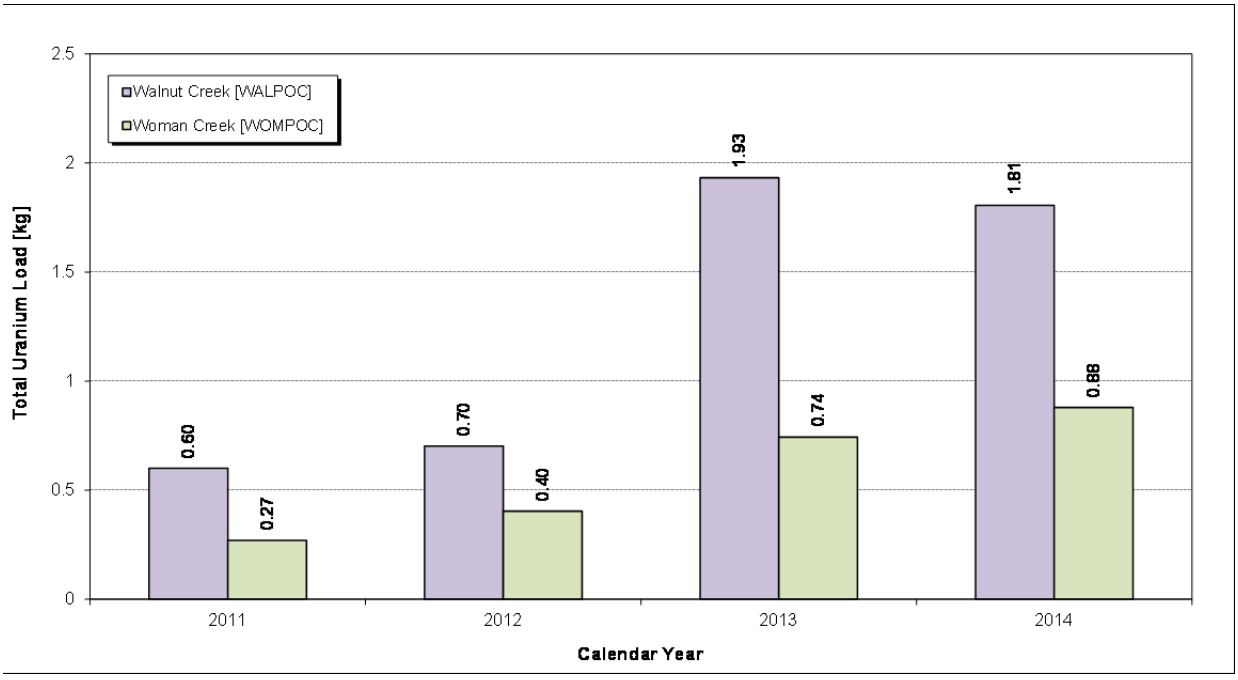


Figure 138. Annual Total U Loads from Walnut and Woman Creeks at Eastern COU Boundary: CY 2011–2014

Table 54. Offsite Pu and Am Loads from Walnut and Woman Creeks at Eastern COU Boundary: CY 2011–2014

Calendar Year	Pu-239,240 (µg)			Am-241 (µg)		
	Walnut Creek [WALPOC]	Woman Creek [WOMPOC]	Total	Walnut Creek [WALPOC]	Woman Creek [WOMPOC]	Total
2011	3.1[a]	2.9[a]	6.1	0.09[a]	0.07[a]	0.15
2012	4.6	4.9	9.4	0.04	0.04	0.08
2013	66.9	40.9	107.9	0.94	0.41	1.34
2014	6.3	14.7	21.1	0.15	0.39	0.54
Total	81	63	144	1.2	0.9	2.1

Notes:
[a] Partial data

Table 55. Total U Loads from Walnut and Woman Creeks at Eastern COU Boundary: CY 2011–2014

Calendar Year	Total U (kg)		
	Walnut Creek [WALPOC]	Woman Creek [WOMPOC]	Total
2011	0.60[a]	0.27[a]	0.87[a]
2012	0.70	0.40	1.11
2013	1.93	0.74	2.68
2014	1.81	0.88	2.69
Total	5.04	2.30	7.34

Notes:
[a] Partial data

Lower Walnut Creek

This section summarizes the calculated Pu, Am, and U loads in Walnut Creek at GS03 (Walnut Creek at Indiana Street), WALPOC (Walnut Creek at the eastern COU boundary), GS08 (Pond B-5 outlet), and GS11 (Pond A-4 outlet). Because WALPOC began operating on September 9, 2011, it is only included in selected tables and figures at this time. The data are presented in Table 56, Table 57, and Table 58 and are depicted on Figure 139, Figure 140, Figure 141, Figure 142, Figure 143, Figure 144, Figure 145, Figure 146, Figure 147, and Figure 148. Total U data collection at GS03 began on November 5, 2002; thus, only CY 2003–2014 data are shown. The following points are noted:

- Pu and Am loads are generally decreasing at GS03 (Figure 139). The slight increase in Am loads at GS03 during CY 2005 is due to increased Am contributions to the A-Series Ponds related to the decontamination and decommissioning of B771. Treatment of Pond A-4 water was successful in reducing Am levels well below the applicable standard (0.15 pCi/L), but the Am activity of the discharged water was somewhat higher than normal. Pond B-5 also showed some increased Am activity due to the temporarily increased Am load associated with solids transport resulting from the construction of FC-4. These slightly higher Am activities were subsequently also measured at GS03 (Figure 143). The measurable increases in CY 2010 and 2013 loads are primarily due to large flow volumes and not significant increases in activity.

- Annual Pu and Am loads can vary by up to two orders of magnitude year to year (Figure 140 and Figure 143). Pre-closure, the significant annual variability in Pu and Am loads is due mostly to variation in measured Pu and Am activities. Post-closure, load variation is due to large runoff variation and the low measured activities with the inherent analytical error at such low levels.
- Annual Pu and Am loads for all Lower Walnut Creek locations have been reduced post-closure (Figure 140 and Figure 143) due to the reduction of runoff and sediment transport resulting from the effectiveness of remedial actions, revegetation, and erosion control measures. Load reductions range between 60 percent and 96 percent.
- Pre-closure Pu and Am loads from Pond B-5 are significantly greater than loads from Pond A-4 (Table 56 and Table 57), a result of both higher activities and larger discharge volumes. However, post-closure loads from Pond A-4 are mostly greater than from Pond B-5, primarily due to larger flow volumes and not higher activities. Post-closure load reductions for Ponds A-4 and B-5 range between 60 percent and 96 percent.
- For most years during 1997 through 2014, total Pu and Am loads from Ponds A-4 and B-5 are comparable to the loads at GS03 (Table 56 and Table 57), suggesting no significant change in water quality between the two locations.

Table 56. Pu Loads at GS03, GS08, GS11, and WALPOC: CY 1997–2014

Calendar Year	Pu-239,240 (µg)				
	Pond A-4 [GS11]	Pond B-5 [GS08]	Walnut Creek Terminal Ponds Total	POC WALPOC	Walnut Creek [GS03]
1997	59.2	8.8	68.0	NA	262.4
1998	20.0	22.4	42.4	NA	172.2
1999	23.8	261.4	285.2	NA	150.2
2000	28.4	244.6	273.0	NA	26.0
2001	4.7	32.3	37.0	NA	58.6
2002	0.1	7.8	7.9	NA	37.4
2003	7.3	111.5	118.8	NA	57.6
2004	2.2	27.1	29.3	NA	33.1
2005	2.2	17.9	20.1	NA	30.3
2006	0.0; No A-4 discharge	0.0; No B-5 discharge	0.0	NA	0.0 No flow
2007	7.8	1.9	9.6	NA	17.2
2008	0.0; No A-4 discharge	0.0; No B-5 discharge	0.0	NA	0.0 No flow
2009	2.3	3.0	5.3	NA	9.5
2010	6.4	5.4	11.9	NA	46.9
2011	1.0	1.8	2.8	3.1[a]	3.2
2012	2.1	1.1	3.3	4.6	3.3
2013	37.3	6.3	43.6	67.0	73.5
2014	2.2[a]	6.8[a]	9.0[a]	6.3	5.8
Total	207[a]	760[a]	967[a]	81	987

Notes:
[a] Partial data

Table 57. Am Loads at GS03, GS08, GS11, and WALPOC: CY 1997–2014

Calendar Year	Am-241 (µg)				
	Pond A-4 [GS11]	Pond B-5 [GS08]	Walnut Creek Terminal Ponds Total	POC WALPOC	Walnut Creek [GS03]
1997	0.70	0.25	0.95	NA	2.99
1998	1.25	0.35	1.60	NA	2.66
1999	0.20	1.81	2.01	NA	1.83
2000	0.02	3.14	3.16	NA	0.74
2001	0.11	0.46	0.57	NA	0.63
2002	0.04	0.25	0.29	NA	0.37
2003	0.18	0.54	0.72	NA	1.07
2004	0.14	0.58	0.73	NA	0.70
2005	0.43	0.97	1.39	NA	1.67
2006	0.0 No A-4 discharge	0.0; No B-5 discharge	0.00	NA	0.0 No flow
2007	0.02	0.03	0.05	NA	0.12
2008	0.0 No A-4 discharge	0.0; No B-5 discharge	0.00	NA	0.0 No flow
2009	0.09	0.02	0.11	NA	0.16
2010	0.14	0.11	0.25	NA	0.71
2011	0.05	0.02	0.07	0.09[a]	0.08
2012	0.06	0.01	0.07	0.04	0.02
2013	0.61	0.20	0.81	0.94	1.13
2014	0.05[a]	0.09[a]	0.14[a]	0.15	0.12
Total	4.09[a]	8.84	12.9[a]	1.21	15.0

Notes:
[a] Partial data

Table 58. Total U Loads at GS03, GS08, GS11, and WALPOC: CY 2003–2014

Calendar Year	Total U (kg)				
	Pond A-4 [GS11]	Pond B-5 [GS08]	Walnut Creek Terminal Ponds Total	POC WALPOC	Walnut Creek [GS03]
2003	0.86	0.61	1.47	NA	1.75
2004	0.32	0.39	0.71	NA	0.74
2005	0.16	1.39	1.55	NA	1.48
2006	0.0; No A-4 discharge	0.0; No B-5 discharge	0.00	NA	0.0 No flow
2007	0.41	0.48	0.89	NA	1.01
2008	0.0; No A-4 discharge	0.0; No B-5 discharge	0.00	NA	0.0 No flow
2009	0.41	0.32	0.73	NA	0.72
2010	1.20	0.75	1.95	NA	2.31
2011	0.43	0.31	0.75	0.60[a]	0.70
2012	0.38	0.13	0.51	0.70	0.67
2013	0.97	0.41	1.38	1.93	1.51
2014	0.88[a]	0.39[a]	1.27[a]	1.81	1.45
Total	6.03[a]	5.18[a]	11.2[a]	5.04	12.3

Notes:
[a] Partial data

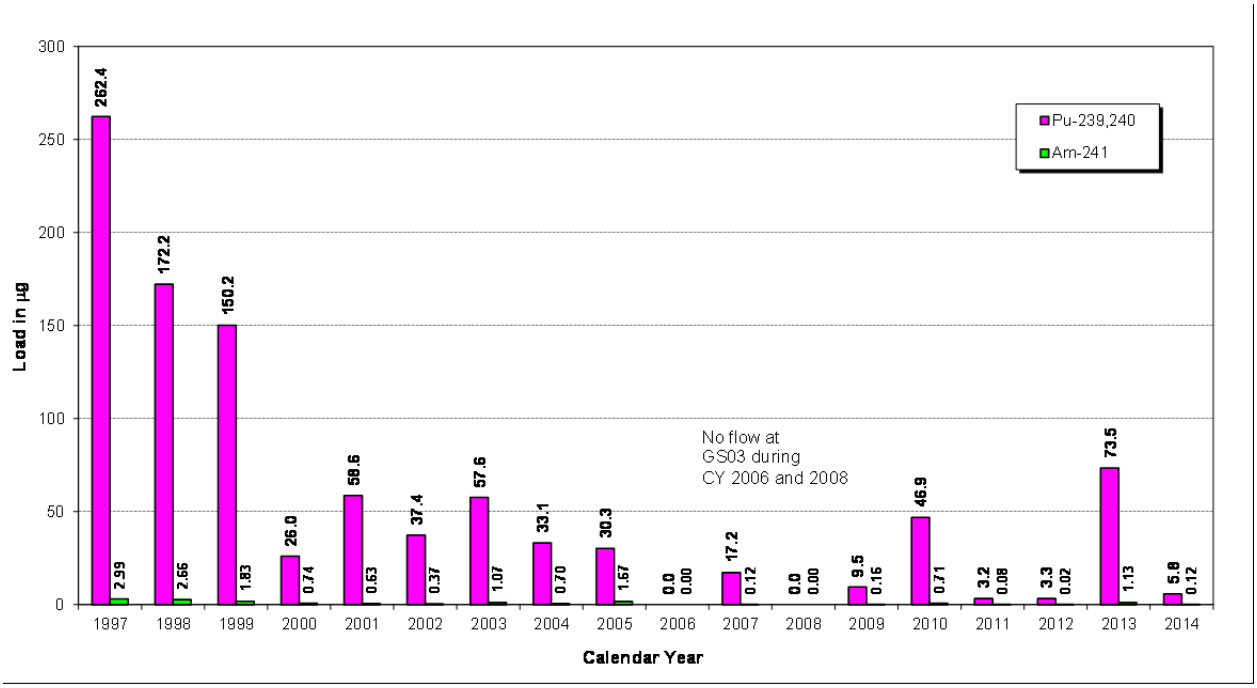


Figure 139. Annual Pu and Am Loads at GS03: CY 1997–2014

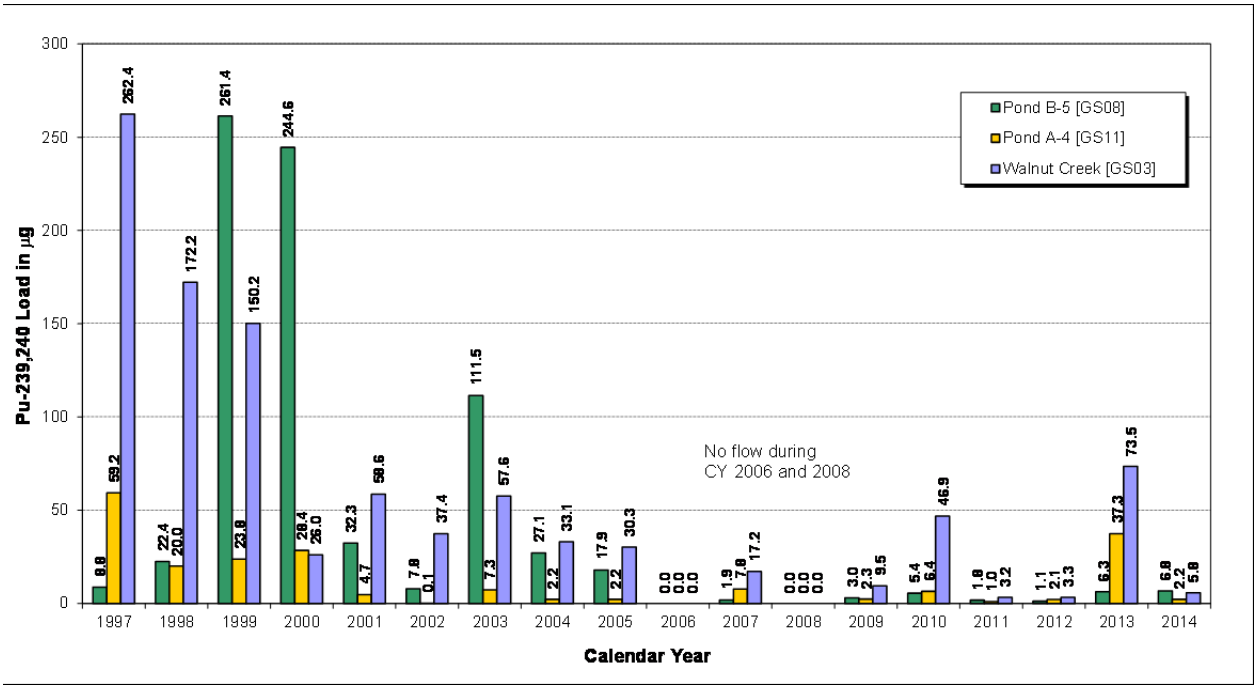


Figure 140. Annual Pu Loads at GS03, GS08, and GS11: CY 1997–2014

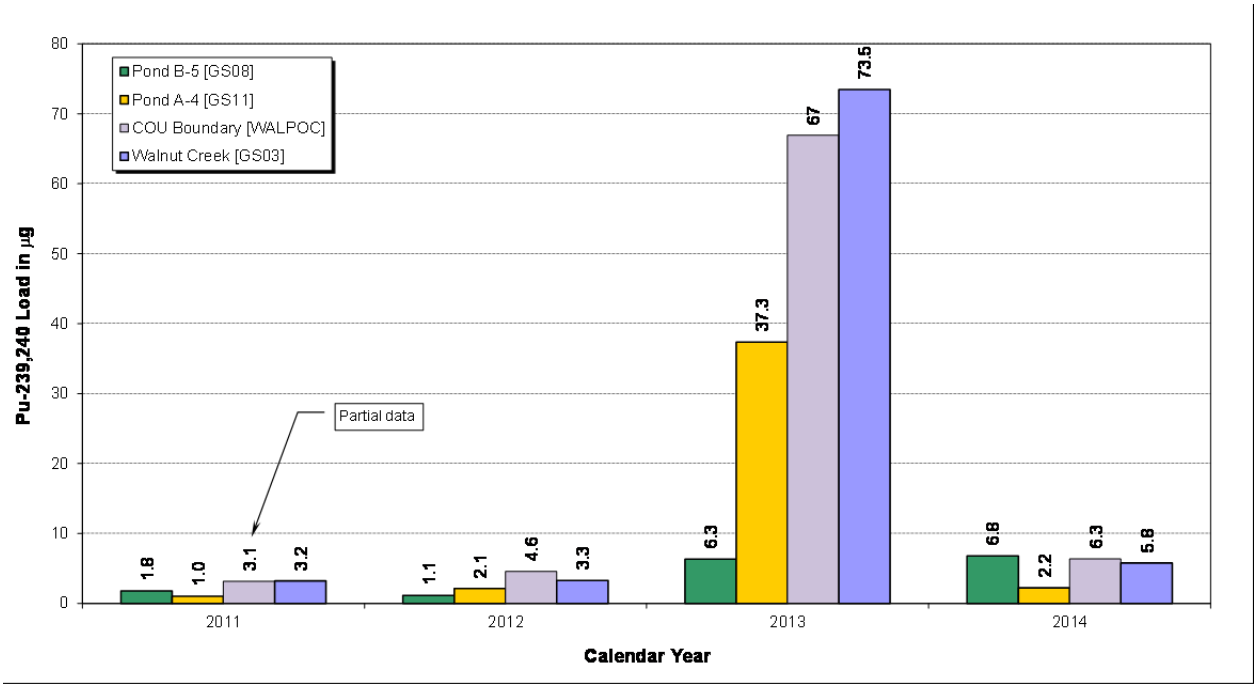
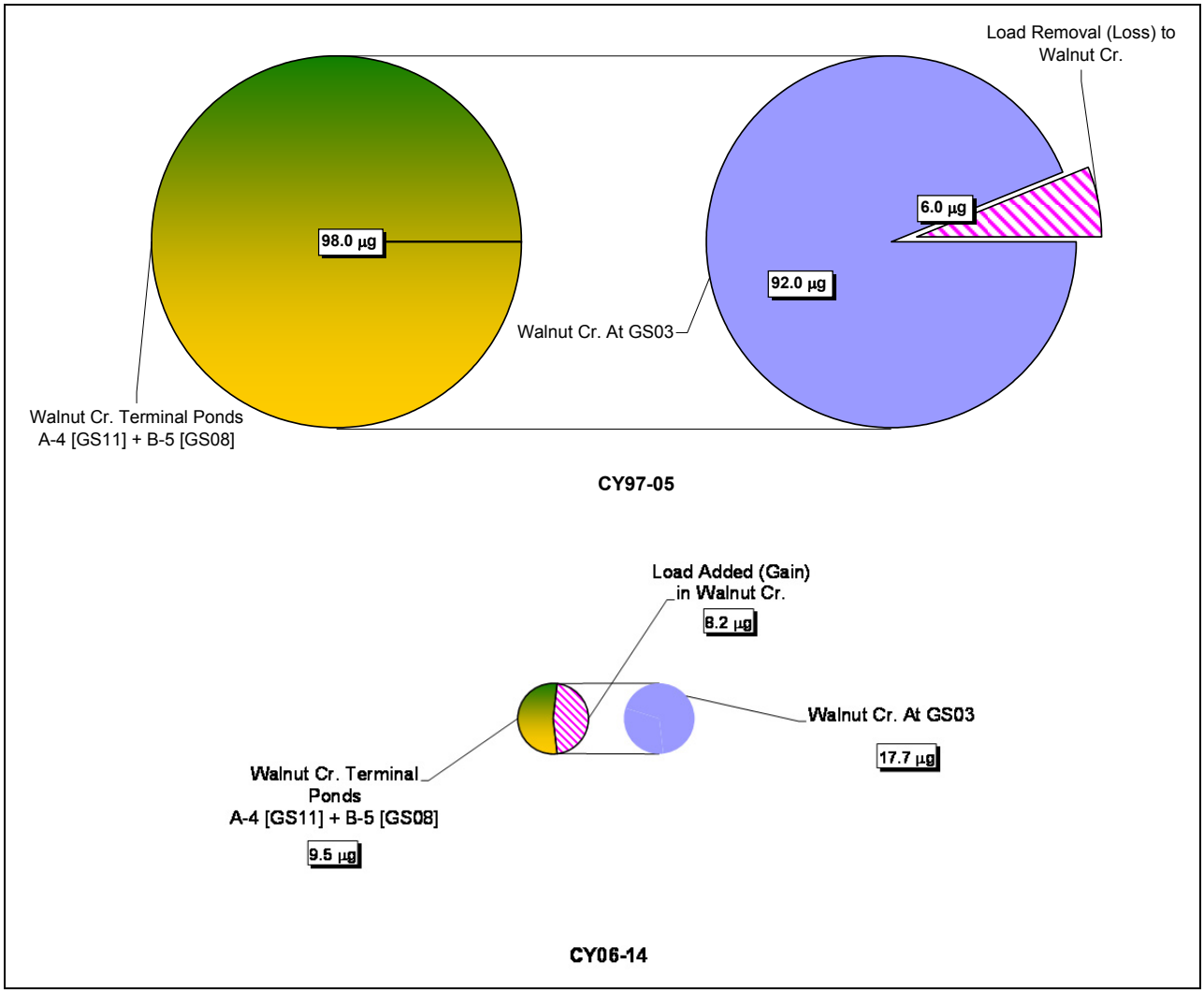


Figure 141. Annual Pu Loads at GS03, GS08, GS11, and WALPOC: CY 2011–2014



Notes: Pie chart diameters are relative to total load.

Figure 142. Relative Average Annual Pu Load Totals at GS03, GS08, and GS11

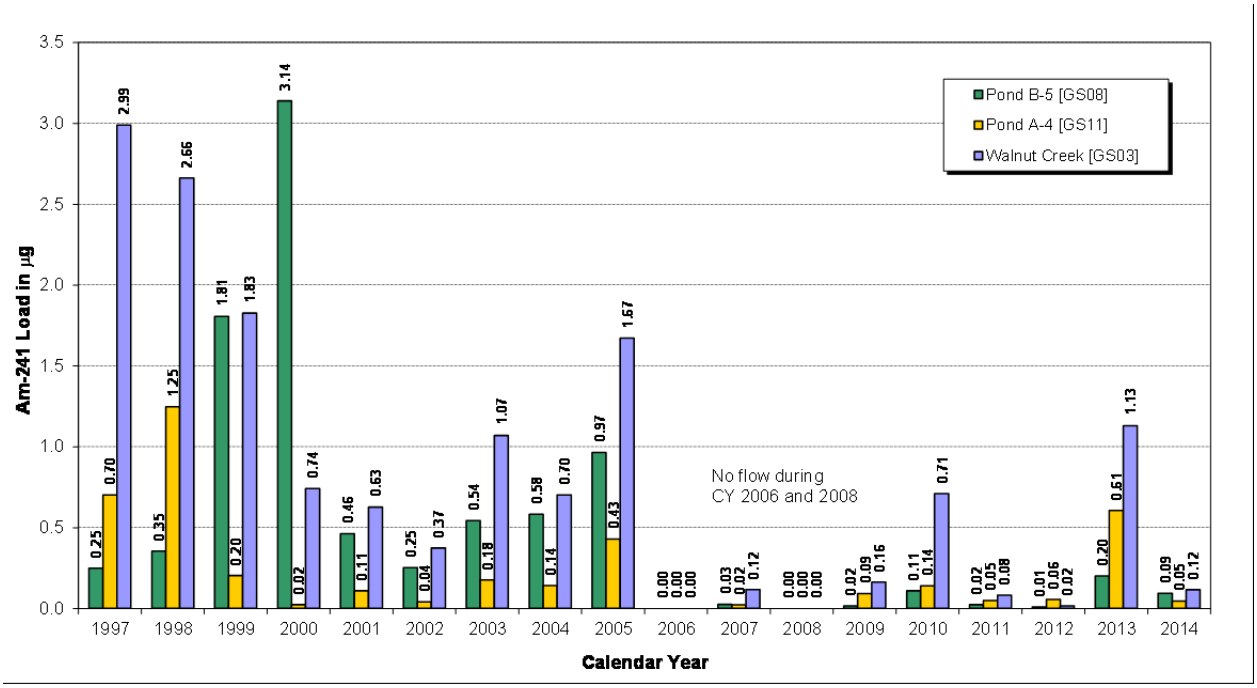


Figure 143. Annual Am Loads at GS03, GS08, and GS11: CY 1997–2014

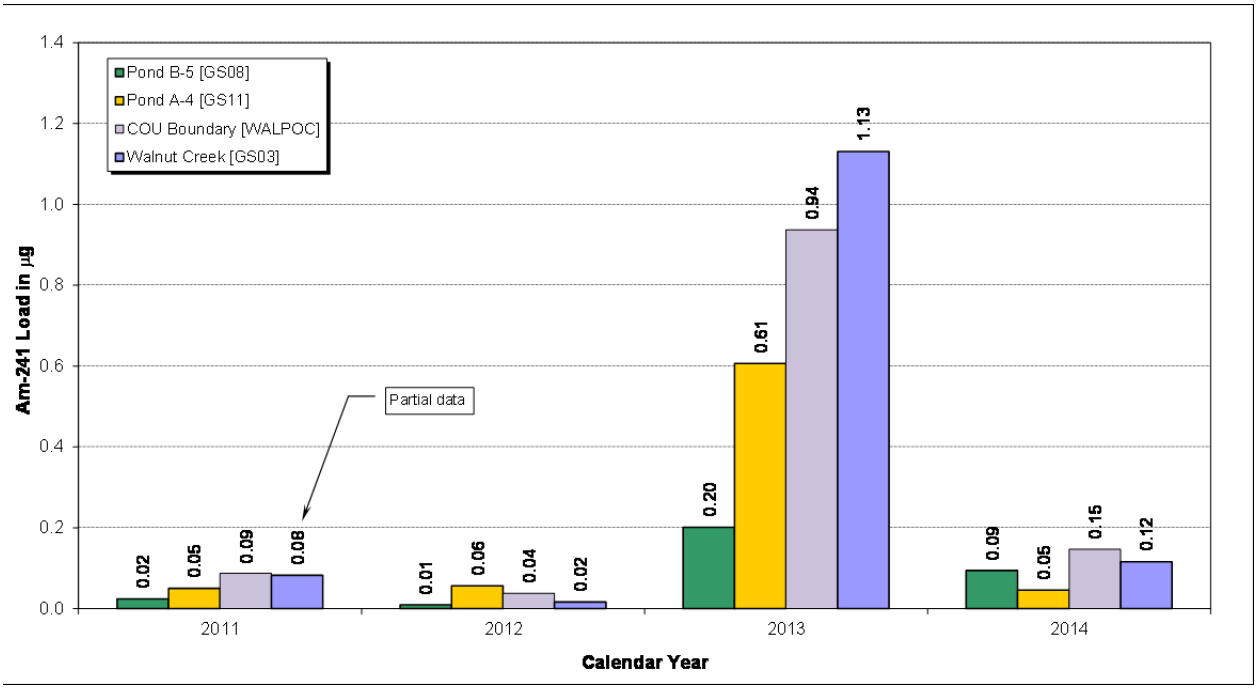
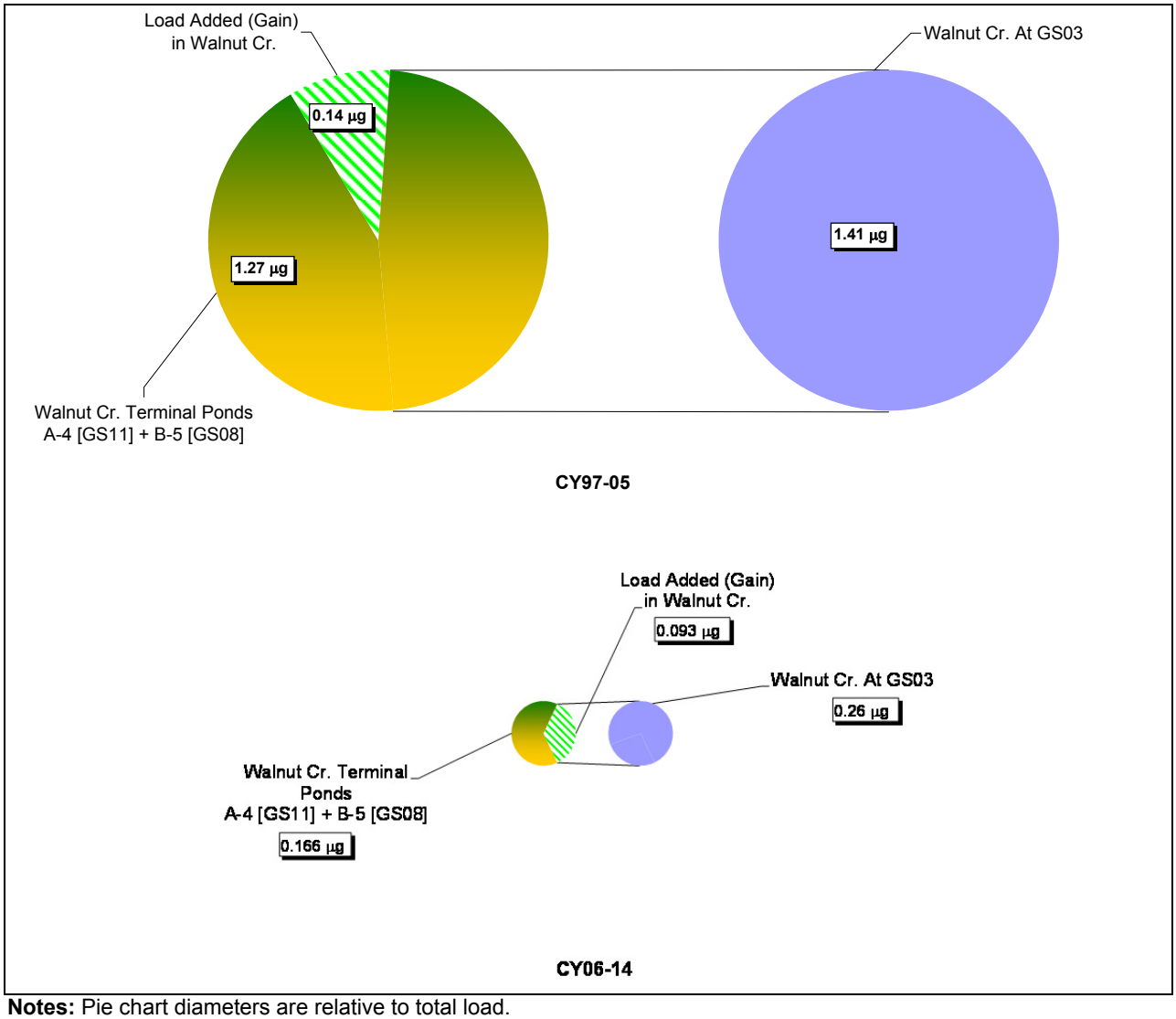


Figure 144. Annual Am Loads at GS03, GS08, GS11, and WALPOC: CY 2011–2014



Notes: Pie chart diameters are relative to total load.

Figure 145. Relative Average Annual Am Load Totals at GS03, GS08, and GS11

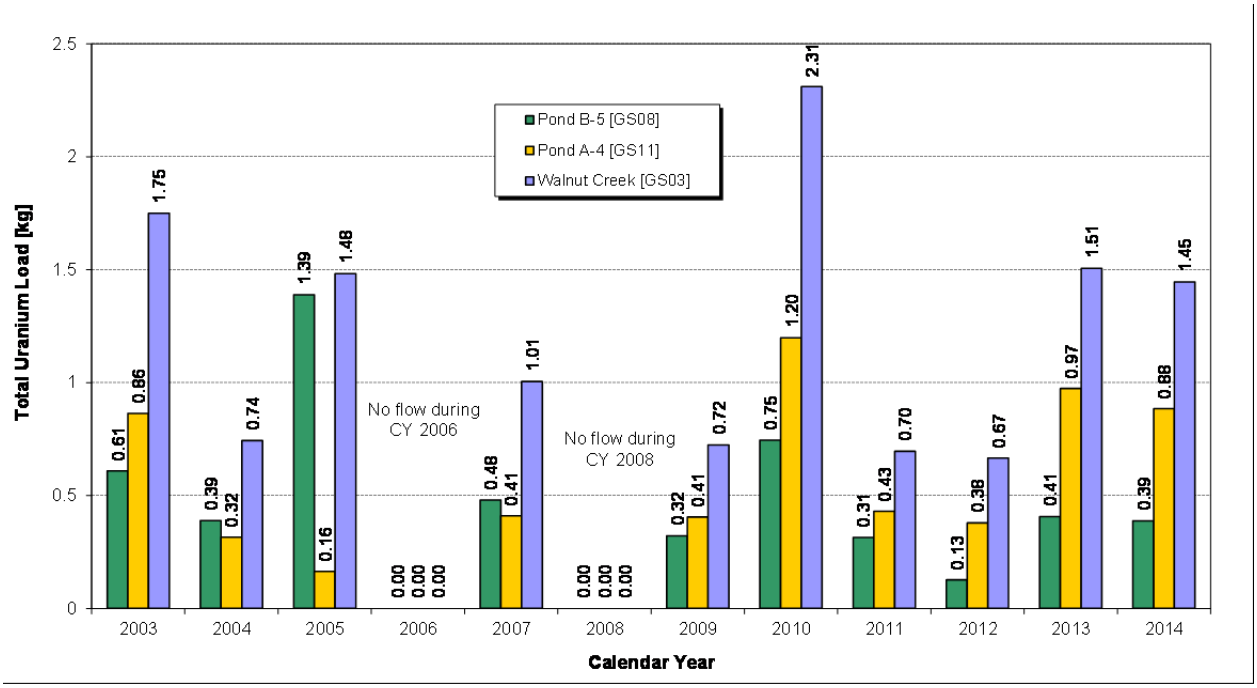


Figure 146. Annual Total U Loads at GS03, GS08, and GS11: CY 2003–2014

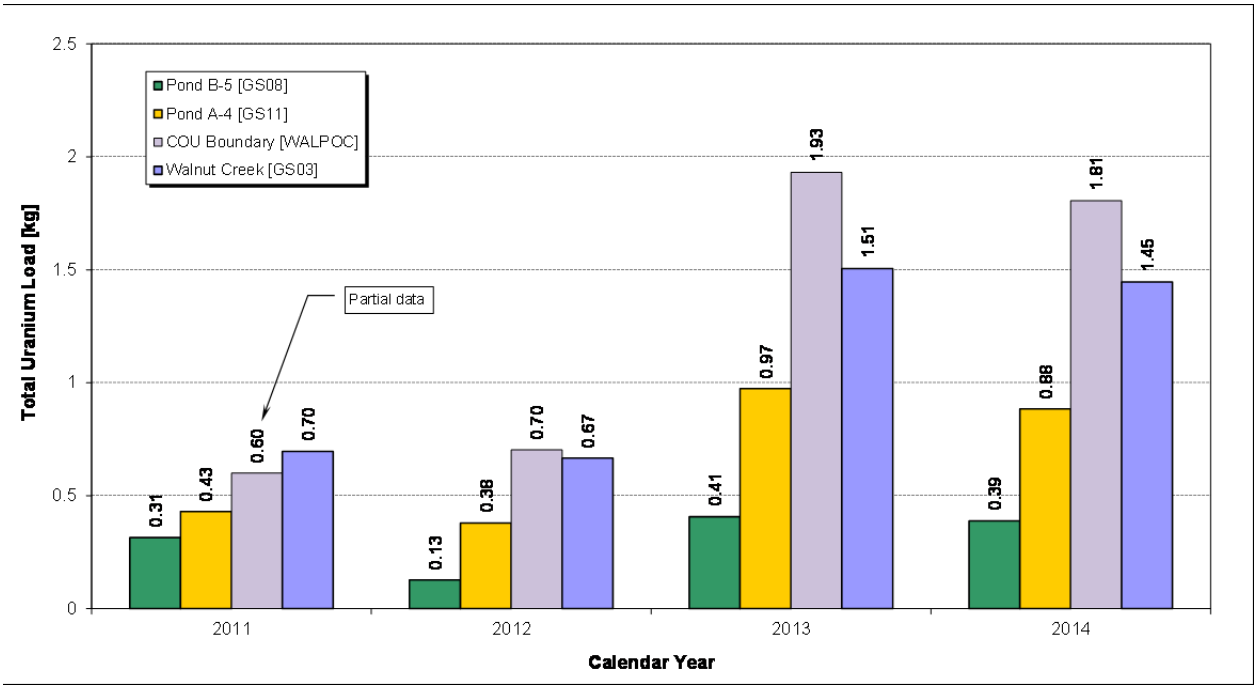
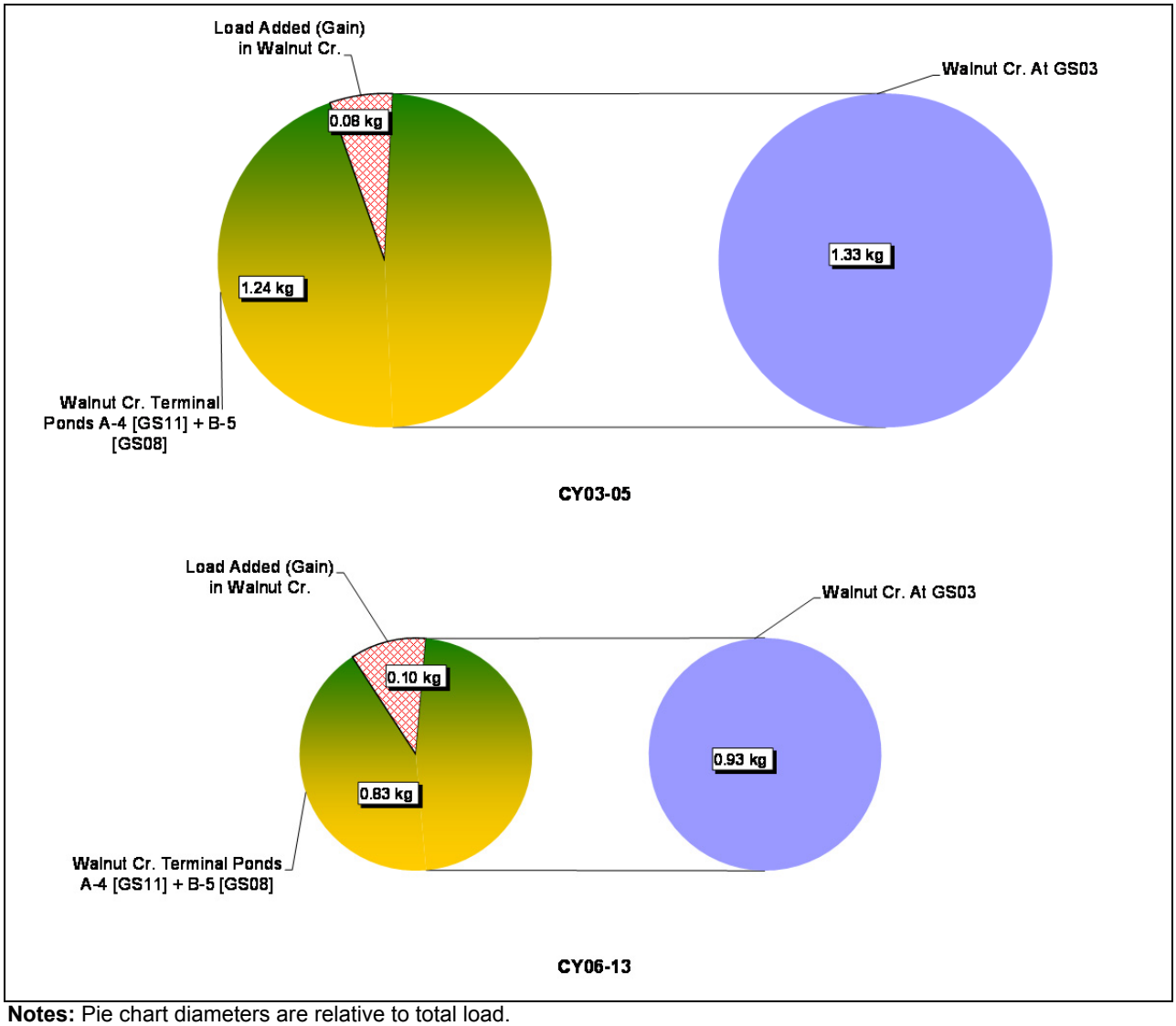


Figure 147. Annual Total U Loads at GS03, GS08, GS11, and WALPOC: CY 2011–2014



Notes: Pie chart diameters are relative to total load.

Figure 148. Relative Average Annual Total U Load Totals at GS03, GS08, and GS11

Lower Woman Creek

This section summarizes the calculated Pu, Am, and U loads in Woman Creek at GS01 (Woman Creek at Indiana Street), WOMPOC (Woman Creek at the eastern COU boundary), and GS31 (Pond C-2 outlet). Since WOMPOC began operating on September 28, 2011, it is only included in selected tables and figures at this time. The data are presented in Table 59, Table 60, and Table 61, and depicted on Figure 149, Figure 150, Figure 151, Figure 152, Figure 153, Figure 154, Figure 155, Figure 156, Figure 157, and Figure 158. Total U data collection began at GS01 on February 3, 2003; therefore, only CY 2003–2014 data are shown. The following points are noted:

- Annual Pu and Am loads generally vary by up to two orders of magnitude year to year (Figure 150 and Figure 153). The significant annual variability in Pu and Am loads is primarily due to large variation in stream discharge volumes and the very low measured activities with inherent analytical error at such low levels.

- Total Pu and Am loads from Pond C-2 are significantly less than the loads at GS01 (Table 59, Figure 152, Table 60, and Figure 155), suggesting a contribution of load from the rest of the Woman Creek drainage. Post-closure, Pond C-2 accounts for approximately 7 percent of the Pu load and 4 percent of the Am load at GS01. However, this calculated increase in load is likely due to large stream discharge volumes and analytical error associated with the very low measured activities at GS01; Pu and Am activities are well below the RFLMA standard of 0.15 pCi/L.
- Total U load for CY 2003–2014 from Pond C-2 is significantly less than the load at GS01 (Figure 156 and Figure 158), indicating a gain of load most likely from naturally occurring U in the rest of the Woman Creek drainage. Post-closure, Pond C-2 accounts for less than 10 percent of the U load at GS01.

Table 59. Pu Loads at GS01, WOMPOC, and GS31: CY 1997–2014

Calendar Year	Pu-239,240 (µg)		
	Pond C-2 [GS31]	POC WOMPOC	Woman Creek [GS01]
1997	16.7	NA	47.9
1998	2.2	NA	55.4
1999	26.9	NA	56.7
2000	0.0; No C-2 discharge	NA	6.1
2001	11.0	NA	22.4
2002	0.2	NA	0.8
2003	11.0	NA	25.9
2004	11.5	NA	4.7
2005	5.0	NA	12.5
2006	0.0; No C-2 discharge	NA	1.4
2007	0.0; No C-2 discharge	NA	68.0
2008	0.0; No C-2 discharge	NA	1.1
2009	4.1	NA	26.7
2010	0.4	NA	70.6
2011	1.0	2.9[a]	5.2
2012	0.3	4.9	2.2
2013	7.8	40.9	38.5
2014	1.9	14.7	19.4
Total	100	63	465

Notes:
[a] Partial data
During CY 1997 (through September 30, 1997), flows from Woman Creek were routinely diverted to Mower Ditch for subsequent monitoring at GS02 (discontinued location). Therefore, the load calculated for Woman Creek at Indiana Street (GS01) includes the water that was measured at GS02. The estimated load diverted to GS02 is calculated by multiplying the CY 1997 volume-weighted activities at GS01 by the streamflow volume measured at GS02, and converting for units. This diverted load is then added to the calculated load at GS01 to obtain the total CY 1997 load at GS01. For subsequent water years, the Mower diversion structure has been upgraded and configured to prevent Woman Creek flows from entering the Mower Ditch.

Table 60. Am Loads at GS01, WOMPOC, and GS31: CY 1997–2014

Calendar Year	Am-241 (µg)		
	Pond C-2 [GS31]	POC WOMPOC	Woman Creek [GS01]
1997	0.17	NA	0.40
1998	0.27	NA	0.99
1999	0.13	NA	0.75
2000	0.00; No C-2 discharge	NA	0.18
2001	0.14	NA	0.30
2002	<0.01	NA	0.03
2003	0.09	NA	0.34
2004	0.11	NA	0.15
2005	0.04	NA	0.30
2006	0.0; No C-2 discharge	NA	0.13
2007	0.0; No C-2 discharge	NA	0.49
2008	0.0; No C-2 discharge	NA	0.02
2009	0.03	NA	0.23
2010	0.02	NA	0.78
2011	0.01	0.07[a]	0.12
2012	0.00	0.04	0.07
2013	0.03	0.41	0.26
2014	0.02	0.39	0.28
Total	1.06	0.91	5.79

Notes:
[a] Partial data
During CY 1997 (through September 30, 1997), flows from Woman Creek were routinely diverted to Mower Ditch for subsequent monitoring at GS02 (discontinued location). Therefore, the load calculated for Woman Creek at Indiana Street (GS01) includes the water that was measured at GS02. The estimated load diverted to GS02 is calculated by multiplying the CY 1997 volume-weighted activities at GS01 by the streamflow volume measured at GS02, and converting for units. This diverted load is then added to the calculated load at GS01 to obtain the total CY 1997 load at GS01. For subsequent water years, the Mower diversion structure has been upgraded and configured to prevent Woman Creek flows from entering the Mower Ditch.

Table 61. Total U Loads at GS01, WOMPOC, and GS31: CY 2003–2014

Calendar Year	Total U (kg)		
	Pond C-2 [GS31]	POC WOMPOC	Woman Creek [GS01]
2003	0.13	NA	0.79
2004	0.09	NA	0.81
2005	0.11	NA	0.92
2006	0.0; No C-2 discharge	NA	0.24
2007	0.0; No C-2 discharge	NA	1.02
2008	0.0; No C-2 discharge	NA	0.17
2009	0.09	NA	0.76
2010	0.06	NA	1.16
2011	0.10	0.27[a]	0.61
2012	0.05	0.40	0.47
2013	0.16	0.74	0.89
2014	0.07	0.88	1.19
Total	0.88	2.30	9.01

Notes:
[a] Partial data

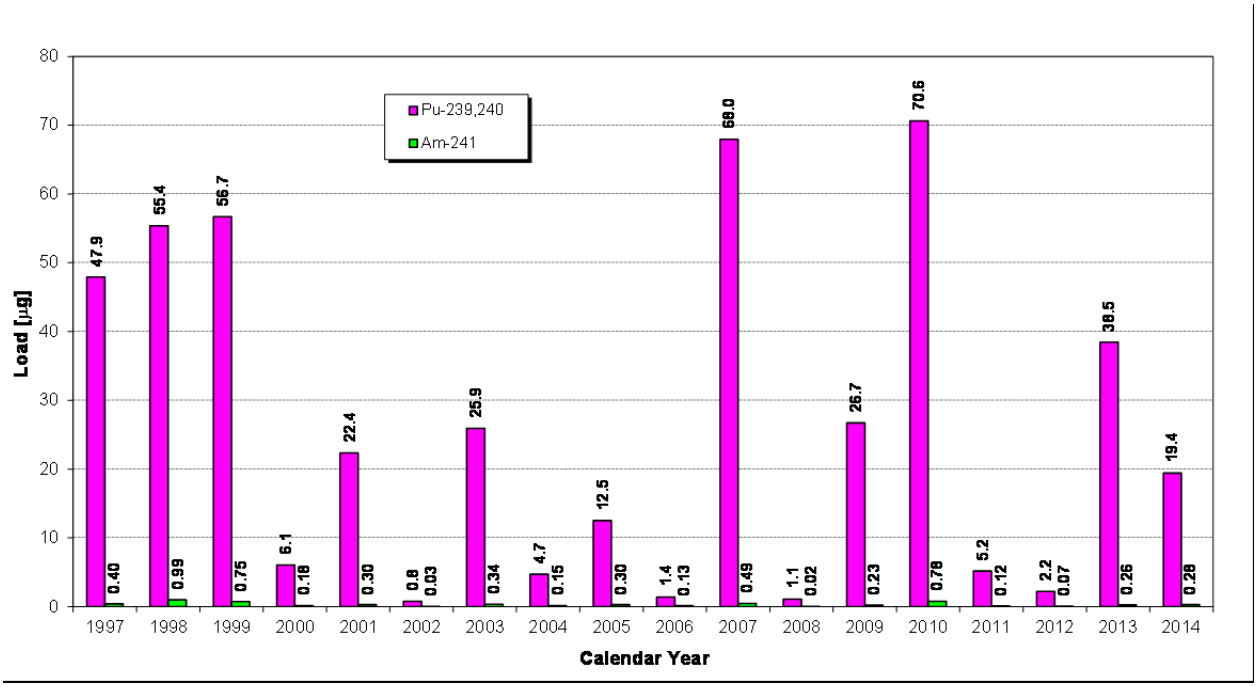


Figure 149. Annual Pu and Am Loads at GS01: CY 1997–2014

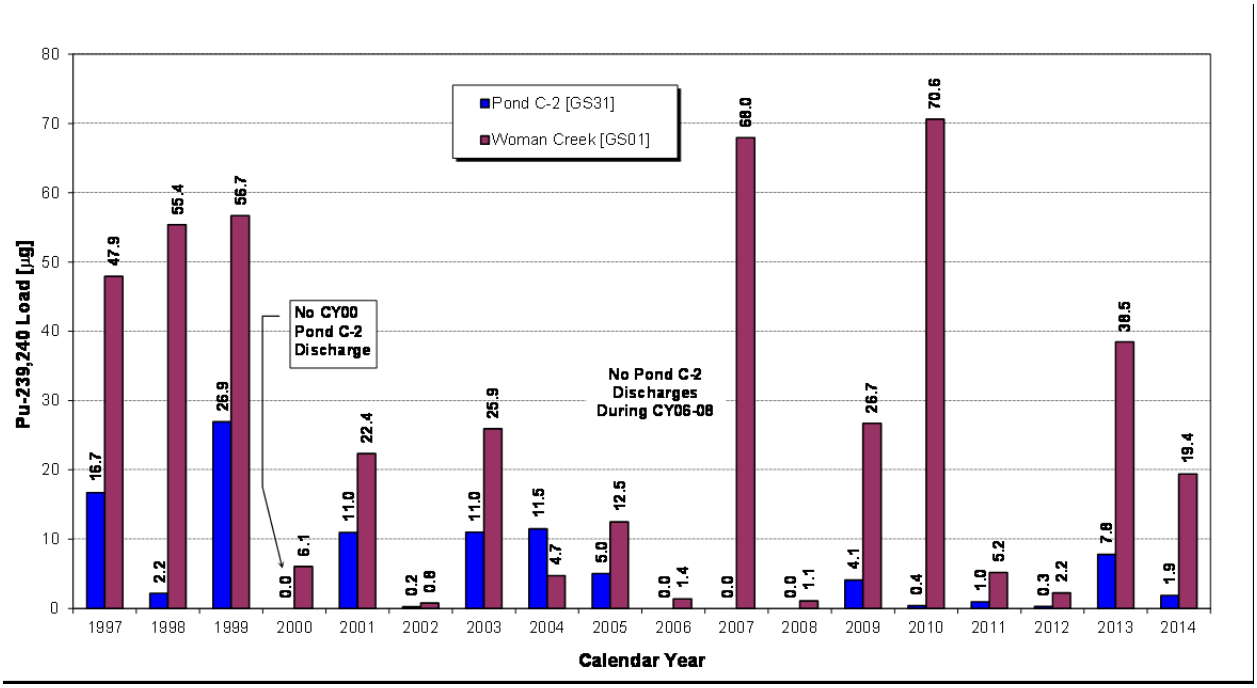


Figure 150. Annual Pu Loads at GS01 and GS31: CY 1997–2014

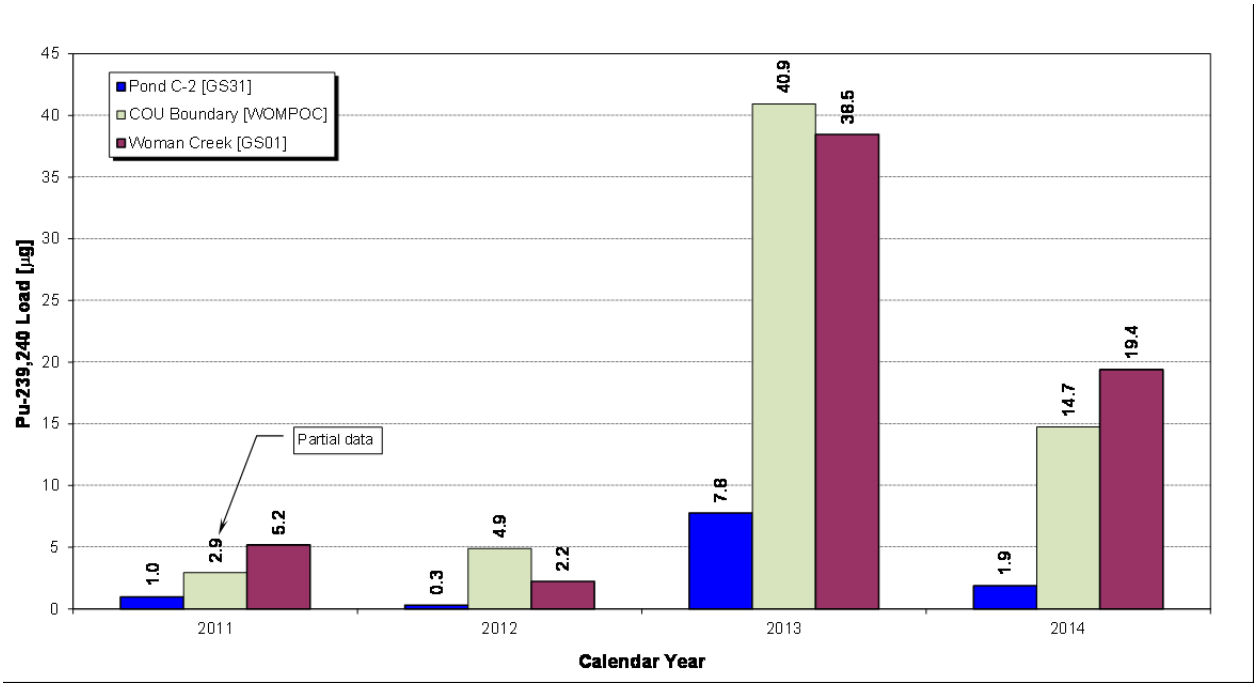
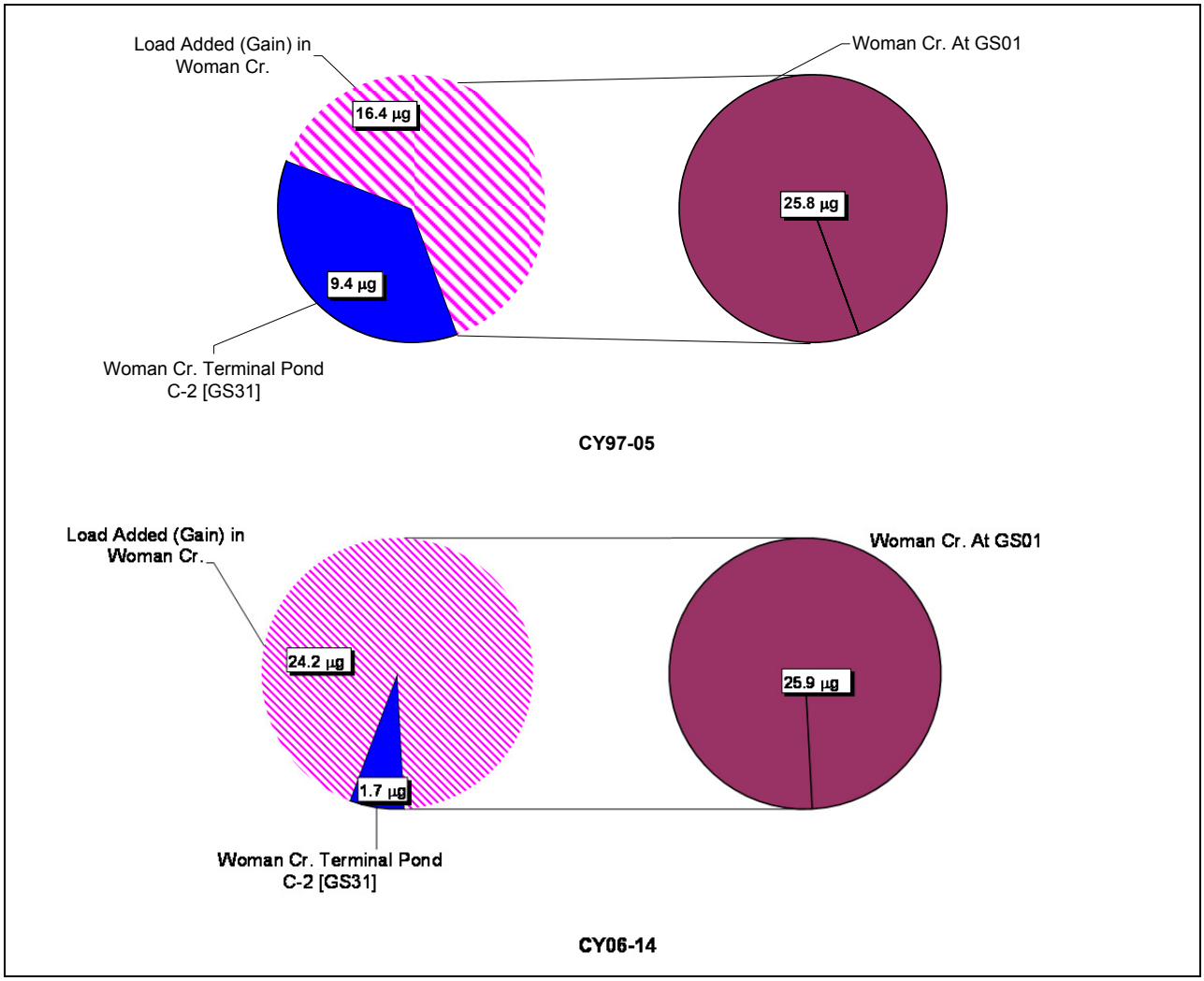


Figure 151. Annual Pu Loads at GS01, WOMPOC, and GS31: CY 2011–2014



Notes: Pie chart diameters are relative to total load.

Figure 152. Relative Average Annual Pu Load Totals at GS01 and GS31

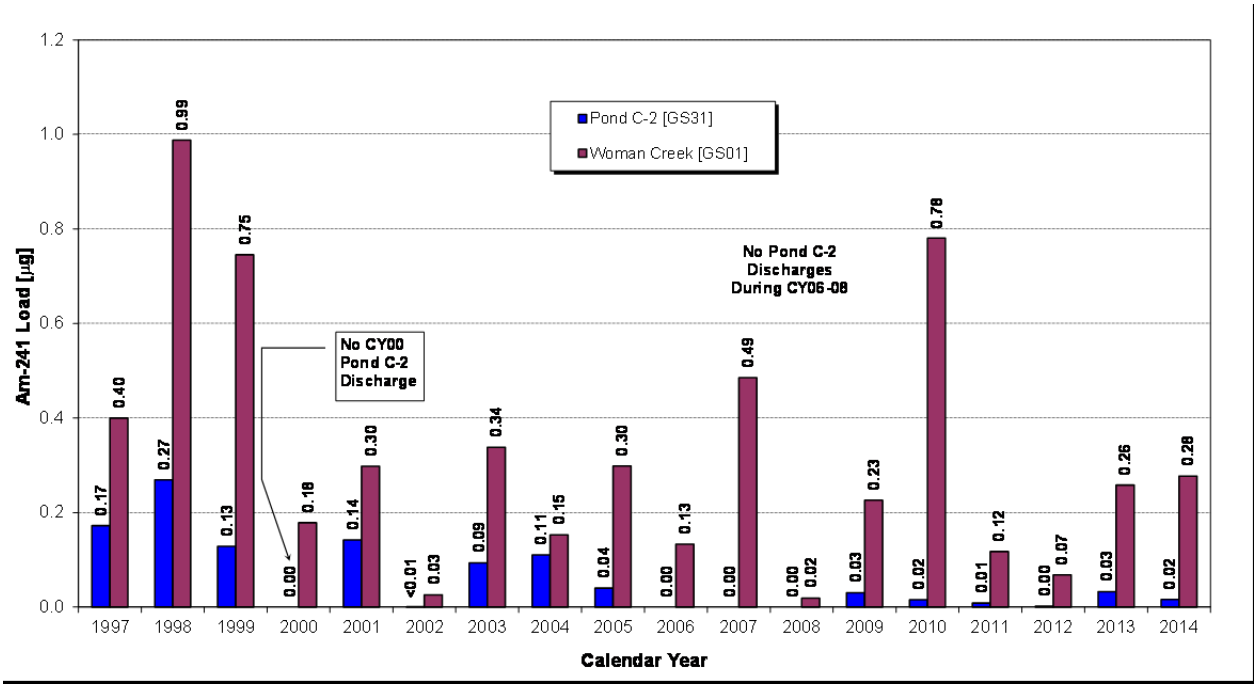


Figure 153. Annual Am Loads at GS01 and GS31: CY 1997–2014

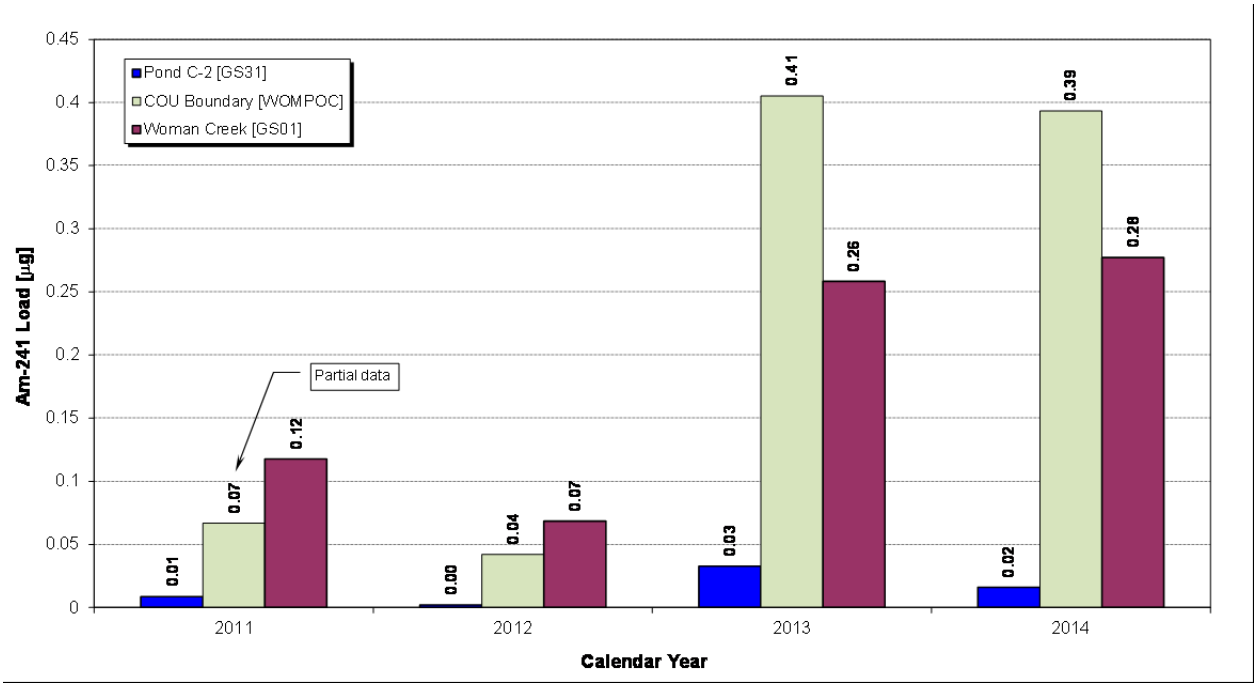
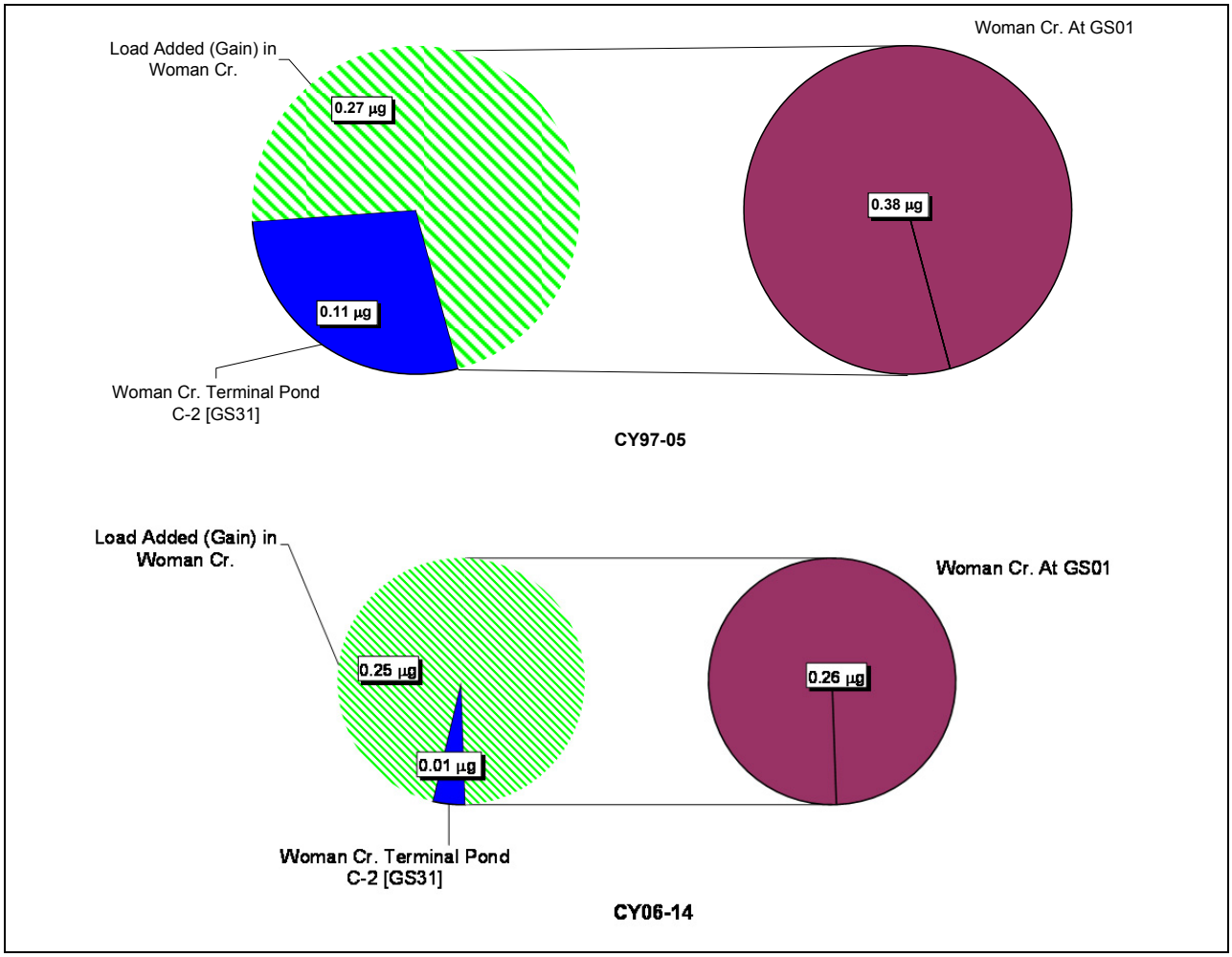


Figure 154. Annual Am Loads at GS01, WOMPOC, and GS31: CY 2011–2014



Notes: Pie chart diameters are relative to total load.

Figure 155. Relative Average Annual Am Load Totals at GS01 and GS31

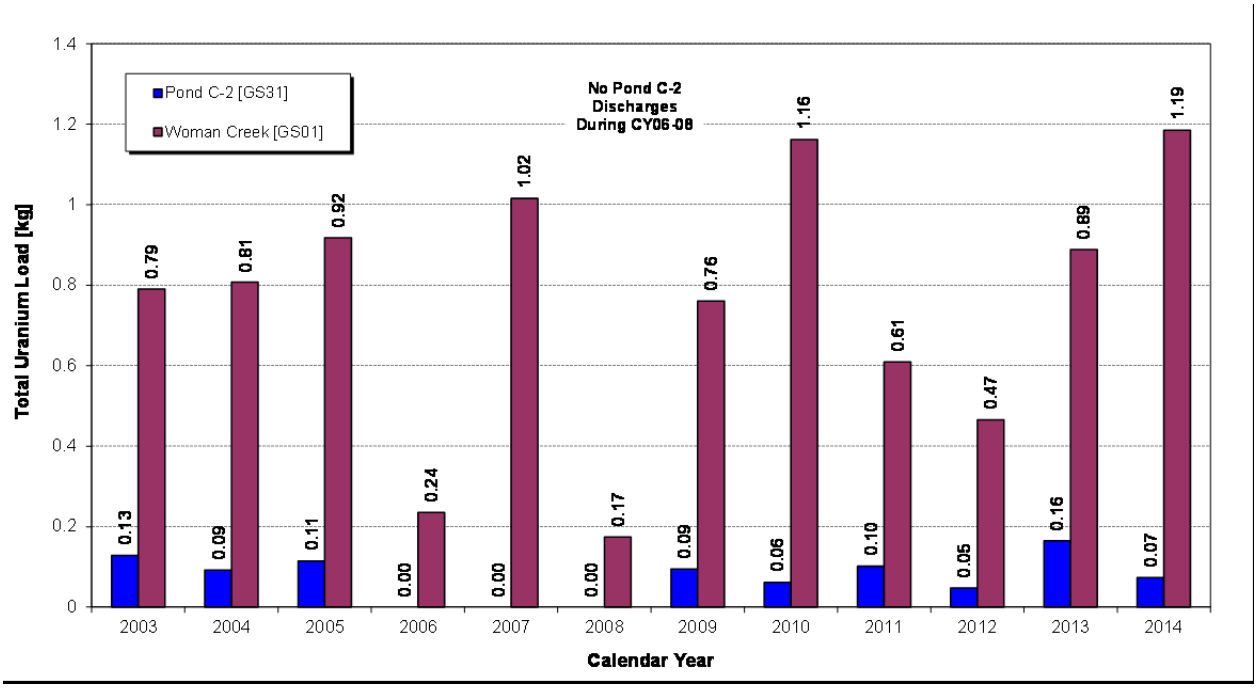


Figure 156. Annual Total U Loads at GS01 and GS31: CY 2003–2014

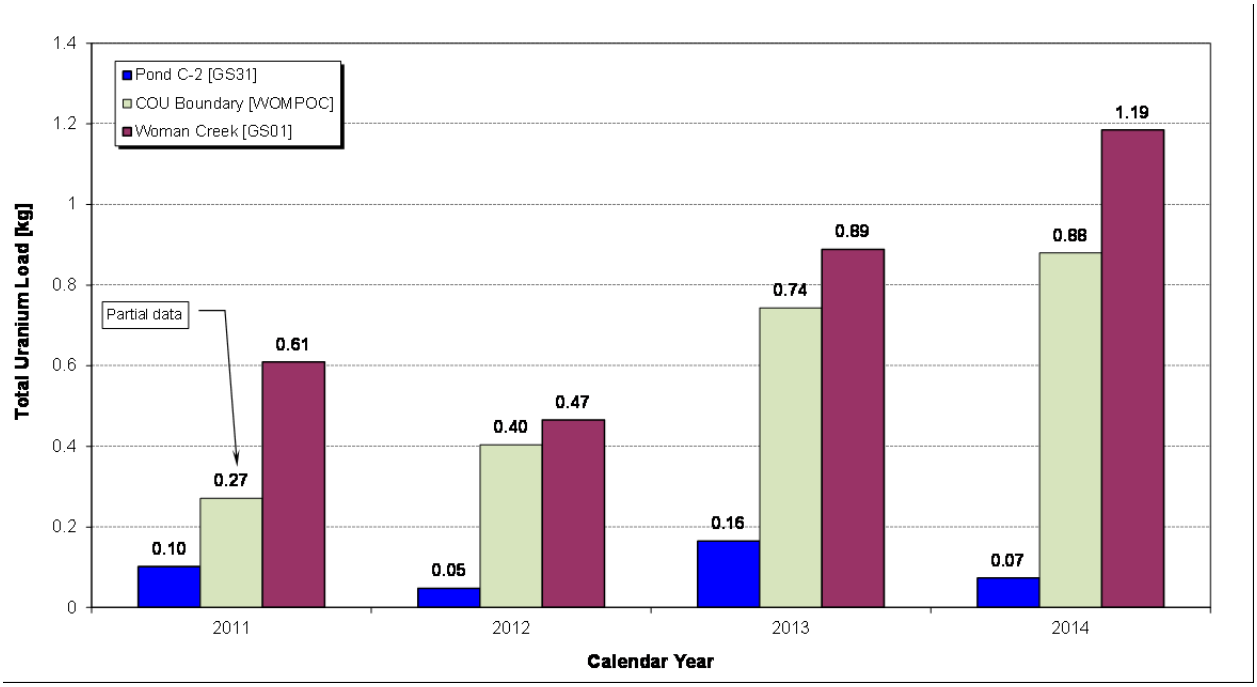
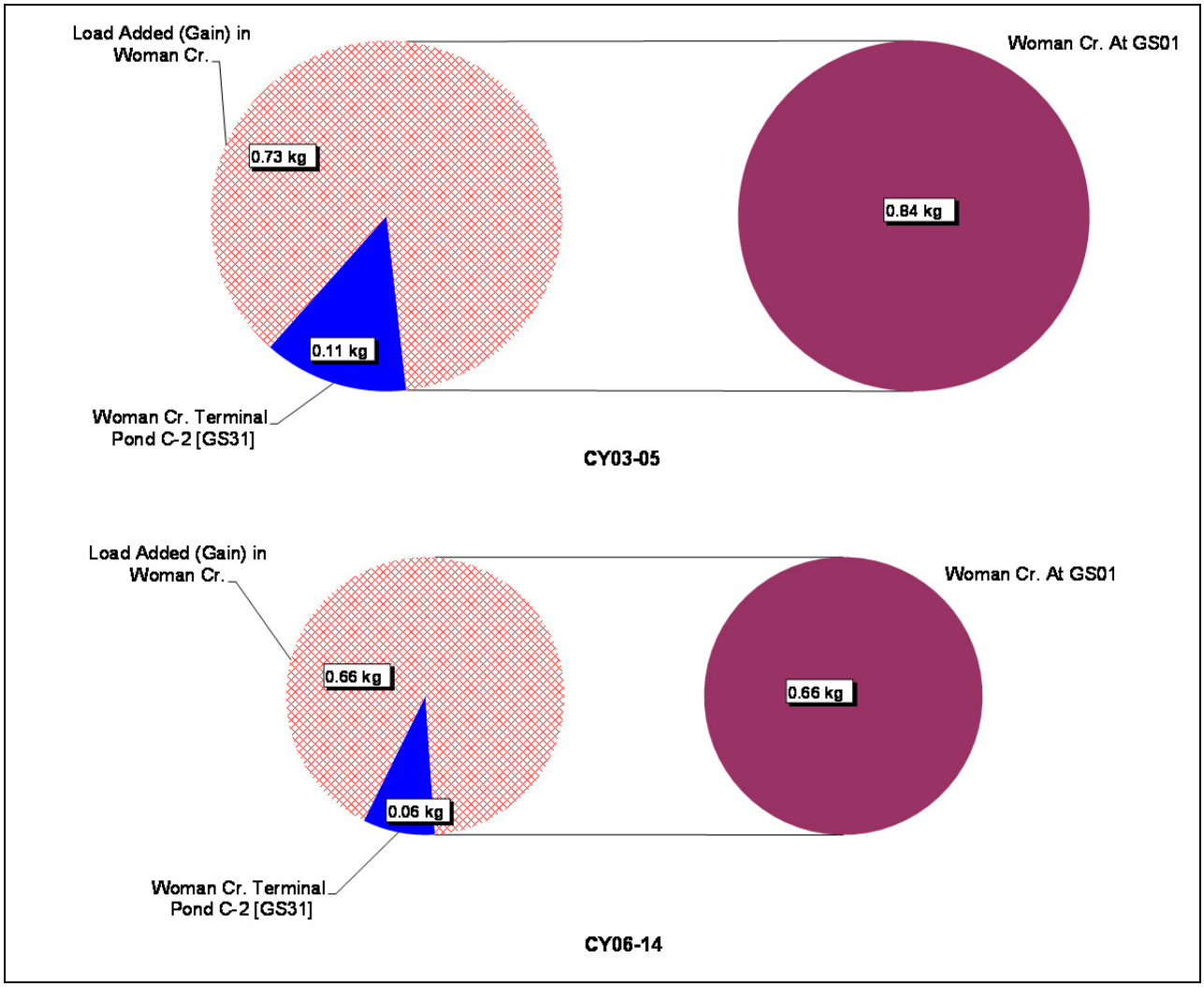


Figure 157. Annual Total U Loads at GS01, WOMPOC, and GS31: CY 2011–2014



Notes: Pie chart diameters are relative to total load.

Figure 158. Relative Average Annual Total U Load Totals at GS01 and GS31

A- and B-Series Ponds

This section summarizes the calculated Pu, Am, and U loads for the A- and B-Series Ponds. The data are presented in Table 62, Table 63, and Table 64, and are depicted on Figure 159, Figure 160, Figure 161, Figure 162, Figure 163, Figure 164, Figure 165, and Figure 166. Since water transfers occurred between ponds pre-closure, the load analysis is performed for both pond series combined. The influent load sources are GS10, the former WWTP (South Walnut; WWTP removed in November 2004), and SW093 (North Walnut). The effluent loads are GS08 (Pond B-5 outlet) and GS11 (Pond A-4 outlet). The following points are noted:

- Table 62 shows GS10 with the highest influent Pu load for CY 1997–2014. Although load increases associated with the recent reportable conditions are noted for 2011–2013, annual average post-closure Pu loads at GS10 have been reduced 82 percent.
- A significant increase in Pu loads to the ponds is noted during CY 2004 due to increased solids transport resulting from active building demolition and soil disturbance

(Figure 159). With the implementation of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2006–2014. However, the CY 2011–2013 loads have been affected by recent increases in Pu activity at GS10 (see Section 3.1.2.2). Post-closure influent and effluent loads have been reduced by 88 percent and 90 percent, respectively.

- Table 63 shows GS10 with the highest influent Am load for CY 1997–2014. Although load increases associated with the recent reportable conditions are noted for 2011–2013, average annual post-closure Am loads at GS10 have been reduced 75 percent.
- A measurable increase in Am loads to the ponds is noted during CY 2004. This increase was partly due to increased solids transport resulting from active building demolition and soil disturbance (Figure 161). Increased Am loads at SW093 were primarily due to contributions from B771 decontamination and decommissioning during the July 2004–November 2004 period. The pathway causing these increased loads was eliminated in December 2004. With the implementation of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2006–2014. However, the CY 2011–2013 loads have been affected by recent increases in Am activity at GS10 (see Section 3.1.2.2). Post-closure influent and effluent loads have been reduced by 84 percent and 87 percent, respectively.
- Pre-closure (Figure 163), GS10 shows the highest average annual influent total U concentration, while SW093 shows the highest average annual influent total U load (due to larger flow volumes at SW093). Post-closure (Figure 164), GS10 shows both the highest average annual influent concentration and load. Although total influent U concentration has increased significantly, corresponding reductions in streamflow volume have actually resulted in a *decrease* in load. Post-closure influent load has been reduced by 11 percent.
- Pre-closure (Figure 163), GS11 shows the highest effluent average annual total U concentration and load. Again, although U activity has increased at both GS08 and GS11, corresponding reductions in discharge volume have resulted in a *decrease* in load. Post-closure effluent load has been reduced by 33 percent.

Table 62. Pu Load Summary for the A- and B-Series Ponds: CY 1997–2014

Calendar Year	Pu-239,240 (µg)				
	Influent [WWTP]	Influent [GS10]	Influent [SW093]	Effluent [GS08]	Effluent [GS11]
1997	11.2	576.0	164.2	8.8	59.2
1998	13.4	328.6	69.1	22.4	20.0
1999	19.4	307.9	127.8	261.4	23.8
2000	17.4	326.2	87.4	244.6	28.4
2001	11.3	141.4	44.4	32.3	4.7
2002	8.3	59.3	9.6	7.8	0.1
2003	3.8	207.2	140.1	111.5	7.3
2004	2.1	523.3	1,330.9	27.1	2.2
2005	0.0; WWTP removed	247.1	29.2	17.9	2.2
2006	0.0; WWTP removed	2.3	2.5	0.0; No B-5 discharge	0.0; No A-4 discharge
2007	0.0; WWTP removed	14.2	17.0	1.9	7.8
2008	0.0; WWTP removed	3.5	13.2	0.0; No B-5 discharge	0.0; No A-4 discharge
2009	0.0; WWTP removed	15.2	23.0	3.0	2.3
2010	0.0; WWTP removed	13.1	16.4	5.4	6.4
2011	0.0; WWTP removed	106.7	4.3	1.8	1.0
2012	0.0; WWTP removed	69.0	1.2	1.1	2.1[a]
2013	0.0; WWTP removed	257.0	4.3	6.3	37.3
2014	0.0; WWTP removed	9.5	5.3	6.8[a]	2.2[a]
Total	86.9	3,208	2,090	760[a]	207[a]

Notes:
[a] Partial data

Table 63. Am Load Summary for the A- and B-Series Ponds: CY 1997–2014

Calendar Year	Am-241 (µg)				
	Influent [WWTP]	Influent [GS10]	Influent [SW093]	Effluent [GS08]	Effluent [GS11]
1997	0.64	12.20	2.24	0.25	0.70
1998	0.32	4.69	1.30	0.35	1.25
1999	0.11	12.55	1.73	1.81	0.20
2000	0.29	14.57	0.98	3.14	0.02
2001	0.32	2.75	0.65	0.46	0.11
2002	0.20	1.76	0.52	0.25	0.04
2003	0.52	4.44	2.05	0.54	0.18
2004	0.25	4.68	28.48	0.58	0.14
2005	0.00; WWTP removed	3.98	0.82	0.97	0.43
2006	0.00; WWTP removed	0.04	0.02	0.00; No B-5 discharge	0.00; No A-4 discharge
2007	0.00; WWTP removed	0.14	0.28	0.03	0.02
2008	0.00; WWTP removed	0.09	0.15	0.00; No B-5 discharge	0.00; No A-4 discharge
2009	0.00; WWTP removed	0.15	0.21	0.02	0.09
2010	0.00; WWTP removed	0.15	0.35	0.11	0.14
2011	0.00; WWTP removed	3.42	0.07	0.02	0.05
2012	0.00; WWTP removed	2.13	0.04	0.01	0.06
2013	0.00; WWTP removed	8.66	0.20	0.20	0.61
2014	0.00; WWTP removed	0.70	0.10	0.09[a]	0.05[a]
Total	2.65	77.1	40.2	8.84[a]	4.09[a]

Notes:
[a] Partial data

Table 64. Total U Load Summary for the A- and B-Series Ponds: CY 1997–2014

Calendar Year	Total U (kg)				
	Influent [WWTP]	**Influent [GS10]**	**Influent [SW093]**	**Effluent [GS08]**	**Effluent [GS11]**
1997	0.26	0.64	0.85	0.25	1.37
1998	0.47	0.63	0.80	0.62	1.30
1999	0.12	0.59	0.71	0.81	0.63
2000	0.10	0.38	0.49	0.46	0.39
2001	0.26	0.52	0.65	0.64	0.56
2002	0.06	0.28	0.45	0.26	0.13
2003	0.16	0.50	0.57	0.61	0.86
2004	0.14	0.43	0.58	0.39	0.32
2005	0.00; WWTP removed	0.88	0.53	1.39	0.16
2006	0.00; WWTP removed	0.23	0.17	0.00; No B-5 discharge	0.00; No A-4 discharge
2007	0.00; WWTP removed	0.83	0.54	0.48	0.41
2008	0.00; WWTP removed	0.28	0.15	0.00; No B-5 discharge	0.00; No A-4 discharge
2009	0.00; WWTP removed	0.76	0.57	0.32	0.41
2010	0.00; WWTP removed	1.16	1.05	0.75	1.20
2011	0.00; WWTP removed	0.76	0.40	0.31	0.43
2012	0.00; WWTP removed	0.68	0.29	0.13	0.38
2013	0.00; WWTP removed	0.93	0.77	0.41	0.97
2014	0.00; WWTP removed	0.58	0.51	0.39[a]	0.88[a]
Total	1.57	11.0	10.1	8.22[a]	10.4[a]

Notes:
[a] Partial data

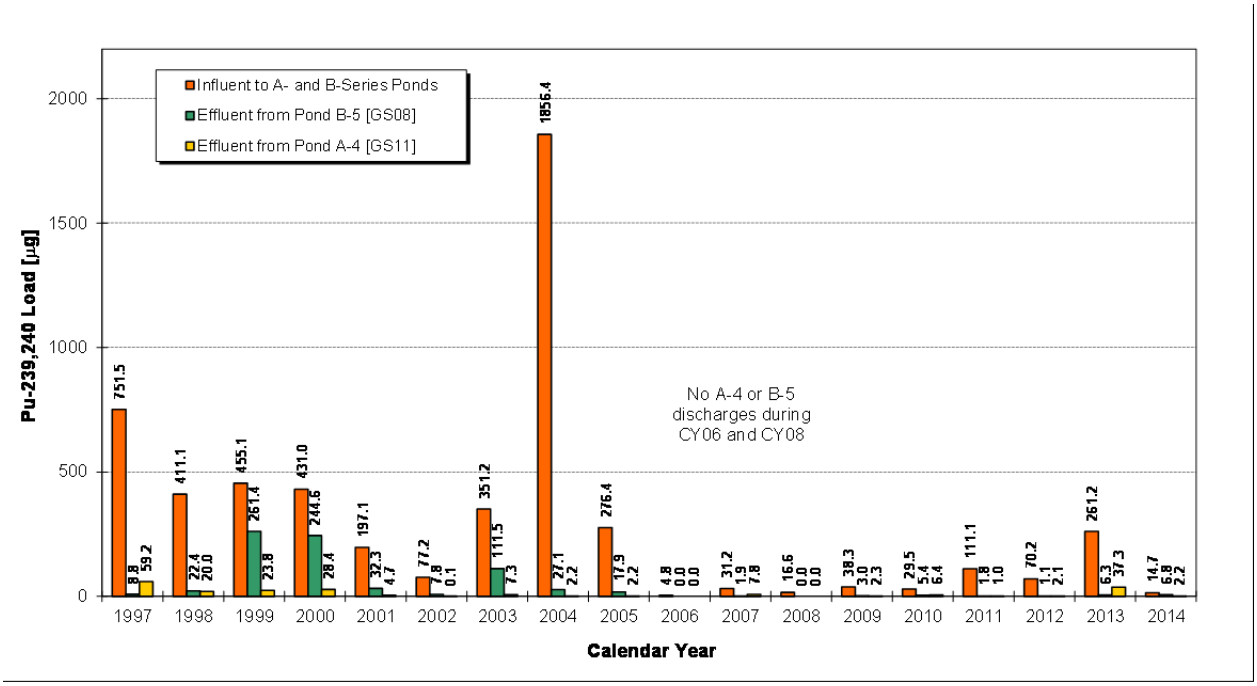
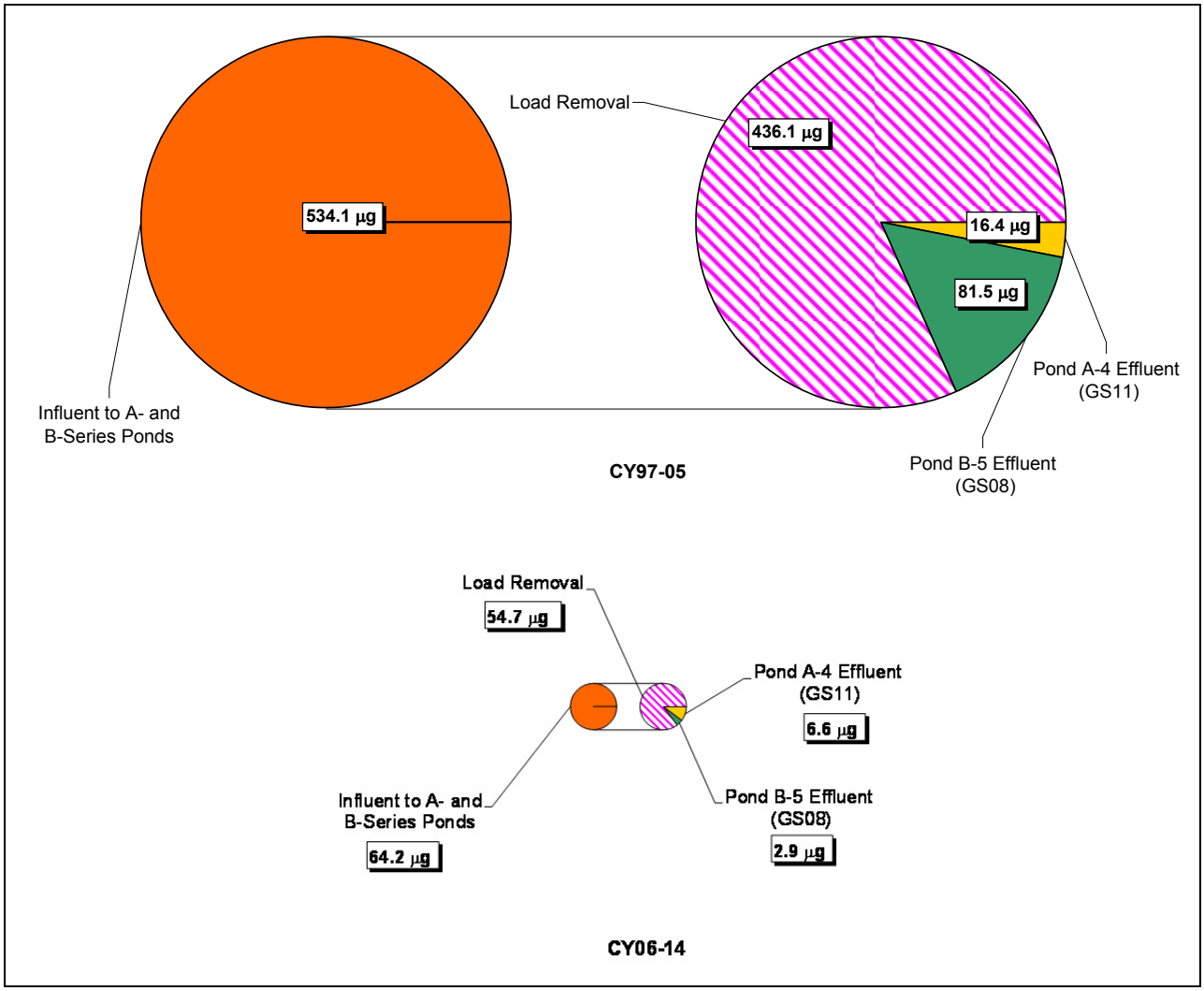


Figure 159. Annual Pu Loads for the A- and B-Series Ponds: CY 1997–2014



Notes: Pie chart diameters are relative to total load.

Figure 160. Relative Average Annual Pu Load Totals for the A- and B-Series Ponds

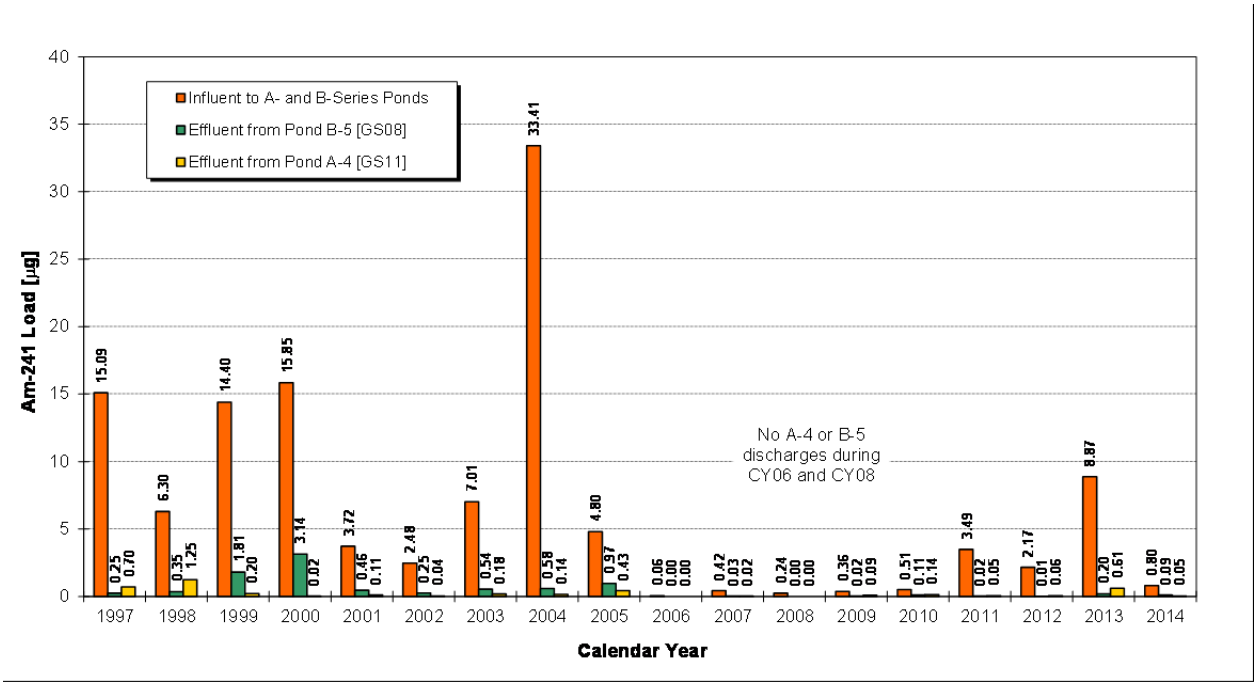
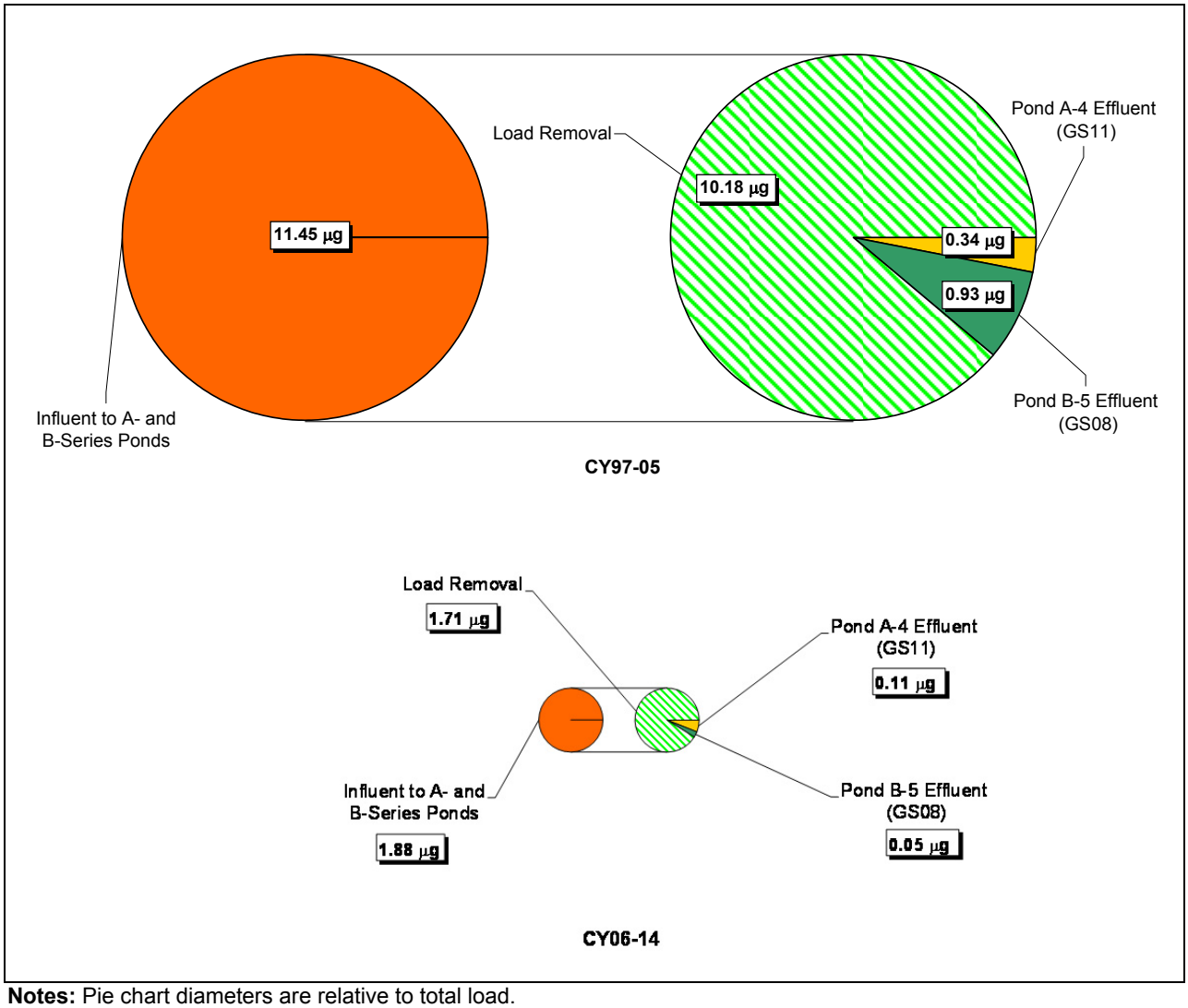
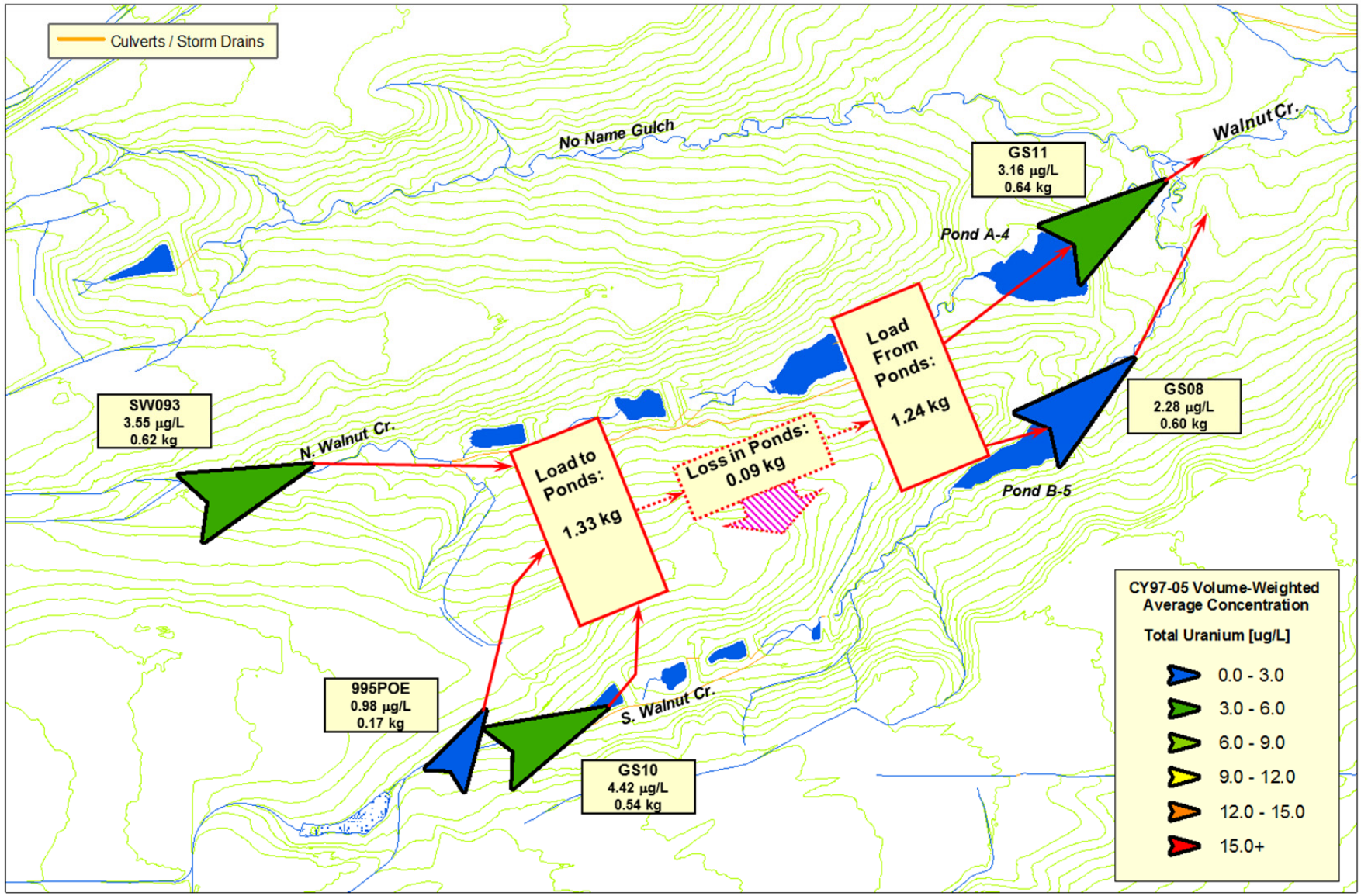


Figure 161. Annual Am Loads for the A- and B-Series Ponds: CY 1997–2014



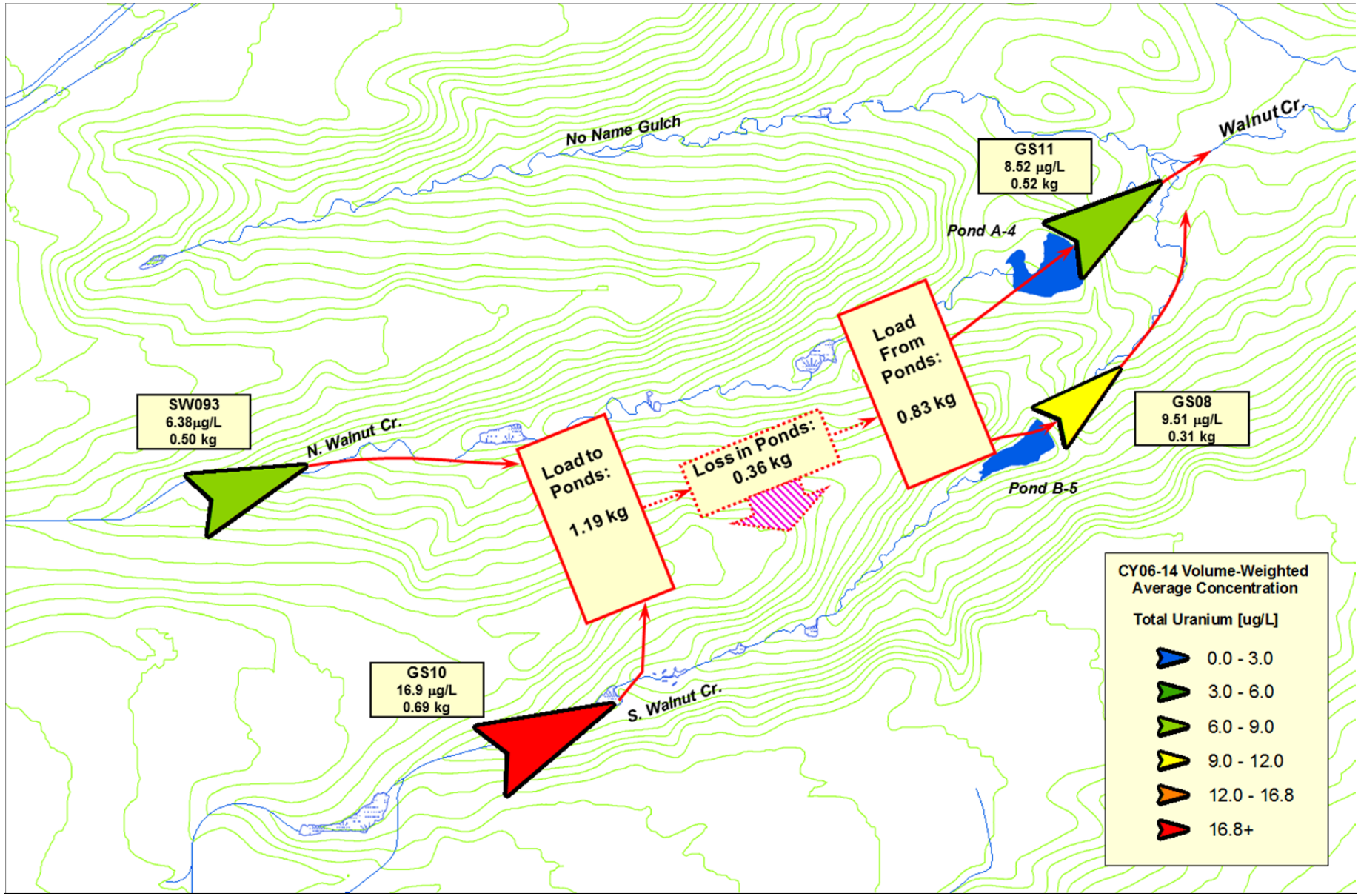
Notes: Pie chart diameters are relative to total load.

Figure 162. Relative Average Annual Am Load Totals for the A- and B-Series Ponds



Notes: Location symbols are sized proportional to the calculated average annual load and colored according to concentration ranges in the legend.

Figure 163. Relative Average Annual Total U Loading Schematic for the A- and B-Series Ponds: CY 1997–2005



Notes: Location symbols are sized proportional to the calculated average annual load and colored according to concentration ranges in the legend.

Figure 164. Relative Average Annual Total U Loading Schematic for the A- and B-Series Ponds: CY 2006–2014

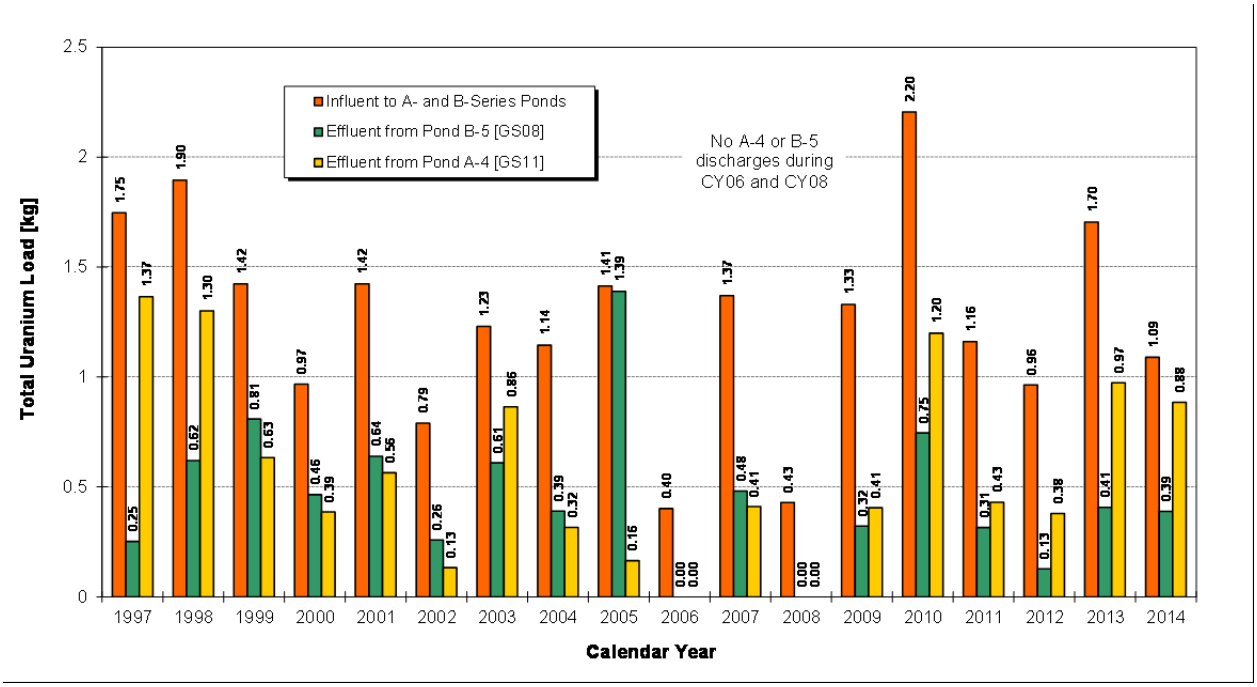
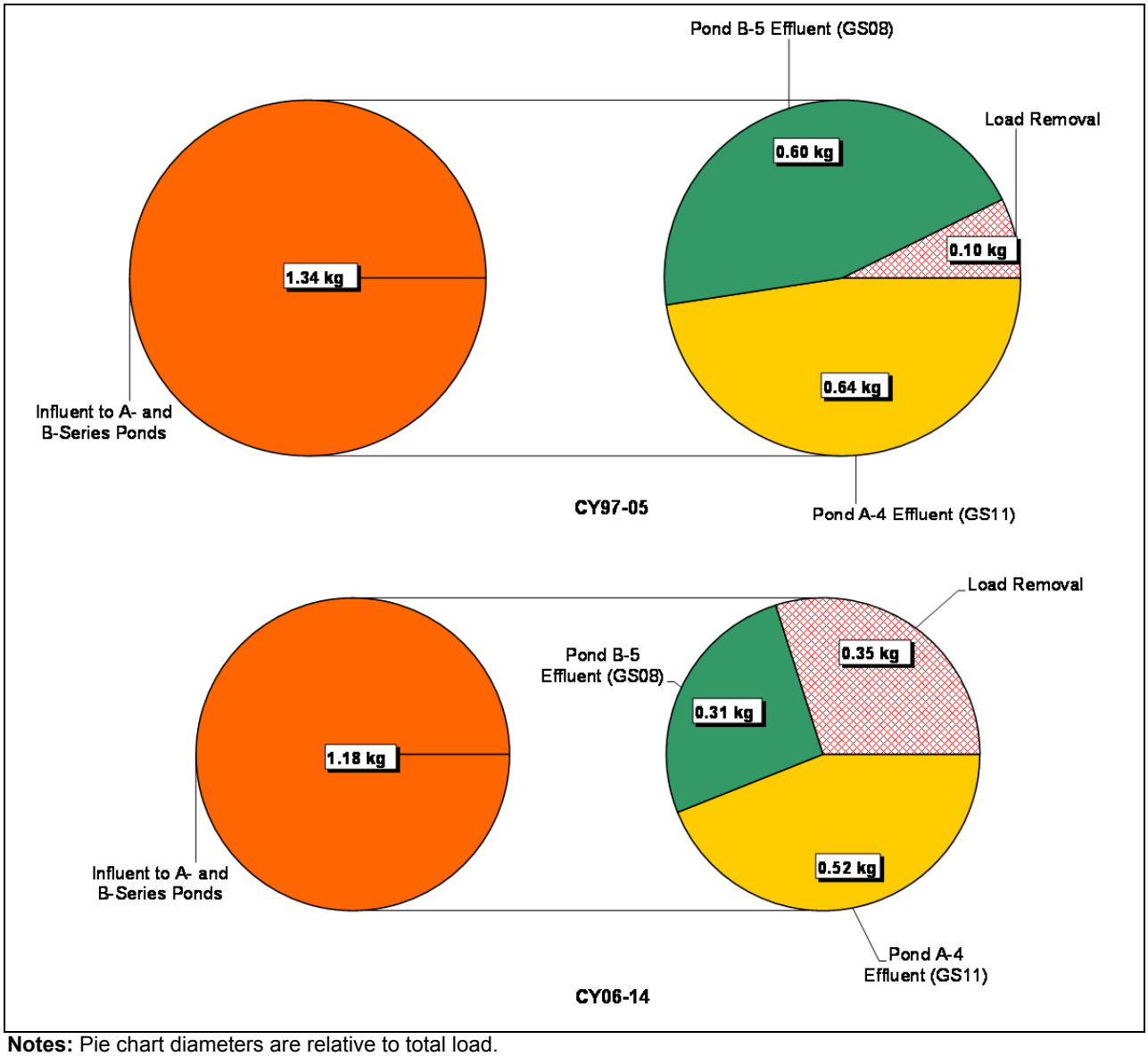


Figure 165. Annual Total U Loads for the A- and B-Series Ponds: CY 1997–2014



Notes: Pie chart diameters are relative to total load.

Figure 166. Relative Average Annual Total U Load Totals for the A- and B-Series Ponds

Pond C-2

This section summarizes the calculated Pu, Am, and U loads for Pond C-2. Data are presented in Table 65, Table 66, and Table 67, and depicted on Figure 167, Figure 168, Figure 169, Figure 170, Figure 171, Figure 172, Figure 173, and Figure 174. The influent load source is SW027 (SID at Pond C-2 inlet). The effluent loads are calculated at GS31 (Pond C-2 outlet). The following points are noted:

- Annual Pu and Am loads vary significantly year to year (Figure 167 and Figure 169). A significant increase in both Pu and Am loads influent to Pond C-2 is noted during CY 2004 due to increased solids transport from extensive soil disturbance in the drainage associated with the 903 Pad-Lip accelerated actions. With the implementation of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for

CY 2005–2014. Post-closure influent and effluent Pu loads have been reduced by 94 percent and 82 percent, respectively. Similarly, post-closure influent and effluent Am loads have been reduced by 93 percent and 89 percent, respectively.

- Annual total U loads also vary significantly year to year (Figure 173). Post-closure influent and effluent U loads have been reduced by 82 percent and 48 percent, respectively.
- There is a measurable average annual U load gain in Pond C-2 (Figure 171). This is likely due to seepage with naturally occurring U entering Pond C-2 from the Woman Creek Diversion Canal and therefore not being accounted for at SW027.

Table 65. Pu Load Summary for Terminal Pond C-2: CY 1997–2014

Calendar Year	Pu-239,240 (µg)	
	Influent [SW027]	Effluent [GS31]
1997	17.4	16.7
1998	87.7	2.2
1999	34.3	26.9
2000	67.2	0.0; No C-2 discharge
2001	10.7	11.0
2002	0.3	0.2
2003	45.1	11.0
2004	820.8	11.5
2005	18.6	5.0
2006	0.0; No flow	0.0; No C-2 discharge
2007	16.5	0.0; No C-2 discharge
2008	0.0; No flow	0.0; No C-2 discharge
2009	6.9	4.1
2010	32.4	0.4
2011	<0.01	1.0
2012	0.0; No flow	0.3
2013	6.0	7.8
2014	0.7[a]	1.9
Total	1,165	99.9

Notes:
[a] Estimated

Table 66. Am Load Summary for Terminal Pond C-2: CY 1997–2014

Calendar Year	Am-241 (µg)	
	Influent (SW027)	Effluent (GS31)
1997	0.08	0.17
1998	0.25	0.27
1999	0.20	0.13
2000	0.24	0.00; No C-2 discharge
2001	0.05	0.14
2002	0.00	<0.01
2003	0.12	0.09
2004	3.09	0.11
2005	0.05	0.04
2006	0.00; No flow	0.00; No C-2 discharge
2007	0.15	0.00; No C-2 discharge
2008	0.00; No flow	0.00; No C-2 discharge
2009	0.02	0.03
2010	0.12	0.02
2011	0.00	0.01
2012	0.00; No flow	<0.005
2013	0.01	0.03
2014	<0.01[a]	0.02
Total	4.40	1.06

Notes:
[a] Estimated

Table 67. Total U Load Summary for Terminal Pond C-2: CY 1997–2014

Calendar Year	Total U (kg)	
	Influent (SW027)	Effluent (GS31)
1997	0.08	0.23
1998	0.24	0.22
1999	0.12	0.19
2000	0.02	0.00; No C-2 discharge
2001	0.07	0.07
2002	~0.0	~0.0
2003	0.11	0.13
2004	0.04	0.09
2005	0.03	0.12
2006	0.00; No flow	0.00; No C-2 discharge
2007	0.04	0.00; No C-2 discharge
2008	0.00; No flow	0.00; No C-2 discharge
2009	0.02	0.10
2010	0.07	0.06
2011	~0.0	0.10
2012	0.00; No flow	0.05
2013	0.01	0.16
2014	~0.0[a]	0.07
Total	0.85	1.58

Notes:
[a] Estimated

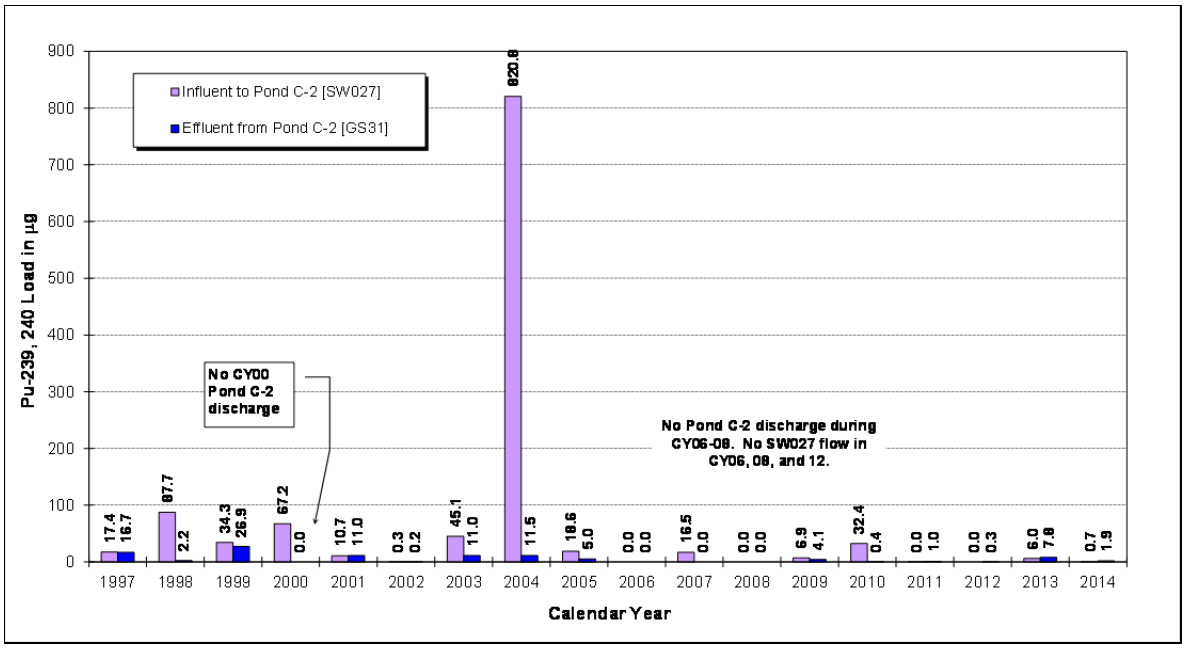
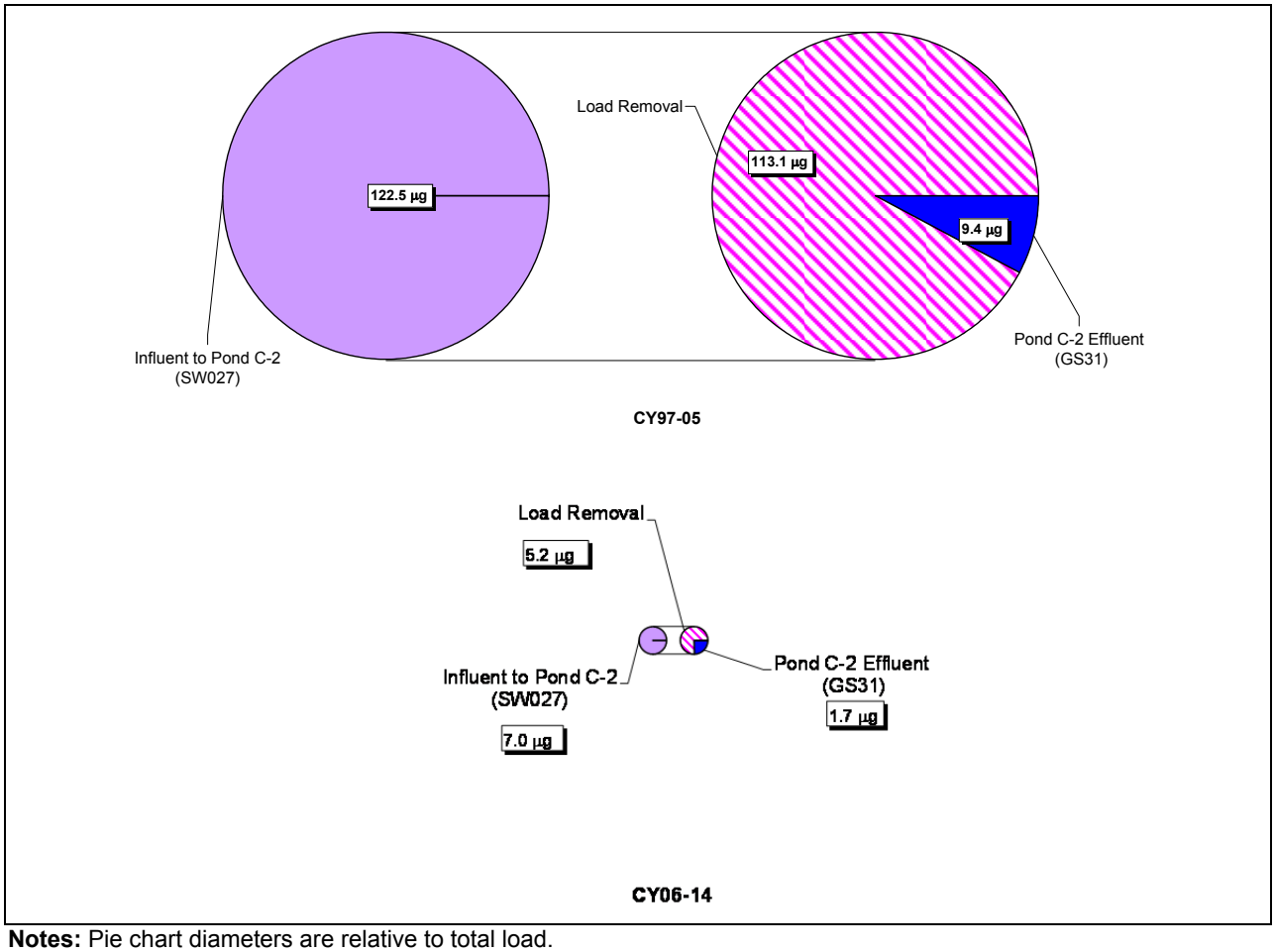


Figure 167. Annual Pu Loads for Pond C-2: CY 1997–2014



Notes: Pie chart diameters are relative to total load.

Figure 168. Relative Average Annual Pu Load Totals for Pond C-2

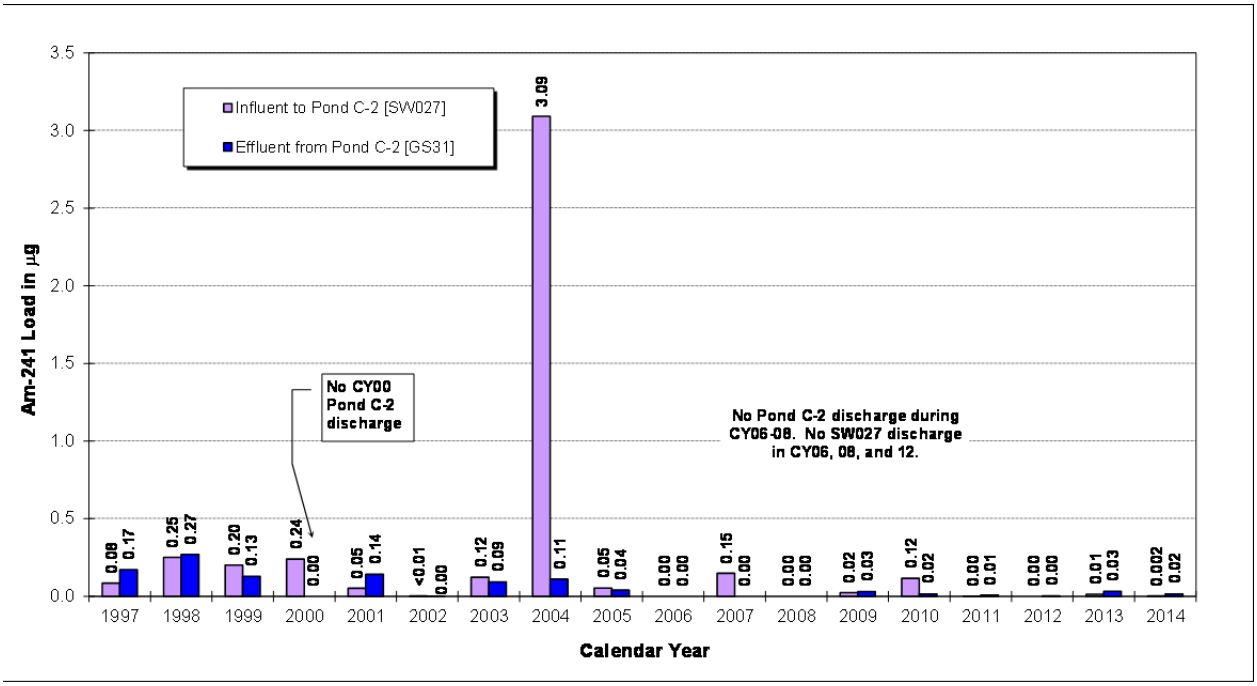
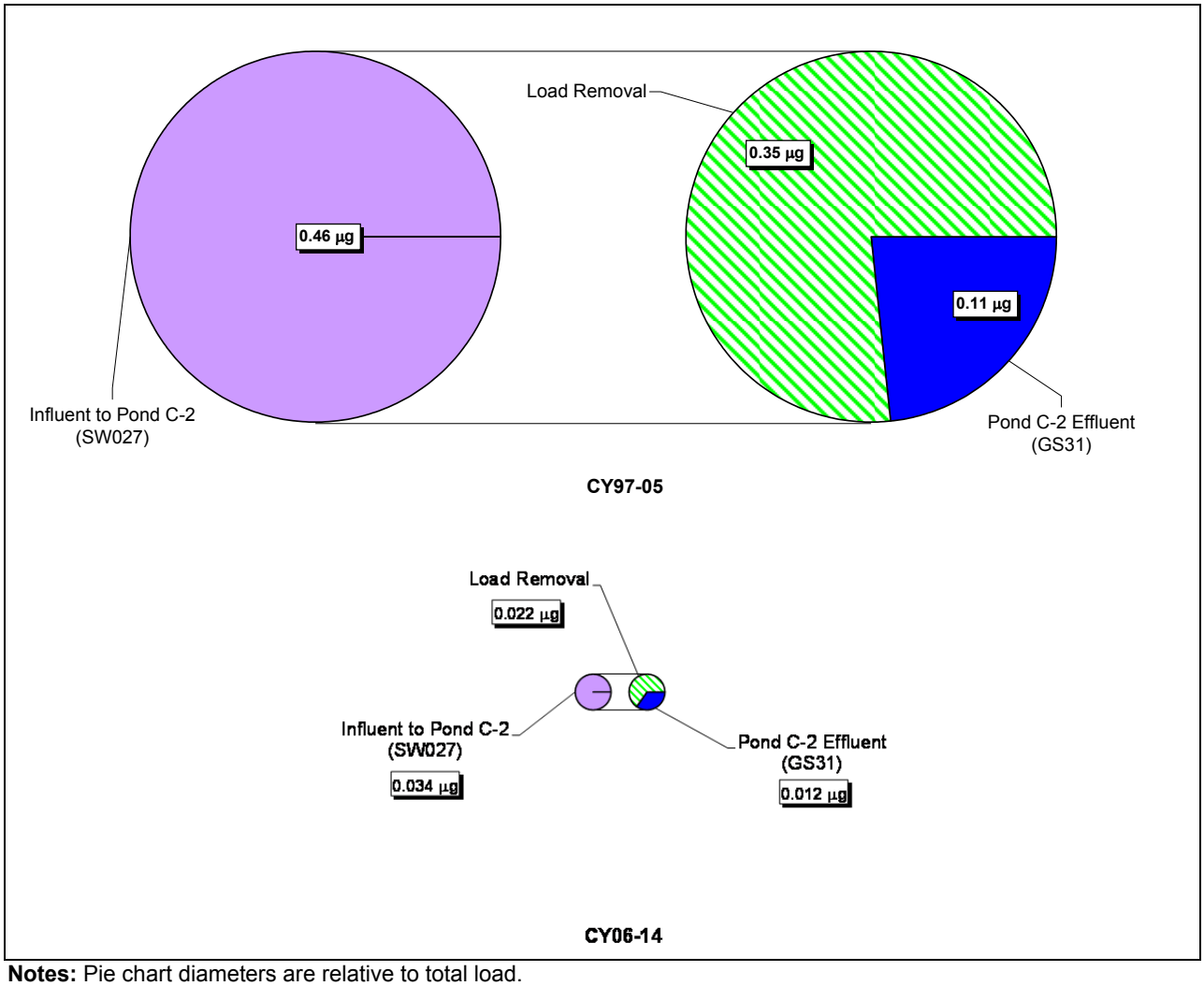
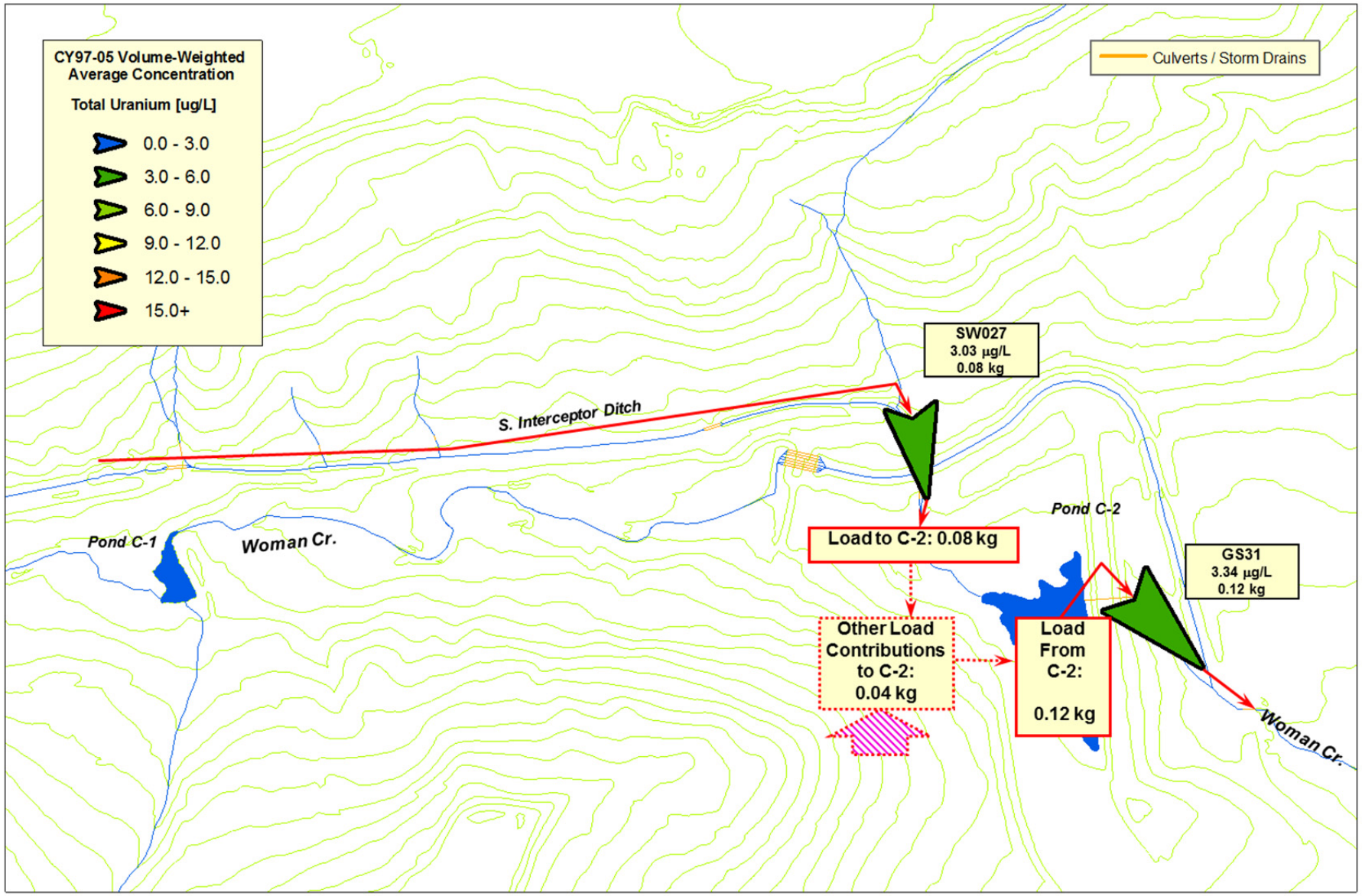


Figure 169. Annual Am Loads for Pond C-2: CY 1997–2014



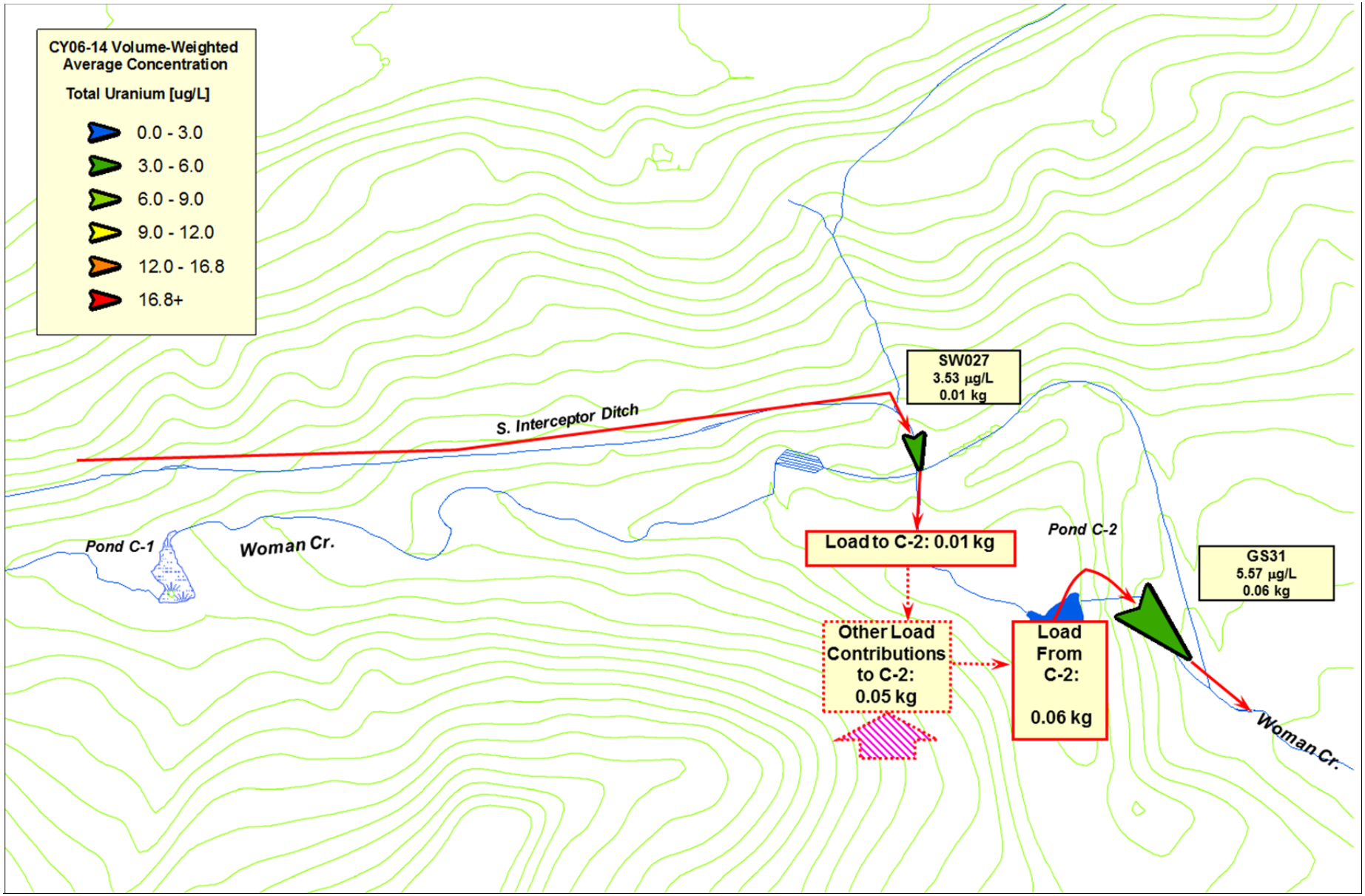
Notes: Pie chart diameters are relative to total load.

Figure 170. Relative Average Annual Am Load Totals for Pond C-2



Notes: Location symbols are sized proportional to the calculated average annual load and colored according to concentration ranges in the legend.

Figure 171. Relative Average Annual U Loading Schematic for Pond C-2: CY 1997–2005



Notes: Location symbols are sized proportional to the calculated average annual load and colored according to concentration ranges in the legend.

Figure 172. Relative Average Annual U Loading Schematic for Pond C-2: CY 2006–2014

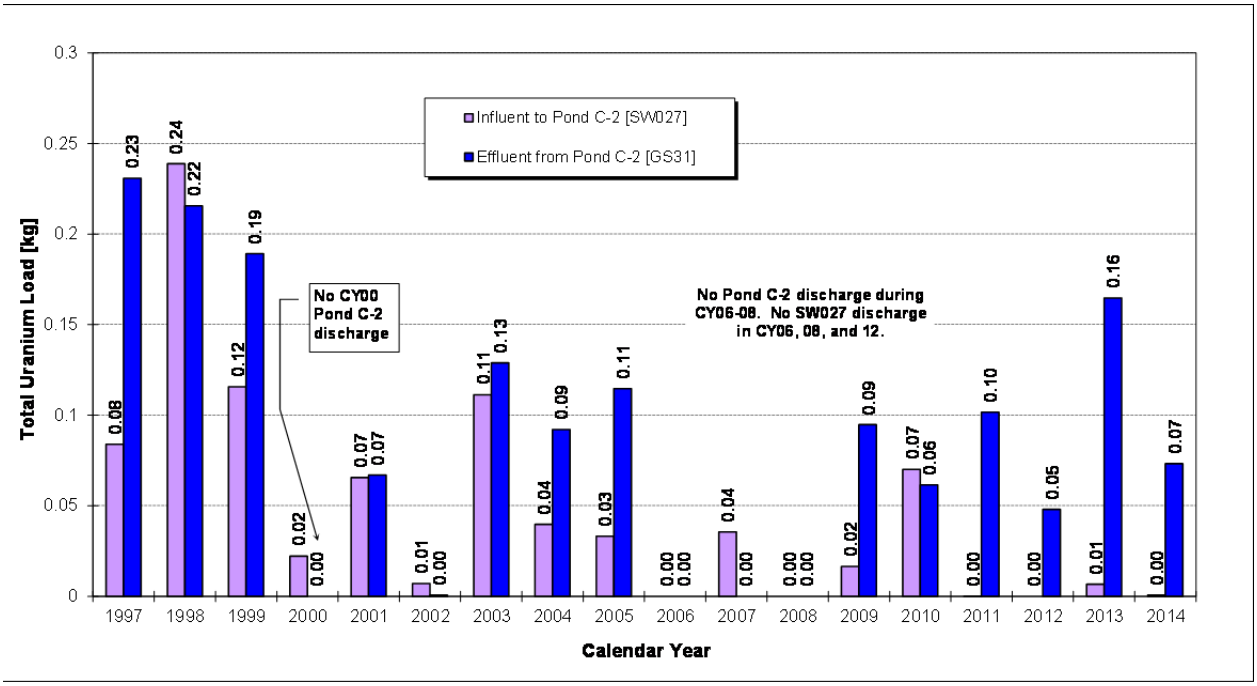
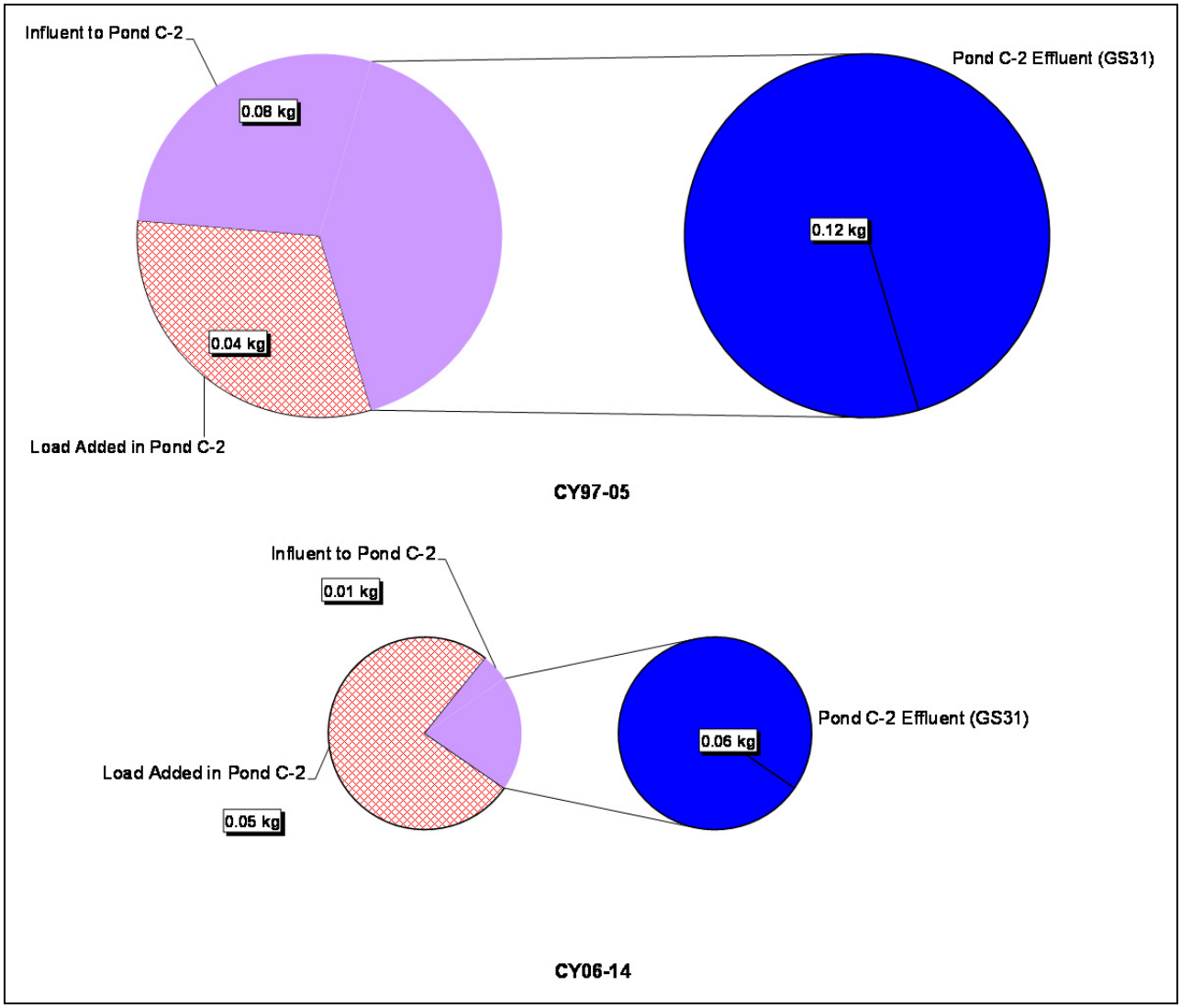


Figure 173. Annual Total U Loads for Pond C-2: CY 1997–2014



Notes: Pie chart diameters are relative to total load.

Figure 174. Relative Average Annual Total U Load Totals for Pond C-2

RFLMA Points of Evaluation

This section summarizes the calculated Pu, Am, and U loads for the three major former IA drainages: North Walnut Creek (SW093), South Walnut Creek (GS10 and the former WWTP), and the SID (SW027). Data are presented in Table 68 and Table 69 and are depicted on Figure 175, Figure 176, Figure 177, Figure 178, Figure 179, Figure 180, Figure 181, Figure 182, Figure 183, and Figure 184. The following points are noted:

- Total Pu load varies year to year and shows a significant increase in CY 2004 mostly due to extensive soil disturbance (Figure 175). With the completion of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2006–2014. Although the CY 2011–2013 loads were affected by recent increases in Pu activity at GS10 (see Section 3.1.2.2), average annual post-closure Pu loads have been reduced by 89 percent.
- Total Am load also varies year to year and shows a measurable increase in CY 2004 due to soil disturbance and contributions from closure actions in the B771 area (Figure 177). With the completion of remedial actions, erosion controls, revegetation, and soil stabilization, a reduction is noted for CY 2006–2014. Data from SW093 in CY 2005 (Figure 182) also clearly show that the B771 pathway elimination was successful. Although the CY 2011–2013 loads were affected by recent increases in Am activity at GS10 (see Section 3.1.2.2), average annual post-closure Am loads have still been reduced by 84 percent.
- South Walnut Creek accounts for a majority (47 percent) of the Pu load from the former IA (Figure 176) pre-closure. Of the South Walnut Creek Pu load, GS10 accounted for 97 percent, and the former WWTP accounted for the remaining 3 percent. Post-closure, South Walnut Creek remains the largest contributor (76 percent) of Pu load.
- South Walnut Creek accounts for a majority (60 percent) of the Am load from the former IA (Figure 178) pre-closure. Of the South Walnut Creek Am load, GS10 accounted for 96 percent, and the former WWTP accounted for the remaining 4 percent. Post-closure, South Walnut Creek remains the largest contributor (90 percent) of the Am loads.
- Annual total U loads are more consistent year to year (Figure 183). The load reductions in CY 2006 and 2008 are due to flow volume reduction and not a decrease in U concentration. Similarly, the load increase in CY 2010 and 2013 is due to large flow volumes and not a significant increase in U concentration. Post-closure overall U loads have been reduced by 15 percent.
- Pre-closure total U loads are fairly evenly divided (44 percent to 50 percent) between North and South Walnut creeks (Figure 184). Post-closure, there is a shift toward South Walnut Creek (58 percent of the total).

Table 68. Former IA Drainage Pu and Am Loads: CY 1997–2014

Calendar Year	Pu-239,240 (µg)				Am-241 (µg)			
	North Walnut Creek [SW093]	South Walnut Creek [GS10]	South Walnut Creek [WWTP]	SID [SW027]	North Walnut Creek [SW093]	South Walnut Creek [GS10]	South Walnut Creek [WWTP]	SID [SW027]
1997	164.2	576.0	11.2	17.4	2.24	12.20	0.64	0.08
1998	69.1	328.6	13.4	87.7	1.30	4.69	0.32	0.25
1999	127.8	307.9	19.4	34.3	1.73	12.55	0.11	0.20
2000	87.4	326.2	17.4	67.2	0.98	14.57	0.29	0.24
2001	44.4	141.4	11.3	10.7	0.65	2.75	0.32	0.05
2002	9.6	59.3	8.3	0.3	0.52	1.76	0.20	0.00
2003	140.1	207.2	3.8	45.1	2.05	4.44	0.52	0.12
2004	1,330.9	523.3	2.1	820.8	28.48	4.68	0.25	3.09
2005	29.2	247.1	0.0; WWTP removed	18.6	0.82	3.98	0.00; WWTP removed	0.05
2006	2.5	2.3	0.0; WWTP removed	0.0; No flow	0.02	0.04	0.00; WWTP removed	0.00; No flow
2007	17.0	14.2	0.0; WWTP removed	16.5	0.28	0.14	0.00; WWTP removed	0.15
2008	13.2	3.5	0.0; WWTP removed	0.0; No flow	0.15	0.09	0.00; WWTP removed	0.00; No flow
2009	23.0	15.2	0.0; WWTP removed	6.9	0.21	0.15	0.00; WWTP removed	0.02
2010	16.4	13.1	0.0; WWTP removed	32.4	0.35	0.15	0.00; WWTP removed	0.12
2011	4.3	106.7	0.0; WWTP removed	<0.01	0.07	3.42	0.00; WWTP removed	0.00
2012	1.2	69.0	0.0; WWTP removed	0.0; No flow	0.04	2.13	0.00; WWTP removed	0.0; No flow
2013	4.3	257.0	0.0; WWTP removed	6.0	0.20	8.66	0.00; WWTP removed	0.01
2014	5.3	9.5	0.0; WWTP removed	0.7	0.10	0.70	0.00; WWTP removed	~0.0[a]
Total	2,090	3,208	86.9	1,165	40.2	77.1	2.65	4.40

Notes:
[a] Estimated

Table 69. Former IA Total U Loads: CY 1997–2014

Calendar Year	Total U (kg)			
	North Walnut Creek [SW093]	South Walnut Creek [GS10]	South Walnut Creek [WWTP]	SID [SW027]
1997	0.85	0.64	0.26	0.08
1998	0.80	0.63	0.47	0.24
1999	0.71	0.59	0.12	0.12
2000	0.49	0.38	0.10	0.02
2001	0.65	0.52	0.26	0.07
2002	0.45	0.28	0.06	<0.01
2003	0.57	0.50	0.16	0.11
2004	0.57	0.43	0.14	0.04
2005	0.53	0.88	0.00; WWTP removed	0.03
2006	0.17	0.23	0.00; WWTP removed	0.00; No flow
2007	0.54	0.83	0.00; WWTP removed	0.04
2008	0.15	0.28	0.00; WWTP removed	0.00; No flow
2009	0.57	0.76	0.00; WWTP removed	0.02
2010	1.05	1.16	0.00; WWTP removed	0.07
2011	0.40	0.76	0.00; WWTP removed	~0.0
2012	0.29	0.68	0.00; WWTP removed	0.00; No flow
2013	0.77	0.93	0.00; WWTP removed	0.07
2014	0.51	0.58	0.00; WWTP removed	~0.0
Total	10.1	11.0	1.57	0.85

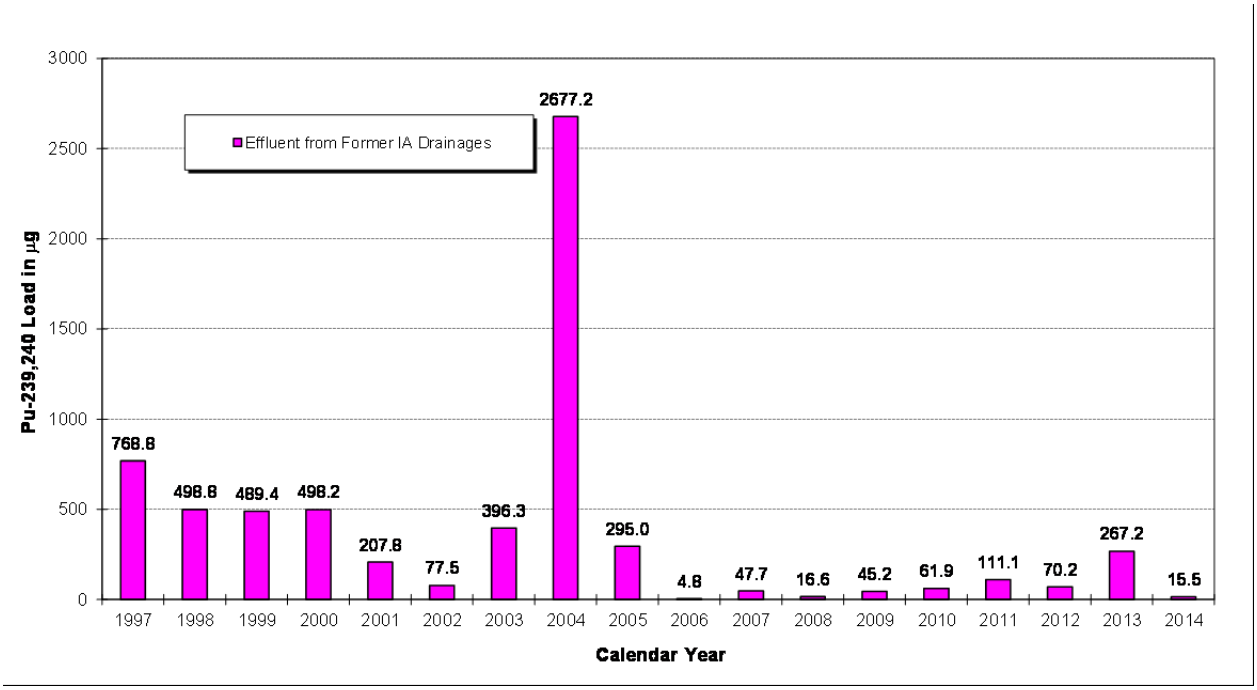
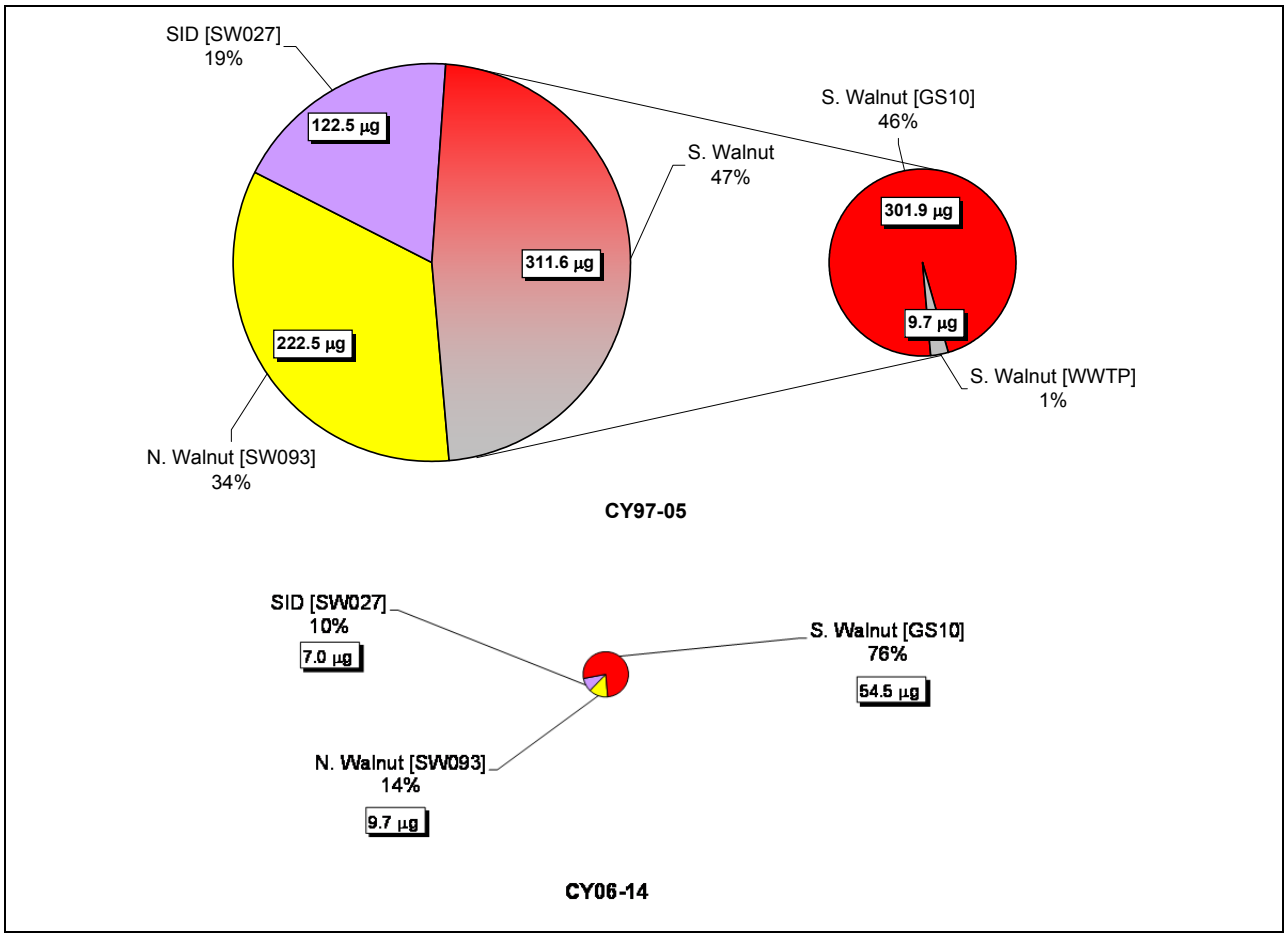


Figure 175. Combined Annual Pu Loads from Former IA Drainages: CY 1997–2014



Notes: Pie chart diameters are relative to total load.

Figure 176. Relative Average Annual Pu Load Totals from Former IA Drainages and WWTP

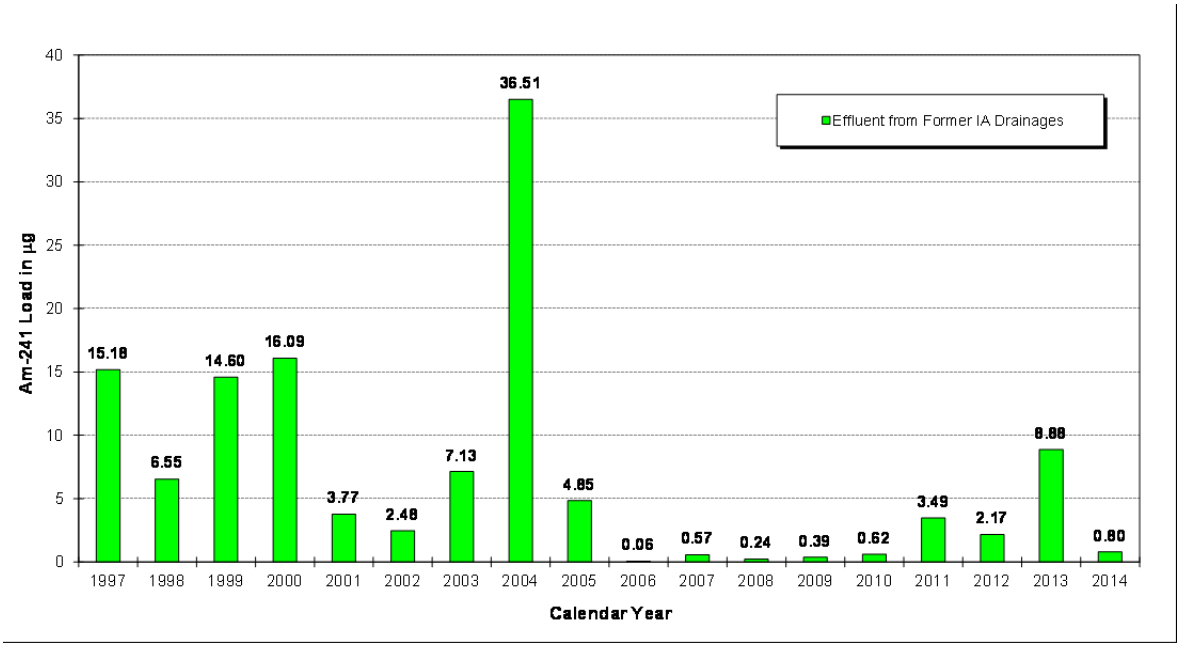
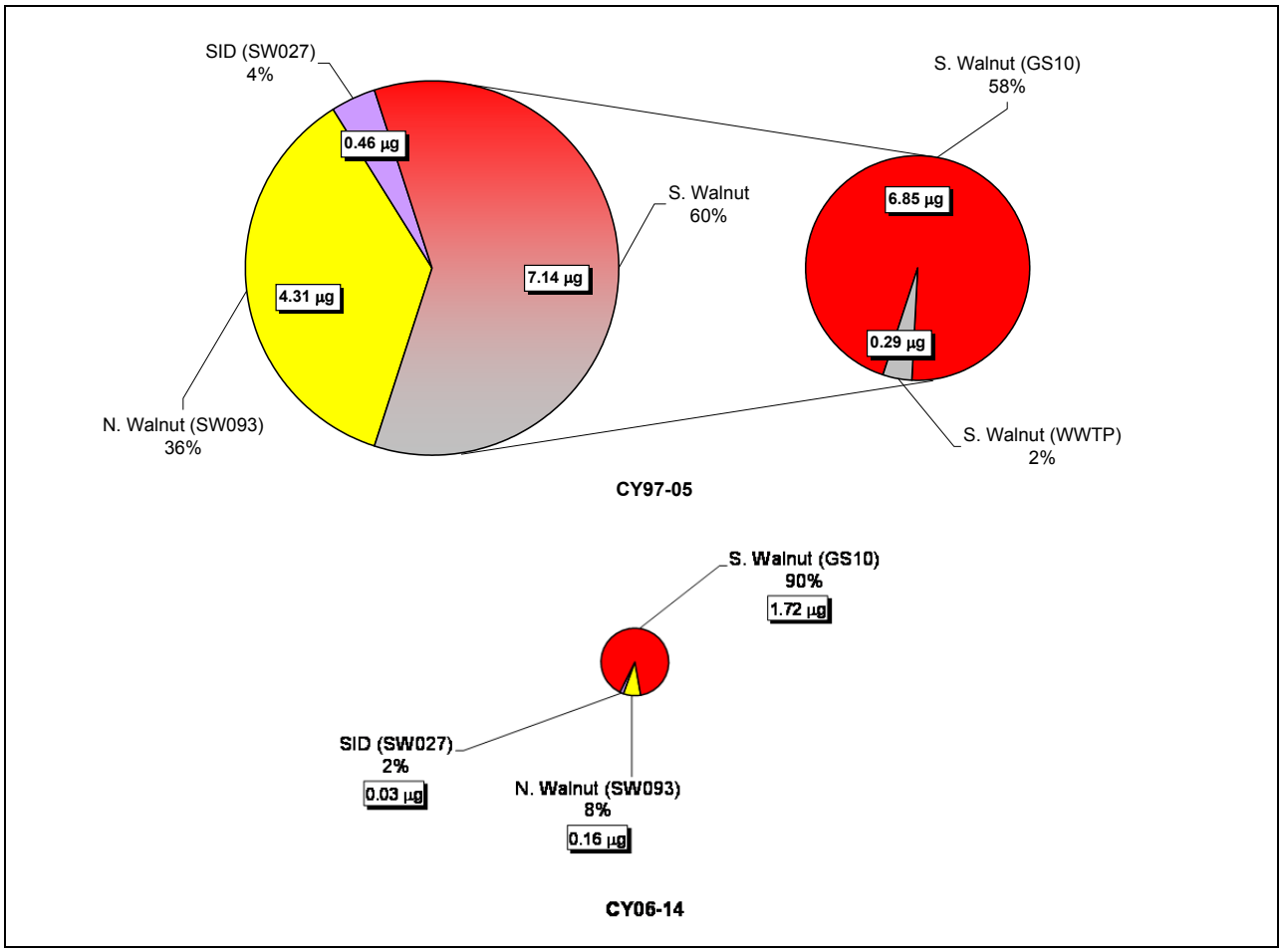


Figure 177. Annual Am Loads from Former IA Drainages and WWTP: CY 1997–2014



Notes: Pie chart diameters are relative to total load.

Figure 178. Relative Average Annual Am Load Totals from Former IA Drainages and WWTP

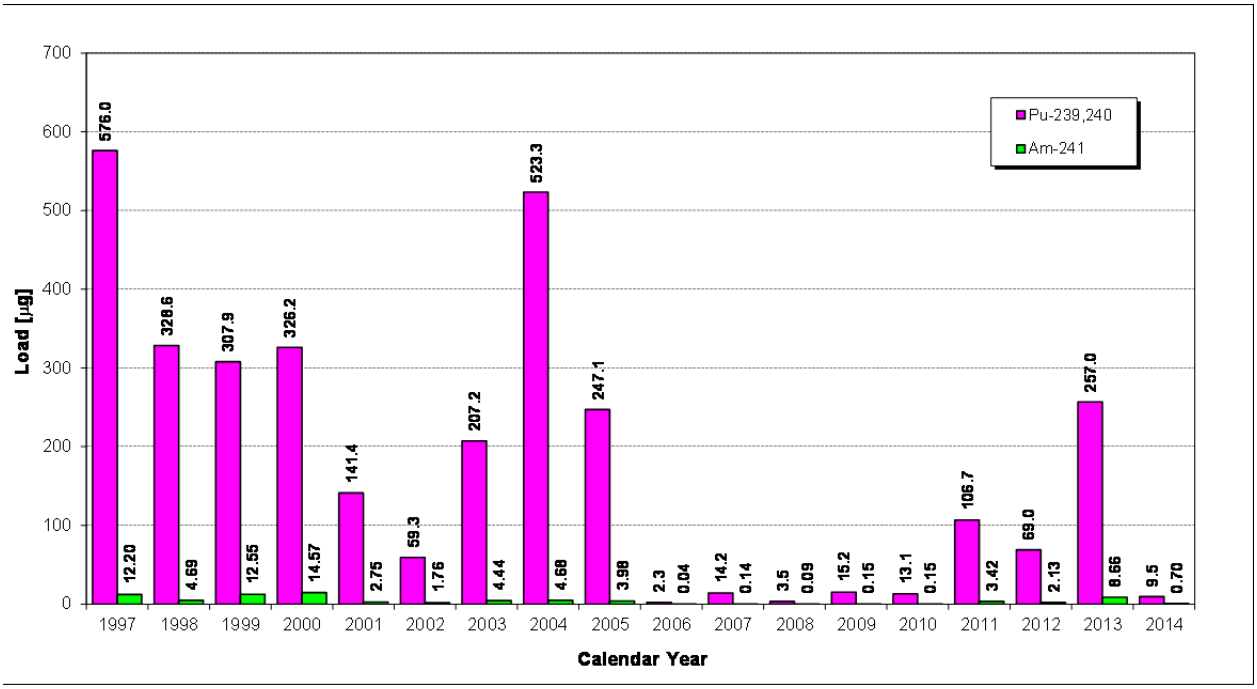


Figure 179. Annual Pu and Am Loads at GS10: CY 1997–2014

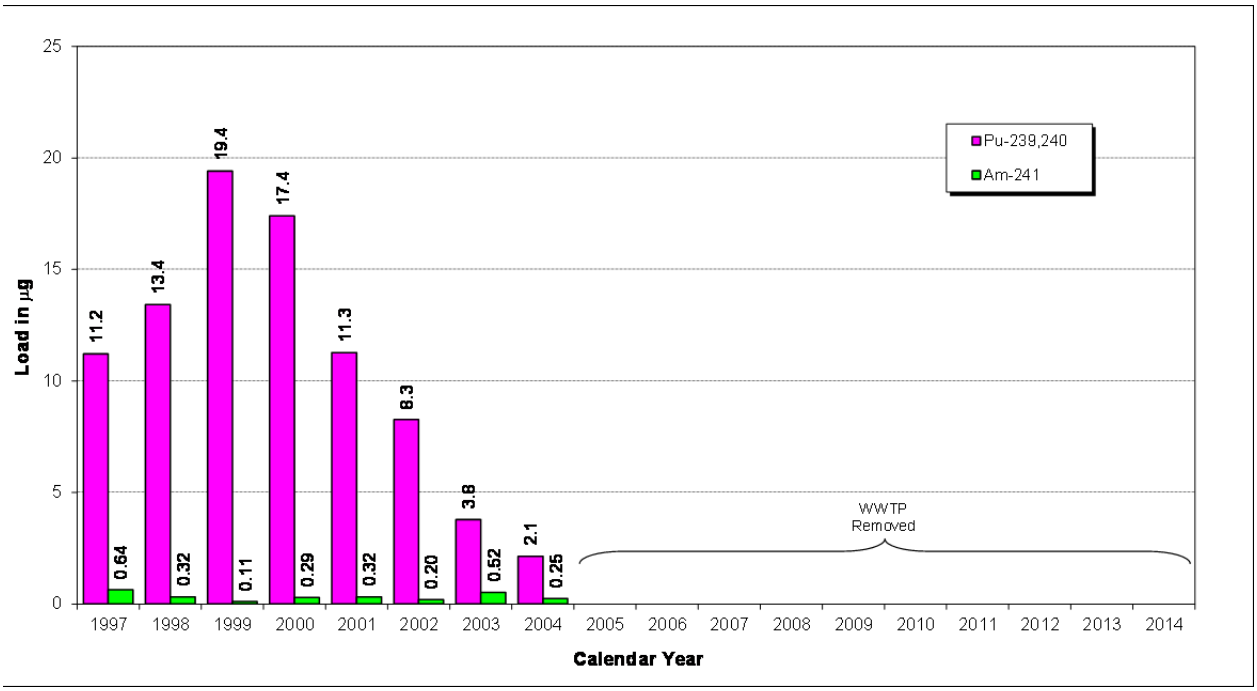


Figure 180. Annual Pu and Am Loads at the WWTP: CY 1997–2014

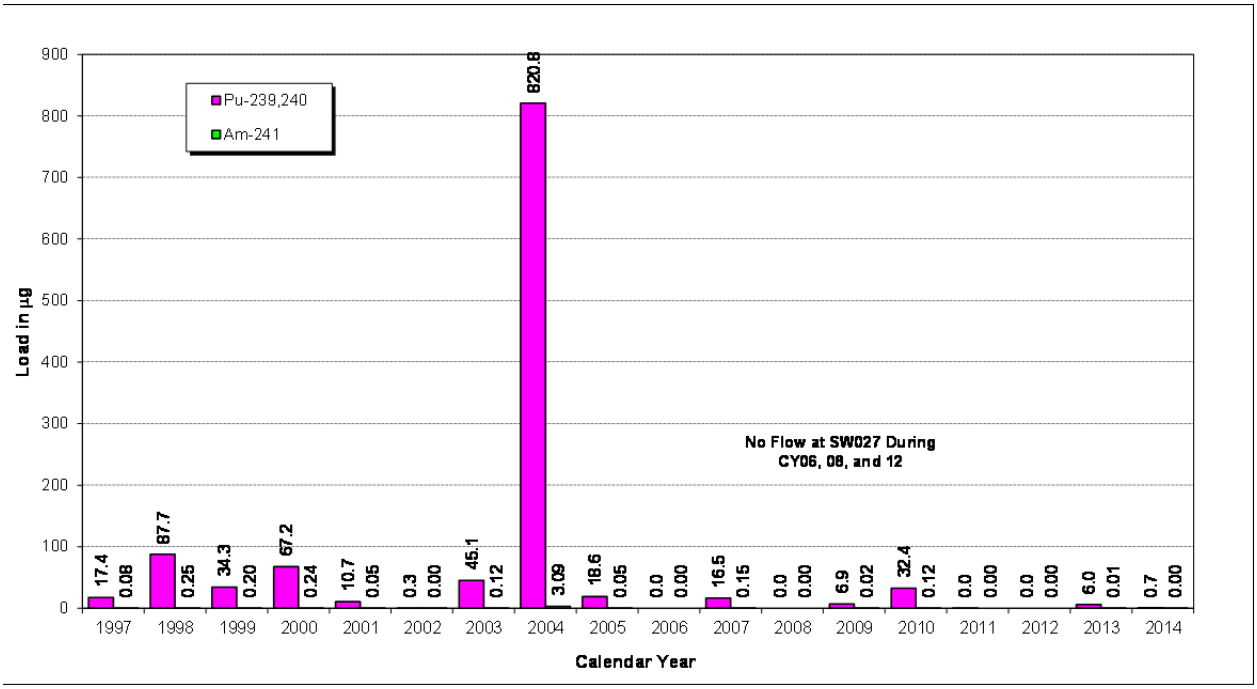


Figure 181. Annual Pu and Am Loads at SW027: CY 1997–2014

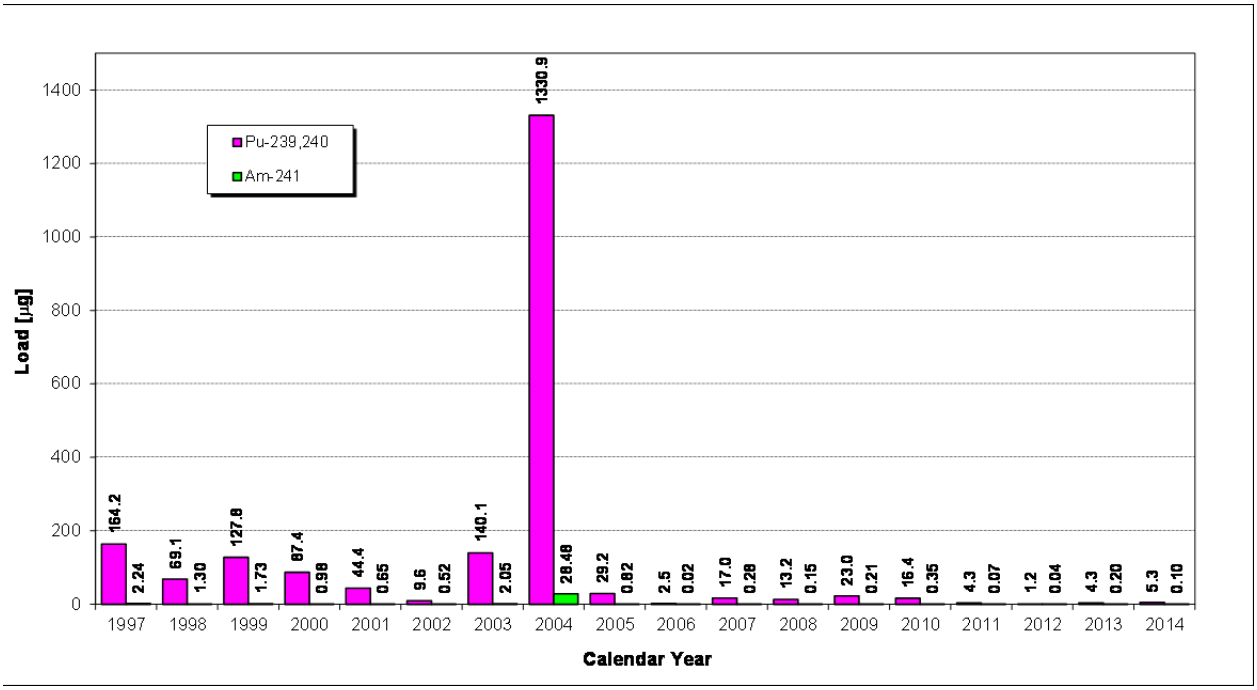


Figure 182. Annual Pu and Am Loads at SW093: CY 1997–2014

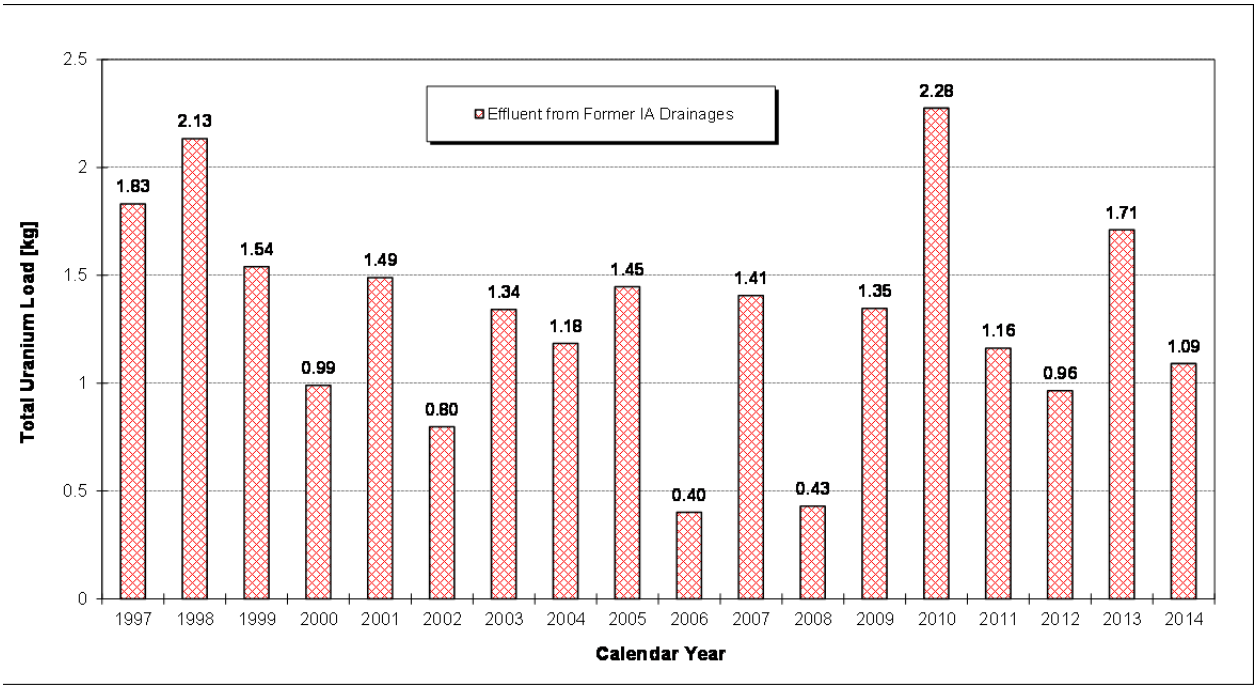
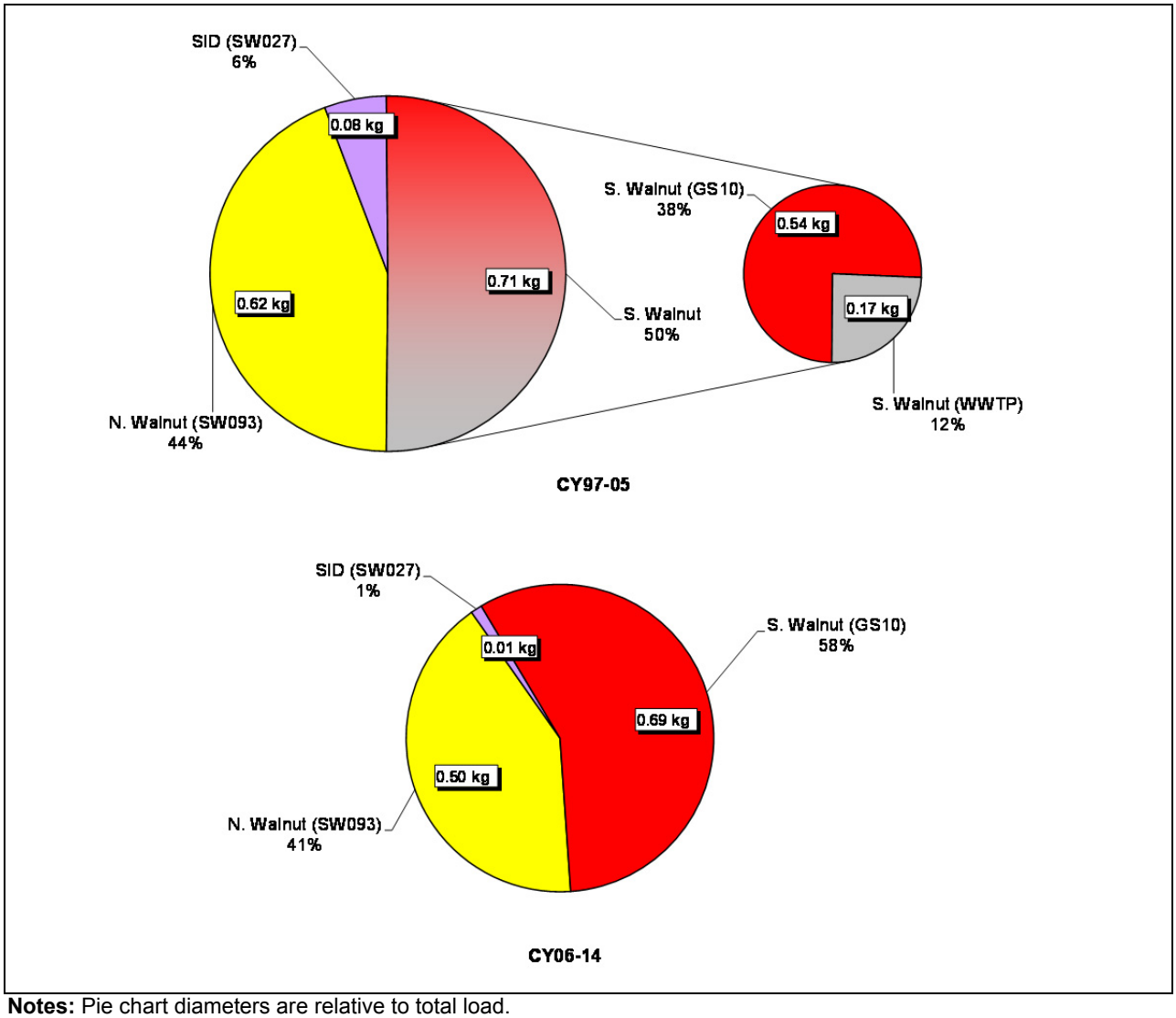


Figure 183. Annual Total U Loads from Former IA Drainages and WWTP: CY 1997–2014



Notes: Pie chart diameters are relative to total load.

Figure 184. Relative Average Annual Total U Loads from Former IA Drainages and WWTP

3.1.5 Groundwater Data Interpretation and Evaluation

This section provides a summary of groundwater monitoring performed in 2014. A discussion of groundwater conditions during 2014, focusing on the most important water-quality aspects in the areas of interest (i.e., the main contaminant plumes), is then presented.

3.1.5.1 RFLMA Groundwater Monitoring Activities of 2014

Routine activities of the groundwater monitoring program in 2014 included sample collection, water-level measurement, groundwater treatment system maintenance, and well maintenance. "Groundwater" monitoring also includes monitoring activities at several surface-water locations, as well as at some locations that may not clearly belong to either category. (Examples of the former include Surface Water Support location SW018 and treatment system-related performance monitoring locations; examples of the latter include locations monitoring effluent from a treatment system before it is discharged.) However, because all of these locations support