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, 2009 (CY 1997–2009), for the locations operational in CY 2009. Radionuclides summarized include Pu, Am,[21] and total U. Additionally, the POE metals (total beryllium [Be], dissolved cadmium [Cd], total chromium [Cr], and dissolved silver [Ag]) 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 3.1.2.11 by monitoring objective.

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 (GS01, GS03, GS08, GS11, and GS31; Section 3.1.2.1) 30-day or 12-month rolling averages. Comparisons of standards/action levels to other locations are noted in this section for reference only. POEs and POCs are highlighted in **bold** in the tables.

Radionuclides

The following summaries include all results that were not rejected through the validation process.[22] 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.[23] 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. Total U activity is calculated by summing the activities for the analyzed isotopes (U-233,234 + U-235 + U-238).

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 [MDA] for Pu and Am analyses) to exclude ratios for very low results with high relative error.

The U-233,234/U-238 ratio is calculated for each sample by dividing the U-233,234 result by the corresponding U-238 result. Ratios are only calculated for samples where *both* the U-233,234 and U-238 results are greater than 0.025 pCi/L (generally the MDA for these isotope analyses) to exclude ratios for very low results with high relative error. The U-233,234/U-238 ratios can only be used to qualitatively infer the characteristics of the U in surface water. In the past, groundwater and surface-water samples from selected locations have been sent to LANL for

[21] In this report, "plutonium" or "Pu" refers to plutonium-239,240; and "americium" or "Am" refers to americium-241.
[22] Summaries do not include supplemental post-closure grab samples from GS13 that were collected to assess modifications to the SPPTS; only routine continuous flow-paced samples are included.
[23] Arithmetic averaging of radionuclide pairs is performed only when the DER is less than 1.5. If the DER is greater than or equal to 1.5, 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."

HR ICP/MS analysis, TIMS analysis, or both. These analyses measure mass ratios of four U isotopes (masses 234, 235, 236, and 238) and are detailed in the reports titled *Uranium in Surface Soil, Surface Water, and Groundwater at the Rocky Flats Environmental Technology Site* (K-H 2004c), and in the *Interim Measure/Interim Remedial Action for Groundwater at the Rocky Flats Environmental Technology Site* (K-H 2005a). Isotopic ratios provide a signature that indicates whether the source of U is natural, anthropogenic (manmade), or mixed. The results to date indicate that the groundwater and surface-water locations at Rocky Flats display a predominately natural signature.

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.

Table 3–41 and Table 3–42 show that post-closure median Pu activities for all locations, except GS51, are well below 0.15 pCi/L. After closure, significant reductions in 85th percentile and maximum Pu activities are noted, most significantly at COU locations GS10, GS51, SW027, and SW093. Figure 3–110 and Figure 3–111 show the pre- and post-closure median Pu activities, respectively.

Table 3–41. Summary Statistics for Pu-239,240 Analytical Results in CY 1997—October 13, 2005

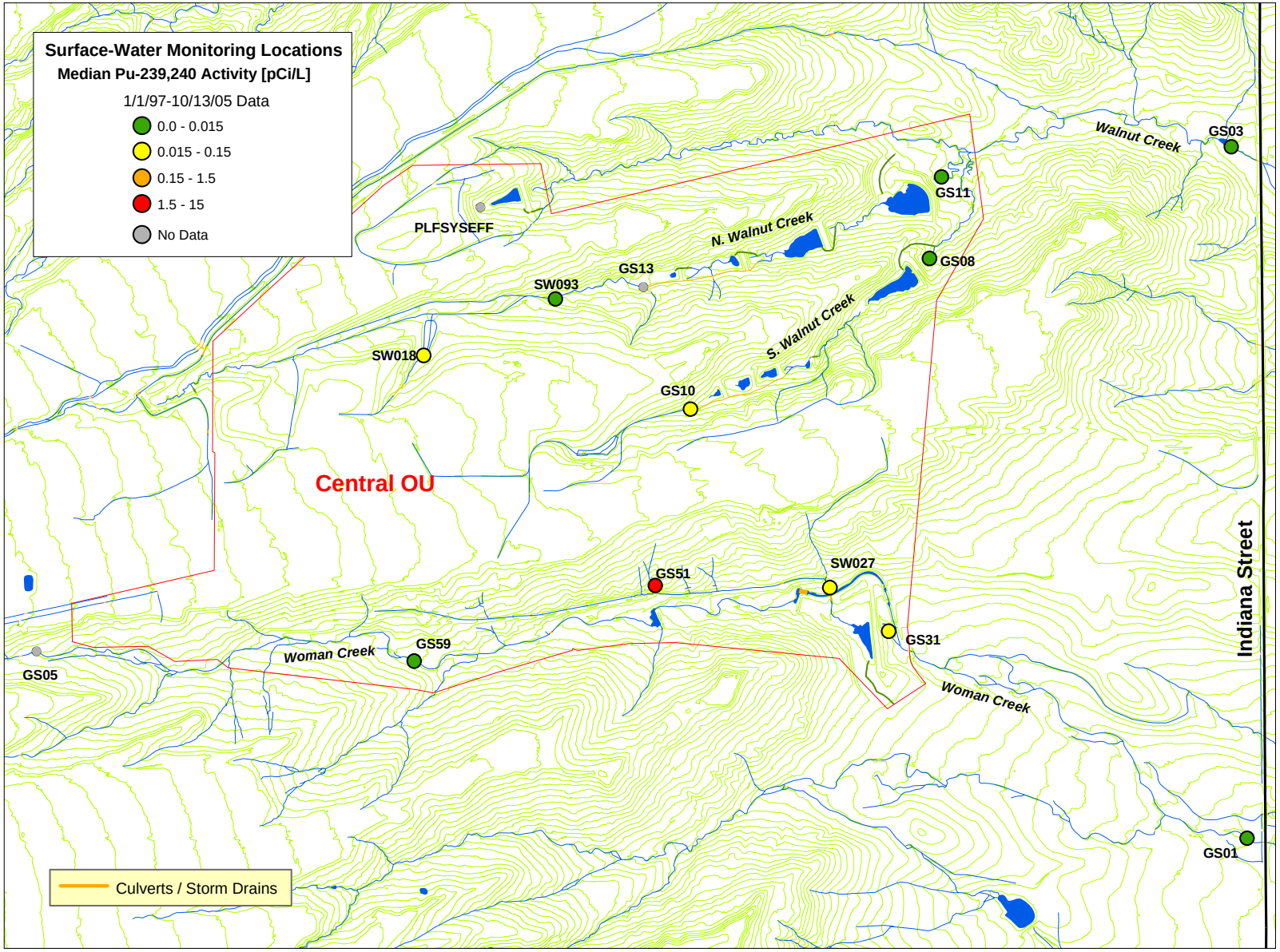
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	**165**	**0.002**	**0.008**	**0.024**
GS03	**257**	**0.005**	**0.016**	**0.220**
GS05	NA	NA	NA	NA
GS08	**118**	**0.004**	**0.013**	**0.864**
GS10	**266**	**0.054**	**0.207**	**2.27**
GS11	**89**	**0.002**	**0.009**	**0.070**
GS13	NA	NA	NA	NA
GS31	**26**	**0.017**	**0.094**	**0.348**
GS51	27	3.97	8.41	99.7
GS59	30	0.000	0.004	0.020
PLFSYSEFF	NA	NA	NA	NA
SW027	**71**	**0.049**	**0.199**	**13.2**
SW093	**284**	**0.010**	**0.063**	**4.18**

Notes: NA = Analyte not sampled; Bold- type = POC or POE

Table 3–42. Post-Closure Summary Statistics for Pu-239,240 Analytical Results (October 13, 2005−December 31, 2009)

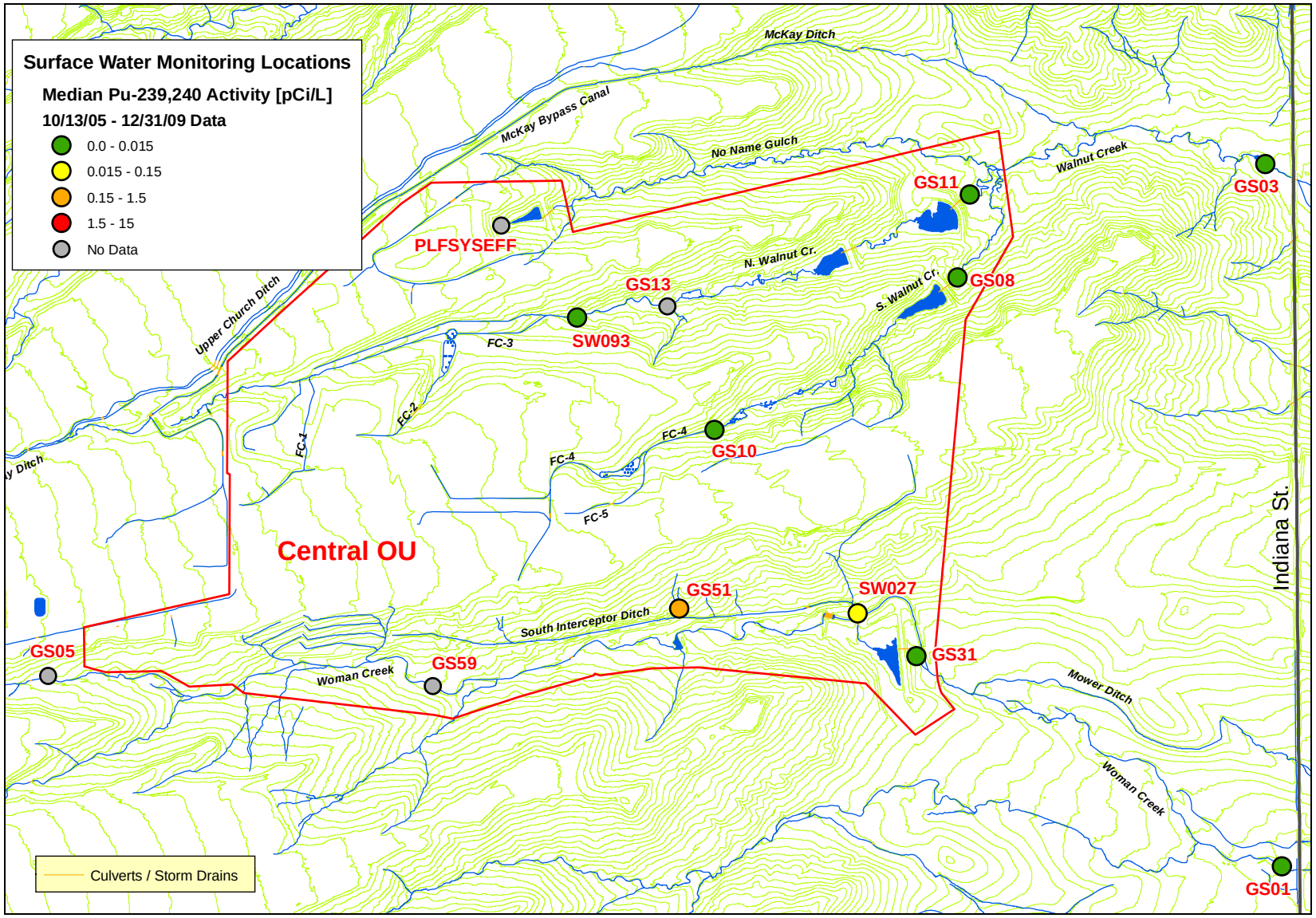
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	**59**	**0.003**	**0.009**	**0.017**
GS03	**36**	**0.003**	**0.006**	**0.024**
GS05	NA	NA	NA	NA
GS08	**16**	**0.003**	**0.008**	**0.017**
GS10	**70**	**0.010**	**0.030**	**0.079**
GS11	**20**	**0.003**	**0.010**	**0.046**
GS13	NA	NA	NA	NA
GS31	**4**	**0.014**	**0.019**	**0.023**
GS51	9	0.794	5.62	13.8
GS59	NA	NA	NA	NA
PLFSYSEFF	NA	NA	NA	NA
SW027	**4**	**0.092**	**0.104**	**0.114**
SW093	**65**	**0.010**	**0.035**	**0.861**

Notes: * = No post-closure results through CY 2009; NA = Analyte not sampled; Bold type = POC or POE



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

Figure 3–110. Median Pu-239,240 Activities for CY 1997–October 13, 2005



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

Figure 3–111. Post-Closure Median Pu-239,240 Activities

Table 3–43 and Table 3–44 show that post-closure median Am activities for all locations, except GS51, are well below 0.15 pCi/L. After closure, significant reductions in 85th percentile and maximum Am activities are noted, most significantly at COU locations GS10, GS51, SW027, and SW093. Figure 3–112 and Figure 3–113 show median Am activities for pre- and post-closure, respectively.

Table 3–43. Summary Statistics for Am-241 Analytical Results in CY 1997−October 13, 2005

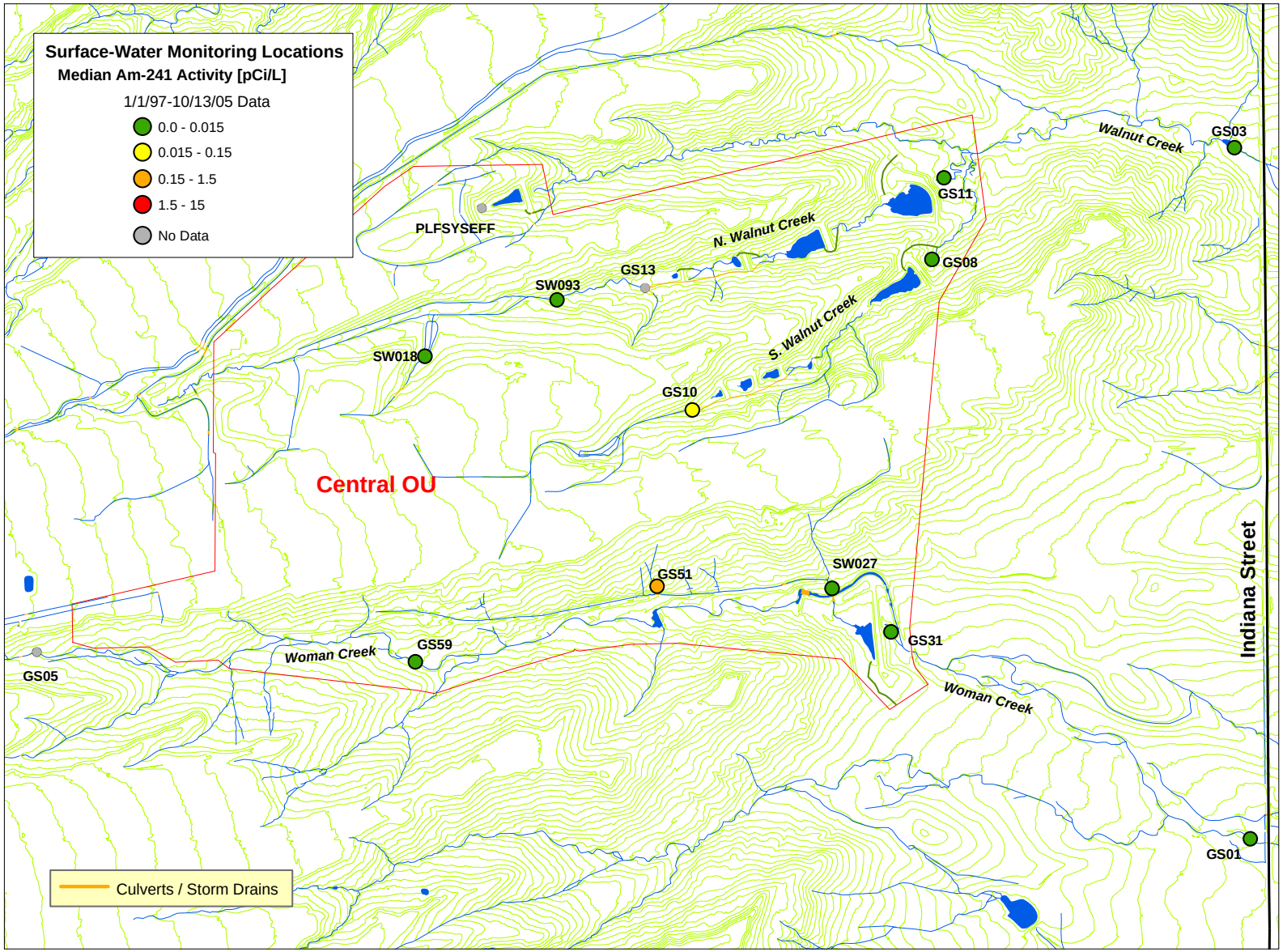
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	**164**	**0.001**	**0.008**	**0.054**
GS03	**258**	**0.006**	**0.018**	**0.066**
GS05	NA	NA	NA	NA
GS08	**118**	**0.006**	**0.015**	**0.275**
GS10	**259**	**0.057**	**0.193**	**8.39**
GS11	**88**	**0.003**	**0.010**	**0.047**
GS13	NA	NA	NA	NA
GS31	**26**	**0.009**	**0.020**	**0.116**
GS51	25	0.807	1.76	3.41
GS59	30	0.001	0.004	0.015
PLFSYSEFF	NA	NA	NA	NA
SW027	**71**	**0.009**	**0.045**	**2.33**
SW093	**279**	**0.012**	**0.052**	**14.1**

Notes: NA = Analyte not sampled
Bold type = POC or POE

Table 3–44. Post-Closure Summary Statistics for Am-241 Analytical Results (October 13, 2005−December 31, 2009)

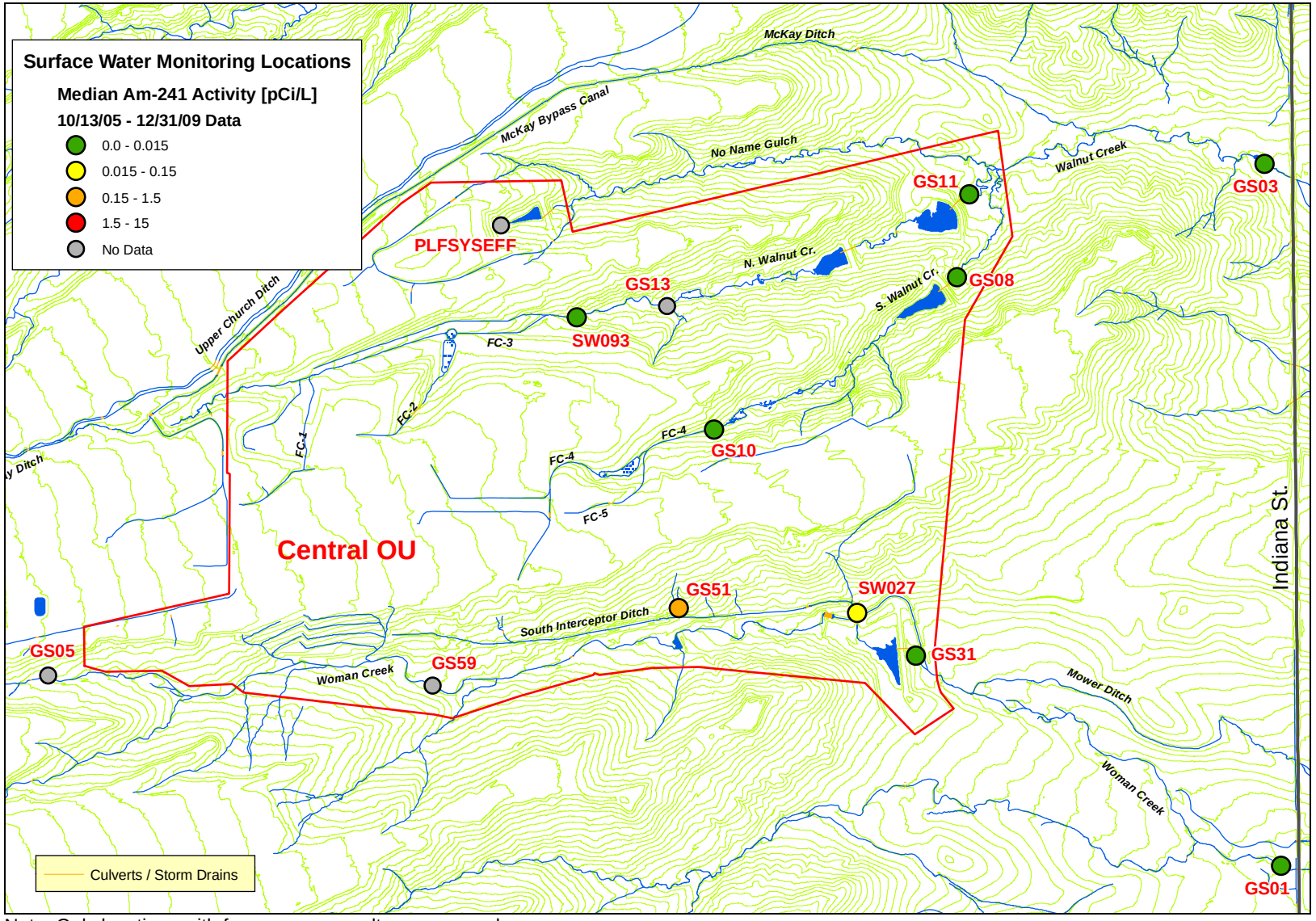
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	**59**	**0.001**	**0.006**	**0.057**
GS03	**36**	**0.001**	**0.007**	**0.023**
GS05	NA	NA	NA	NA
GS08	**16**	**0.001**	**0.004**	**0.012**
GS10	**70**	**0.008**	**0.036**	**0.074**
GS11	**20**	**0.001**	**0.004**	**0.027**
GS13	NA	NA	NA	NA
GS31	**4**	**0.005**	**0.007**	**0.008**
GS51	9	0.186	0.989	3.03
GS59	NA	NA	NA	NA
PLFSYSEFF	NA	NA	NA	NA
SW027	**4**	**0.016**	**0.029**	**0.040**
SW093	**65**	**0.006**	**0.021**	**0.357**

Notes: NA = Analyte not sampled
Bold type = POC or POE



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

Figure 3–112. Median Am-241 Activities for CY 1997–October 13, 2005



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

Figure 3–113. Post-Closure Median Am-241 Activities

Table 3–45 and Table 3–46 show that post-closure median total U concentrations for most locations are below the standard of 16.8 µg/L. Recent data from GS10, GS13, and SW093 show total U levels in excess of 16.8 µg/L. U activities at GS13 are known to be directly affected by groundwater associated with the SPPTS. The measurements at GS10 and SW093 are likely due to contributions of naturally occurring U in groundwater and hydrologic changes post-closure (see Section 3.1.2.2 for further detail regarding GS10). These U concentrations can also be seen in samples collected at downstream locations GS11, GS08, and GS03. Figure 3–114 and Figure 3–115 show median total U activities for pre- and post-closure, respectively.

Table 3–45. Summary Statistics for Total U Analytical Results in CY 1997−October 13, 2005

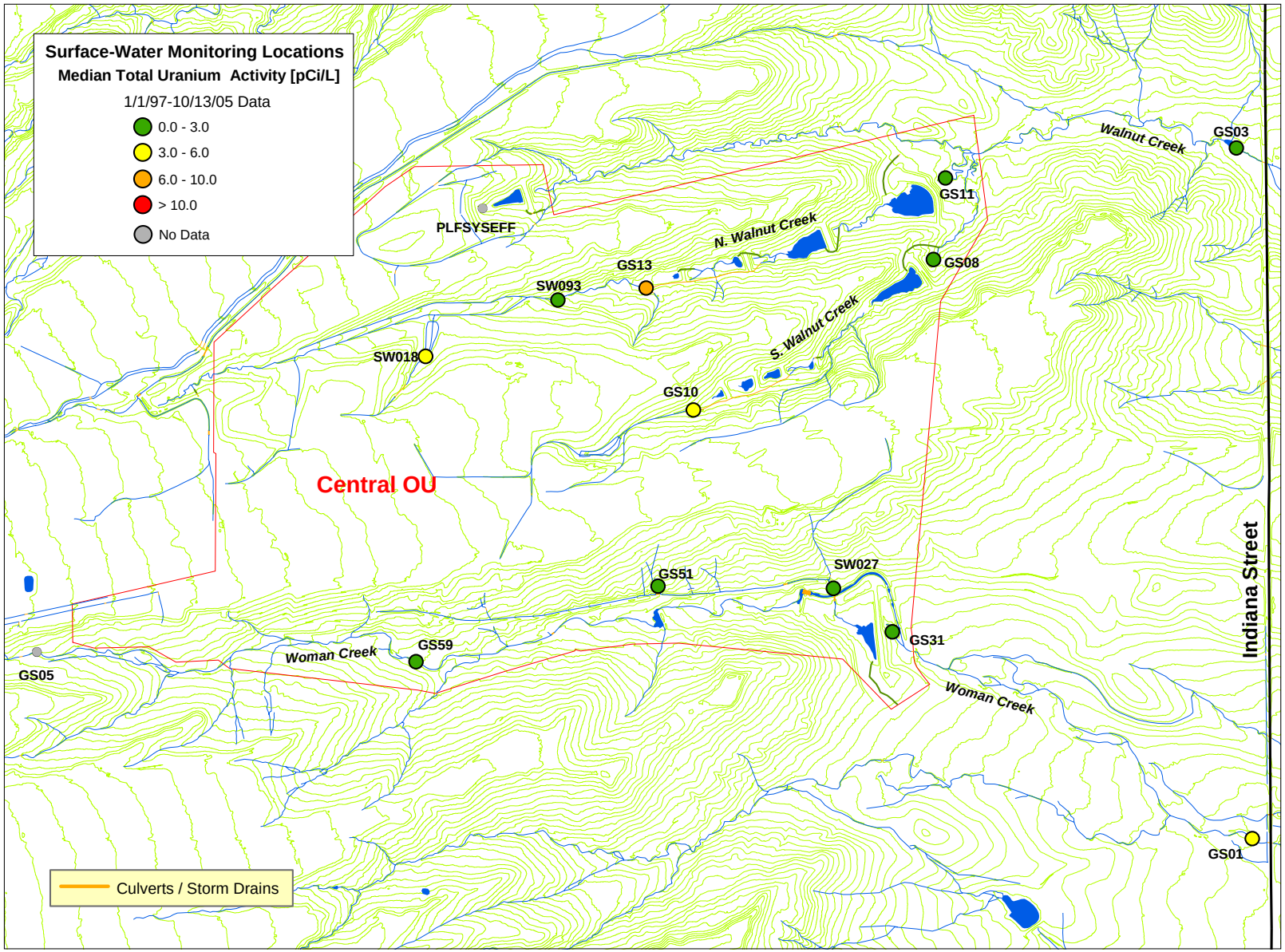
Location	Samples (N)	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
GS01	**53**	**4.29**	**6.51**	**11.9**
GS03	**78**	**2.37**	**4.48**	**7.64**
GS05	NA	NA	NA	NA
GS08	**118**	**1.83**	**3.09**	**9.88**
GS10	**266**	**4.48**	**7.15**	**20.5**
GS11	**89**	**3.00**	**4.29**	**5.62**
GS13	68	11.7	17.2	33.0
GS31	**26**	**3.48**	**4.22**	**6.27**
GS51	26	1.56	2.85	4.08
GS59	31	0.93	1.74	4.66
PLFSYSEFF	NA	NA	NA	NA
SW027	**71**	**2.06**	**4.47**	**8.70**
SW093	**284**	**3.99**	**6.35**	**11.1**

Notes: NA = Analyte not sampled
Bold type = POC or POE

Table 3–46. Post-Closure Summary Statistics for Total U Analytical Results (October 13, 2005−December 31, 2009)

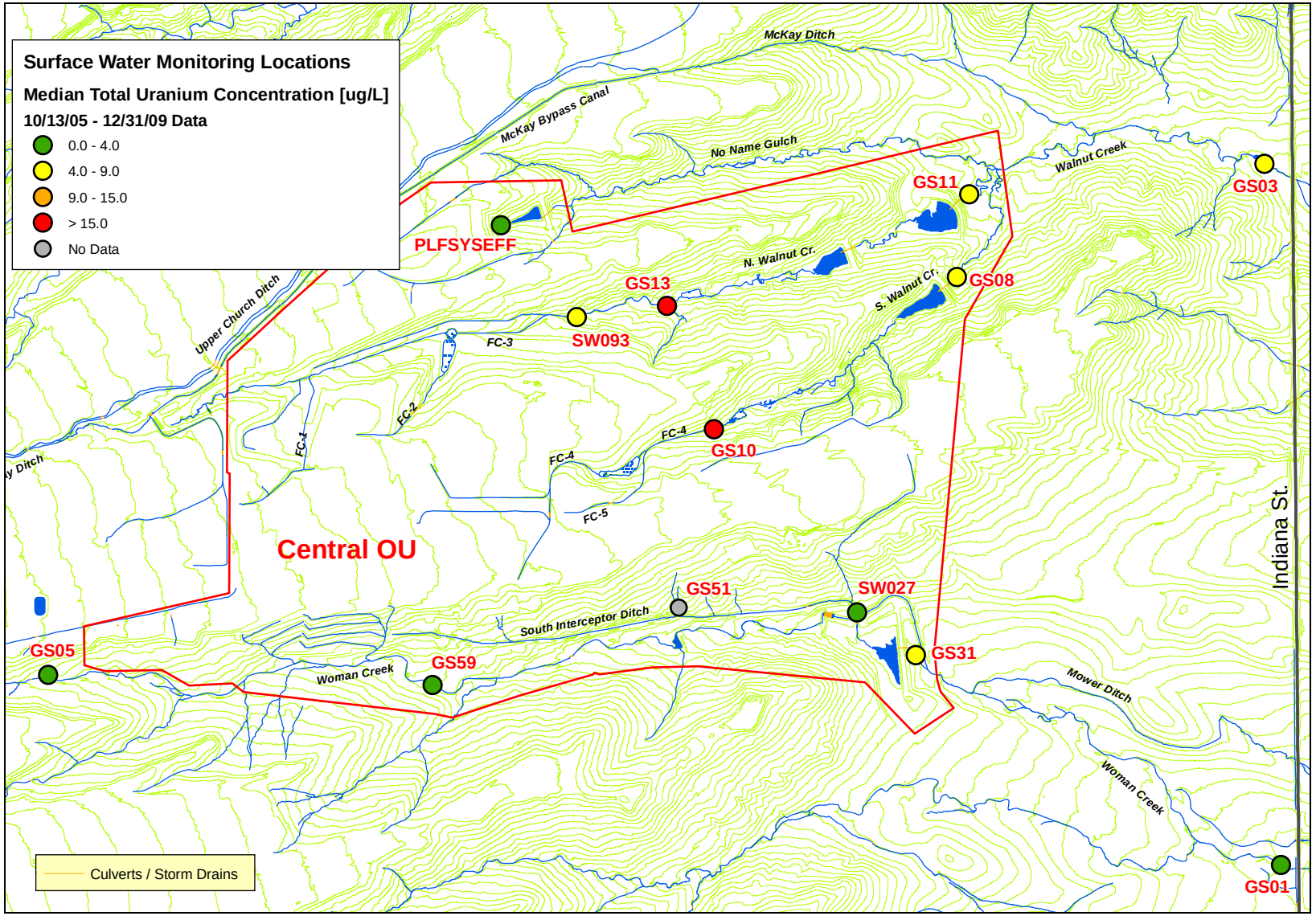
Location	Samples (N)	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
GS01	**59**	**3.71**	**6.43**	**9.09**
GS03	**36**	**5.52**	**7.87**	**9.15**
GS05	34	0.81	1.51	4.67
GS08	**16**	**7.48**	**14.1**	**15.1**
GS10	**70**	**16.6**	**24.1**	**41.9**
GS11	**20**	**6.15**	**6.61**	**7.22**
GS13	52	24.3	51.1	63.6
GS31	**4**	**5.15**	**5.49**	**5.66**
GS51	NA	NA	NA	NA
GS59	33	1.18	2.16	7.01
PLFSYSEFF	17	2.03	7.24	11.8
SW027	**4**	**2.71**	**3.10**	**3.36**
SW093	**65**	**8.11**	**11.9**	**23.4**

Notes: NA = Analyte not sampled
Bold type = POC or POE



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

Figure 3–114. Median Total U Activities for CY 1997–October 13, 2005



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

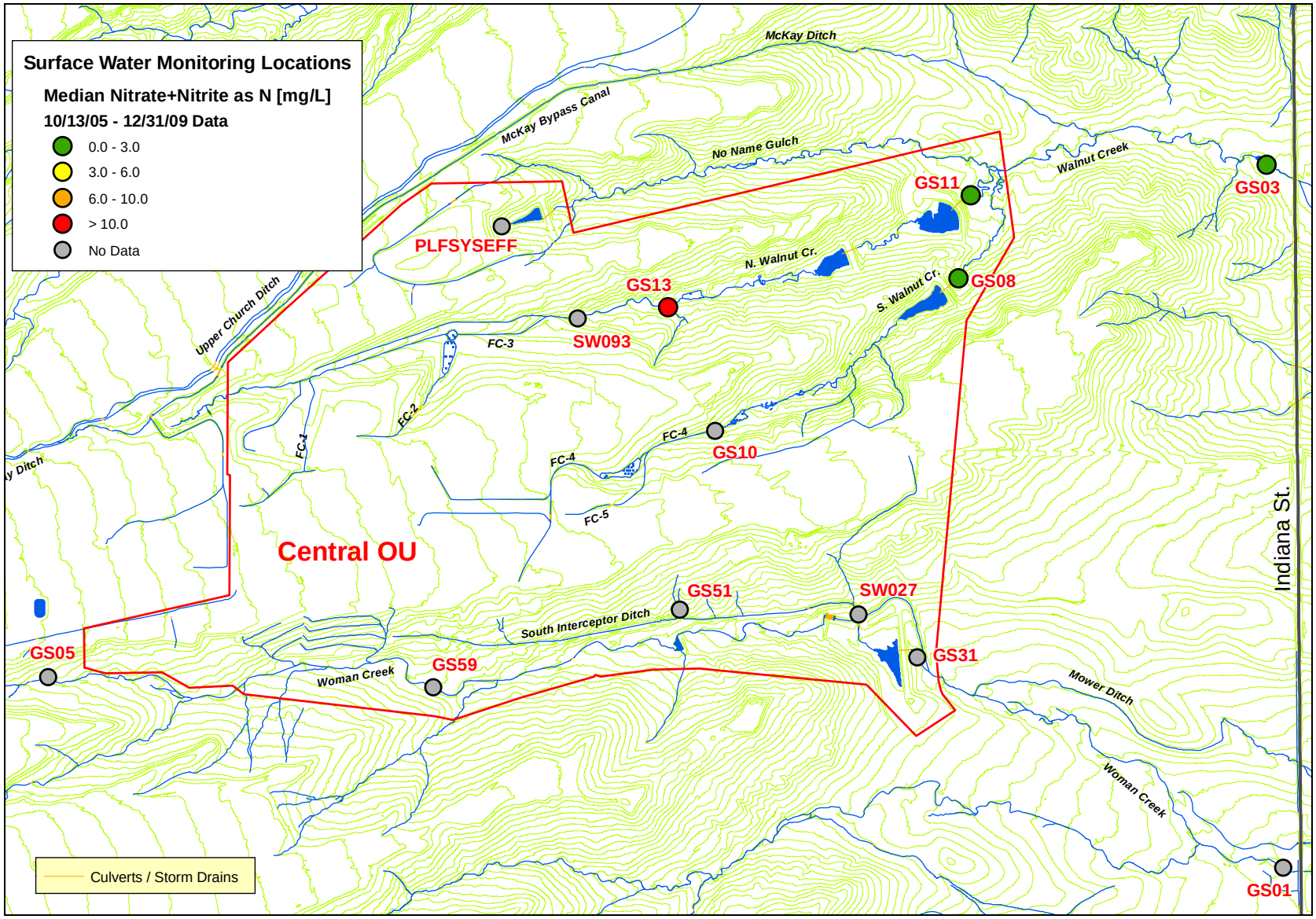
Figure 3–115. Post-Closure Median Total U Activities

Table 3–47 and Figure 3–116 show that post-closure median nitrate concentrations for most locations are below the standard of 10 mg/L (a temporary modification [TM] of 100 mg/L is in effect for Walnut Creek above Ponds A-4 and B-5). Location GS13 clearly shows the effects of groundwater associated with the SPPTS.

Table 3–47. Post-Closure Summary Statistics for Nitrate+Nitrite as Nitrogen Analytical Results (October 13, 2005−December 31, 2009)

Location	Samples (N)	Median (mg/L)	85th Percentile (mg/L)	Maximum (mg/L)
GS03	**24**	**0.14**	**3.43**	**5.10**
GS08	**16**	**0.02**	**0.64**	**0.73**
GS11	**20**	**0.62**	**5.68**	**6.26**
GS13	31	38	74	100

Notes: Bold type = POC or POE



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

Figure 3–116. Post-Closure Median Nitrate+Nitrite as Nitrogen Concentrations

Table 3–48 and Table 3–49 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. Figure 3–117 and Figure 3–118 present pre- and post-closure average Am/Pu ratios, respectively.

Table 3–48. Average Pu/Am Ratios for Analytical Results in CY 1997−October 13, 2005

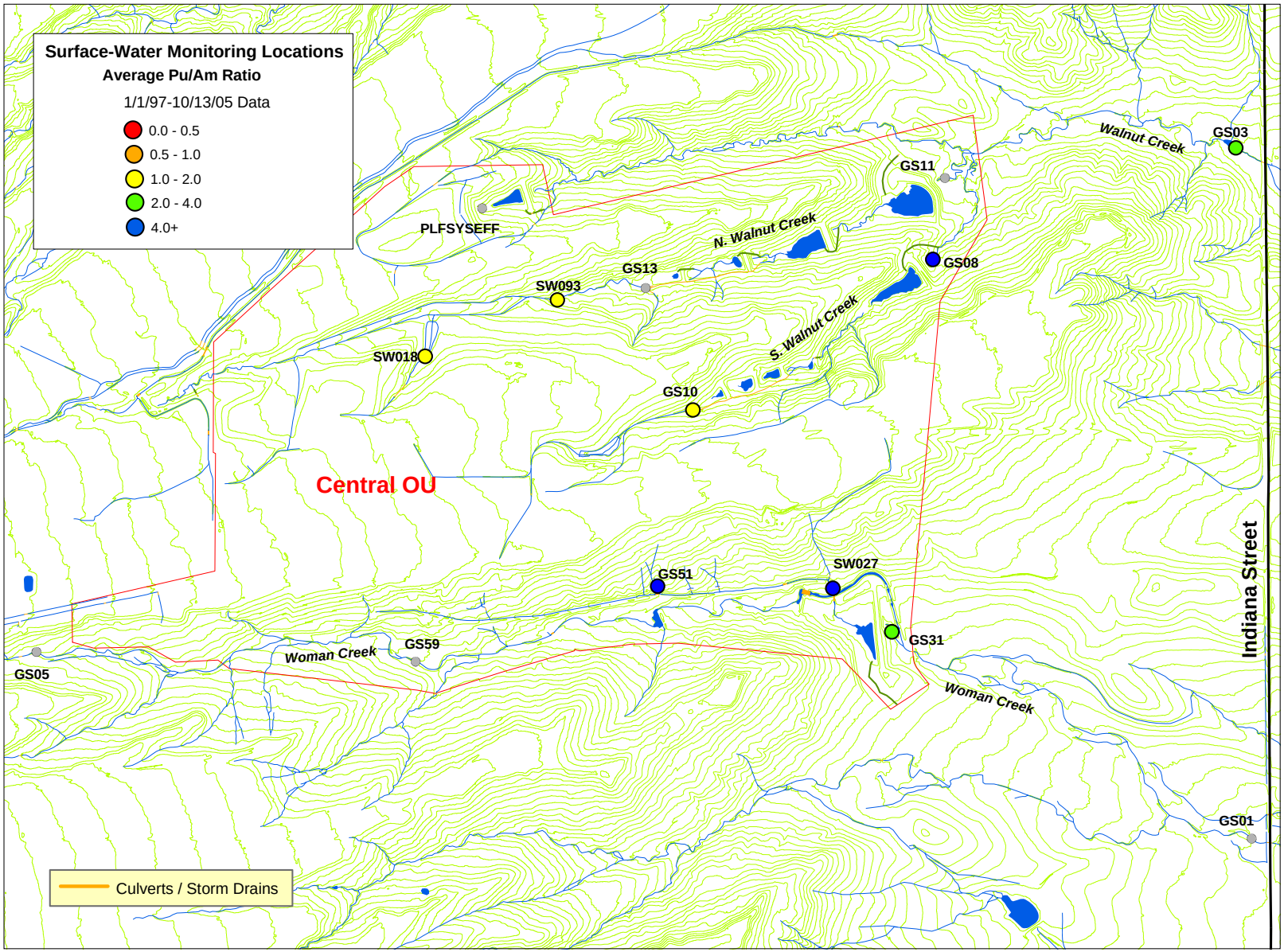
Location	Samples (N)[a]	Average Pu/Am Ratio
GS01	**1**	**1.5**
GS03	**14**	**2.1**
GS05	NA	NA
GS08	**5**	**8.9**
GS10	**196**	**1.3**
GS11	*	*
GS13	NA	NA
GS31	**4**	**3.9**
GS51	24	4.6
GS59	*	*
PLFSYSEFF	NA	NA
SW027	**26**	**4.9**
SW093	**95**	**1.8**

[a]Number of samples where both Pu and Am were greater than 0.015 pCi/L
*No results greater than 0.015 pCi/L
Bold type = POC or POE
NA = Analyte not sampled

Table 3–49. Post-Closure Average Pu/Am Ratios for Analytical Results (October 13, 2005−December 31, 2009)

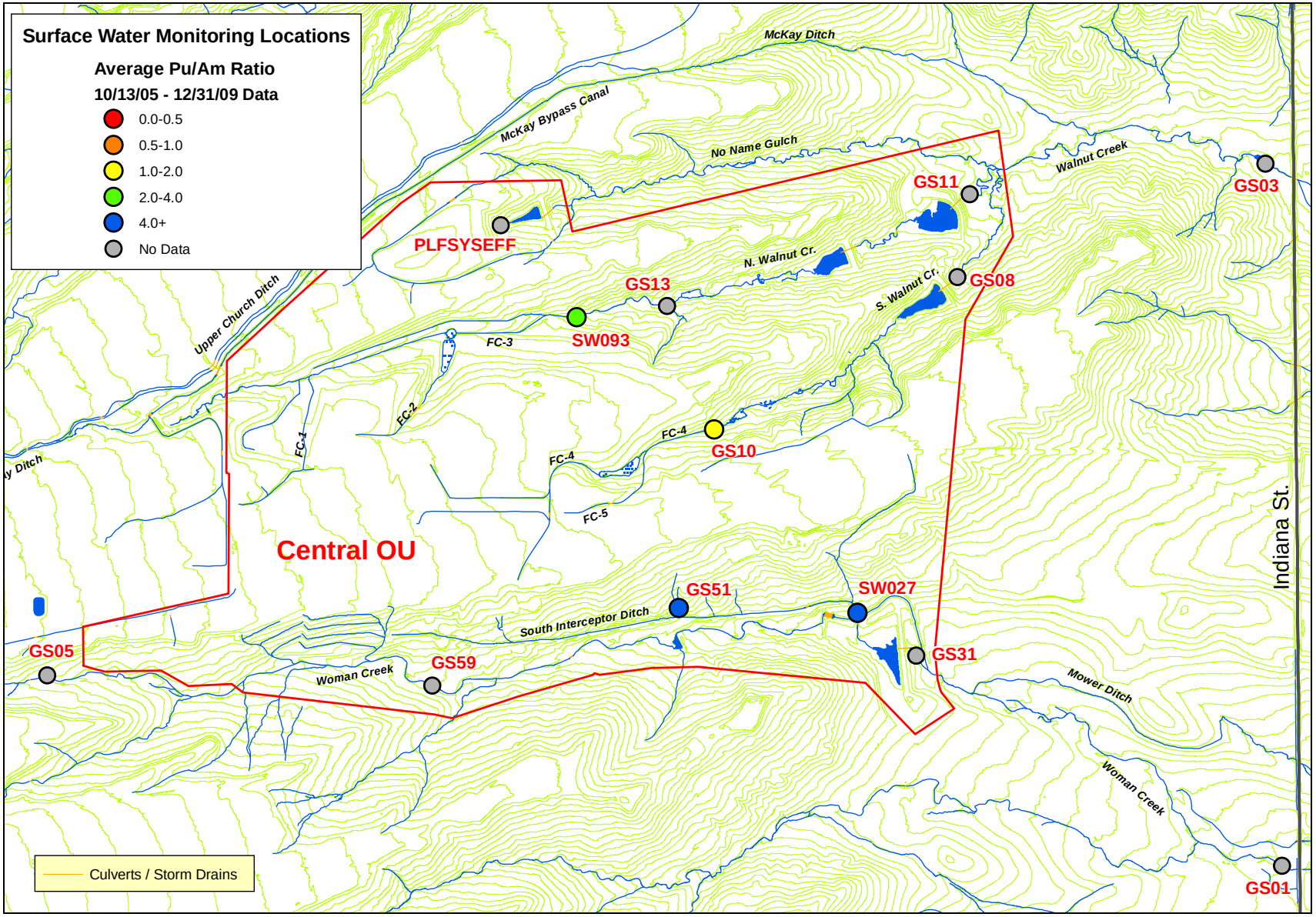
Location	Samples (N)[a]	Average Pu/Am Ratio
GS01	*	*
GS03	*	*
GS05	NA	NA
GS08	*	*
GS10	**15**	**1.2**
GS11	*	*
GS13	NA	NA
GS31	*	*
GS51	9	5.1
GS59	NA	NA
PLFSYSEFF	NA	NA
SW027	**3**	**4.8**
SW093	**12**	**2.1**

[a]Number of samples where both Pu and Am were greater than 0.015 pCi/L
*No results greater than 0.015 pCi/L
Bold type = POC or POE
NA = Analyte not sampled



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

Figure 3–117. Average Pu/Am Ratios for CY 1997–October 13, 2005



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

Figure 3–118. Post-Closure Average Pu/Am Ratios

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, activities, 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 calculation purposes. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the "real" value and the "duplicate."[24] 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 3–50, Table 3–51, Table 3–52, Table 3–53, Table 3–54, and Table 3–55 present summary statistics for the POE metals. All three POEs generally show reduced metals concentrations post-closure.

Table 3–50. Summary Statistics for POE Metals Results from GS10 in CY 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

Table 3–51. Post-Closure Summary Statistics for POE Metals Results from GS10 (October 13, 2005−December 31, 2009)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	70	100%	0.50	0.50	0.50
Dissolved Cd	70	90.0%	0.06	0.06	0.34
Total Cr	70	80.0%	0.50	1.62	7.10
Dissolved Ag	70	98.6%	0.10	0.10	0.20

Table 3–52. Summary Statistics for POE Metals Results from SW027 in CY 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

[24] Arithmetic averaging of metal pairs is performed only when the 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.

Table 3–53. Post-Closure Summary Statistics for POE Metals Results from SW027 (October 13, 2005−December 31, 2009)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	4	4	0.50	0.50	0.50
Dissolved Cd	4	4	0.06	0.06	0.06
Total Cr	4	3	1.00	1.63	2.15
Dissolved Ag	4	4	0.10	0.10	0.10

Notes: NA = not applicable

Table 3–54. Summary Statistics for POE Metals Results from SW093 in CY 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 3–55. Post-Closure Summary Statistics for POE Metals Results from SW093 (October 13, 2005−December 31, 2009)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	65	100.0%	0.50	0.50	0.50
Dissolved Cd	65	89.2%	0.06	0.06	0.24
Total Cr	65	63.1%	1.00	2.48	25.7
Dissolved Ag	65	100.0%	0.10	0.10	0.10

3.1.4.2 Surface-Water Loading Analysis

This section provides a summary of radionuclide loads (Am, Pu, and total U) for RFCA POEs and POCs. These locations 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.

This loading analysis should not be confused with demonstration of compliance at POCs and POEs. Compliance is demonstrated based on water activity or concentration (in 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 successful demonstration of compliance, can be used to support conclusions regarding the 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 (pCi). The total pCi value is then converted to micrograms (μg) using the conversion factors in Table 3–56.[25] A detailed description of the method for load estimation is given in Appendix B.[26]

Table 3–56. Activity to Mass Conversion Factors for Pu, Am, and U Isotopes

Analyte	Mass/Activity (g/Ci)
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

Note: Starting on 4/1/09, uranium was analyzed as total uranium in μg/L.

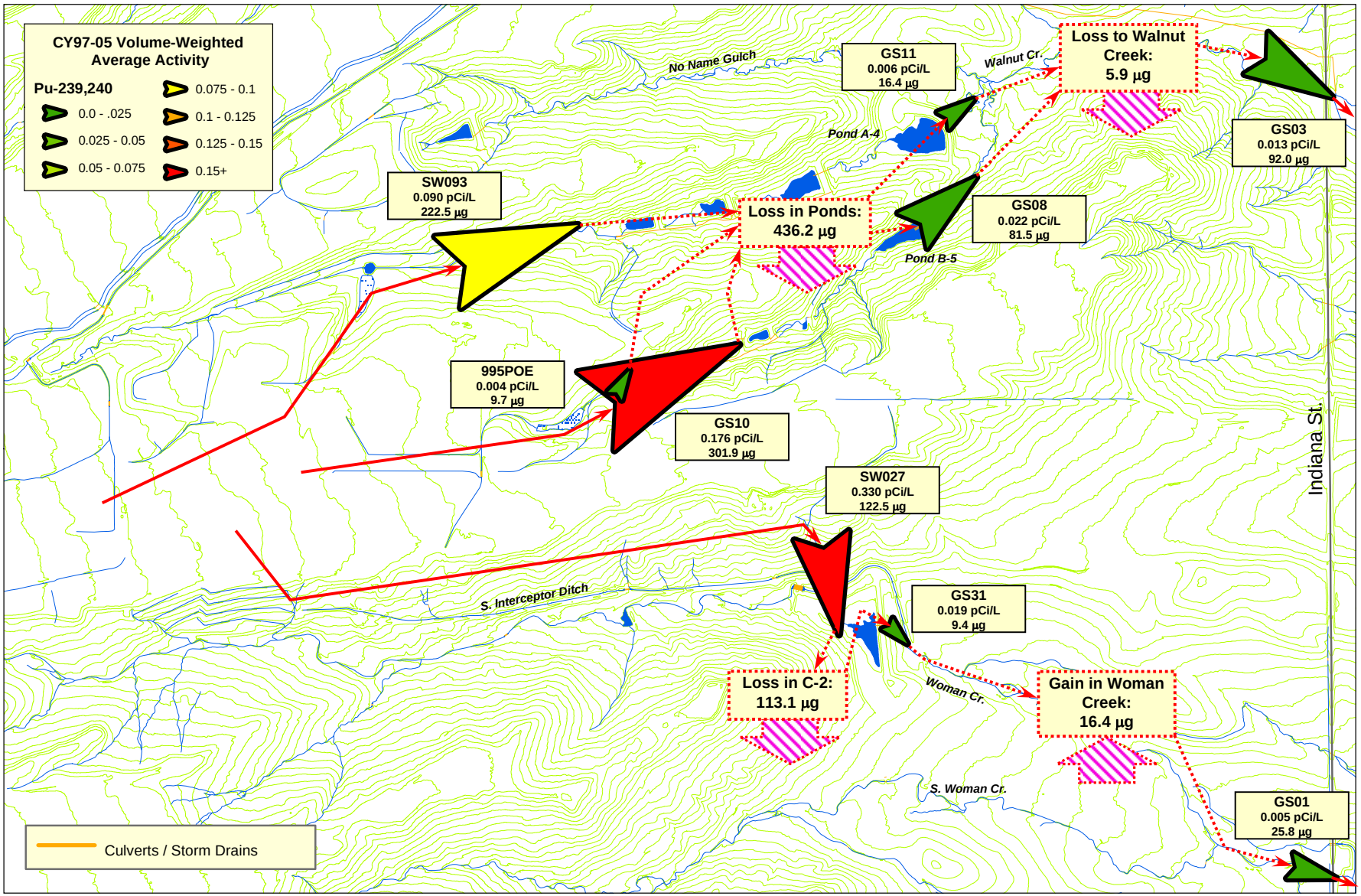
The Pu-239,240 conversion factor was derived from Table 2.7.2-2 in the April 1980 *Final Environmental Impact Statement (Final Statement to ERDA 1545-D)*, Rocky Flats Plant Site. The conversion factors for Am-241, U-233,234, U-235, and U-238 were taken from Title 40 *Code of Federal Regulations* Part 302.4 (40 CFR 302.4), Appendix B, October 7, 2000.[27]

Site and Refuge Area

This section summarizes the calculated overall Pu and Am loads for selected locations. Total U data collection began at GS01 and GS03 just prior to CY 2003; as such only CY 2003−2009 data are shown. The following points are noted:

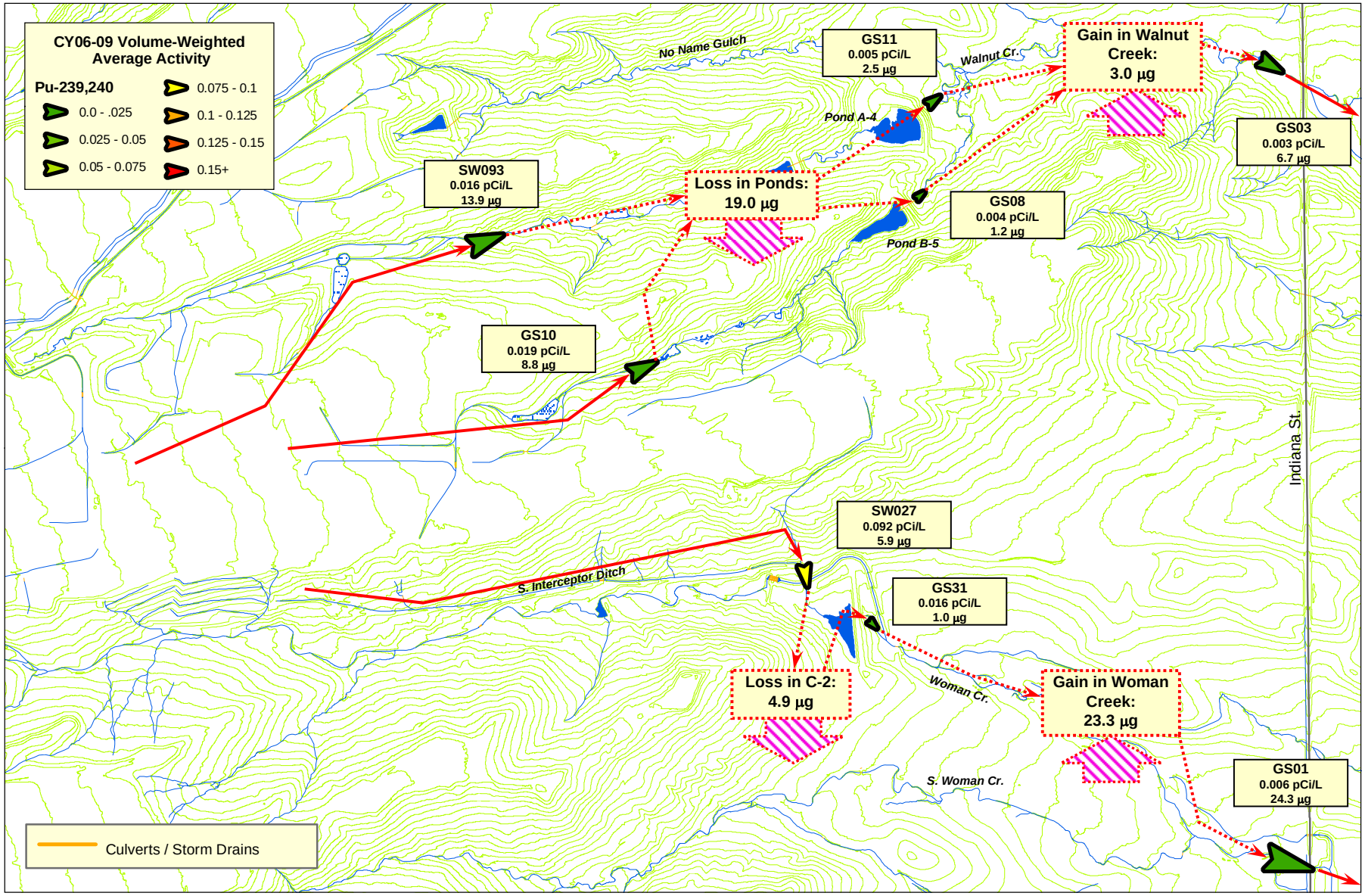
- Figure 3–119, Figure 3–120, Figure 3–121, and Figure 3–122 show a significant reduction in average annual Pu and Am load and activity from the COU, the terminal ponds, and Walnut Creek at Indiana Street post-closure. The load reductions are generally an order of magnitude for all Walnut Creek locations affected directly by the former IA. For lower Woman Creek (GS01), however, loads and activities are not reduced to the same extent. This is likely due to transport of diffuse, low-level contamination in the much larger flow volumes measured at GS01, a location not significantly affected by the former IA. It should be noted that GS01 post-closure volume-weighted average Pu and Am activities of 0.006 and 0.003 pCi/L, respectively, are significantly below the standard of 0.15 pCi/L for each analyte.
- For both Pu and Am, remedial actions, removal of impervious surfaces (reducing runoff), revegetation, and erosion control efforts have significantly improved water quality.
- Figure 3–123 and Figure 3–124 show a measurable increase in average annual total U concentration in Walnut Creek post-closure. This increase is likely 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 resulted in decreased total U loads in Walnut Creek. For lower Woman Creek (GS01), however, loads and activities have changed to a lesser extent. 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.

[25] In the following tables and plots, values are rounded for presentation.
[26] Data are generally presented at varying precision for presentation. Accuracy should not be inferred; both analytical and flow measurement error have not been quantified in this report.
[27] The U-234 conversion factor was used to represent U-233,234 due to the small relative abundance of U-233.



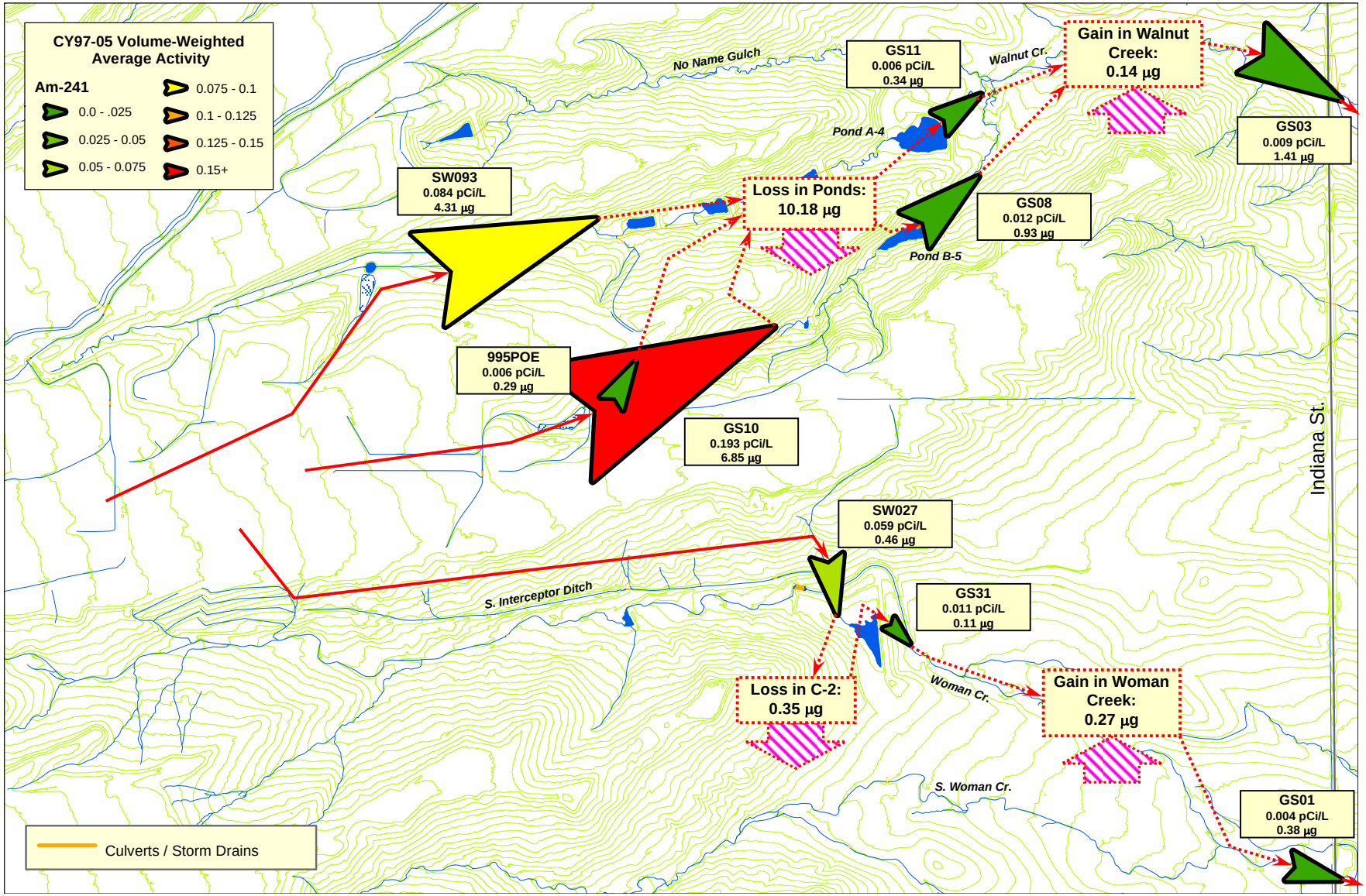
Note: Location symbols are displayed proportional to calculated average annual load and colored according to activity ranges in legend.

Figure 3–119. Relative Average Annual Pu Loading Schematic: CY 1997−2005



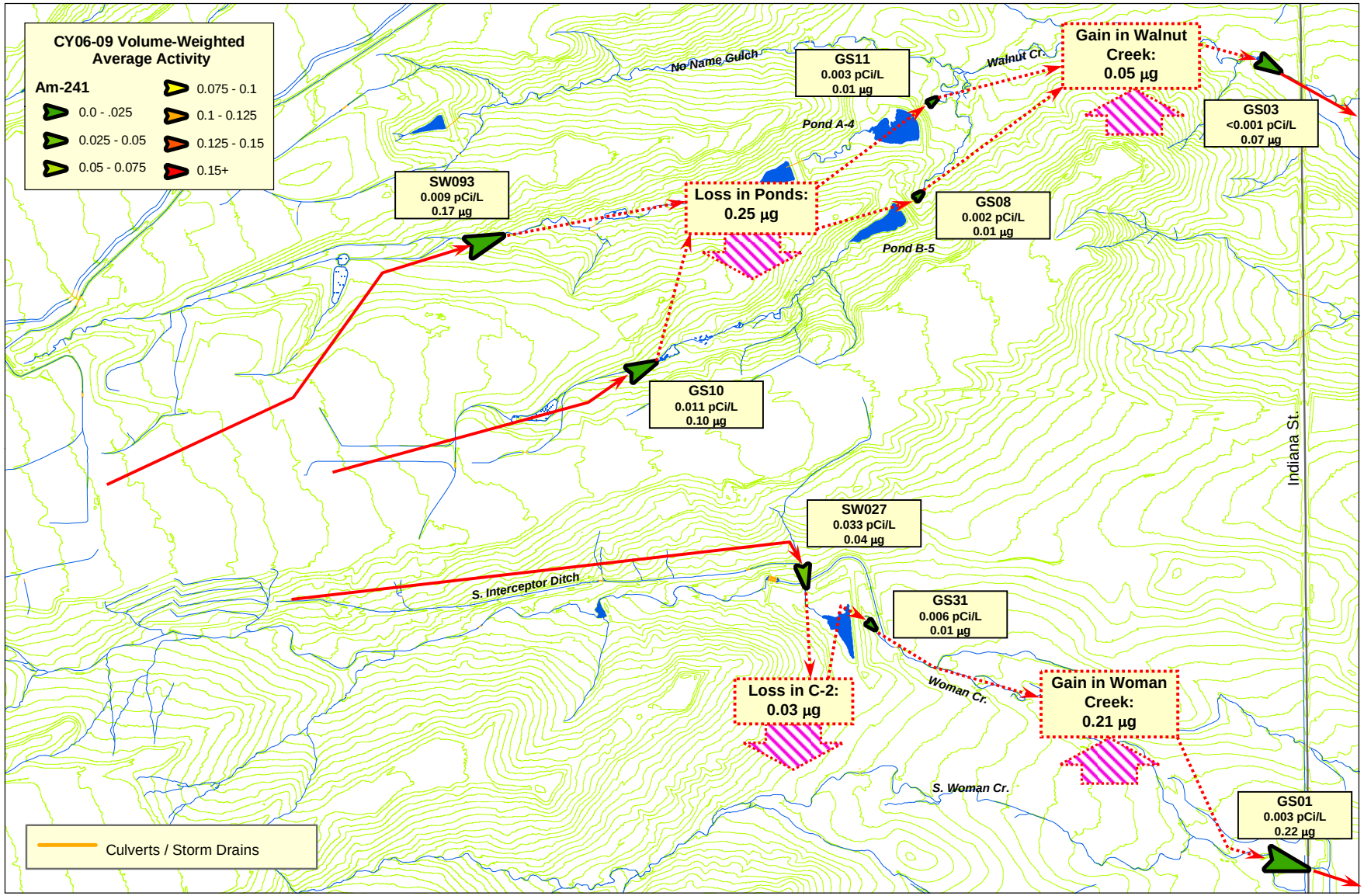
Note: Location symbols are displayed proportional to calculated average annual load and colored according to activity ranges in legend.

Figure 3–120. Relative Average Annual Pu Loading Schematic: CY 2006−2009



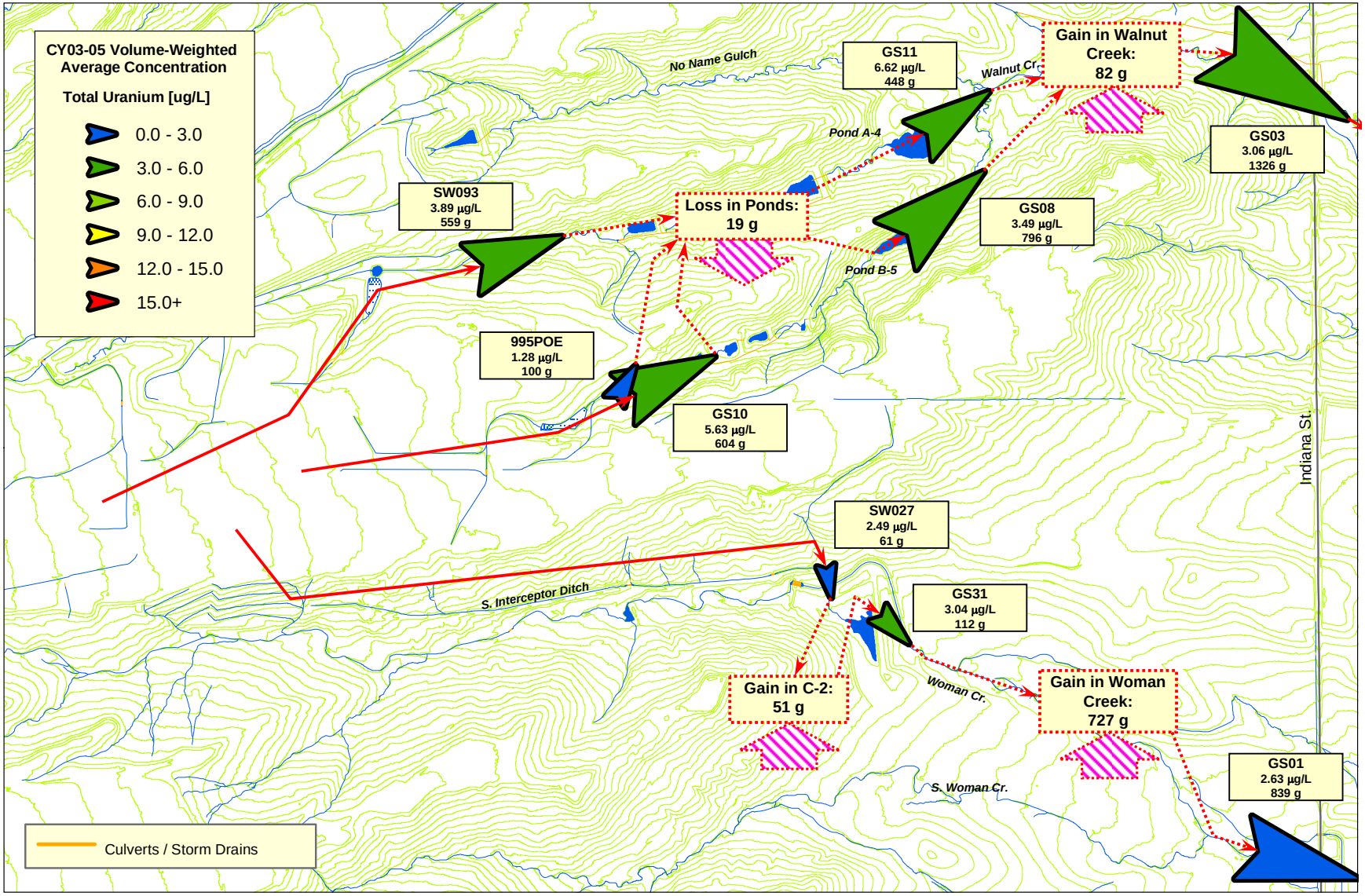
Note: Location symbols are displayed proportional to calculated average annual load and colored according to activity ranges in legend.

Figure 3–121. Relative Average Annual Am Loading Schematic: CY 1997−2005



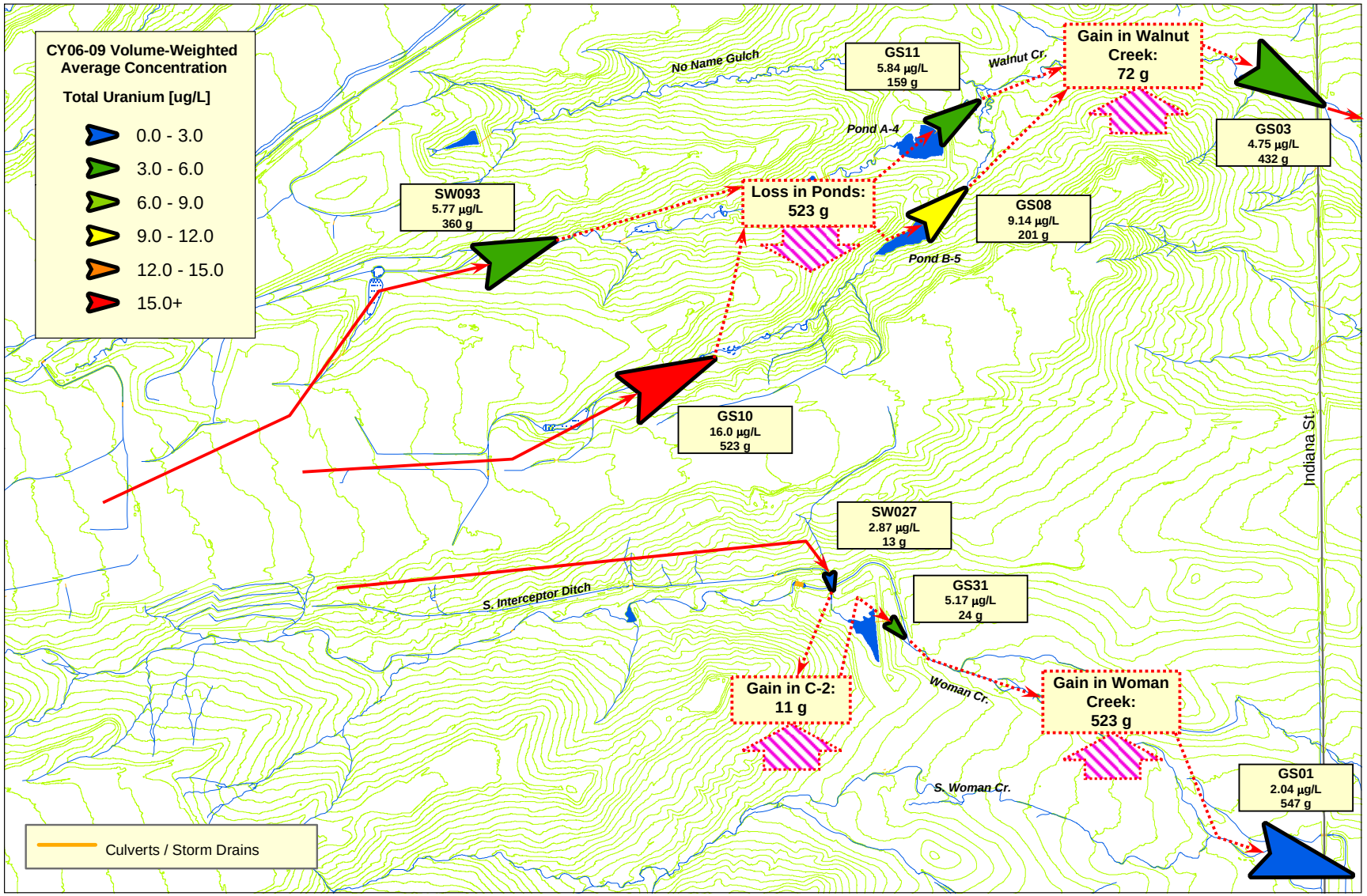
Note: Location symbols are displayed proportional to calculated average annual load and colored according to activity ranges in legend.

Figure 3–122. Relative Average Annual Am Loading Schematic: CY 2006−2009



Note: Location symbols are displayed proportional to calculated average annual load and colored according to concentration ranges in legend.

Figure 3–123. Relative Average Annual Total U Loading Schematic: CY 2003−2005



Note: Location symbols are displayed proportional to calculated average annual load and colored according to concentration ranges in legend.

Figure 3–124. Relative Average Annual Total U Loading Schematic: CY 2006−2009

Indiana Street POCs

This section summarizes the calculated Pu and Am loads from Walnut and Woman Creeks at Indiana Street. Figure 3–125, Figure 3–126, Figure 3–127, Figure 3–128, Figure 3–129, Figure 3–130, and Figure 3–131, as well as Table 3–57 and Table 3–58 present the load data. The following points are noted:

- Walnut Creek accounts for nearly 80 percent of both the Pu (Figure 3–127) and Am (Figure 3–129) loads at Indiana Street pre-closure. However, post-closure these proportions are reversed due to the reduction in runoff and transport due to the effectiveness of remedial actions, revegetation, and erosion control measures.
- 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 3–125).
- Figure 3–126 and Figure 3–128 show a significant post-closure reduction in both Pu and Am loads in Walnut Creek at Indiana Street.
- The somewhat higher CY 2007 Pu and Am loads in Woman Creek at Indiana Street (Figure 3–126 and Figure 3–128) can be attributed to high flow volumes at GS01.[28] Post-closure average annual volume-weighted Pu and Am activities at GS01 are 0.006 and 0.003 pCi/L, respectively.
- Walnut Creek accounts for 61 percent of the pre-closure and 44 percent of the post-closure U loads at Indiana Street (Figure 3–131). Although U concentration has increased in Walnut Creek post-closure, reduced flow volumes have resulted in decreased loads comparable to pre-closure loads.

[28] 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.

Table 3–57. Off-Site Pu and Am Loads from Walnut and Woman Creeks: CY 1997–2009

Calendar Year	Pu-239,240 (µg)			Am-241 (µg)		
	Walnut Creek	Woman Creek	Total	Walnut Creek	Woman Creek	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
Total	854.4	329.5	1,183.9	12.95	4.29	17.24

Note: 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.

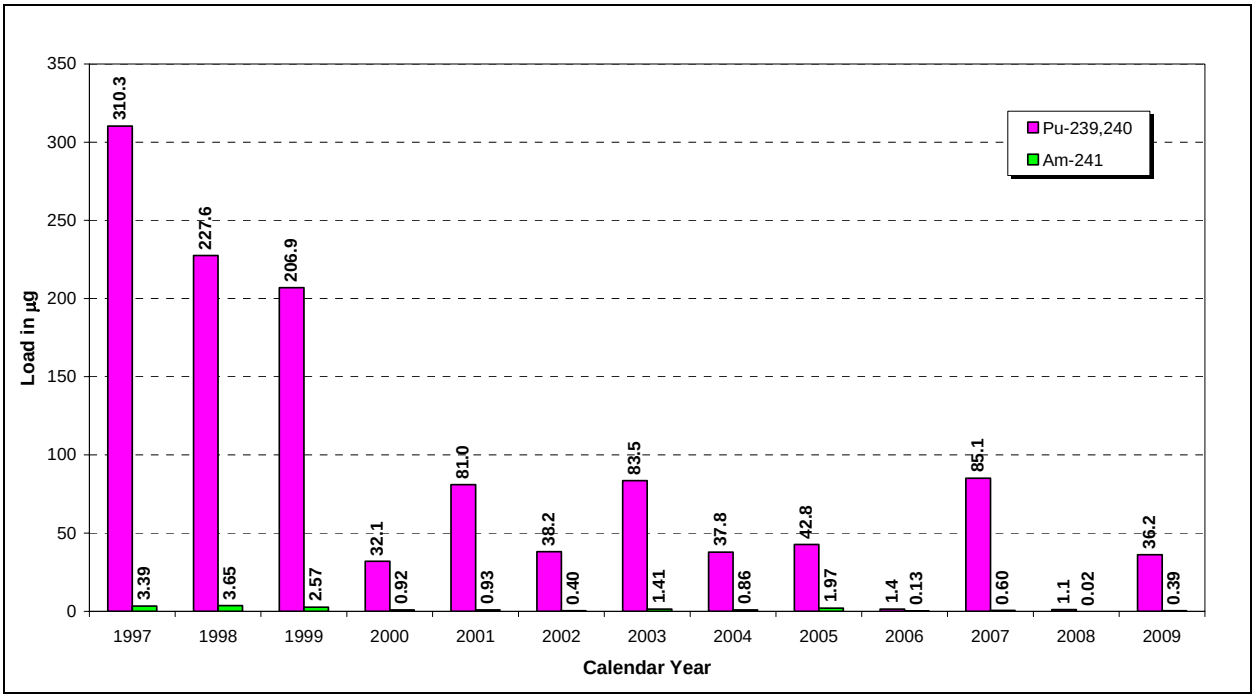


Figure 3–125. Combined Annual Pu and Am Loads from Walnut and Woman Creeks: CY 1997–2009

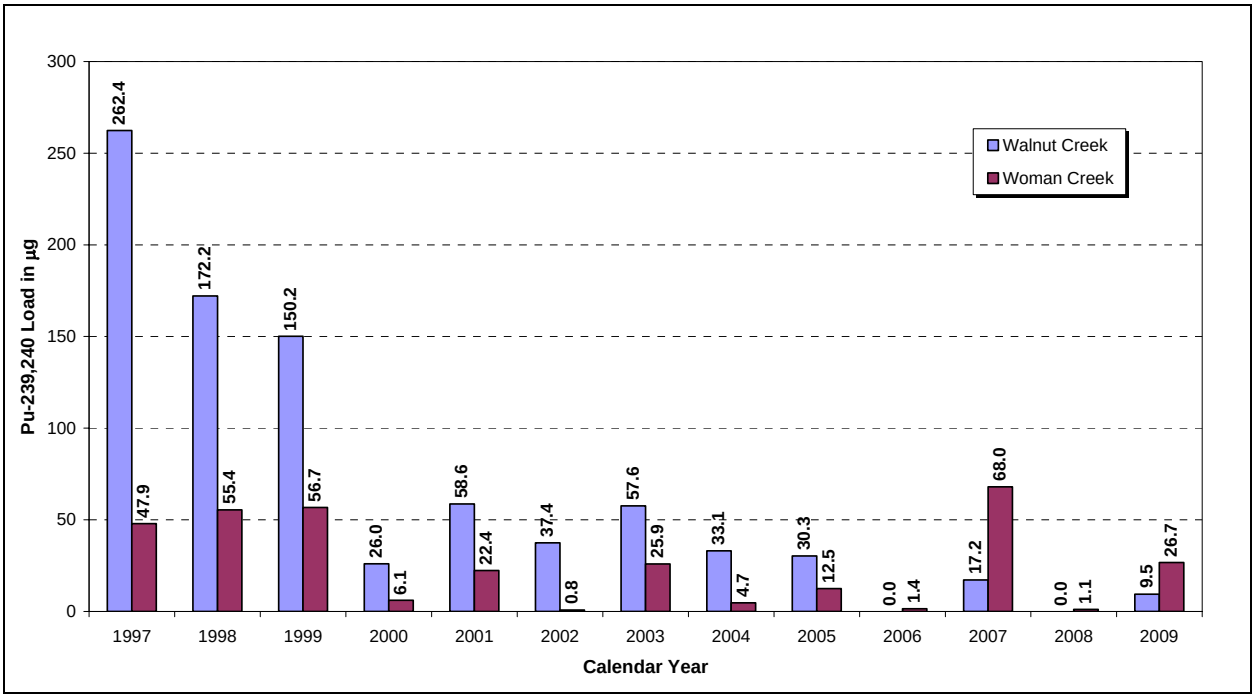


Figure 3–126. Annual Pu Loads from Walnut and Woman Creeks: CY 1997–2009

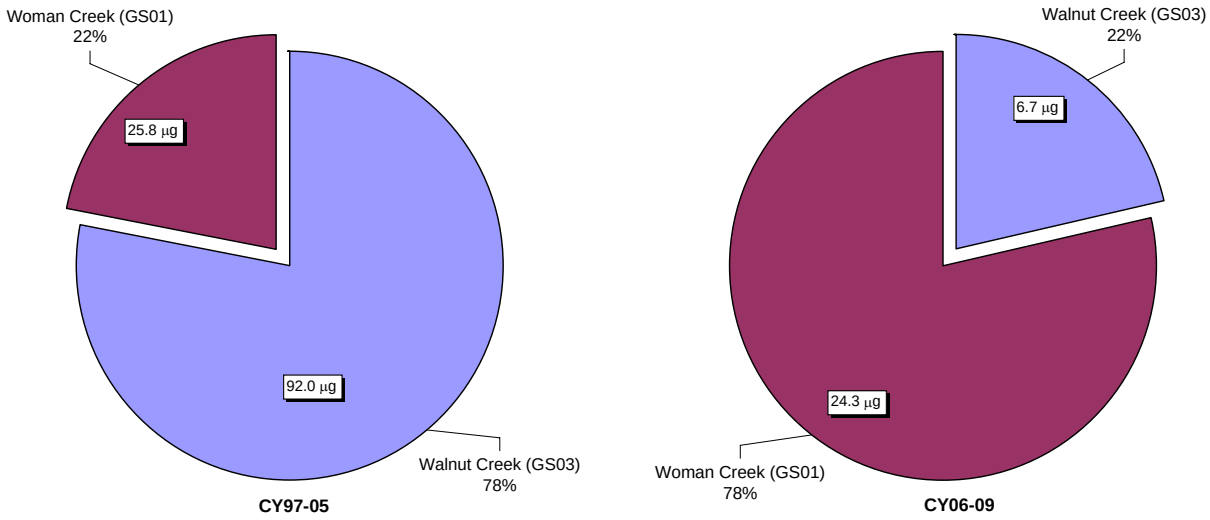


Figure 3–127. Relative Average Annual Pu Load Totals from Walnut and Woman Creeks

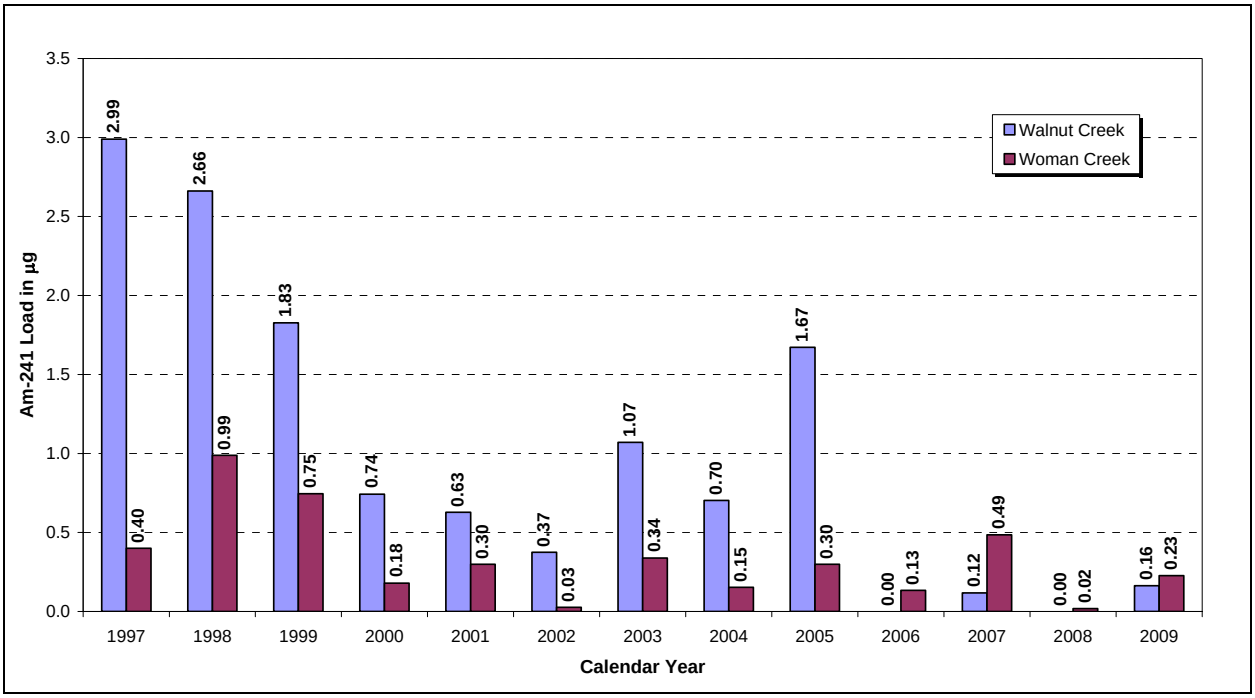


Figure 3–128. Annual Am Loads from Walnut and Woman Creeks: CY 1997–2009

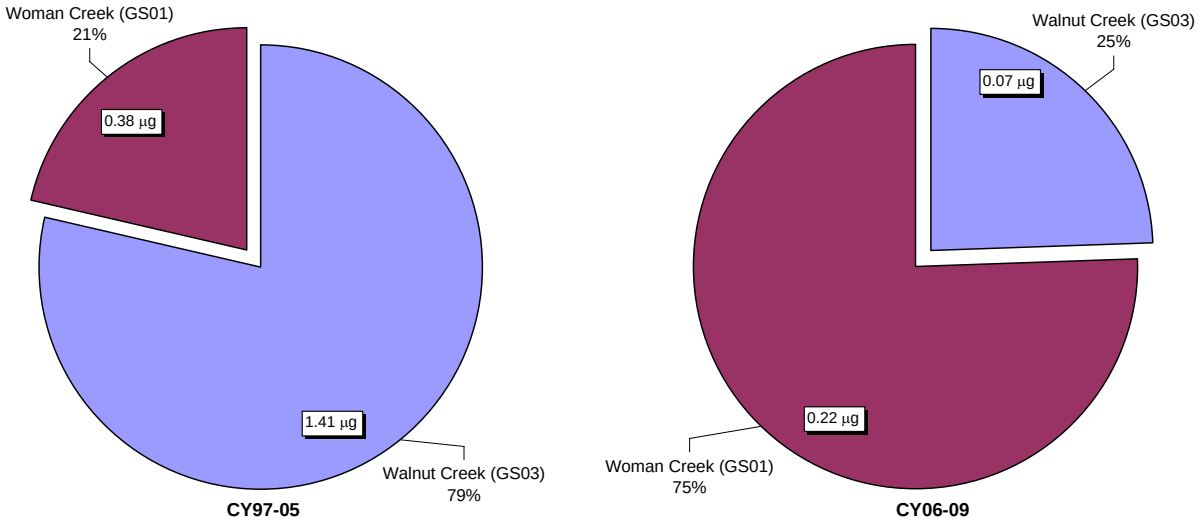


Figure 3–129. Relative Average Annual Am Load Totals from Walnut and Woman Creeks

Table 3–58. Total U Loads from Walnut and Woman Creeks: CY 2003−2009

Calendar Year	Total U (g)		
	Walnut Creek	Woman Creek	Total
2003	1,751	790	2,541
2004	744	808	1,551
2005	1,482	918	2,400
2006	0; No flow	235	235
2007	1,005	1,016	2,021
2008	0; No flow	174	174
2009	725	761	1,486
Total	5,706	4,702	10,408

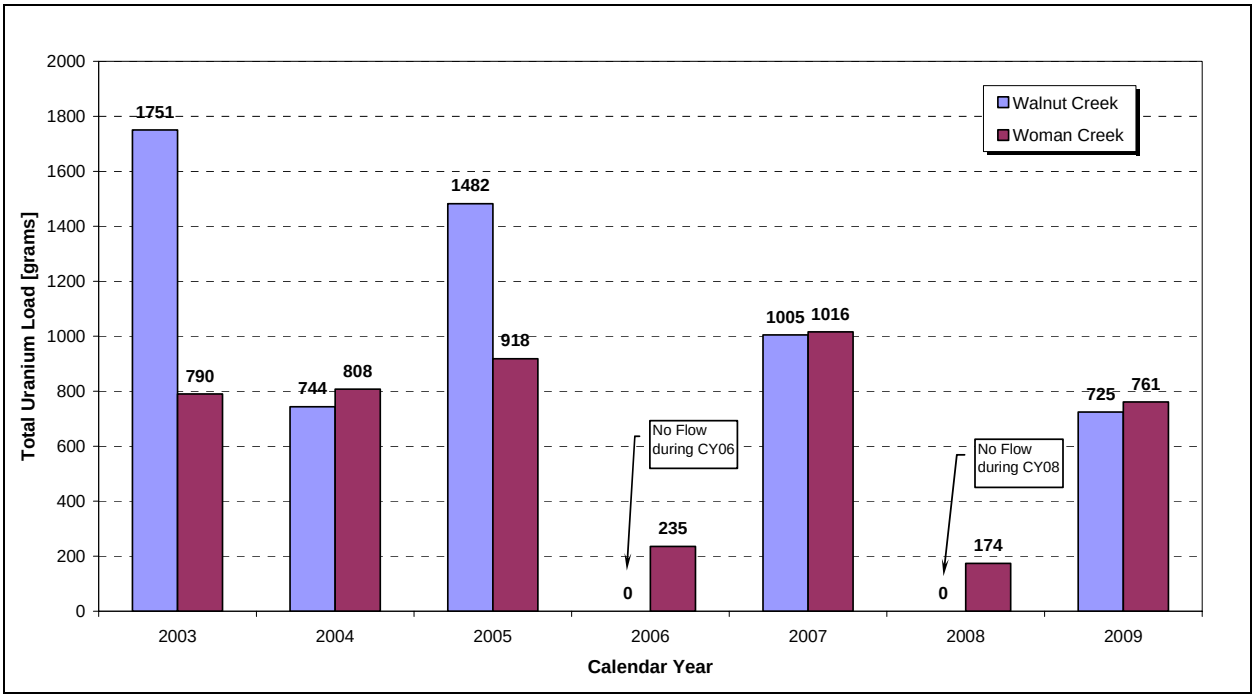


Figure 3–130. Annual Total U Loads from Walnut and Woman Creeks: CY 2003–2009

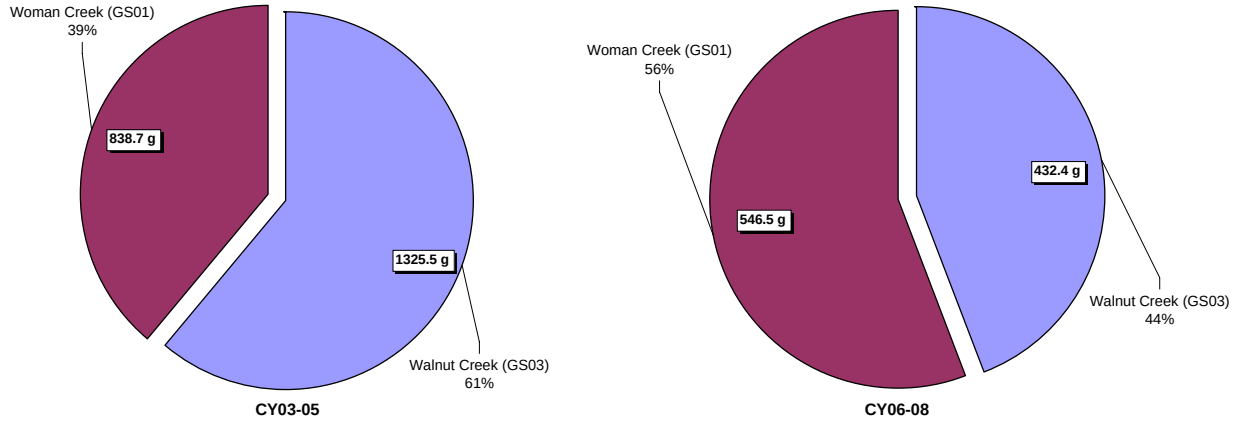


Figure 3–131. Relative Average Annual Total U Load Totals from Walnut and Woman Creeks

Lower Walnut Creek

This section summarizes the calculated Pu and Am loads in Walnut Creek at GS03 (Walnut Creek at Indiana Street), GS08 (Pond B-5 outlet), and GS11 (Pond A-4 outlet). The data are presented in Table 3–59, Table 3–60, and Table 3–61 and are depicted on Figure 3–132, Figure 3–133, Figure 3–134, Figure 3–135, Figure 3–136, Figure 3–137, and Figure 3–138. Total U data collection at GS03 began on November 5, 2002; thus, only CY 2003−2009 data are shown. The following points are noted:

- Annual Pu and Am loads vary by up to two orders of magnitude year to year (Figure 3–133 and Figure 3–135). The significant annual variability in Pu and Am loads is likely due to water-quality variation during active closure and the very low measured activities with the inherent analytical error at such low levels.
- Pu and Am loads are generally decreasing at GS03 (Figure 3–132). 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 (D&D) 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 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 3–135).
- Annual Pu and Am loads for all locations have been reduced significantly post-closure (Figure 3–133 and Figure 3–135) due to the reduction in runoff and sediment transport resulting from the effectiveness of remedial actions, revegetation, and erosion control measures.
- Pre-closure Pu and Am loads from Pond B-5 are significantly greater than loads from Pond A-4 (Table 3–59 and Table 3–60), a result of both higher activities and larger discharge volumes.

- Total Pu loads from Ponds A-4 and B-5 for the entire period of 1997 through 2009 are marginally greater than the loads at GS03 (Table 3–59), indicating a small net loss of load to the Walnut Creek streambed below Ponds A-4 and B-5.
- Total Am loads from Ponds A-4 and B-5 for the entire period of 1997 through 2009 are marginally less than the loads at GS03 (Table 3–60), indicating a small net gain of load from tributaries and the Walnut Creek streambed below Ponds A-4 and B-5.
- Total U loads from Ponds A-4 and B-5 are slightly less than the loads at GS03 (Figure 3–138), indicating a small net gain of load from tributaries and seeps in Walnut Creek below Ponds A-4 and B-5.

Table 3–59. Pu Loads at GS03, GS08, and GS11: CY 1997–2009

Calendar Year	Pu-239,240 (µg)			
	Pond A-4 (GS11)	Pond B-5 (GS08)	Walnut Creek Terminal Ponds Total	POC GS03
1997	59.2	8.8	68.0	262.4
1998	20.0	22.4	42.4	172.2
1999	23.8	261.4	285.2	150.2
2000	28.4	244.6	273.0	26.0
2001	4.7	32.3	37.0	58.6
2002	0.1	7.8	7.9	37.4
2003	7.3	111.5	118.8	57.6
2004	2.2	27.1	29.3	33.1
2005	2.2	17.9	20.1	30.3
2006	0.0; No A-4 discharge	0.0; No B-5 discharge	0.0	0.0 No flow
2007	7.8	1.9	9.6	17.2
2008	0.0; No A-4 discharge	0.0; No B-5 discharge	0.0	0.0 No flow
2009	2.1	3.0	5.1	9.5
Total	157.8	738.7	896.5	854.4

Table 3–60. Am Loads at GS03, GS08, and GS11: CY 1997–2009

Calendar Year	Am-241 (µg)			
	Pond A-4 (GS11)	Pond B-5 (GS08)	Walnut Creek Terminal Ponds Total	POC GS03
1997	0.70	0.25	0.95	2.99
1998	1.25	0.35	1.60	2.66
1999	0.20	1.81	2.01	1.83
2000	0.02	3.14	3.16	0.74
2001	0.11	0.46	0.57	0.63
2002	0.04	0.25	0.29	0.37
2003	0.18	0.54	0.72	1.07
2004	0.14	0.58	0.73	0.70
2005	0.43	0.97	1.39	1.67
2006	0.0 No A-4 discharge	0.0; No B-5 discharge	0.00	0.0 No flow
2007	0.02	0.03	0.05	0.12
2008	0.0 No A-4 discharge	0.0; No B-5 discharge	0.00	0.0 No flow
2009	0.03	0.02	0.05	0.16
Total	3.13	8.40	11.53	12.95

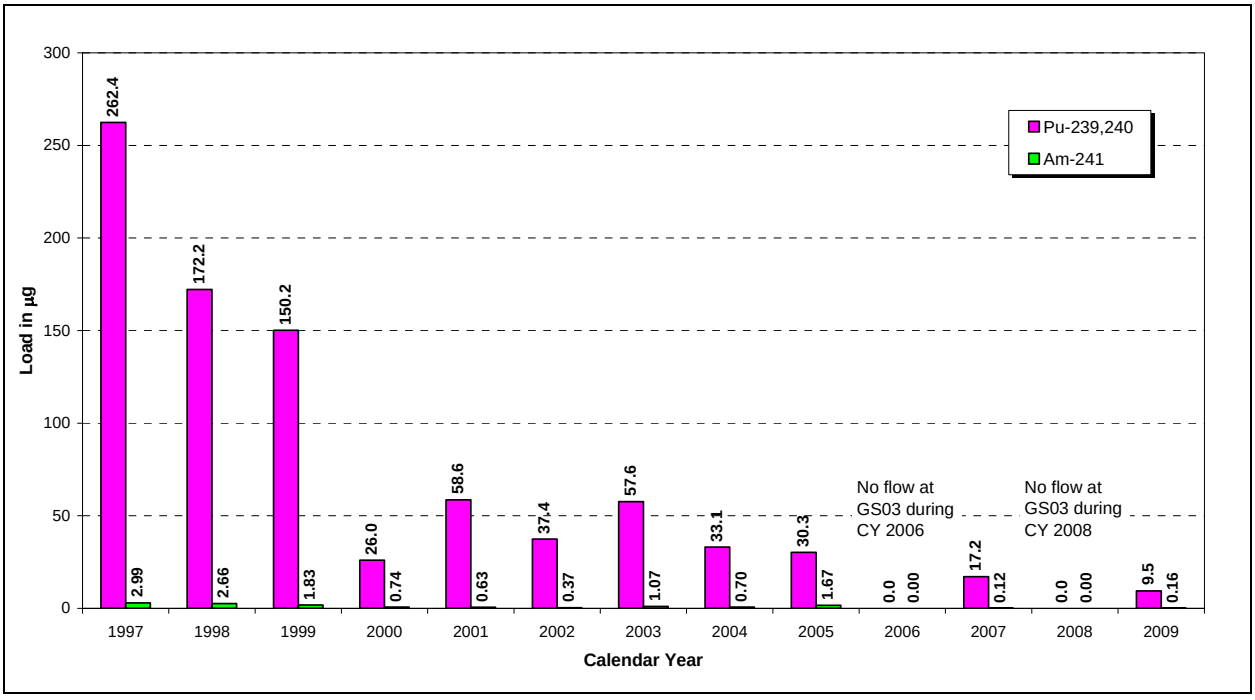


Figure 3–132. Annual Pu and Am Loads at GS03: CY 1997–2009

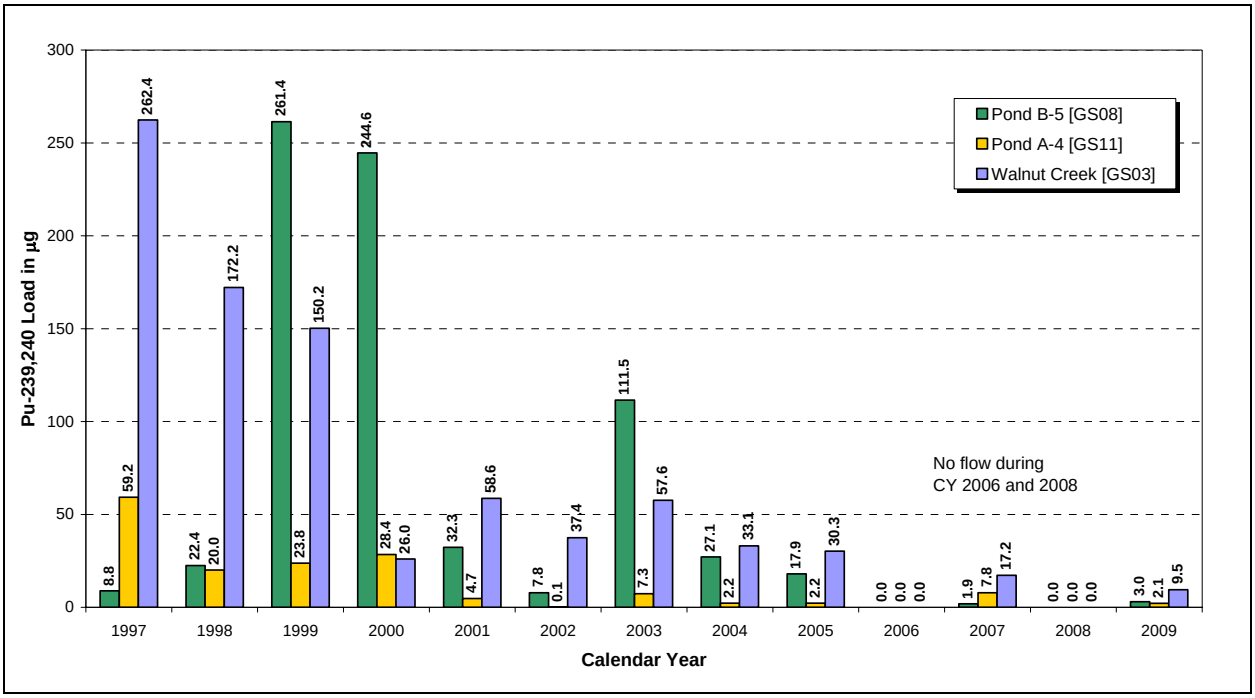


Figure 3–133. Annual Pu Loads at GS03, GS08, and GS11: CY 1997–2009

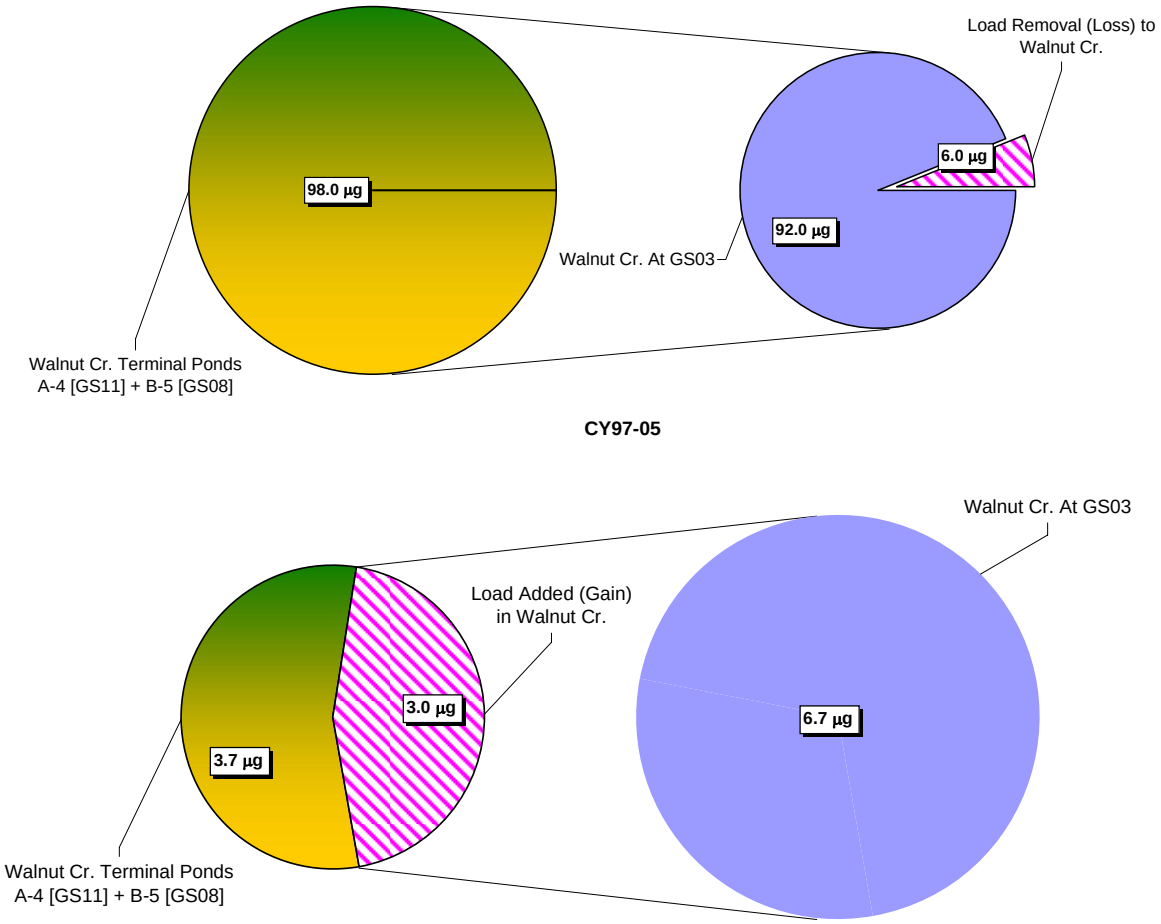


Figure 3–134. Relative Average Annual Pu Load Totals at GS03, GS08, and GS11

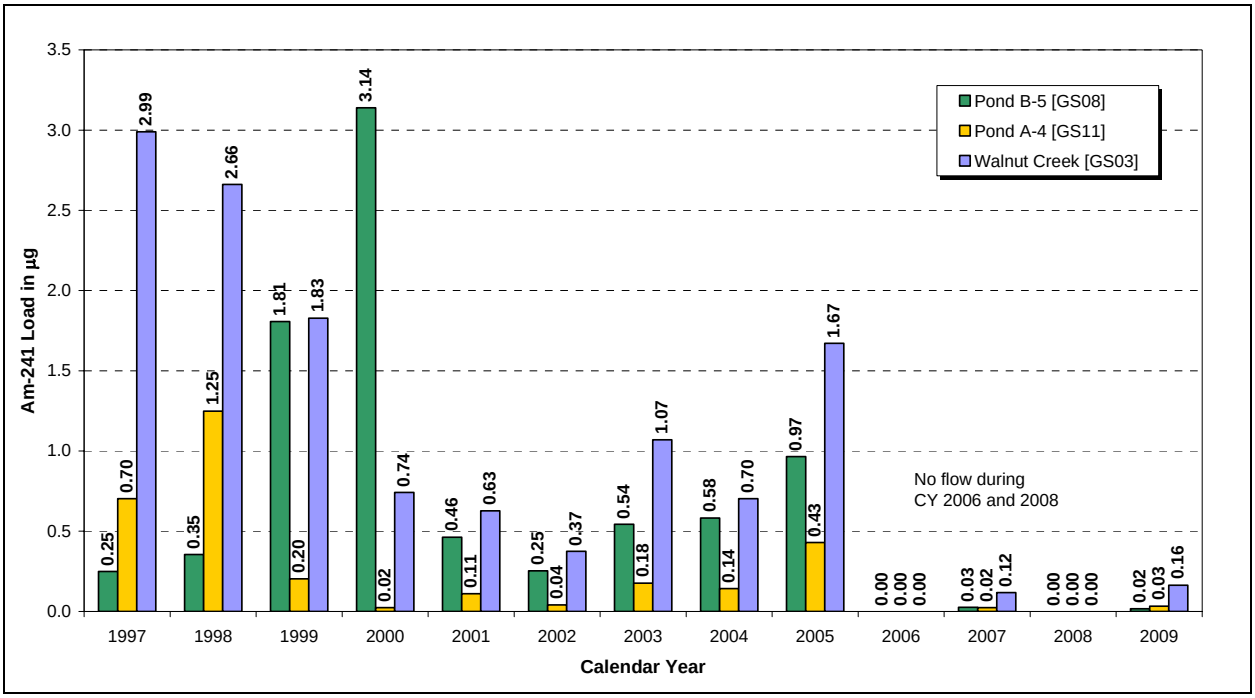


Figure 3–135. Annual Am Loads at GS03, GS08, and GS11: CY 1997–2009

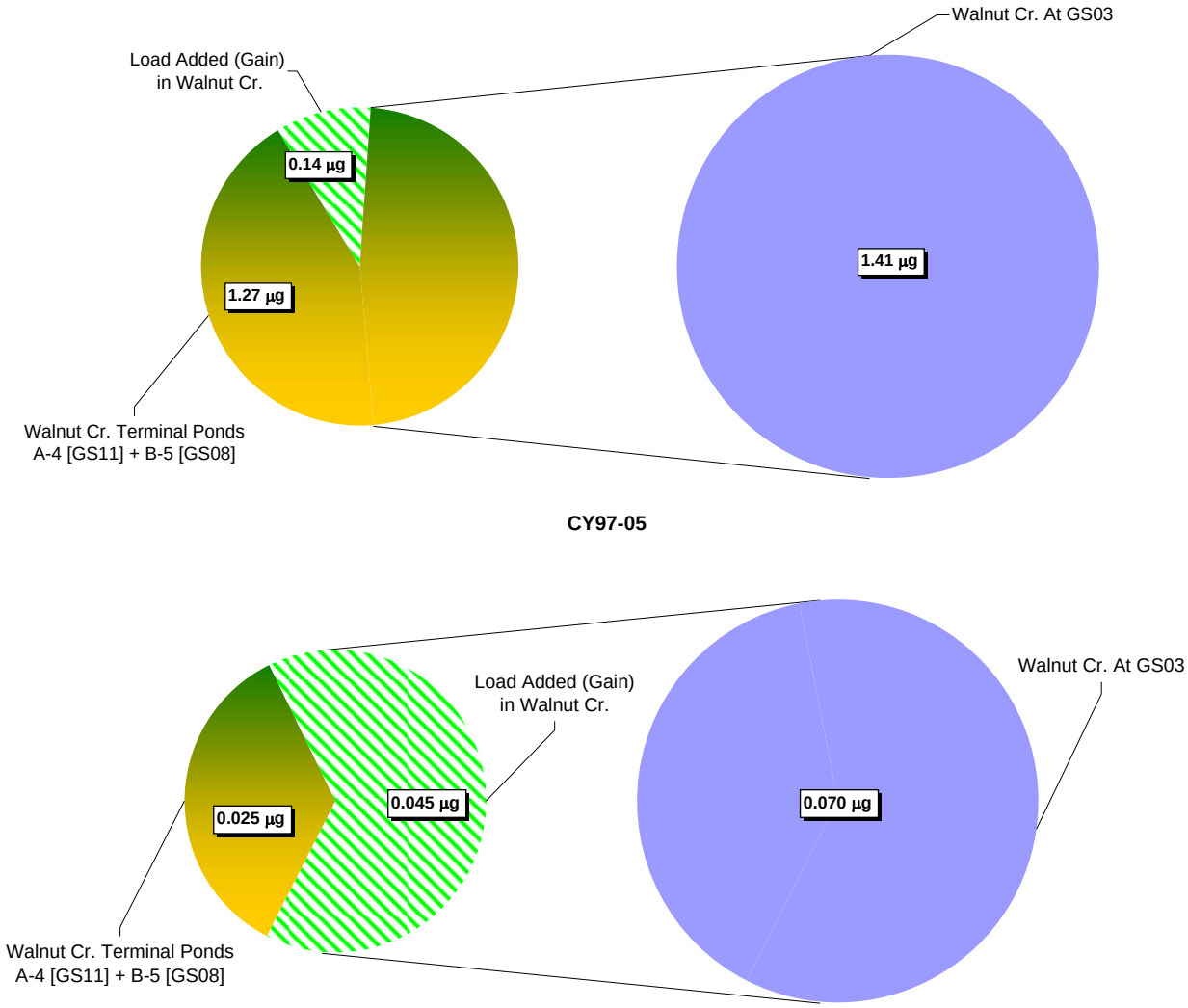


Figure 3–136. Relative Average Annual Am Load Totals at GS03, GS08, and GS11

Table 3–61. Total U Loads at GS03, GS08, and GS11: CY 2003−2009

Calendar Year	Total U (g)			
	Pond A-4 (GS11)	Pond B-5 (GS08)	Walnut Creek Terminal Ponds Total	POC GS03
2003	865	610	1,474	1,751
2004	316	390	705	744
2005	165	1,389	1,554	1,482
2006	0; No A-4 discharge	0; No B-5 discharge	0	0 No flow
2007	411	481	892	1,005
2008	0; No A-4 discharge	0; No B-5 discharge	0	0 No flow
2009	224	322	546	725
Total	1,980	3,192	5,171	5,706

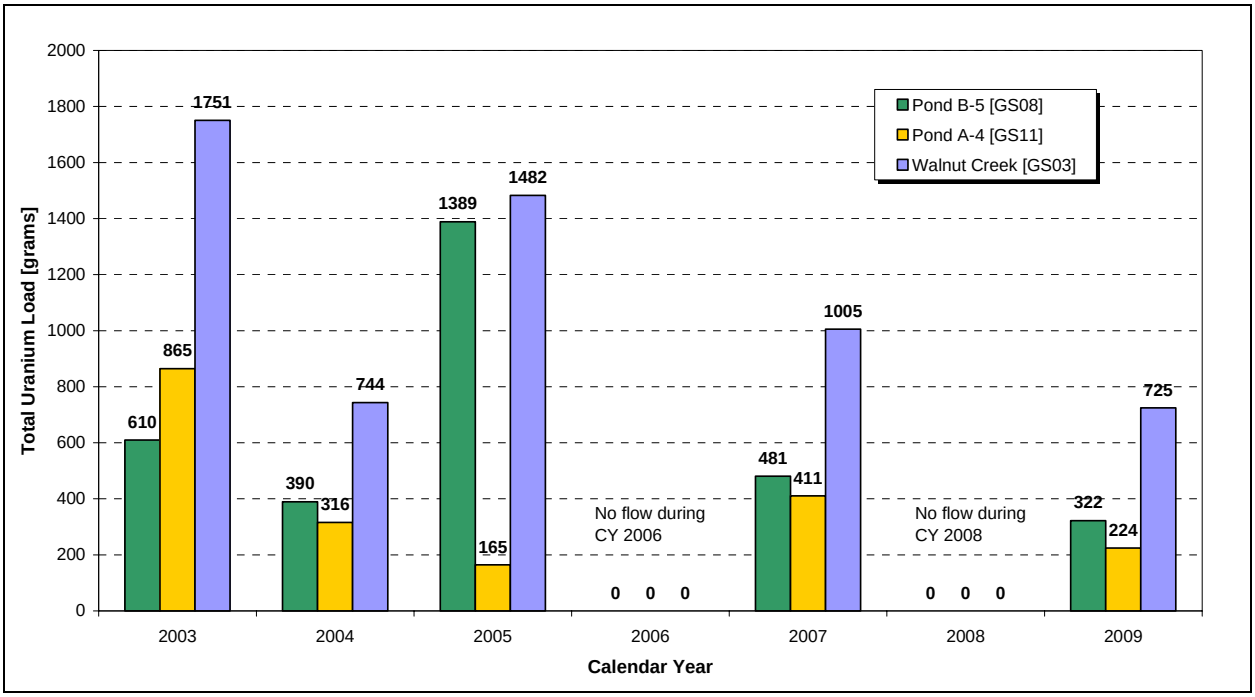


Figure 3–137. Annual Total U Loads at GS03, GS08, and GS11: CY 2003−2009

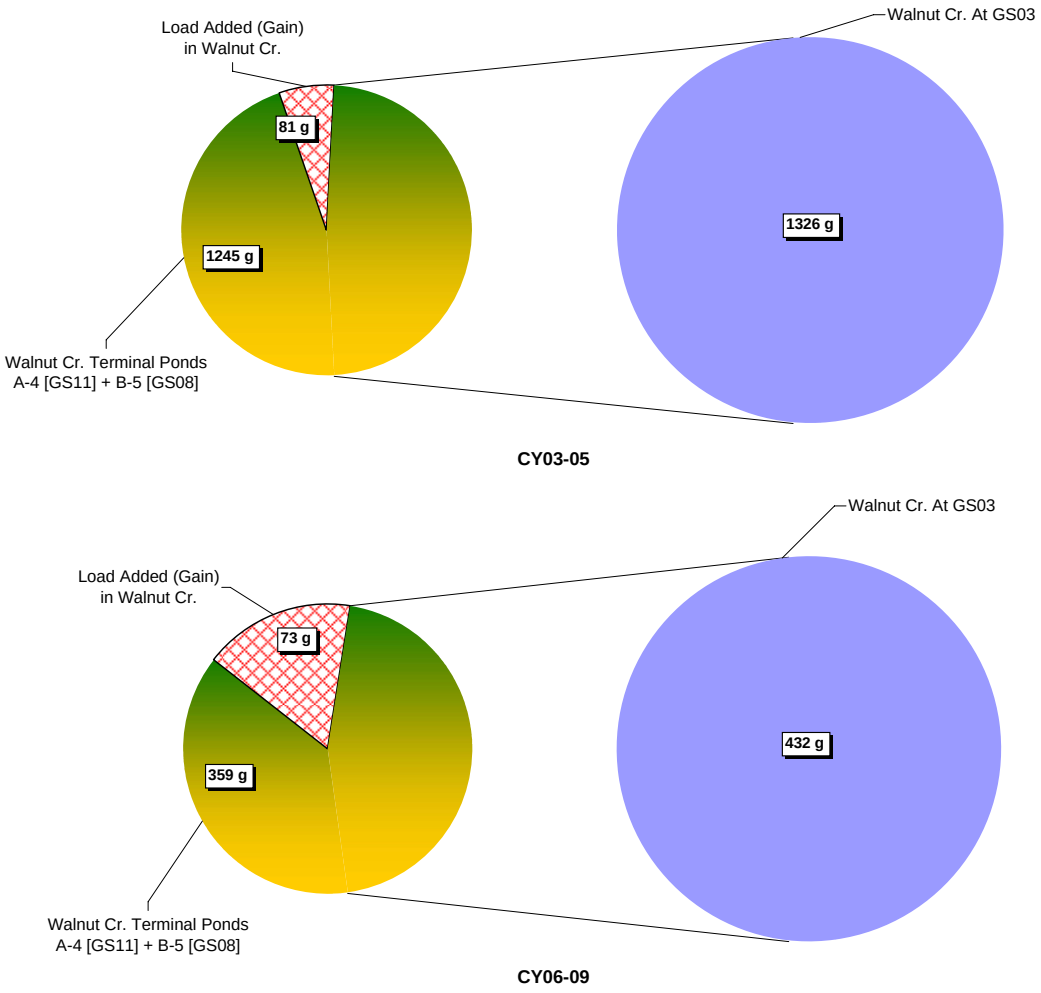


Figure 3–138. Relative Average Annual Total U Load Totals at GS03, GS08, and GS11

Lower Woman Creek

This section summarizes the calculated Pu, Am, and total U loads in Woman Creek at GS01 (Woman Creek at Indiana Street) and GS31 (Pond C-2 outlet). The data are presented in Table 3–62, Table 3–63, and Table 3–64, and depicted on Figure 3–139, Figure 3–140, Figure 3–141, Figure 3–142, Figure 3–143, Figure 3–144, and Figure 3–145. Total U data collection began at GS01 on February 3, 2003, as such only CY 2003−2009 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 3–140 and Figure 3–142). The significant annual variability in Pu and Am loads is likely due to large fluctuations in stream discharge volumes and the very low measured activities with inherent analytical error at such low levels.
- Pu and Am loads are variable at GS01 (Figure 3–139). During CY 2007, there is a measurable load increase. This increase can be attributed to larger-than-normal flow volumes, and not increases in activity.

- Total Pu loads from Pond C-2 are less than the loads at GS01 (Table 3–62 and Figure 3–141), indicating a gain of load from the Woman Creek drainage.
- Total Am loads from Pond C-2 are less than the loads at GS01 (Table 3–63 and Figure 3–143), also indicating a gain of load from the Woman Creek drainage.
- Total CY 2003−2009 U load from Pond C-2 is significantly less than the load at GS01 (Table 3–64 and Figure 3–145), indicating a gain of load most likely from naturally occurring U in the Woman Creek drainage.

Table 3–62. Pu Loads at GS01 and GS31: CY 1997–2009

Calendar Year	Pu-239,240 (µg)	
	Pond C-2 (GS31)	**POC GS01**
1997	16.7	47.9
1998	2.2	55.4
1999	26.9	56.7
2000	0.0; No C-2 discharge	6.1
2001	11.0	22.4
2002	0.2	0.8
2003	11.0	25.9
2004	11.5	4.7
2005	5.0	12.5
2006	0.0; No C-2 discharge	1.4
2007	0.0; No C-2 discharge	68.0
2008	0.0; No C-2 discharge	1.1
2009	4.1	26.7
Total	88.6	329.5

Note: 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 3–63. Am Loads at GS01 and GS31: CY 1997–2009

Calendar Year	Am-241 (µg)	
	Pond C-2 (GS31)	POC GS01
1997	0.17	0.40
1998	0.27	0.99
1999	0.13	0.75
2000	0.00; No C-2 discharge	0.18
2001	0.14	0.30
2002	<0.01	0.03
2003	0.09	0.34
2004	0.11	0.15
2005	0.04	0.30
2006	0.0; No C-2 discharge	0.13
2007	0.0; No C-2 discharge	0.49
2008	0.0; No C-2 discharge	0.02
2009	0.03	0.23
Total	0.99	4.29

Note: 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.

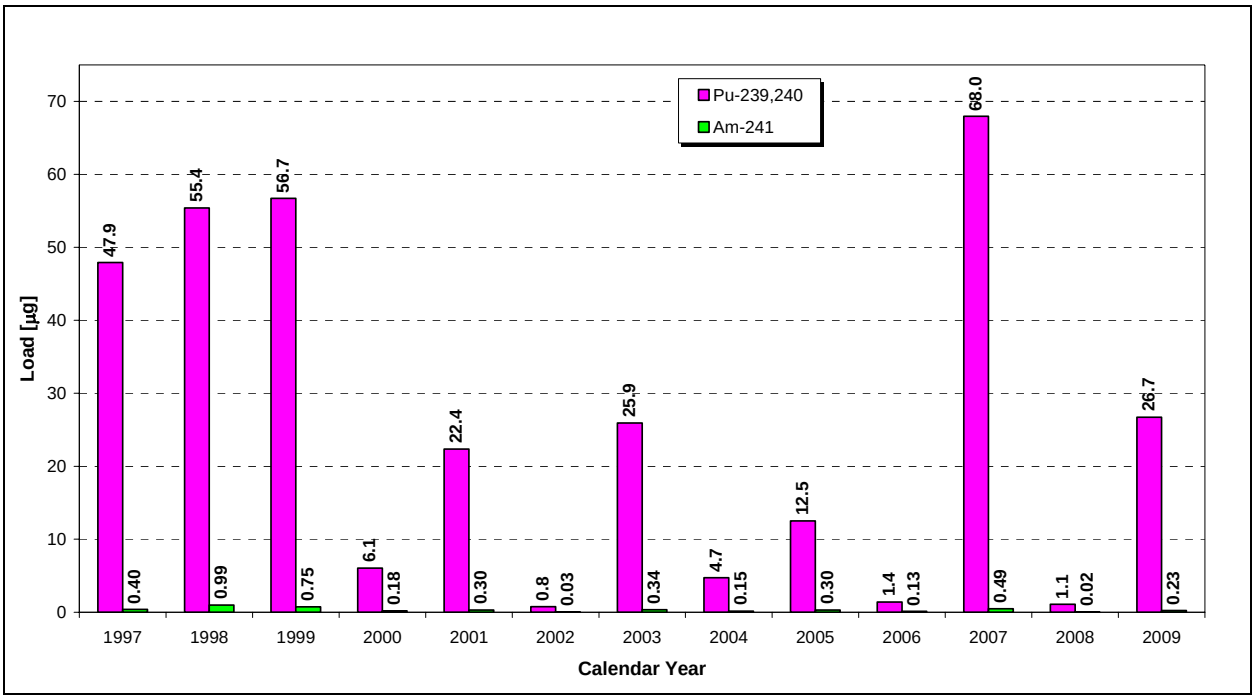


Figure 3–139. Annual Pu and Am Loads at GS01: CY 1997–2009

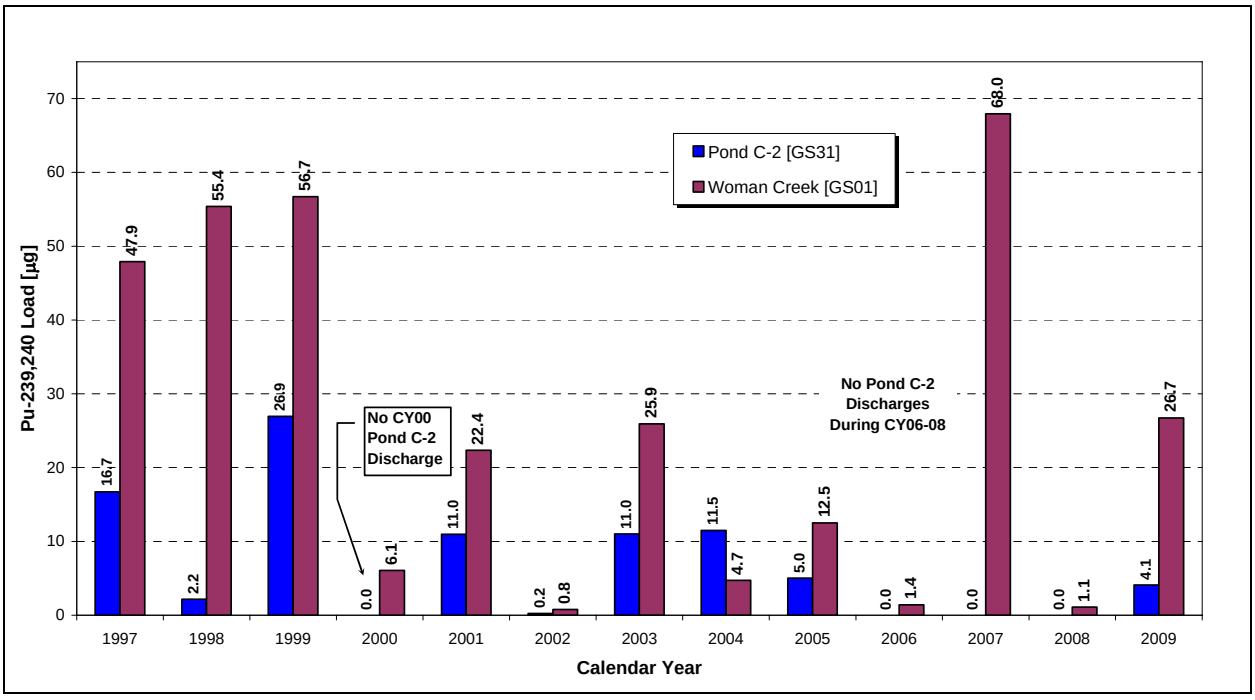


Figure 3–140. Annual Pu Loads at GS01 and GS31: CY 1997–2009

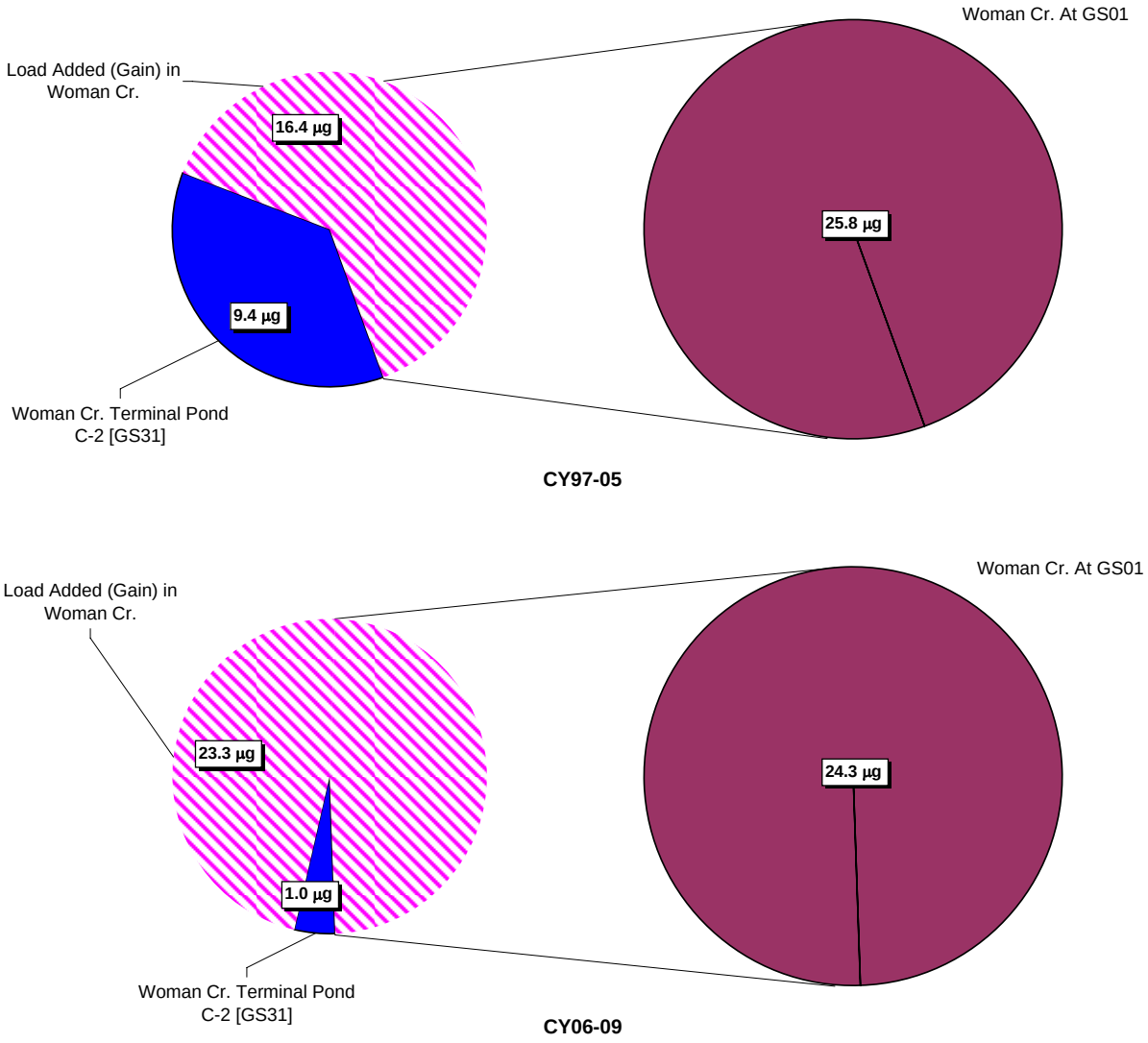


Figure 3–141. Relative Average Annual Pu Load Totals at GS01 and GS31

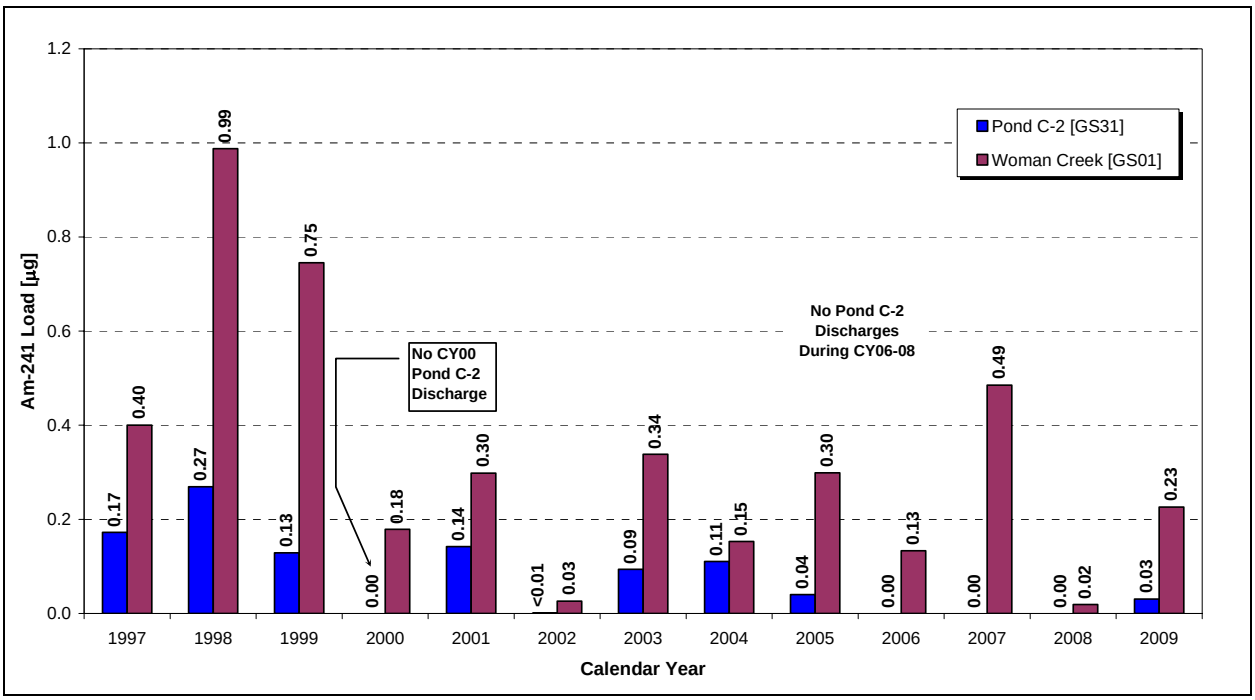


Figure 3–142. Annual Am Loads at GS01 and GS31: CY 1997–2009

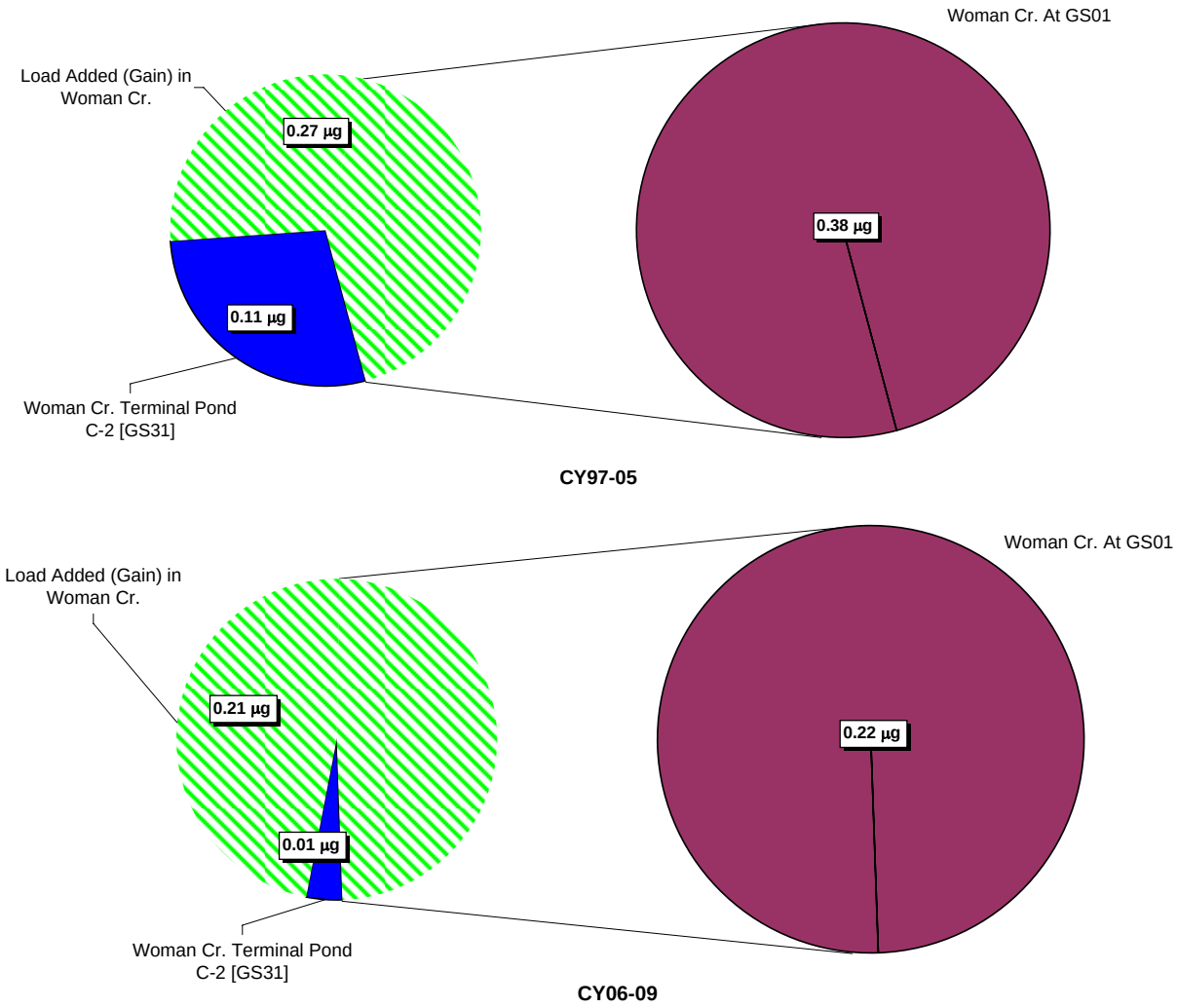


Figure 3–143. Relative Average Annual Am Load Totals at GS01 and GS31

Table 3–64. Total U Loads at GS01 and GS31: CY 2003−2009

Calendar Year	Total U (g)	
	Pond C-2 (GS31)	POC GS01
2003	129	790
2004	92	808
2005	115	918
2006	0; No C-2 discharge	235
2007	0; No C-2 discharge	1,016
2008	0; No C-2 discharge	174
2009	95	761
Total	430	4,702

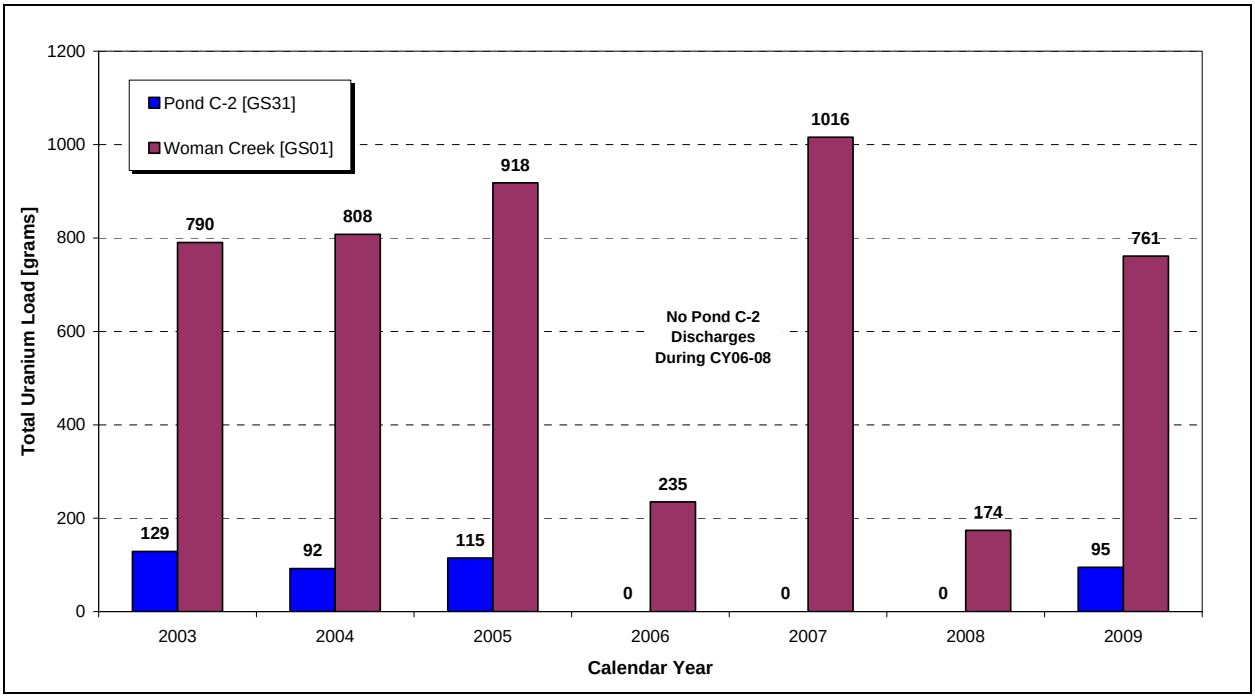


Figure 3–144. Annual Total U Loads at GS01 and GS31: CY 2003−2009

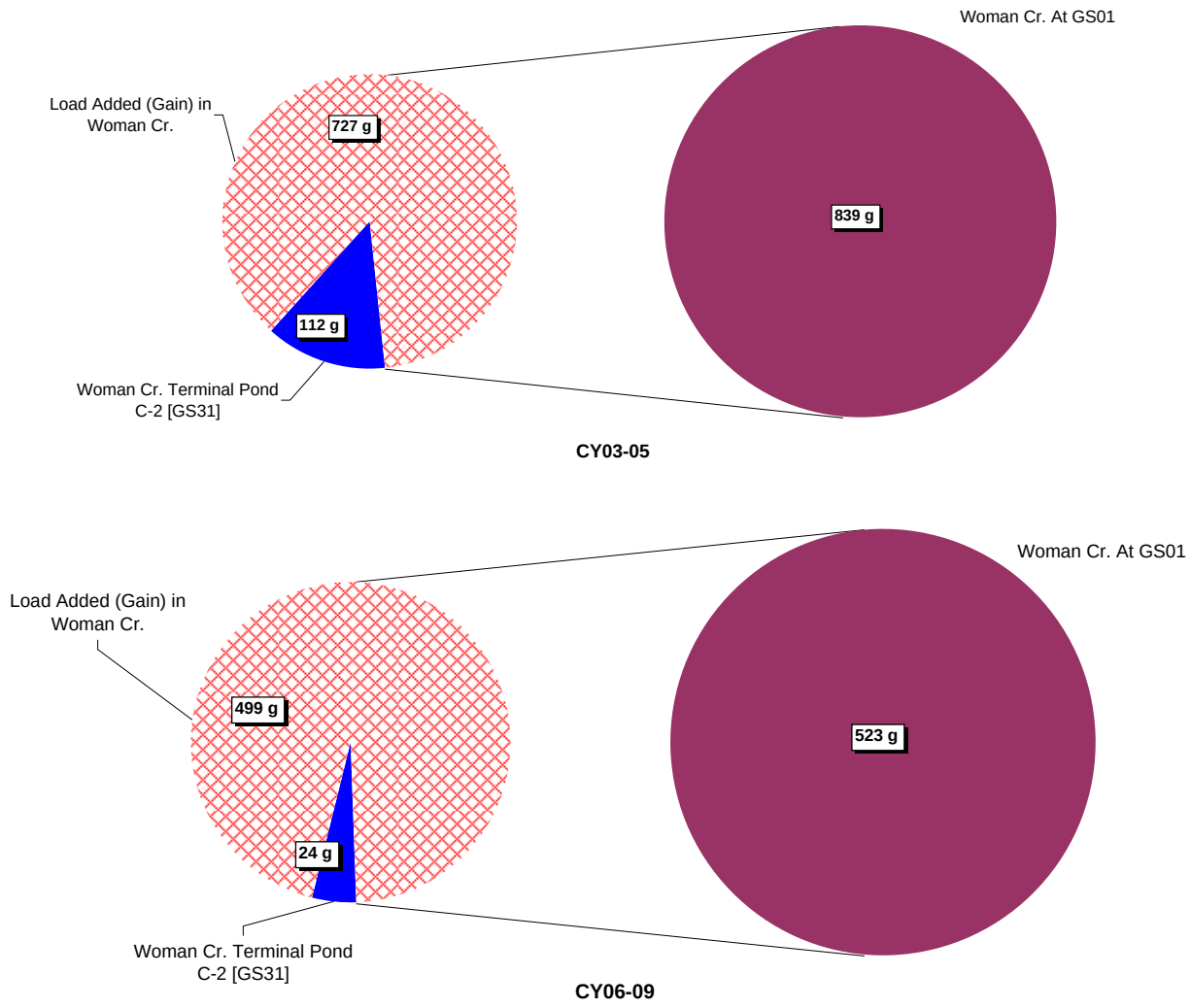


Figure 3–145. Relative Average Annual Total U Load Totals at GS01 and GS31

Terminal Ponds A-4, B-5, and C-2

This section summarizes the calculated Pu, Am, and total U loads from terminal Ponds A-4, B-5, and C-2. The data are presented in Table 3–65 and Table 3–66, and depicted on Figure 3–146, Figure 3–147, Figure 3–148, Figure 3–149, Figure 3–150, and Figure 3–151. The following points are noted:

- Annual Pu and Am loads vary significantly year to year (Figure 3–146 and Figure 3–148). A general reduction in Pu and Am loads is noted during active closure, with a significant reduction post-closure due to the reduction in runoff and sediment transport attributed to the effectiveness of remedial actions, revegetation, and erosion control measures.
- Pond B-5 accounts for most (76 percent) of the Pu load from the terminal ponds (Figure 3–147) pre-closure. With the reduction of both discharge volume and activity, Pond B-5 accounts for 26 percent of the post-closure load; Pond A-4 accounts for 52 percent of the post-closure Pu load due to larger discharge volumes, and not higher Pu activity.

- Pond B-5 accounts for most (67 percent) of the Am load from the terminal ponds (Figure 3–149). With the reduction of both discharge volume and activity, Pond B-5 accounts for 33 percent of the post-closure load; Pond A-4 accounts for 43 percent of the post-closure Am load due to larger discharge volumes, and not higher Am activity.
- Pond A-4 accounts for a slim majority (46 percent) of the total U loads from the terminal ponds (Figure 3–151) pre-closure. With the increased U concentrations in South Walnut Creek post-closure, Pond B-5 accounts for most of the load (53 percent).

Table 3–65. Pu and Am Loads from Terminal Ponds A-4, B-5, and C-2: CY 1997–2009

Calendar Year	Pu-239,240 (µg)			Am-241 (µg)		
	Pond A-4 (GS11)	Pond B-5 (GS08)	Pond C-2 (GS31)	Pond A-4 (GS11)	Pond B-5 (GS08)	Pond C-2 (GS31)
1997	59.2	8.8	16.7	0.70	0.25	0.17
1998	20.0	22.4	2.2	1.25	0.35	0.27
1999	23.8	261.4	26.9	0.20	1.81	0.13
2000	28.4	244.6	0.0; No C-2 discharge	0.02	3.14	0.00; No C-2 discharge
2001	4.7	32.3	11.0	0.11	0.46	0.14
2002	0.1	7.8	0.2	0.04	0.25	<0.01
2003	7.3	111.5	11.0	0.18	0.54	0.09
2004	2.2	27.1	11.5	0.14	0.58	0.11
2005	2.2	17.9	5.0	0.43	0.97	0.04
2006	0.0; No A-4 discharge	0.0; No B-5 discharge	0.0; No C-2 discharge	0.00; No A-4 discharge	0.00; No B-5 discharge	0.0; No C-2 discharge
2007	7.8	1.9	0.0; No C-2 discharge	0.02	0.03	0.0; No C-2 discharge
2008	0.0; No A-4 discharge	0.0; No B-5 discharge	0.0; No C-2 discharge	0.00; No A-4 discharge	0.00; No B-5 discharge	0.0; No C-2 discharge
2009	2.1	3.0	4.1	0.03	0.02	0.03
Total	157.8	738.7	88.6	3.13	8.40	0.99

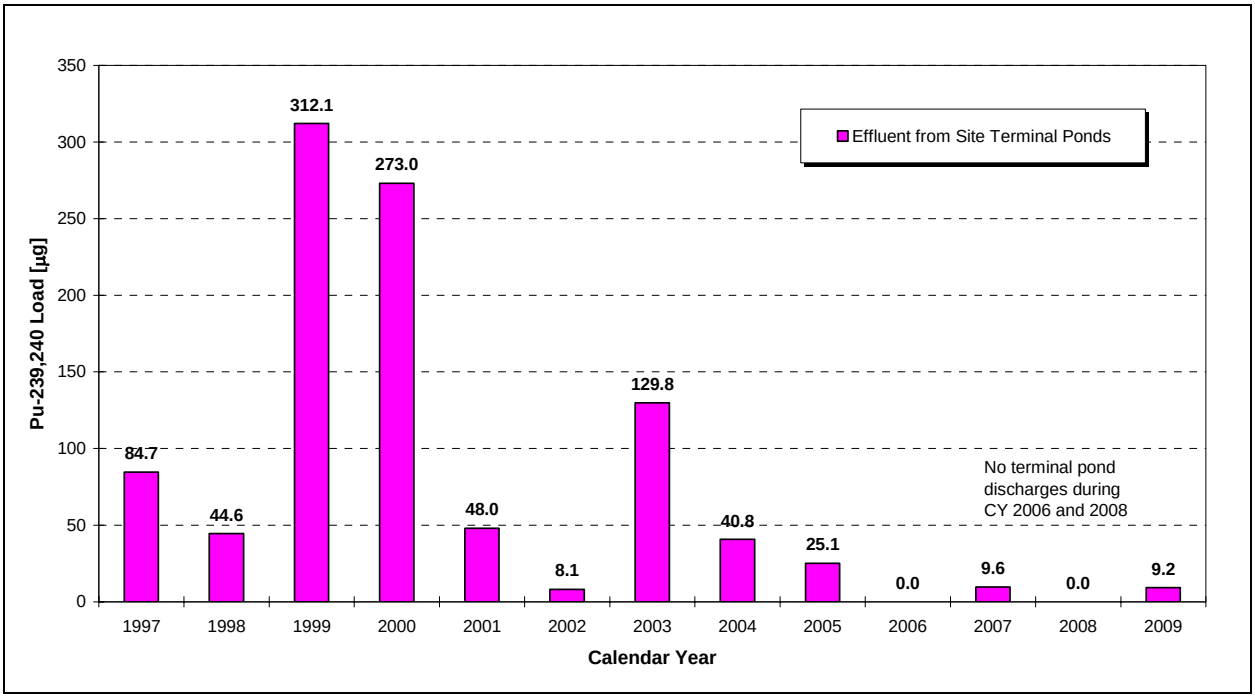


Figure 3–146. Annual Pu Loads from Terminal Ponds A-4, B-5, and C-2: CY 1997–2009

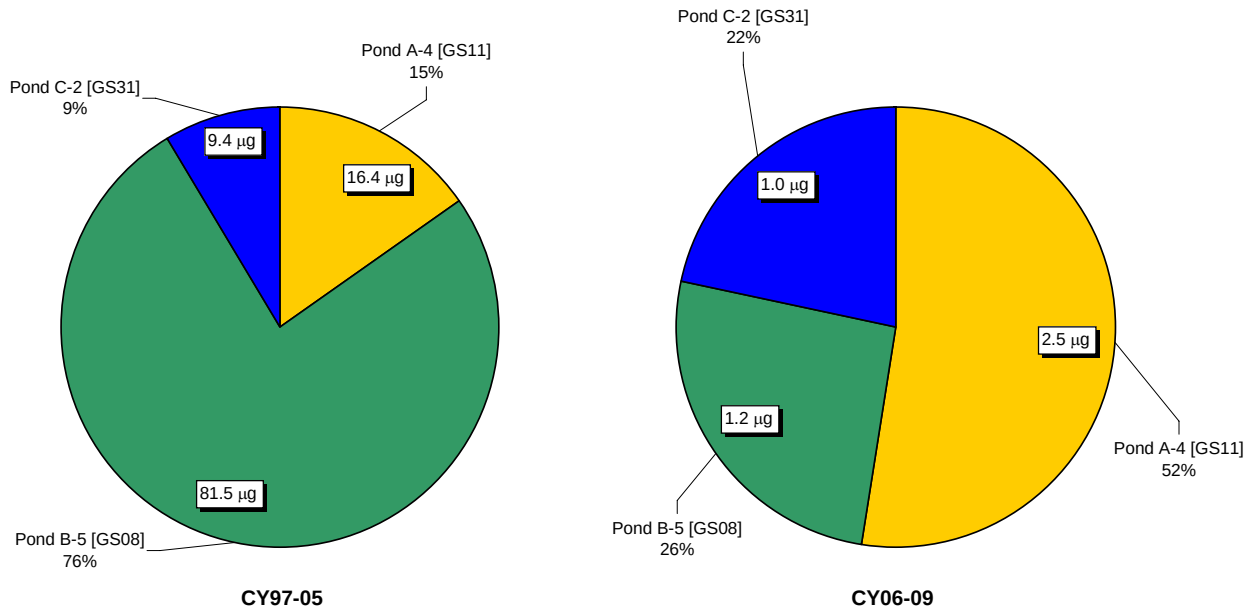


Figure 3–147. Relative Average Annual Pu Load Totals from Terminal Ponds A-4, B-5, and C-2

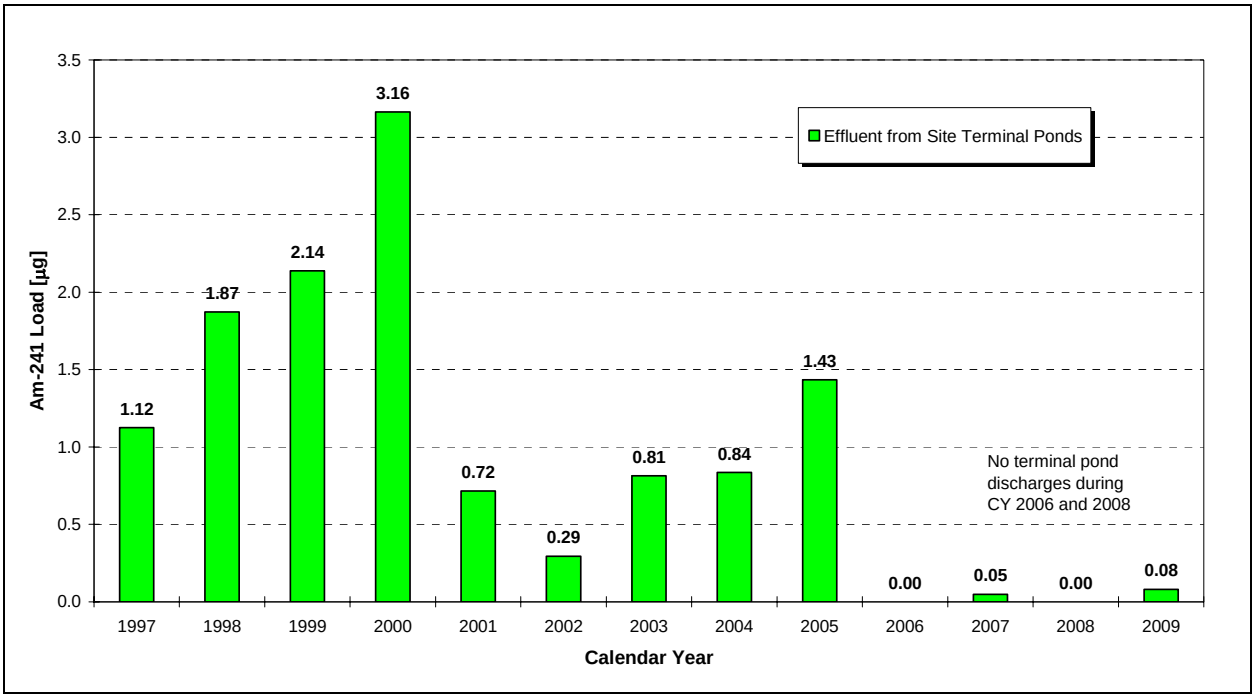


Figure 3–148. Annual Am Loads from Terminal Ponds A-4, B-5, and C-2: CY 1997–2009

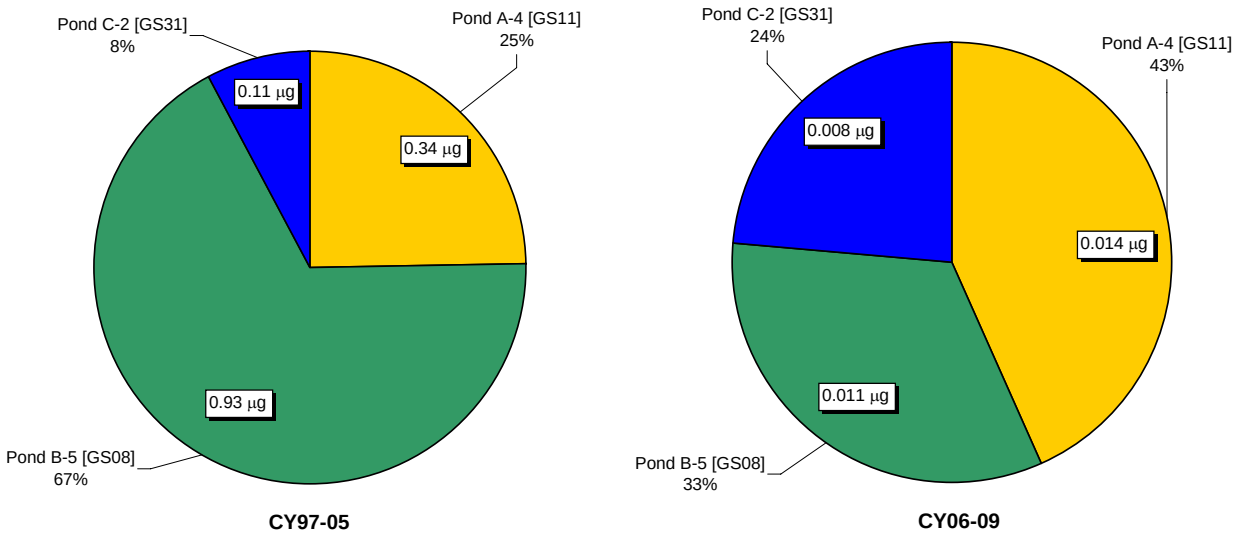


Figure 3–149. Relative Average Annual Am Load Totals from Terminal Ponds A-4, B-5, and C-2

Table 3–66. Total U Loads from Terminal Ponds A-4, B-5, and C-2: CY 1997–2009

Calendar Year	Total U (g)		
	Pond A-4 (GS11)	Pond B-5 (GS08)	Pond C-2 (GS31)
1997	1,365	252	231
1998	1,301	620	216
1999	633	809	189
2000	386	465	0; No C-2 discharge
2001	564	639	67
2002	132	258	1
2003	865	610	129
2004	316	390	92
2005	165	1,389	115
2006	0; No A-4 discharge	0; No B-5 discharge	0; No C-2 discharge
2007	411	481	0; No C-2 discharge
2008	0; No A-4 discharge	0; No B-5 discharge	0; No C-2 discharge
2009	224	322	95
Total	6,361	6,236	1,133

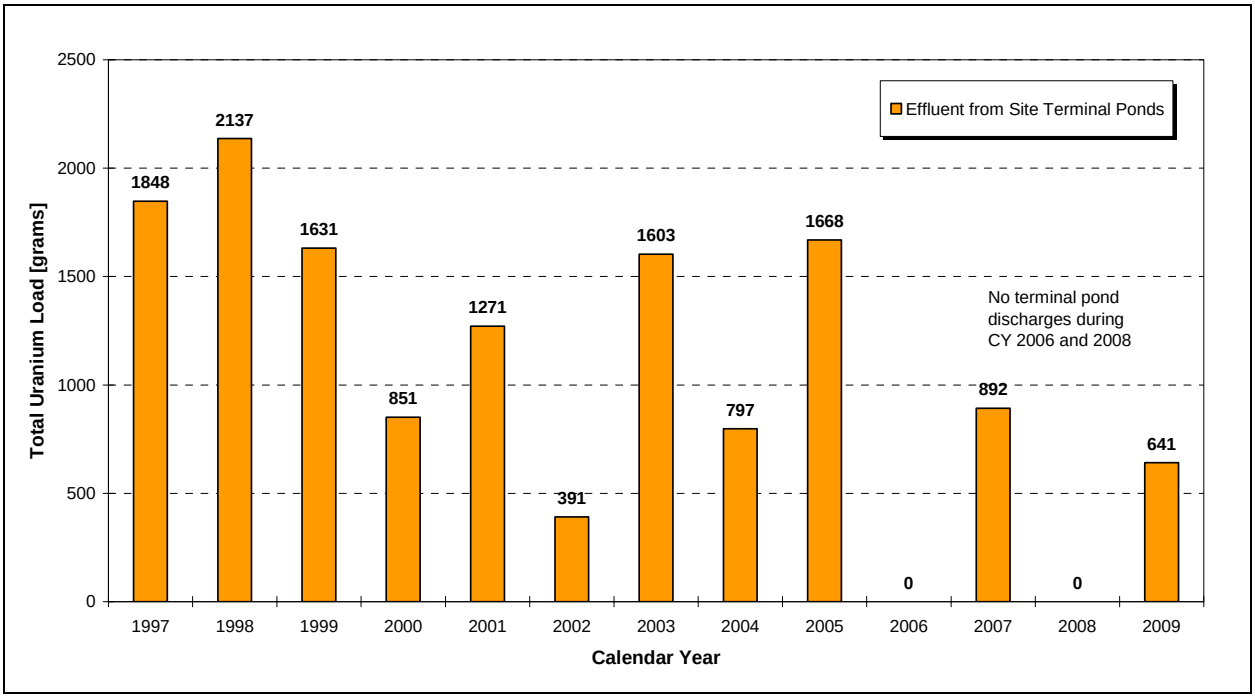


Figure 3–150. Annual Total U Loads from Terminal Ponds A-4, B-5, and C-2: CY 1997–2009

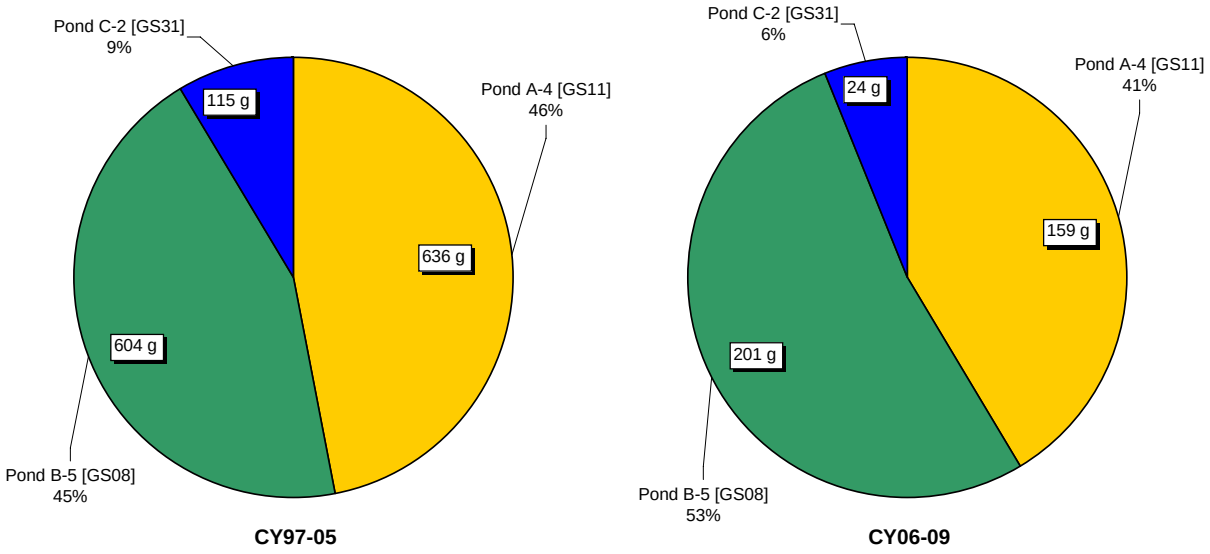


Figure 3–151. Relative Average Annual Total U Load Totals from Terminal Ponds A-4, B-5, and C-2

A- and B-Series Ponds (POCs GS08 and GS11)

This section summarizes the calculated Pu, Am, and total U loads for the A- and B-series ponds. The data are presented in Table 3–67, Table 3–68, and Table 3–69, and are depicted on Figure 3–152, Figure 3–153, Figure 3–154, Figure 3–155, Figure 3–156, Figure 3–157, Figure 3–158, and Figure 3–159. Since water transfers occurred between ponds pre-closure, the load analysis is performed for both pond series combined. The influent load sources are GS10 and 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 3–67 shows GS10 with the highest influent Pu load for CY1997-2009.
- 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 3–152). With the implementation of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2006−2009.
- Table 3–68 shows GS10 with the highest influent Am load for CY1997−2009.
- 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 3–154). Increased Am loads at SW093 were primarily due to contributions from B771 D&D 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 2006−2009.
- Annual Pu and Am loads vary significantly year to year (Figure 3–152 and Figure 3–154), primarily due to streamflow volume and solids transport variation.

- Pre-closure (Figure 3–156), 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 3–157), GS10 shows both the highest average annual concentration and load. Although U concentration has increased significantly, corresponding reductions in streamflow volume have resulted in a *decrease* in load.
- Pre-closure (Figure 3–156), GS11 shows the highest effluent average annual total U concentration and load. However, with the increased concentration in South Walnut Creek, GS08 shows the highest effluent average annual total U concentration post-closure. Again, although U activity has increased significantly at GS08, corresponding reductions in discharge volume have resulted in a *decrease* in load.

Table 3–67. Pu Load Summary for the A- and B-Series Ponds: CY 1997–2009

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	2.1
Total	86.9	2,752.3	2,058.5	738.7	157.8

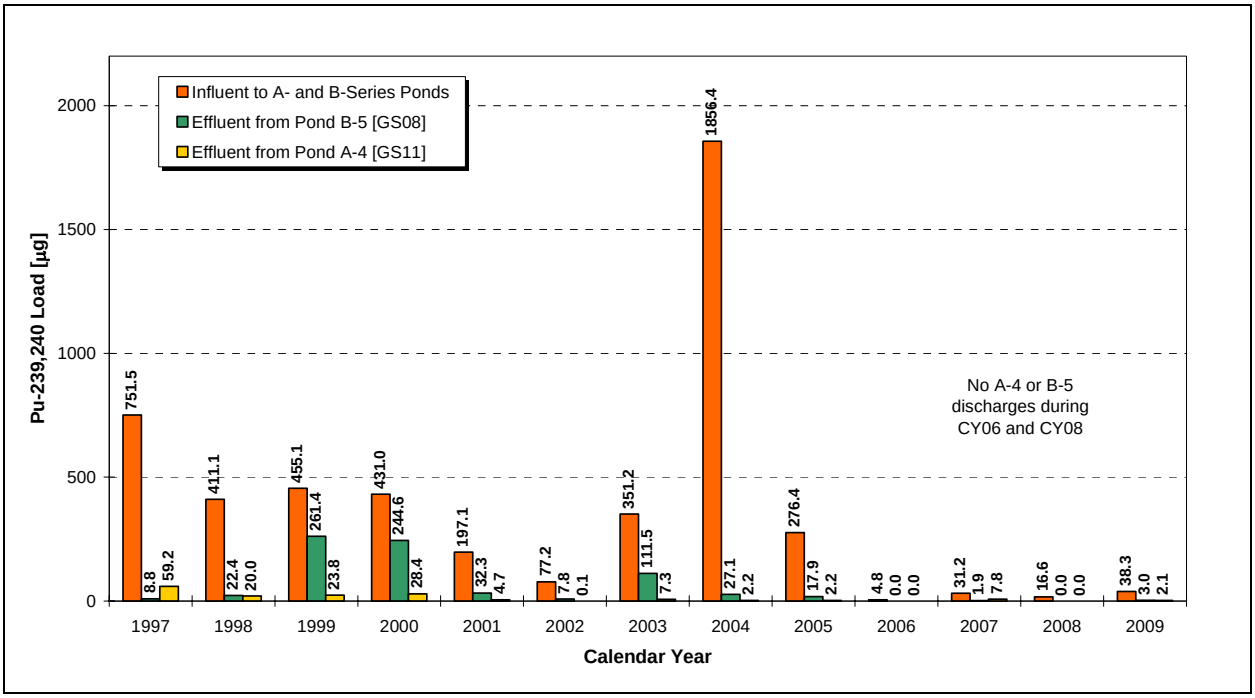


Figure 3–152. Annual Pu Loads for the A- and B-Series Ponds: CY 1997–2009

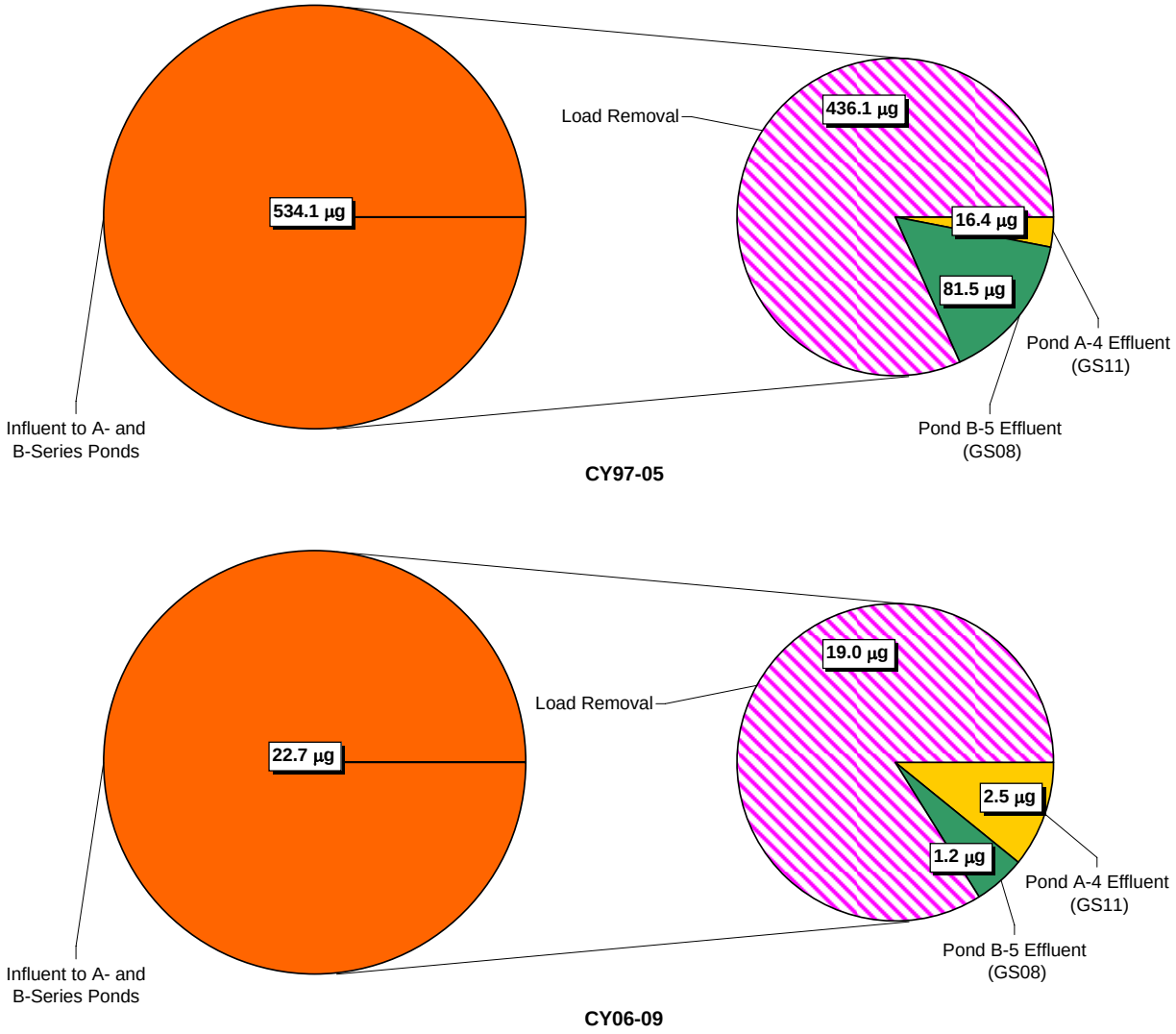


Figure 3–153. Relative Average Annual Pu Load Totals for the A- and B-Series Ponds

Table 3–68. Am Load Summary for the A- and B-Series Ponds: CY 1997–2009

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	0.03
Total	2.65	62.04	39.45	8.40	3.13

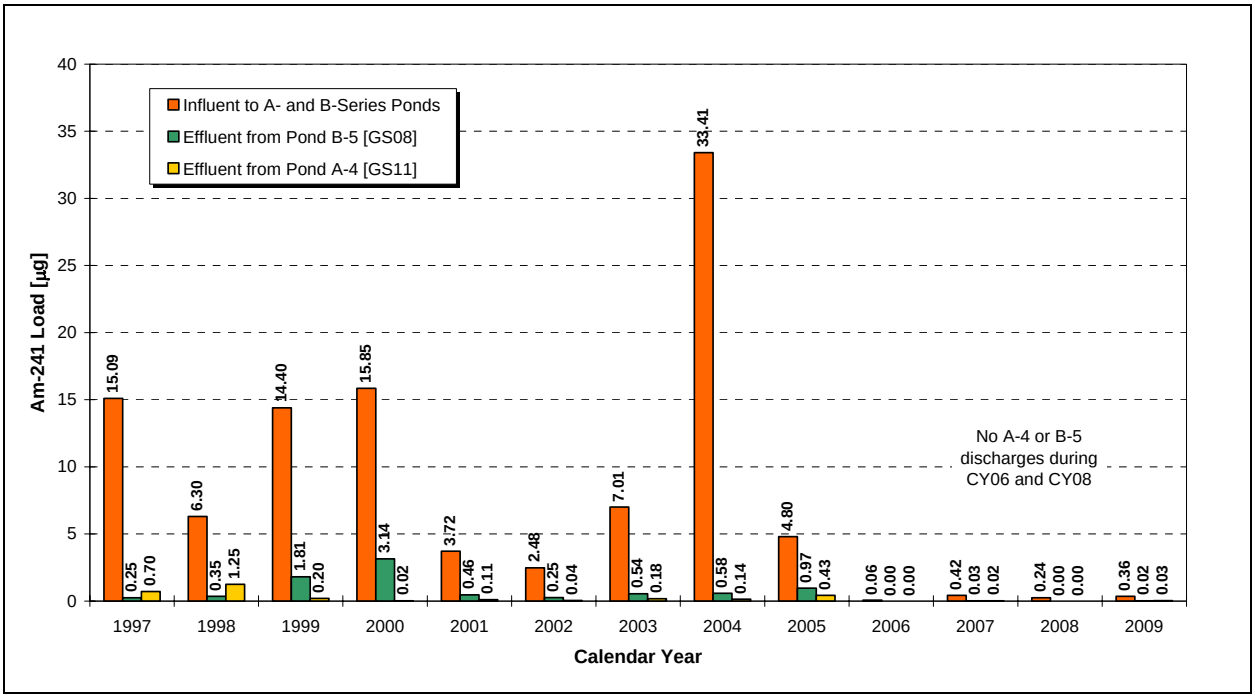


Figure 3–154. Annual Am Loads for the A- and B-Series Ponds: CY 1997–2009

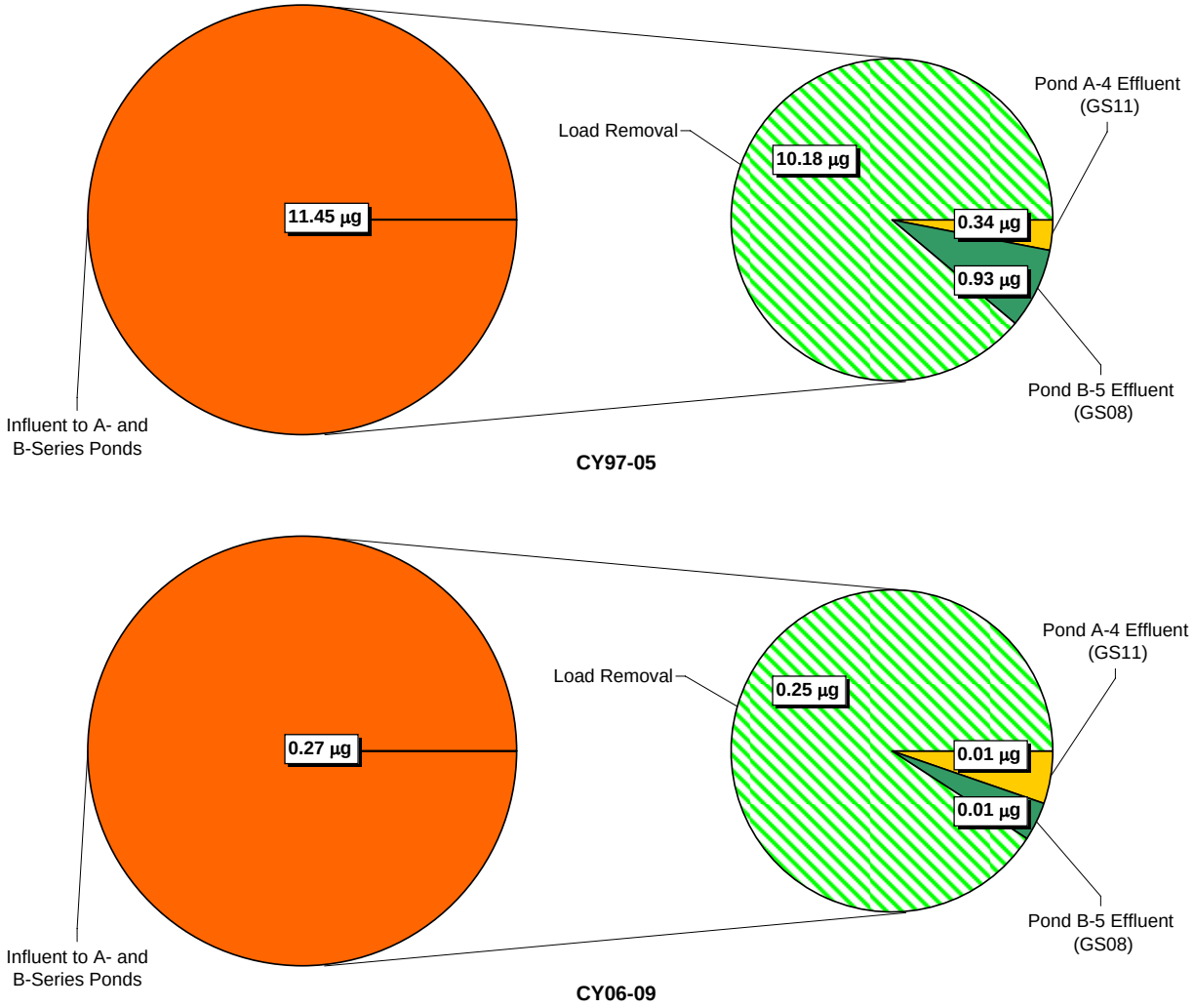
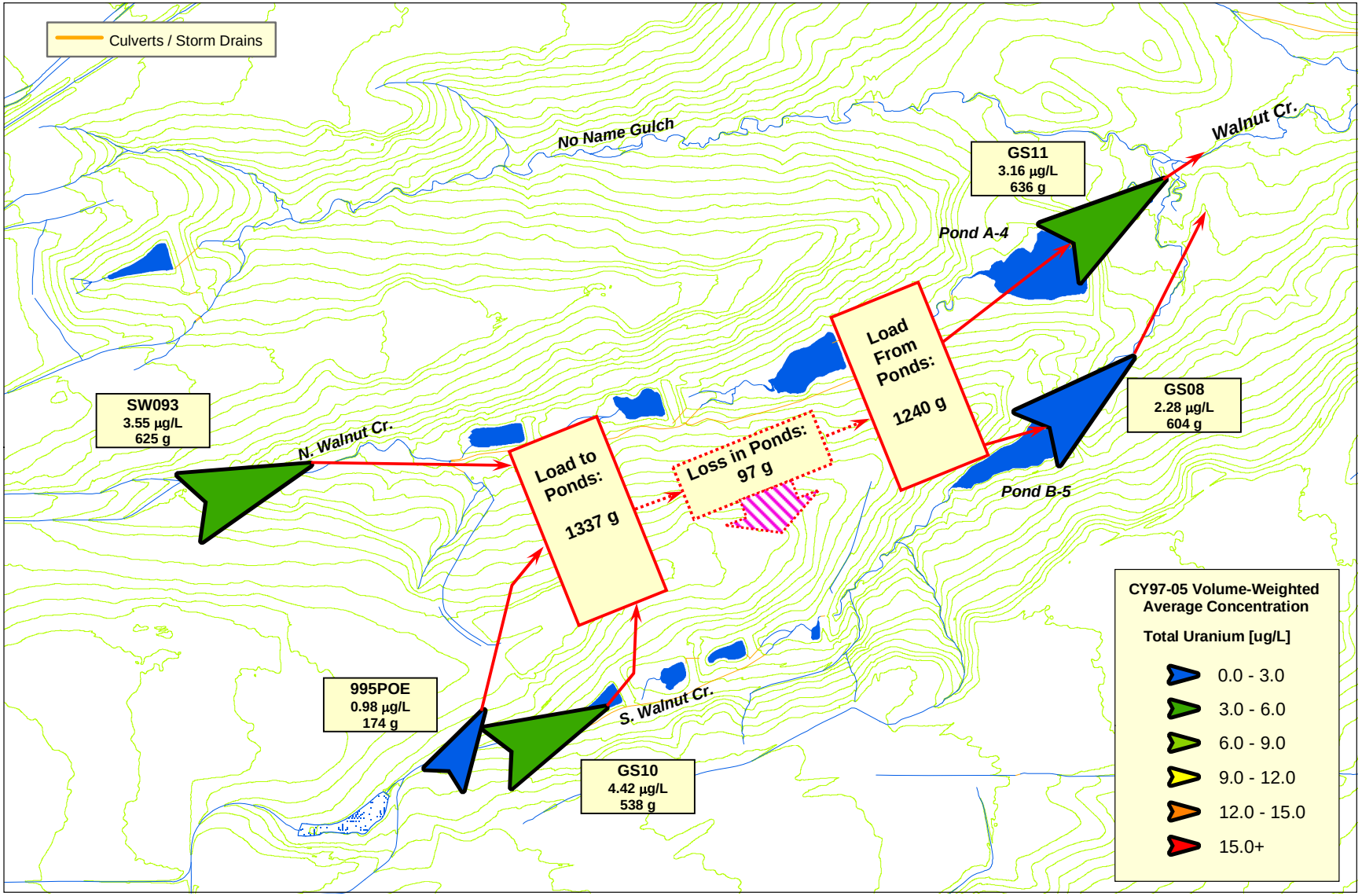
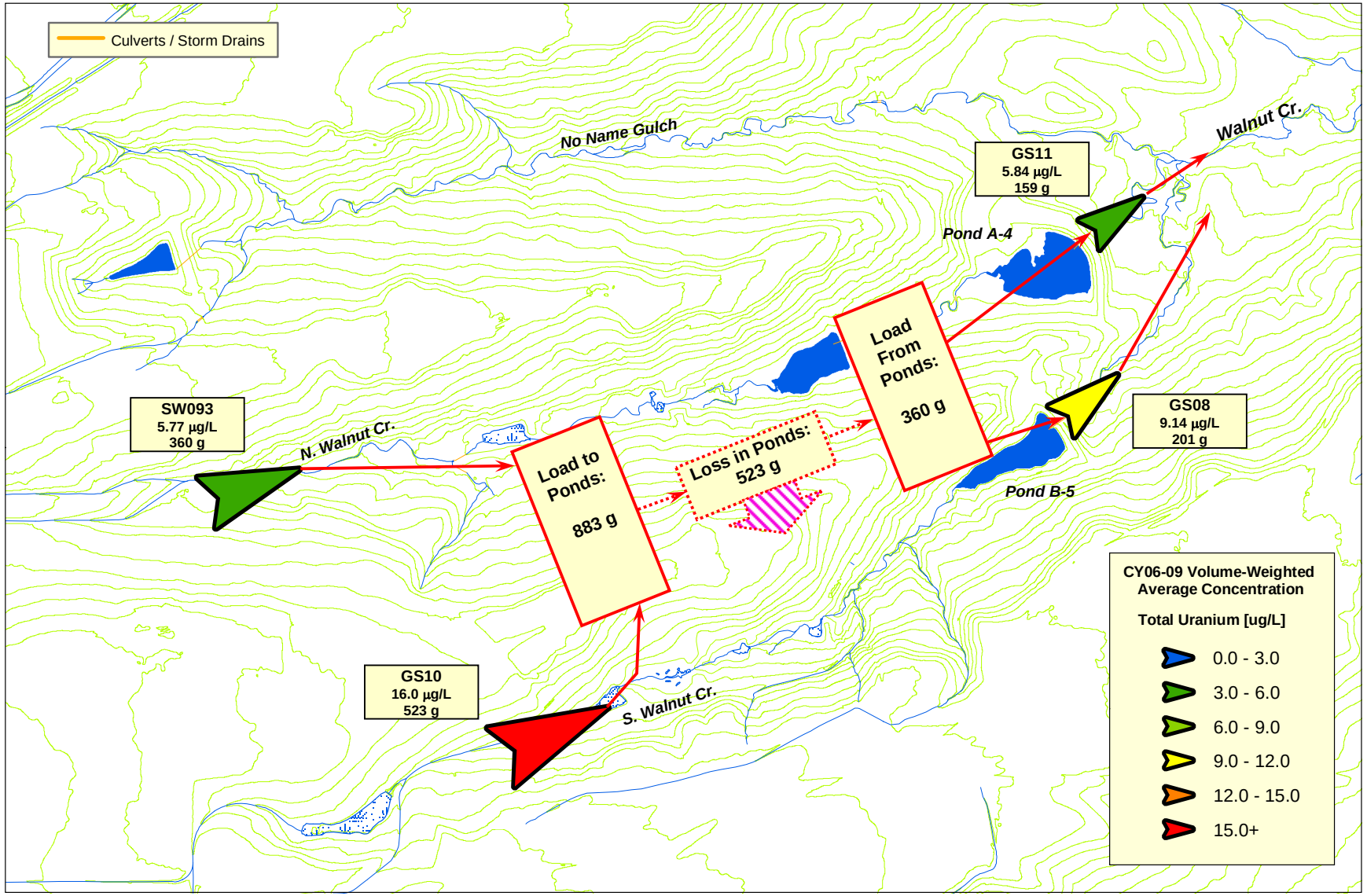


Figure 3–155. Relative Average Annual Am Load Totals for the A- and B-Series Ponds



Note: Location symbols are displayed proportional to calculated average annual load and colored according to concentration ranges in legend.

Figure 3–156. Relative Average Annual Total U Loading Schematic for the A- and B-Series Ponds: CY 1997–2005



Note: Location symbols are displayed proportional to calculated average annual load and colored according to concentration ranges in legend.

Figure 3–157. Relative Average Annual Total U Loading Schematic for the A- and B-Series Ponds: CY 2006–2009

Table 3–69. Total U Load Summary for the A- and B-Series Ponds: CY 1997–2009

Calendar Year	Total U (g)				
	Influent (WWTP)	Influent (GS10)	Influent (SW093)	Effluent (GS08)	Effluent (GS11)
1997	257	637	853	252	1,365
1998	467	631	797	620	1,301
1999	121	589	714	809	633
2000	103	379	485	465	386
2001	259	519	646	639	564
2002	61	279	450	258	132
2003	161	501	568	610	865
2004	139	430	575	390	316
2005	0 WWTP removed	879	534	1,389	165
2006	0 WWTP removed	230	171	0; No B-5 discharge	0; No A-4 discharge
2007	0 WWTP removed	830	540	481	411
2008	0 WWTP removed	275	154	0; No B-5 discharge	0; No A-4 discharge
2009	0 WWTP removed	756	574	322	224
Total	1,569	6,937	7,061	6,236	6,361

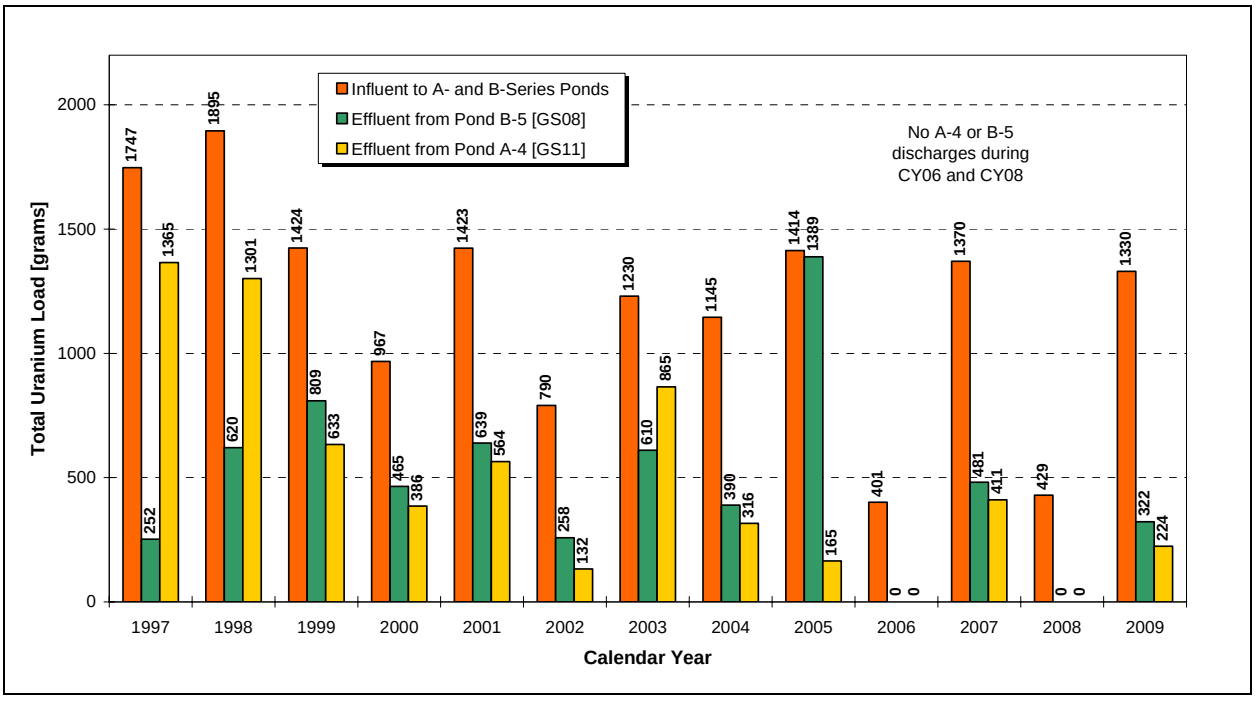


Figure 3–158. Annual Total U Loads for the A- and B-Series Ponds: CY 1997–2009

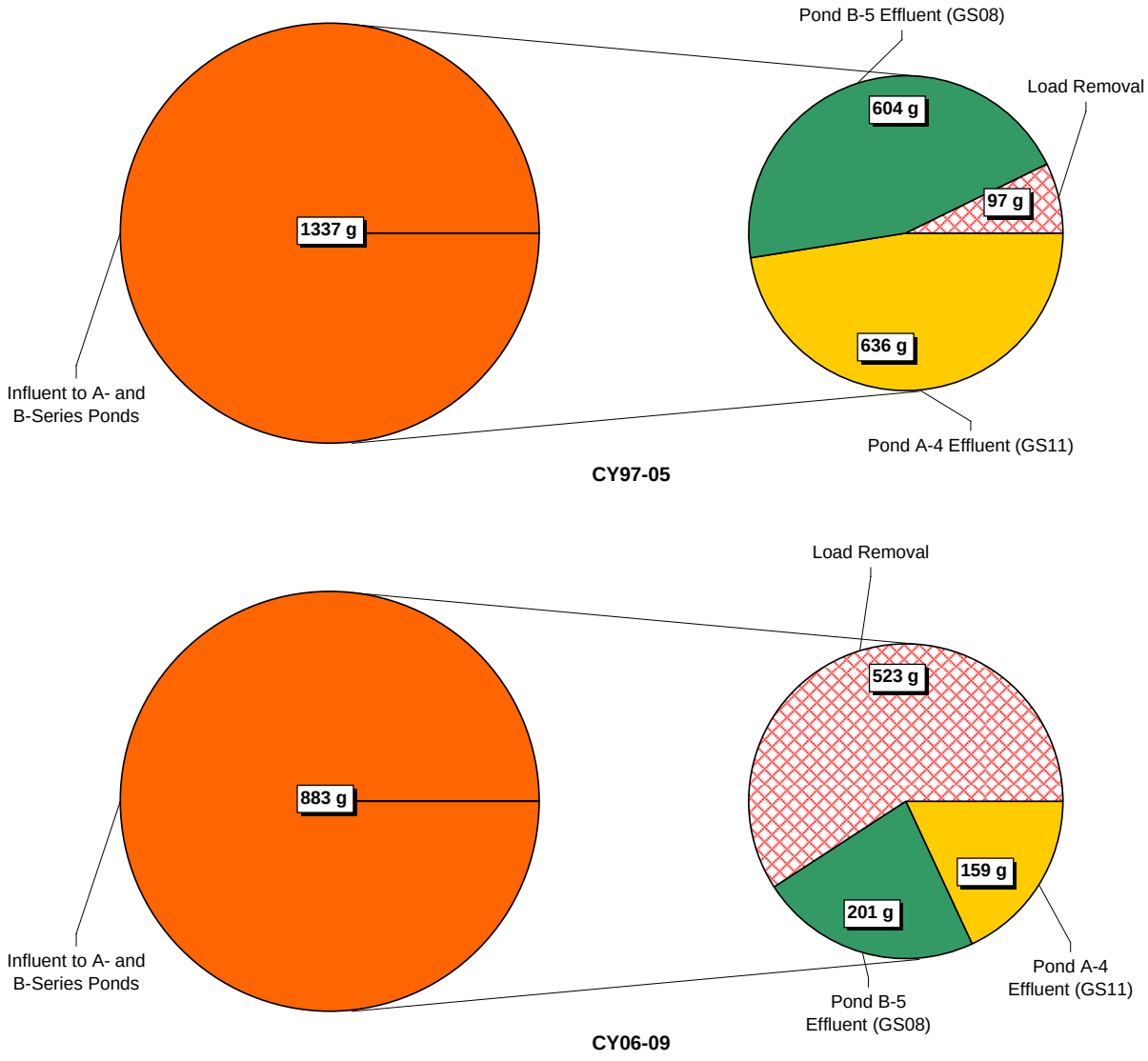


Figure 3–159. Relative Average Annual Total U Load Totals for the A- and B-Series Ponds

Pond C-2 (POC GS31)

This section summarizes the calculated Pu, Am, and total U loads for Pond C-2. Data are presented in Table 3–70, Table 3–71, and Table 3–72, and depicted on Figure 3–160, Figure 3–161, Figure 3–162, Figure 3–163, Figure 3–164, Figure 3–165, Figure 3–166, and Figure 3–167. 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 3–160 and Figure 3–162). 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 enhanced implementation of erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2005−2009.

- Annual total U loads also vary significantly year to year (Figure 3–166).
- There is a measurable pre-closure average annual total U load gain in Pond C-2 (Figure 3–164). This is likely due to groundwater seepage with naturally occurring U entering Pond C-2. Post-closure, there is a similar gain in total U in Pond C-2.

Table 3–70. Pu Load Summary for Terminal Pond C-2: CY 1997–2009

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
Total	1,125.6	88.6

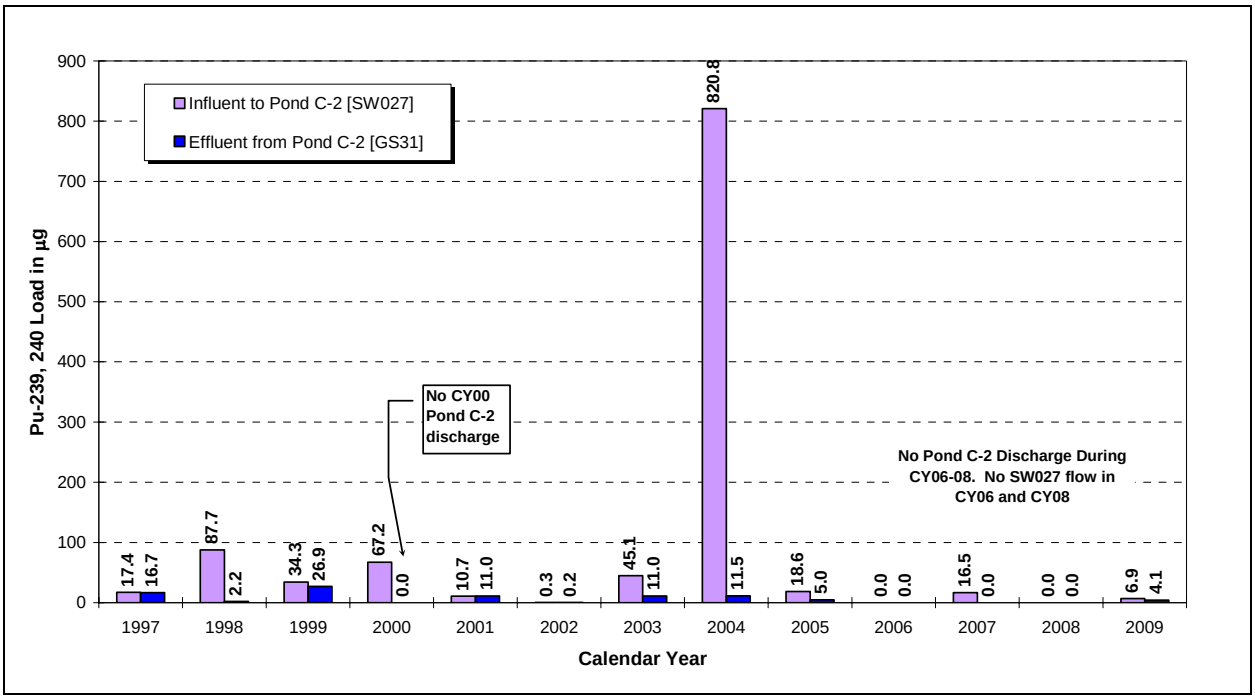


Figure 3–160. Annual Pu Loads for Pond C-2: CY 1997–2009

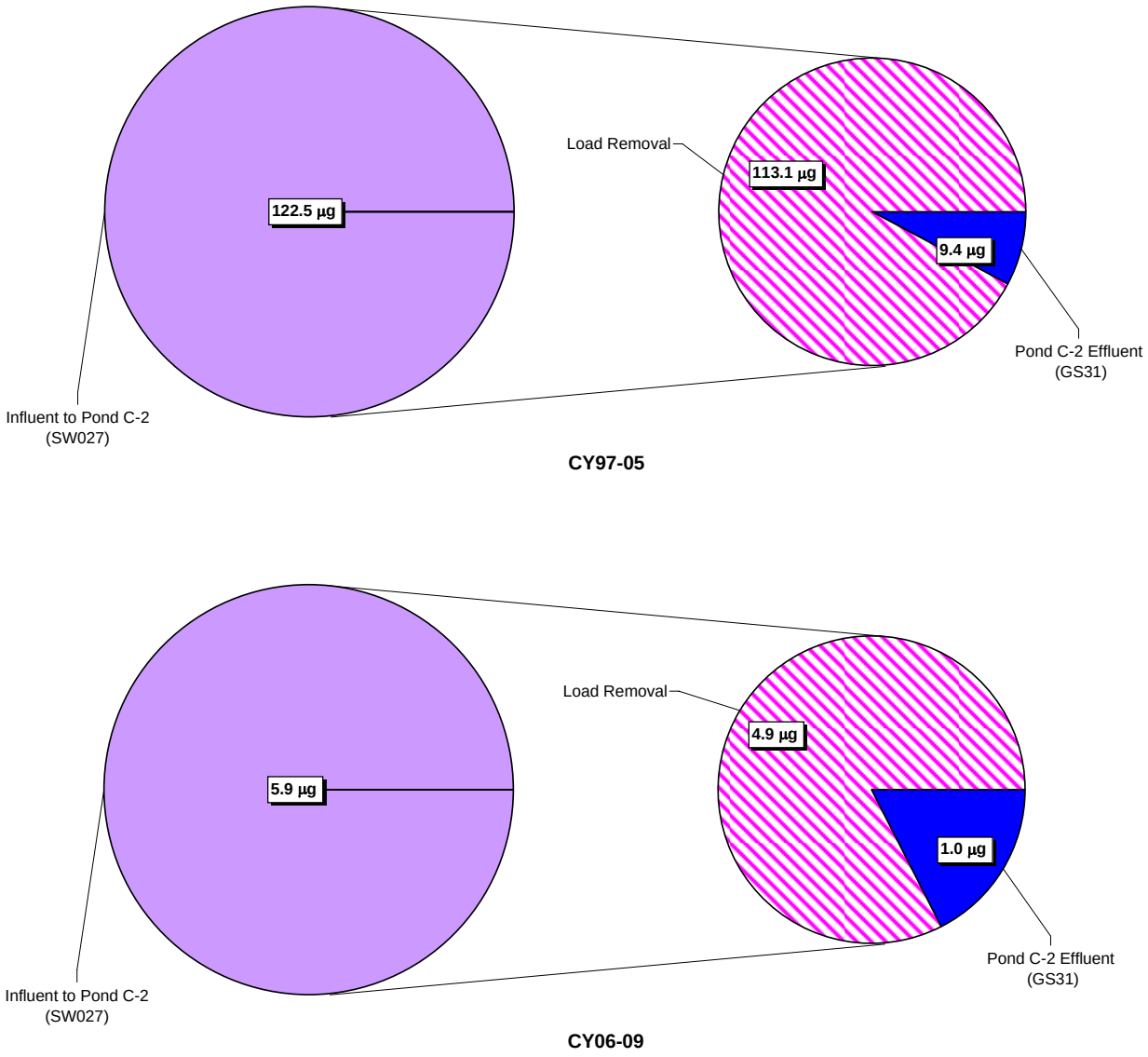


Figure 3–161. Relative Average Annual Pu Load Totals for Pond C-2

Table 3–71. Am Load Summary for Terminal Pond C-2: CY 1997–2009

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
Total	4.27	0.99

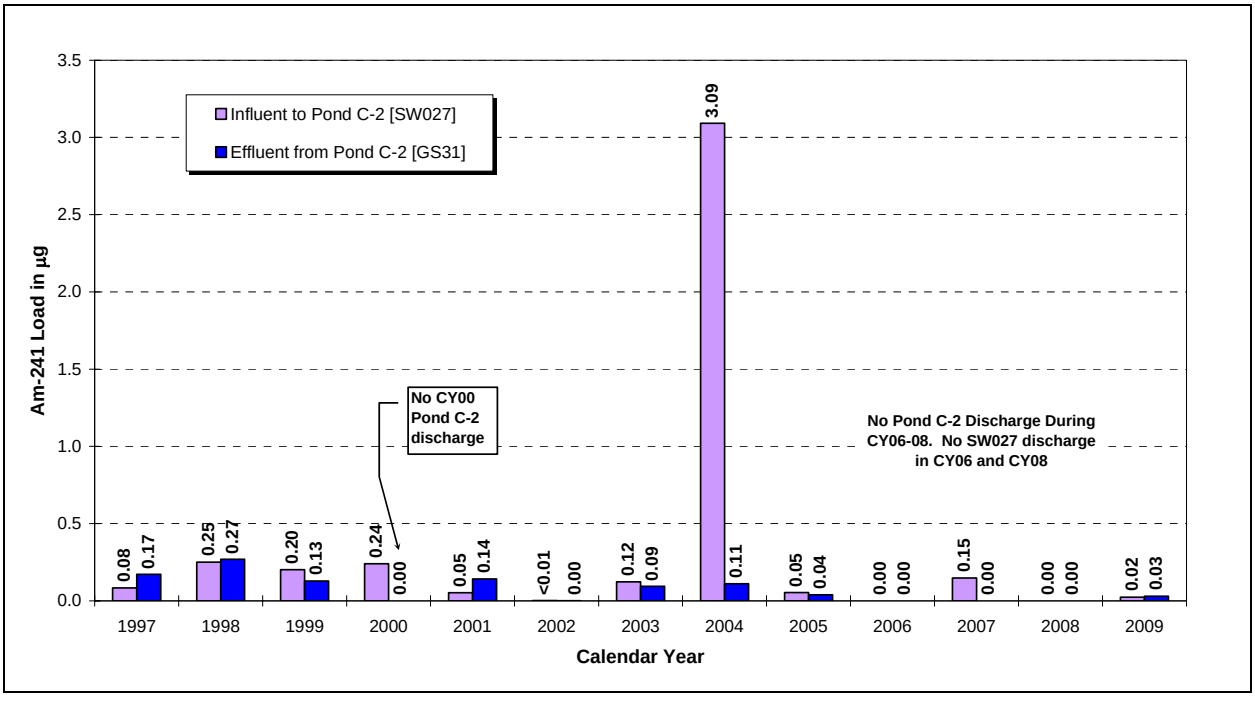


Figure 3–162. Annual Am Loads for Pond C-2: CY 1997–2009

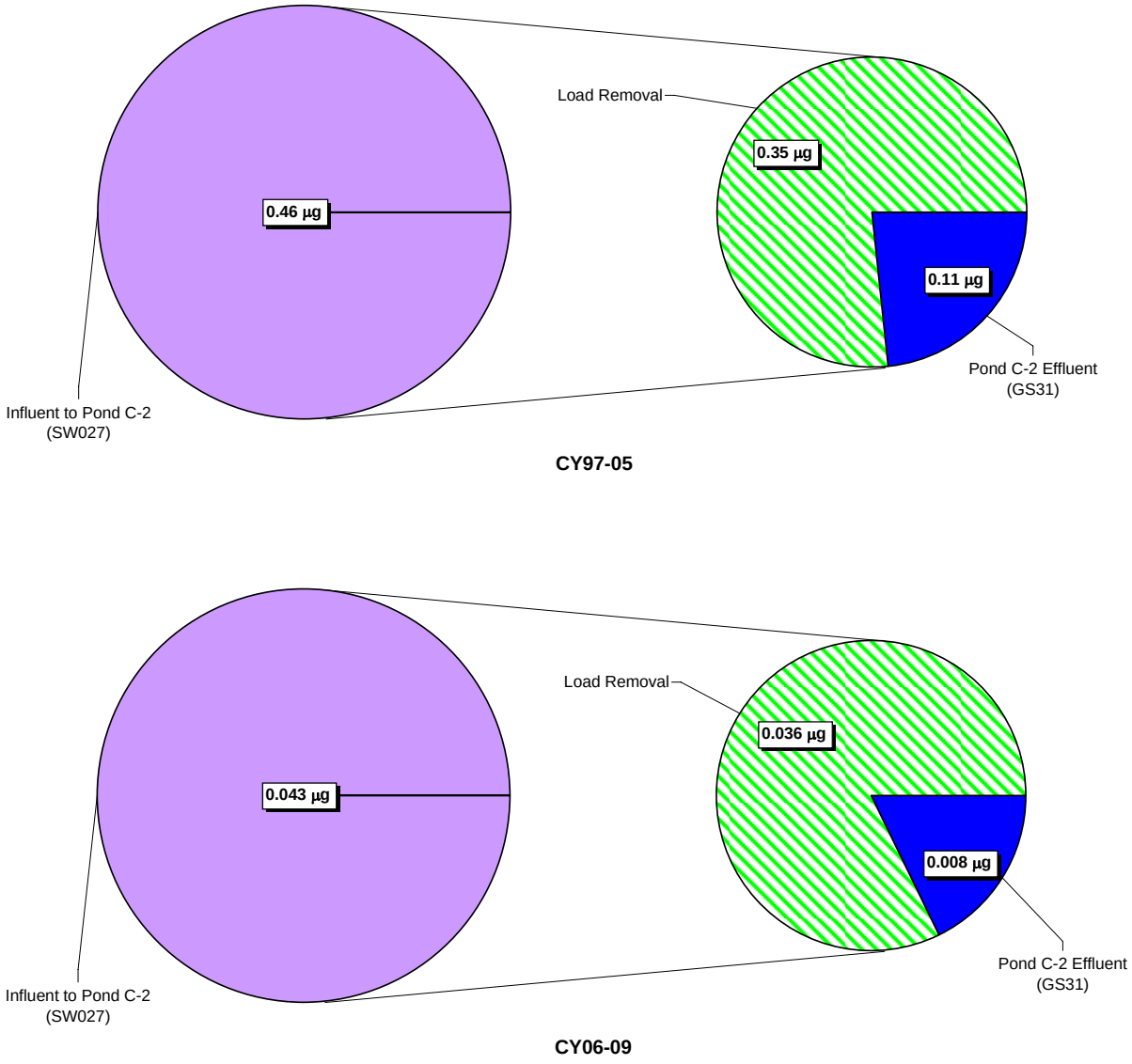
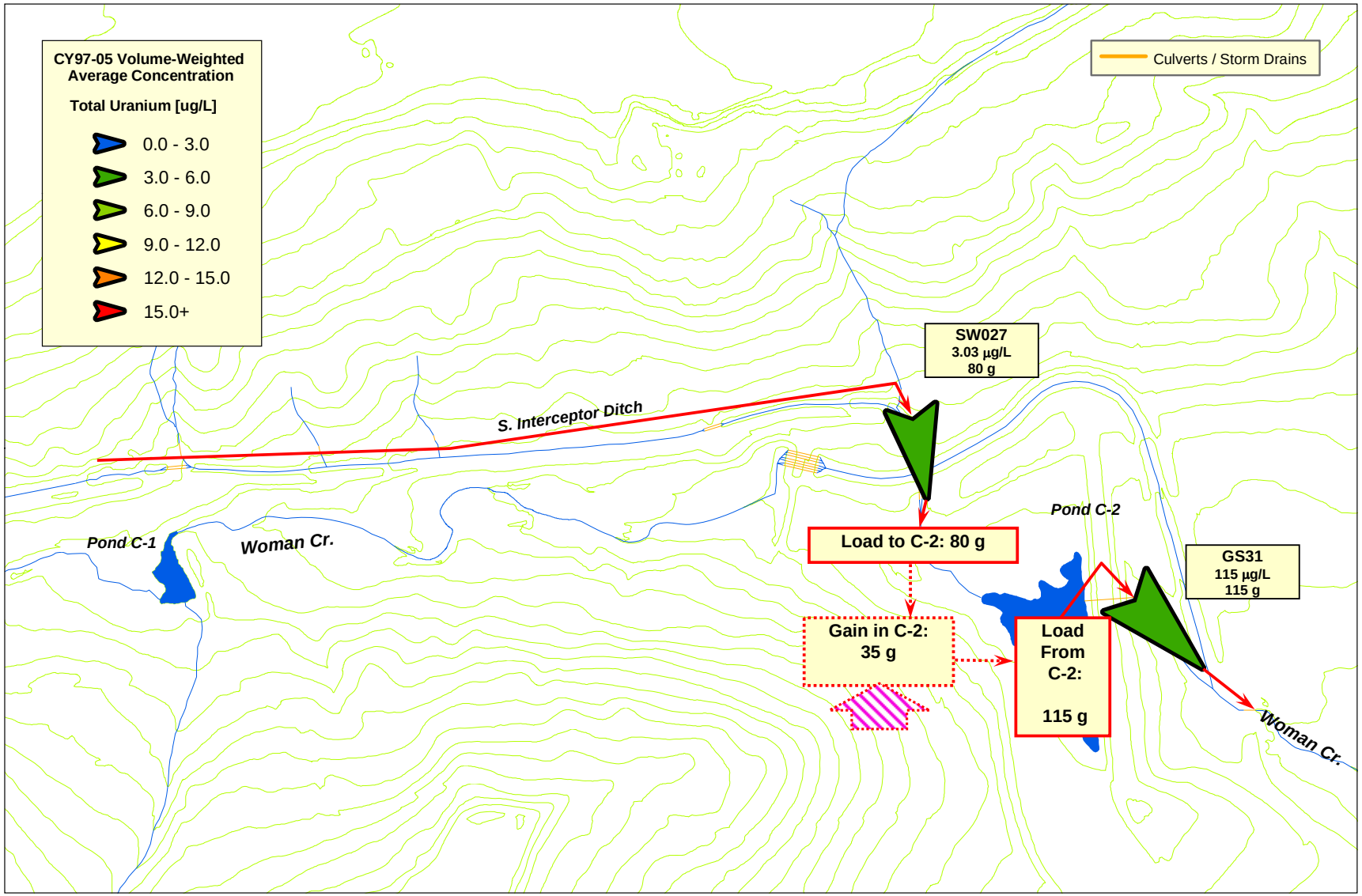


Figure 3–163. Relative Average Annual Am Load Totals for Pond C-2

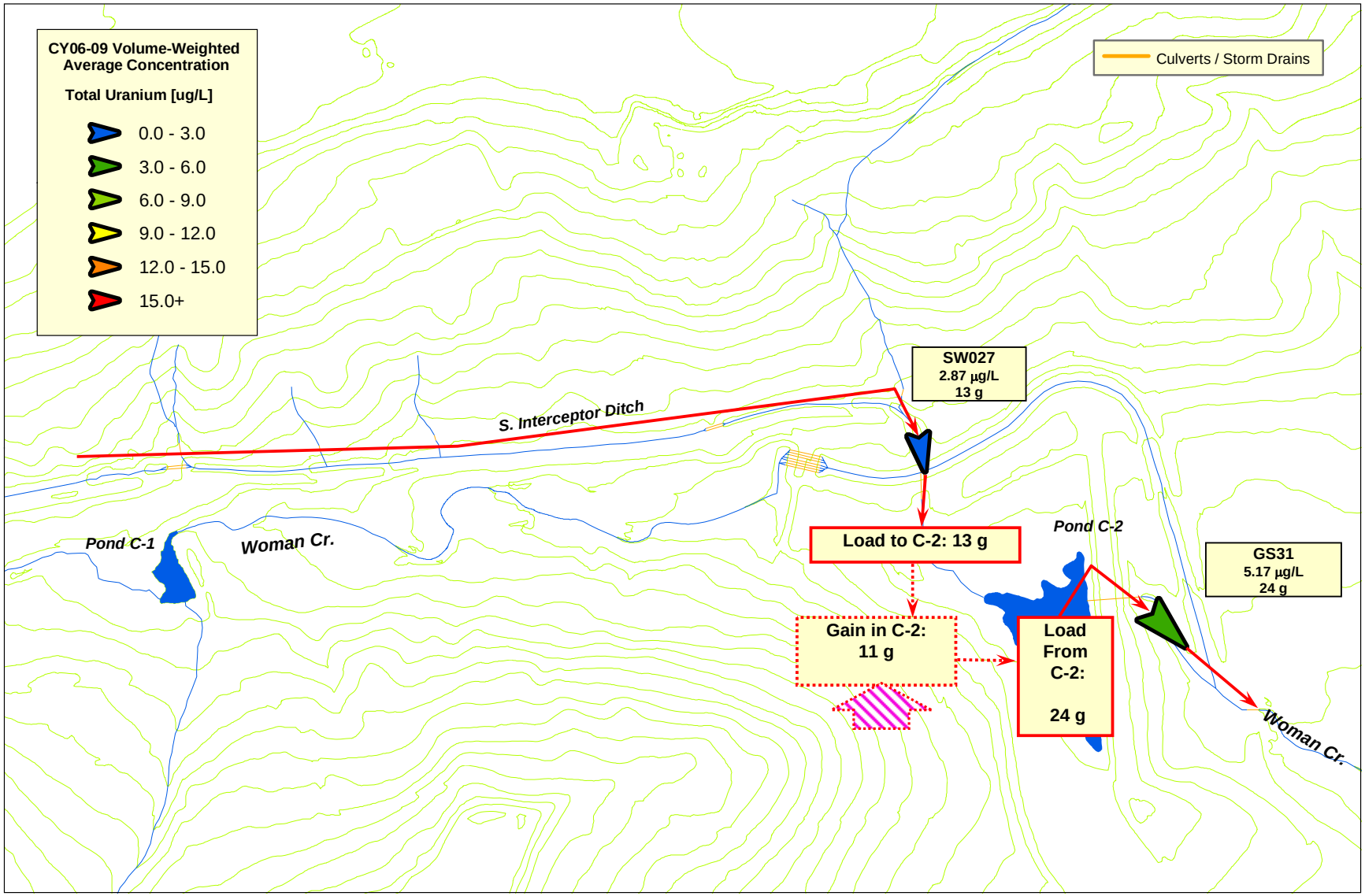
Table 3–72. Total U Load Summary for Terminal Pond C-2: CY 1997–2009

Calendar Year	Total U (g)	
	Influent (SW027)	Effluent (GS31)
1997	84	231
1998	239	216
1999	116	189
2000	22	0.00; No C-2 discharge
2001	66	67
2002	7	1
2003	111	129
2004	40	92
2005	33	115
2006	0; No flow	0; No C-2 discharge
2007	36	0; No C-2 discharge
2008	0; No flow	0; No C-2 discharge
2009	16	95
Total	770	1,133



Note: Location symbols are displayed proportional to calculated average annual load and colored according to concentration ranges in legend.

Figure 3–164. Relative Average Annual U Loading Schematic for Pond C-2: CY 1997–2005



Note: Location symbols are displayed proportional to calculated average annual load and colored according to concentration ranges in legend.

Figure 3–165. Relative Average Annual U Loading Schematic for Pond C-2: CY 2006–2009

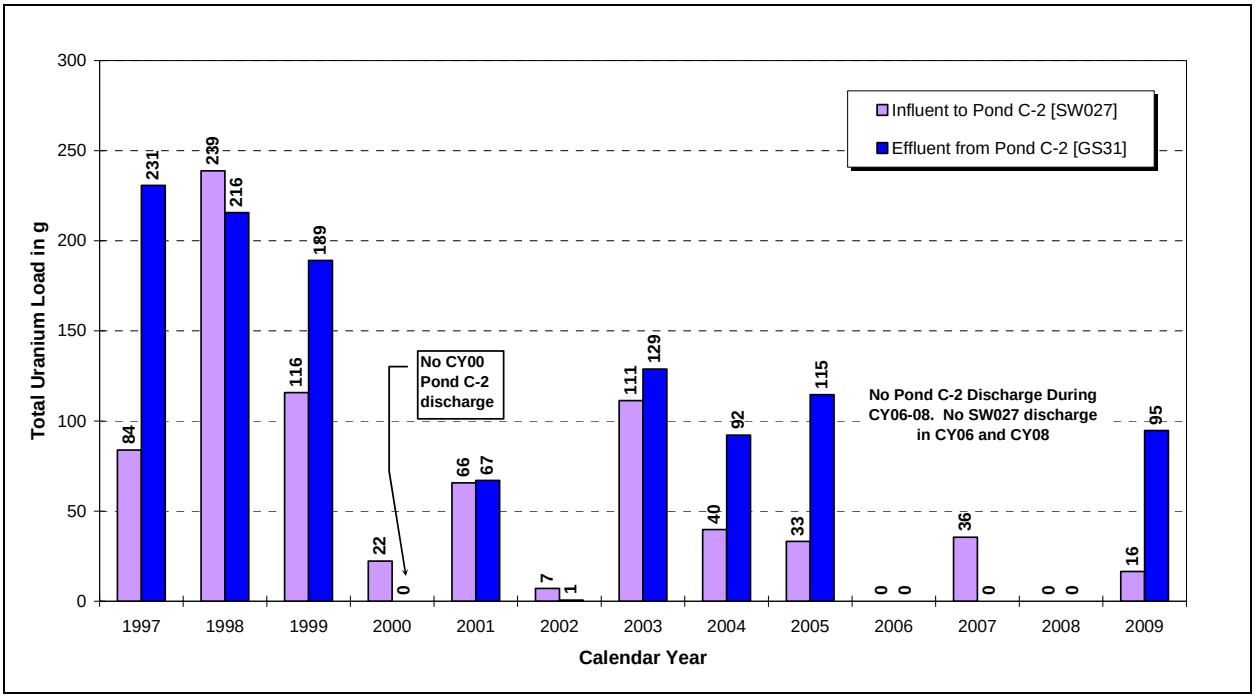


Figure 3–166. Annual Total U Loads for Pond C-2: CY 1997–2009

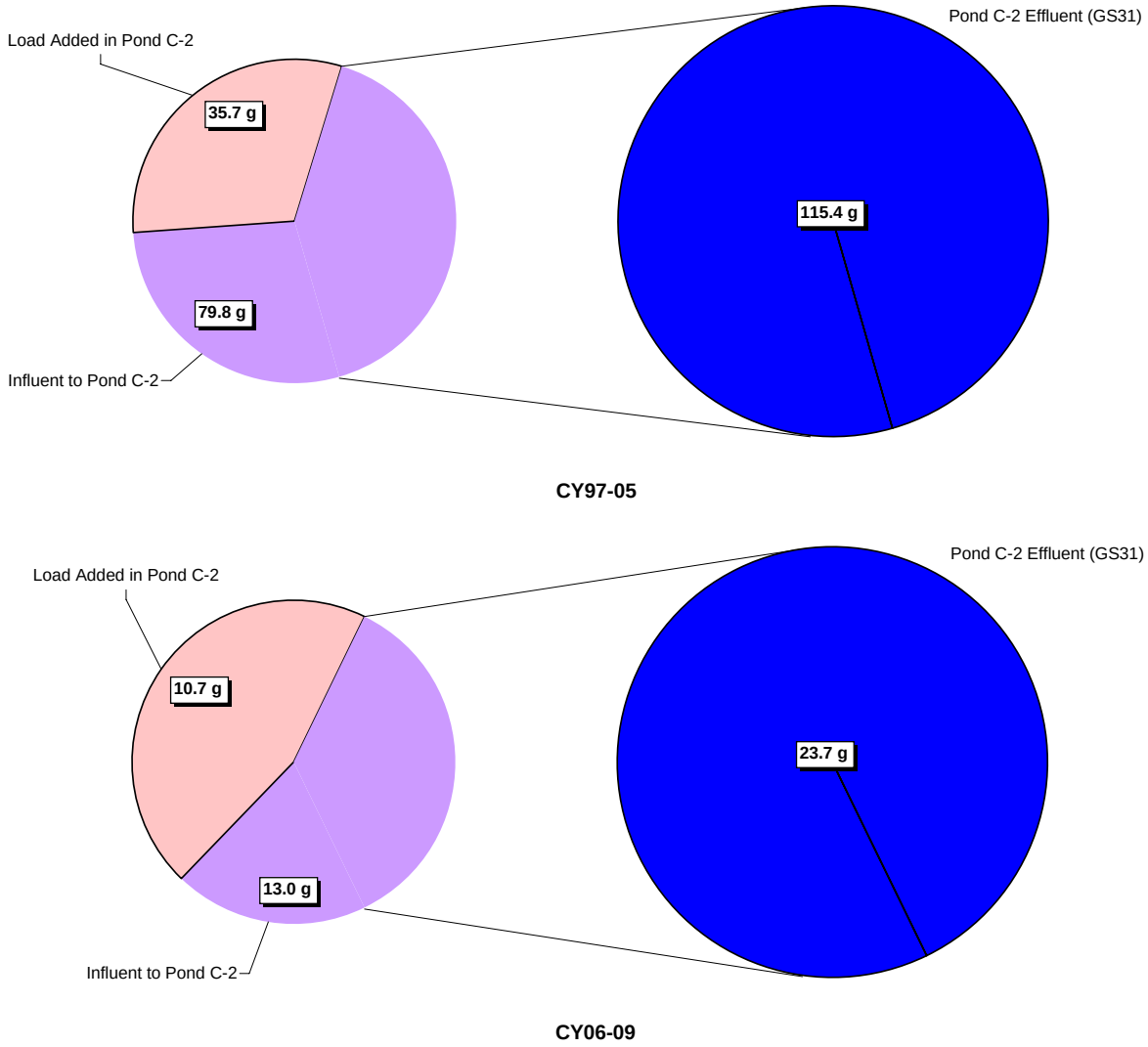


Figure 3–167. Relative Average Annual Total U Load Totals for Pond C-2

RFCA Points of Evaluation

Major COU Drainages

This section summarizes the calculated Pu, Am, and total U loads for the three major COU drainages: North Walnut Creek (SW093), South Walnut Creek (GS10 and the former WWTP), and the SID (SW027). Data are presented in Table 3–73 and Table 3–74 and are depicted on Figure 3–168, Figure 3–169, Figure 3–170, Figure 3–171, Figure 3–172, Figure 3–173, Figure 3–174, Figure 3–175, Figure 3–176, and Figure 3–177. The following points are noted:

- Total Pu load varies year to year and shows a significant increase in CY 2004 due to extensive soil disturbance (Figure 3–168). With the implementation of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2006−2009.
- Total Am load also varies year to year and shows a measurable increase in CY 2004 due to soil disturbance and contributions from the B771 area (Figure 3–170). With the implementation of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2006−2009. Data from SW093 in CY 2005 (Figure 3–175) also clearly show that the B771 pathway elimination was successful.
- South Walnut Creek accounts for a majority (47 percent) of the Pu load from the COU (Figure 3–169) 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, North Walnut Creek is the largest contributor (48 percent) of Pu load; this is attributed to larger streamflow volumes and not higher activities.
- South Walnut Creek accounts for a majority (60 percent) of the Am load from the COU (Figure 3–171) 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, North Walnut Creek accounts for the majority (53 percent) of the Am loads; this is attributed to larger streamflow volumes and not higher activities.
- Annual total U loads are more consistent year to year (Figure 3–176). The load reductions in CY 2006 and 2008 are due to flow volume reduction and not a decrease in U concentration.
- Pre-closure total U loads are fairly evenly divided (44 percent to 50 percent) between North and South Walnut Creeks (Figure 3–177). Post-closure, South Walnut Creek accounts for an increased proportion of the load, due to concentration increases in the drainage.

Table 3–73. COU Pu and Am Loads: CY 1997–2009

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
Total	2,058.5	2,752.3	86.9	1,125.6	39.45	62.04	2.65	4.27

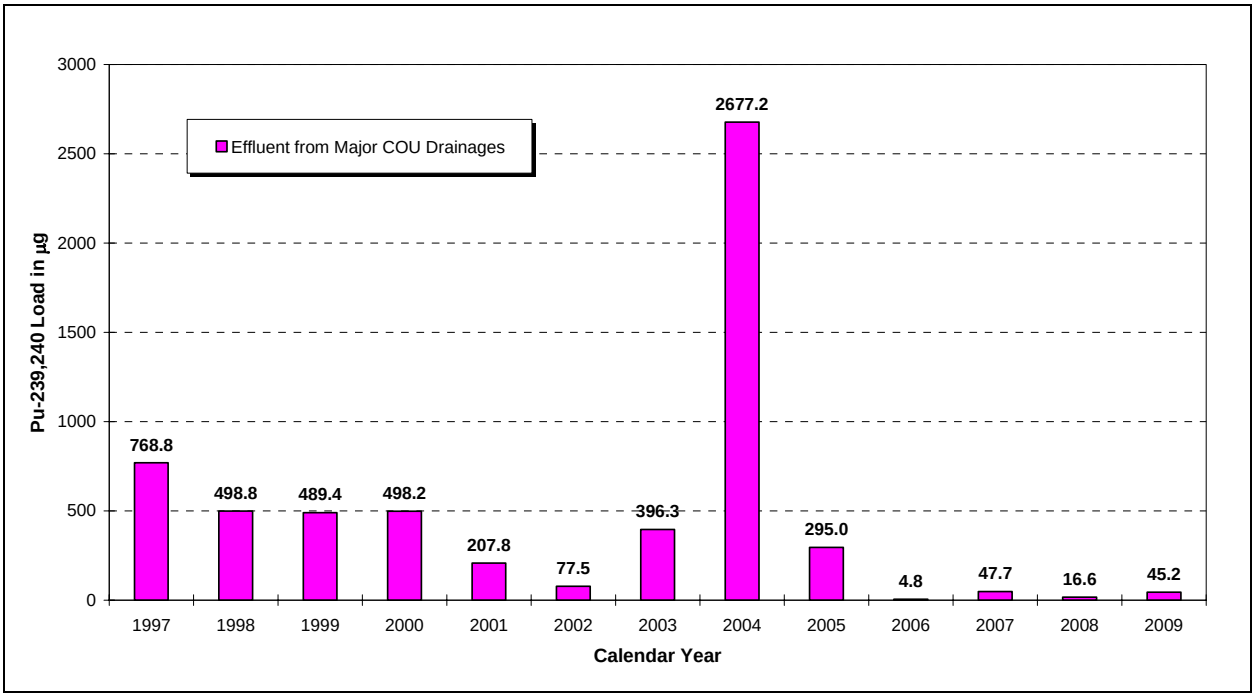


Figure 3–168. Combined Annual Pu Loads from Major COU Drainages and Former WWTP: CY 1997–2009

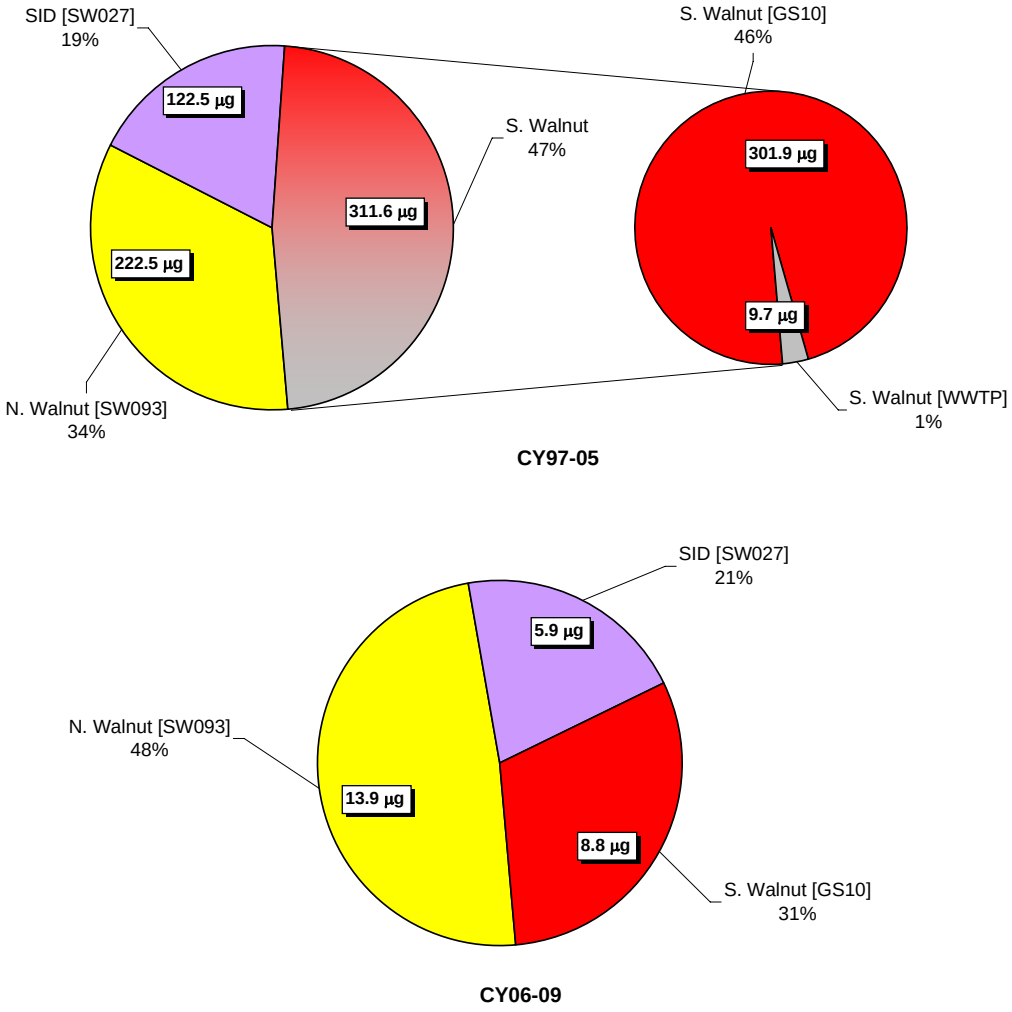


Figure 3–169. Relative Average Annual Pu Load Totals from Major COU Drainages and Former WWTP

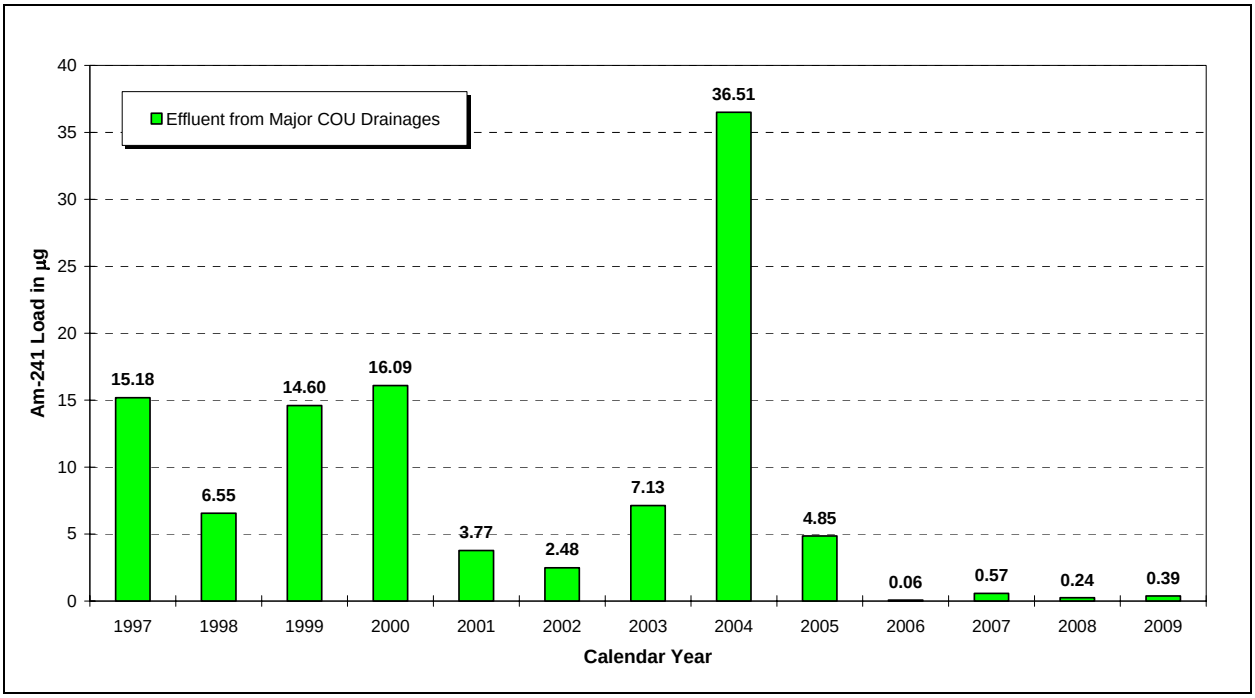


Figure 3–170. Annual Am Loads from Major COU Drainages and WWTP: CY 1997–2009

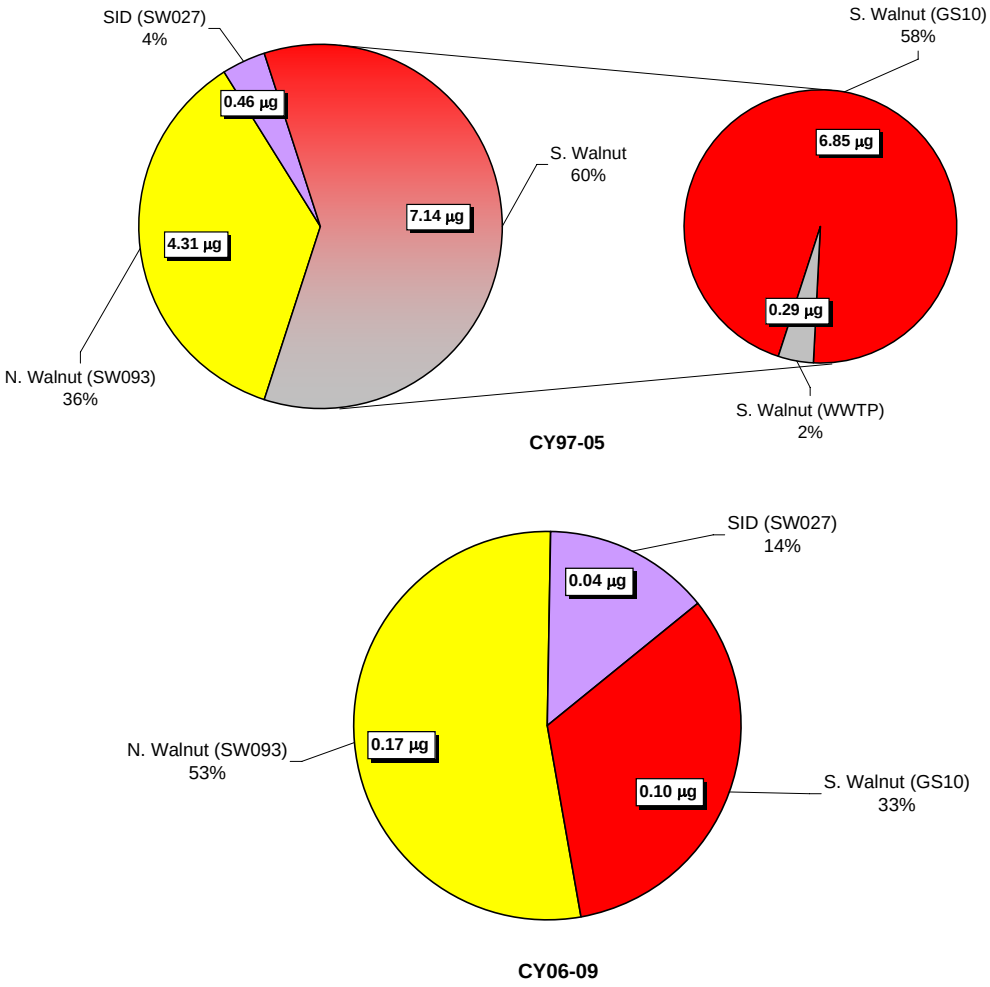


Figure 3–171. Relative Average Annual Am Load Totals from Major COU Drainages and WWTP

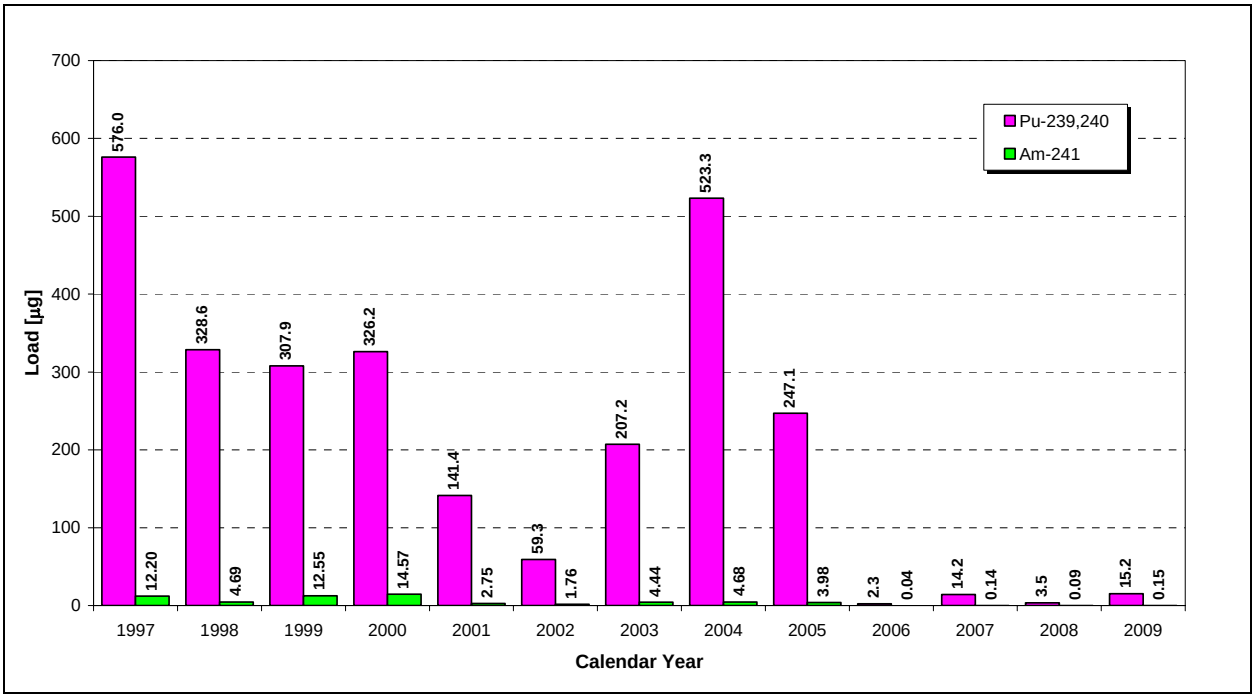


Figure 3–172. Annual Pu and Am Loads at GS10: CY 1997–2009

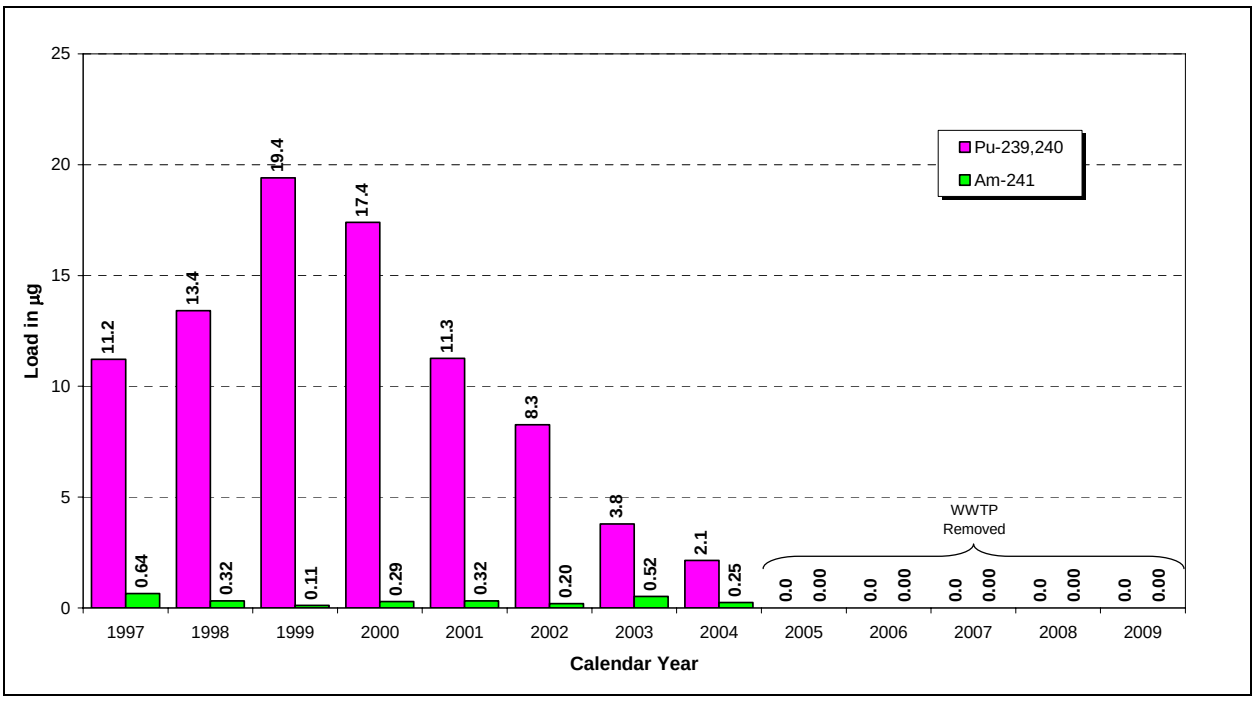


Figure 3–173. Annual Pu and Am Loads at the WWTP: CY 1997–2009

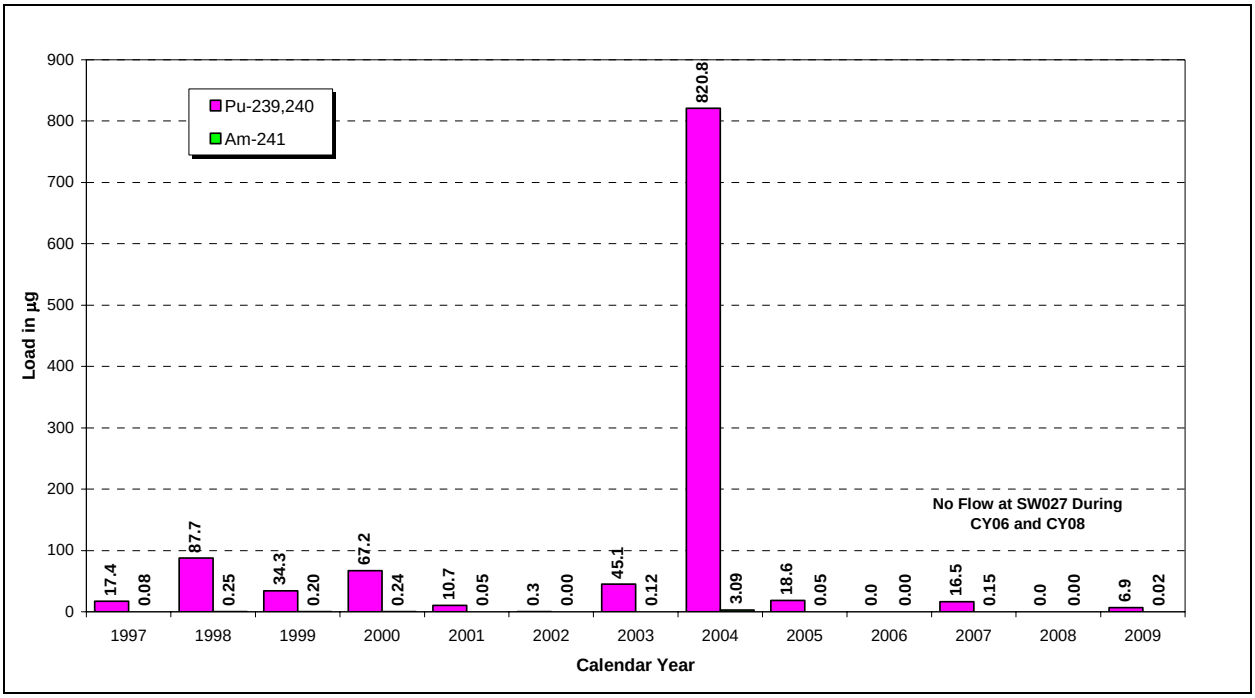


Figure 3–174. Annual Pu and Am Loads at SW027: CY 1997–2009

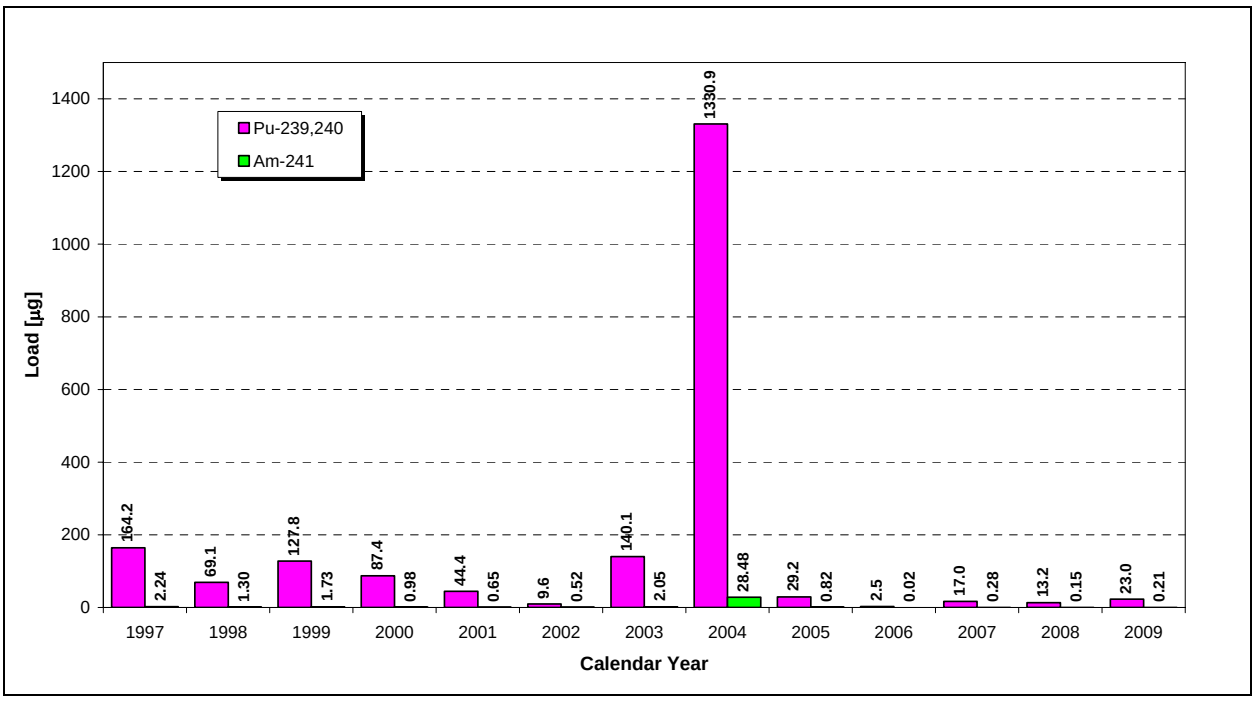


Figure 3–175. Annual Pu and Am Loads at SW093: CY 1997–2009

Table 3–74. COU Total U Loads: CY 1997–2009

Calendar Year	Total U (g)			
	North Walnut Creek (SW093)	South Walnut Creek (GS10)	South Walnut Creek (WWTP)	SID (SW027)
1997	853	637	257	84
1998	797	631	467	239
1999	714	589	121	116
2000	485	379	103	22
2001	646	519	259	66
2002	450	279	61	7
2003	568	501	161	111
2004	575	430	139	40
2005	534	879	0; WWTP removed	33
2006	171	230	0; WWTP removed	0; No flow
2007	540	830	0; WWTP removed	36
2008	154	275	0; WWTP removed	0; No flow
2009	574	756	0; WWTP removed	16
Total	7,061	6,937	1,569	770

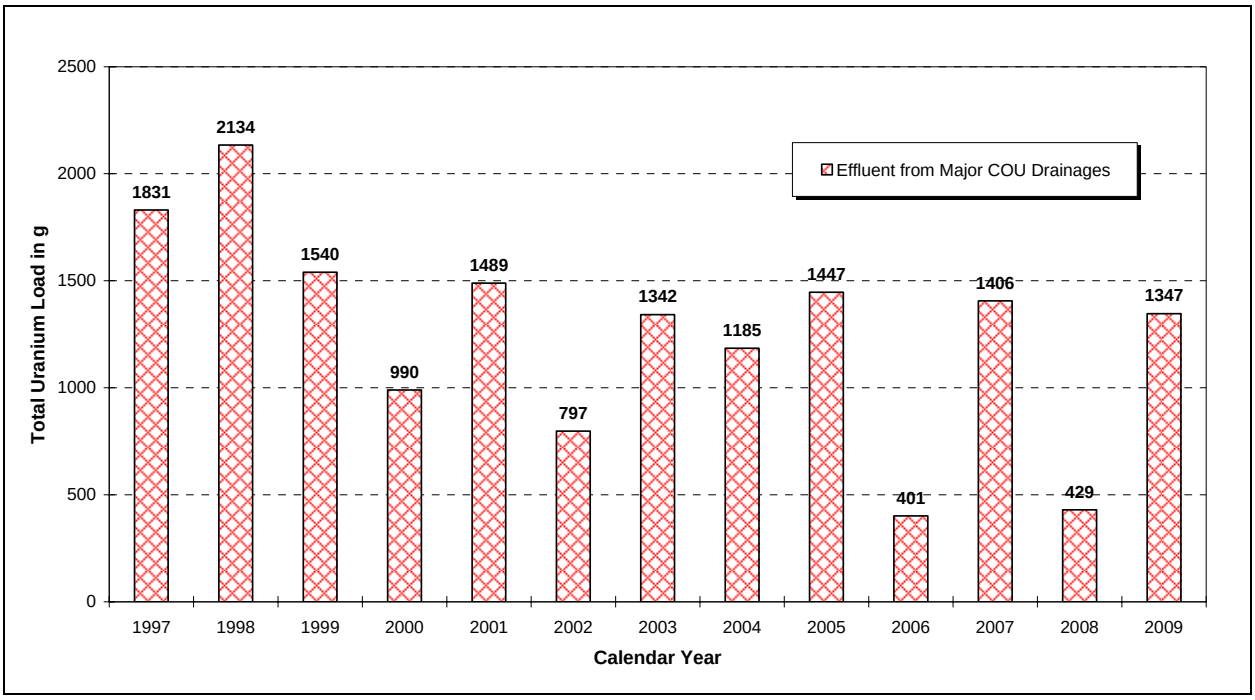


Figure 3–176. Annual Total U Loads from Major COU Drainages and Former WWTP: CY 1997–2009

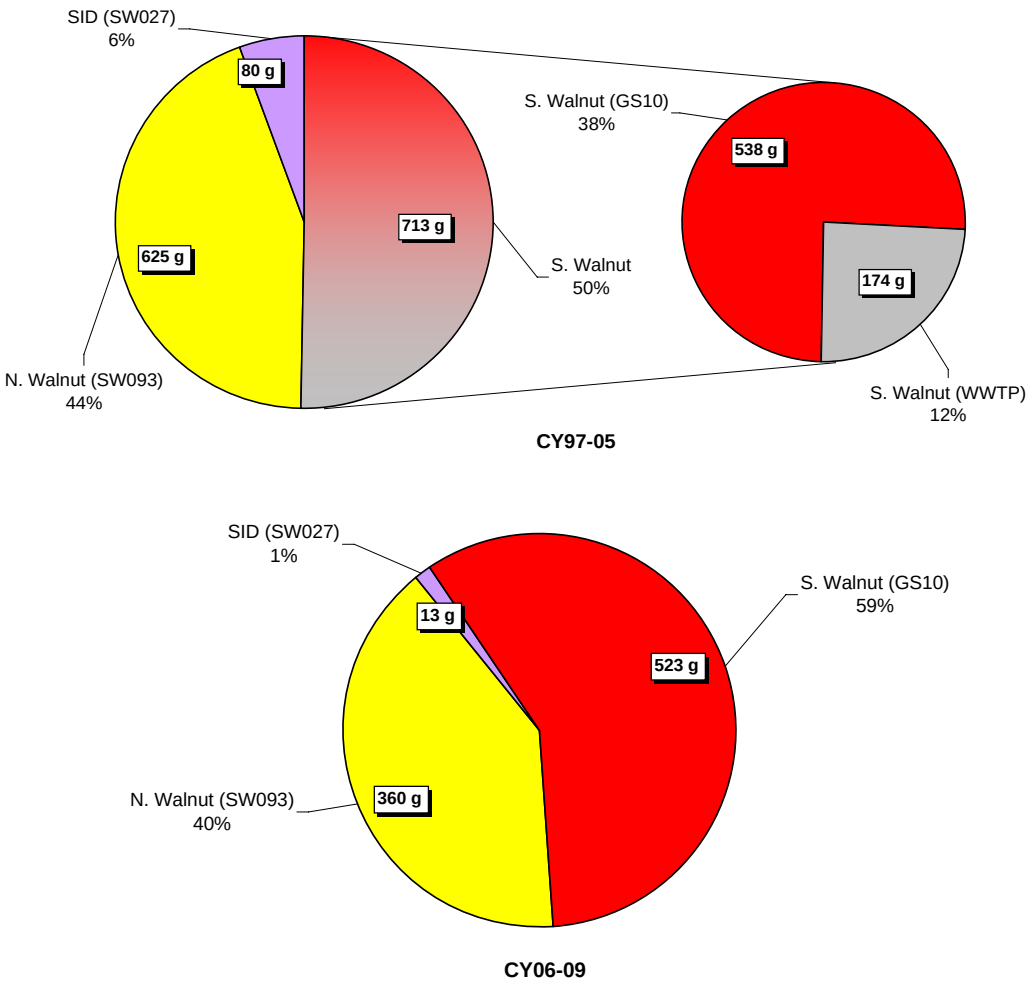


Figure 3–177. Relative Average Annual Total U Loads from Major COU Drainages and Former WWTP

3.1.5 Groundwater Data Interpretation and Evaluation

This section provides a summary of groundwater monitoring performed in 2009, separated into RFLMA-required and non-RFLMA-required. A discussion of groundwater conditions during 2009, focusing on the most important water-quality aspects in the areas of interest (i.e., the main plumes), is then presented.

3.1.5.1 RFLMA Groundwater Monitoring Activities of 2009

Routine activities of the groundwater monitoring program in 2009 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 groundwater treatment system-related performance monitoring locations within streams and ponds; examples of the latter include locations monitoring effluent from a treatment system.) However, because all of these locations support groundwater monitoring objectives, the data collected from them in support of these objectives are included as part of the groundwater discussion.