quarters) are equivalent to those estimated in 2009 (DOE 2010d). Both of these wells were sampled in 2010. Data from AOC well 10304 did include a second-quarter detection of TCE that was well below the corresponding RFLMA Table 1 value (DOE 2007a), with an estimated (J-qualified) concentration of 0.68 µg/L. This is the second detection of TCE reported for this well, the first being from a sample collected in fourth-quarter 2007. TCE was not detected in the subsequent sample collected from this well in the fourth quarter of 2010. Given the consistent estimates of travel time, this TCE detection does not appear indicative of a change in flow conditions. See Section 3.1.5.3 for additional discussion of the 903 Pad/Ryan's Pit Plume.

Overall, groundwater flow paths and flow velocities in 2010 show little change from previous years.

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 2010 potentiometric surface maps are from the 1995 Hydrogeologic Characterization Report (EG&G 1995a). Although this depiction of seeps has been the best available map of the seeps for the Site for several years, it is no longer accurate, having been most strongly affected by the removal of all artificial water sources, as well as land surface reconfiguration (e.g., excavations and placement of fill) in some areas. Thus, efforts to map existing seeps in the COU began in 2010. Although not a rigorous investigation, the project is designed to qualitatively establish the presence of seeps and document their general location.

One observation made during 2010 is that seeps often occur where former building foundations, footer drains, and other features remain that have created preferential pathways for groundwater to reach the surface. This observation supports the design of the monitoring network, which considered the anticipated post-closure groundwater flow directions.

Figure 126 presents the locations where seeps and wet areas were observed during CY 2010. Note that many of the wet areas observed were dry later in the year, including most seeps on the OLF and those identified near the former Building 771 area.

New seeps and wet areas have developed at several locations throughout the COU where wetlands are developing naturally. The *Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan* (DOE 2006b) provides guidance for monitoring mitigation wetlands and reporting. The 2010 results are presented in the *Rocky Flats, Colorado, Site, 2010 Annual Wetland Mitigation Monitoring Report* (DOE 2011c).

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, 2010 (CY 1997–2010) for the locations operational in

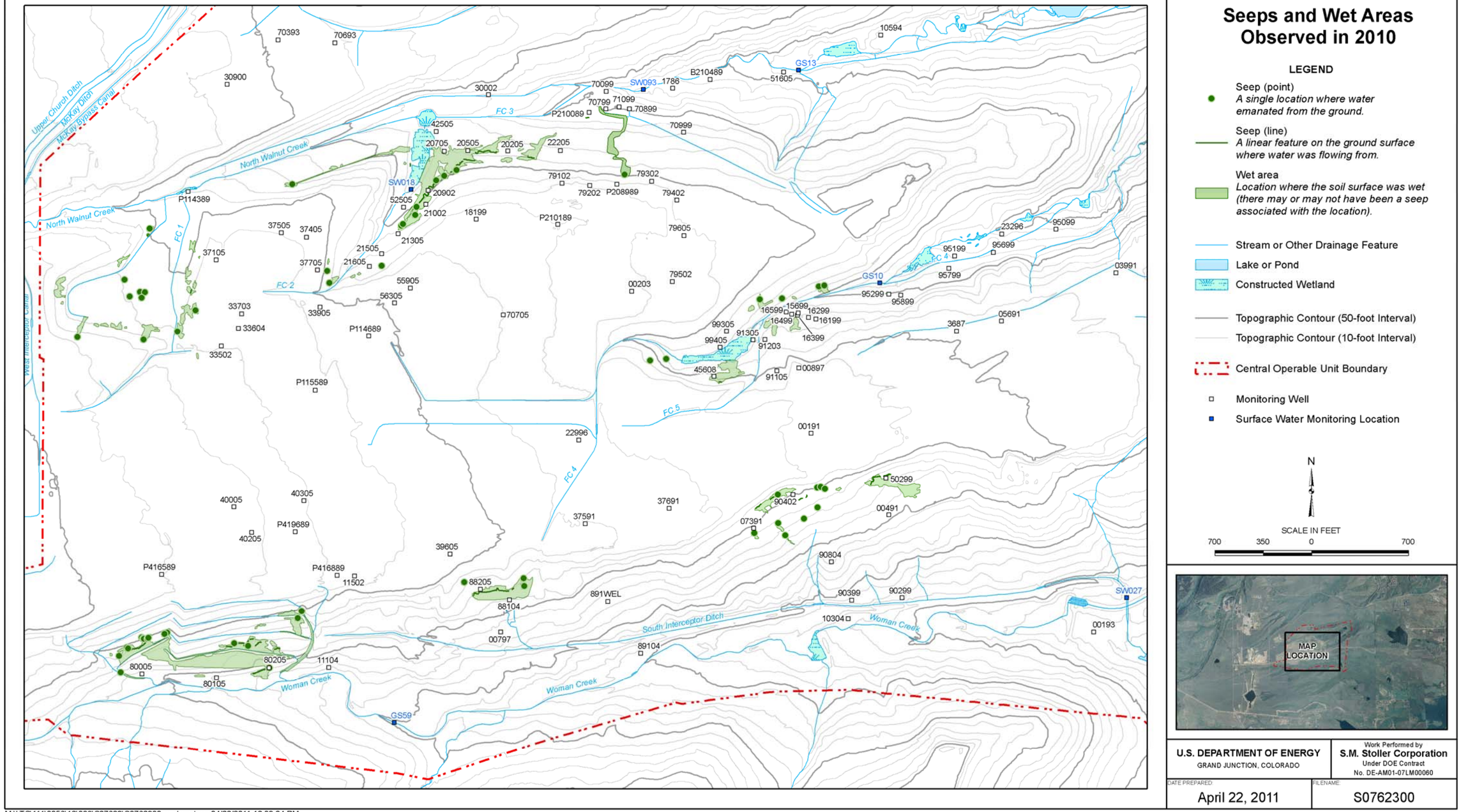

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Figure 126. Seeps and Wet Areas Observed in 2010

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CY 2010. Radionuclides summarized include Pu, Am,[13] and total U. Additionally, the POE metals (total beryllium [Be], dissolved cadmium [Cd], total chromium [Cr], and dissolved silver [Ag]) and nitrate+nitrite as N 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 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 (GS01, GS03, GS08, GS11, and GS31; 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 results that were not rejected through the validation process.[14] 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.[15] 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 [MDA] 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.

Table 40 and Table 41 show that post-closure median Pu activities for all locations, except GS51, are 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, and SW093. Figure 127 and Figure 128 show the pre- and post-closure median Pu activities, respectively.

[13] In this report, "plutonium" or "Pu" refers to plutonium-239,240; and "americium" or "Am" refers to americium-241.
[14] 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.
[15] 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."

Table 39. Summary Statistics for Pu-239,240 Analytical Results in CY 1997—October 13, 2005

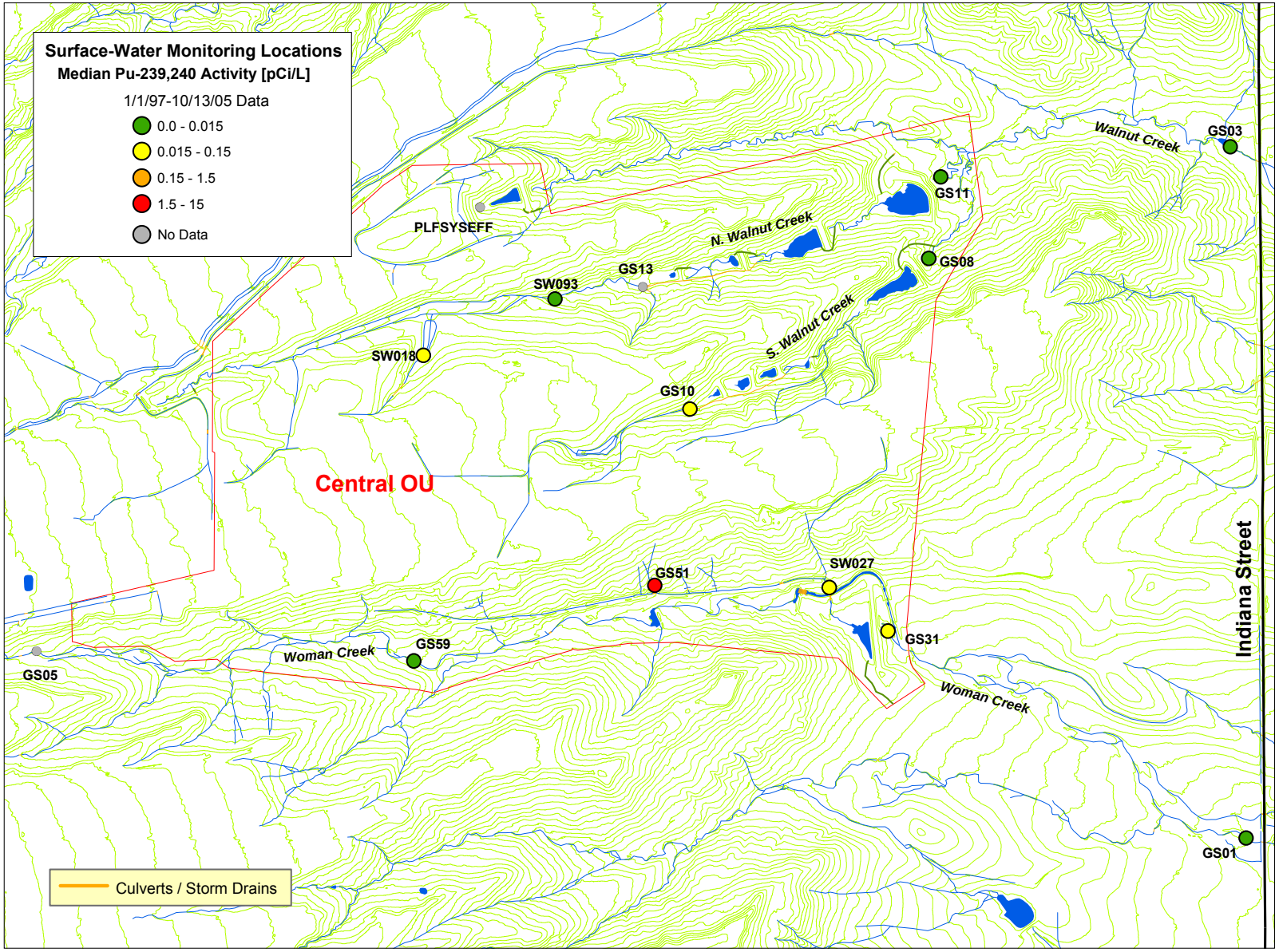
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	**165**	**0.002**	**0.008**	**0.024**
GS03	**257**	**0.005**	**0.016**	**0.220**
GS05	NA	NA	NA	NA
GS08	**118**	**0.004**	**0.013**	**0.864**
GS10	**266**	**0.054**	**0.207**	**2.27**
GS11	**89**	**0.002**	**0.009**	**0.070**
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 40. Post-Closure Summary Statistics for Pu-239,240 Analytical Results (October 13, 2005−December 31, 2010)

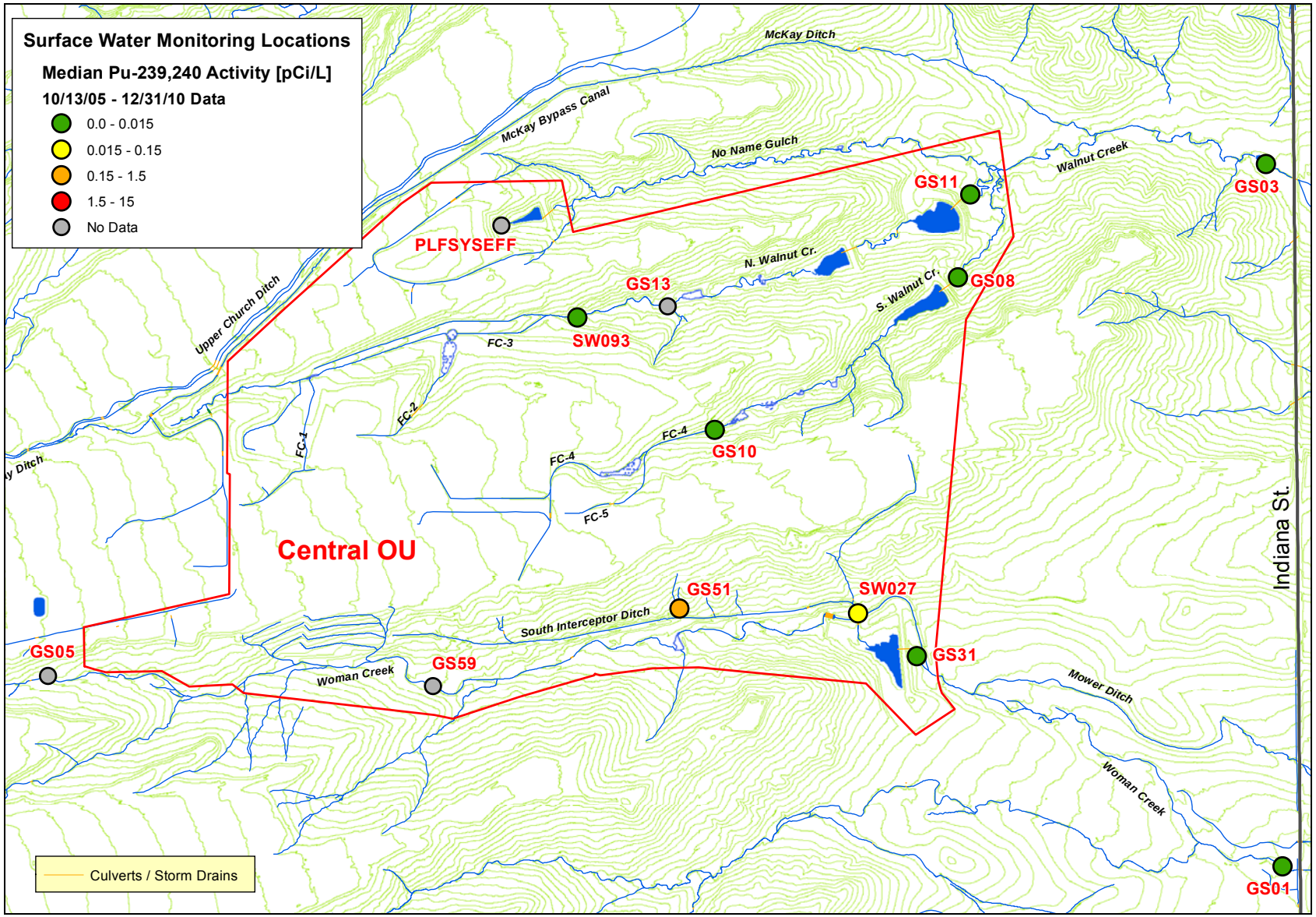
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	**82**	**0.002**	**0.008**	**0.025**
GS03	**58**	**0.003**	**0.007**	**0.036**
GS05	NA	NA	NA	NA
GS08	**26**	**0.003**	**0.008**	**0.017**
GS10	**87**	**0.008**	**0.027**	**0.079**
GS11	**29**	**0.003**	**0.008**	**0.046**
GS13	NA	NA	NA	NA
GS31	**10**	**0.003**	**0.014**	**0.023**
GS51	16	0.922	6.82	13.8
GS59	NA	NA	NA	NA
PLFSYSEFF	NA	NA	NA	NA
SW027	**9**	**0.092**	**0.260**	**0.300**
SW093	**83**	**0.009**	**0.028**	**0.861**

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



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

Figure 127. Median Pu-239,240 Activities for CY 1997—October 13, 2005



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

Figure 128. Post-Closure Median Pu-239,240 Activities

Table 41 and Table 42 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, and SW093. Figure 129 and Figure 130 show median Am activities for pre- and post-closure, respectively.

Table 41. Summary Statistics for Am-241 Analytical Results in CY 1997—October 13, 2005

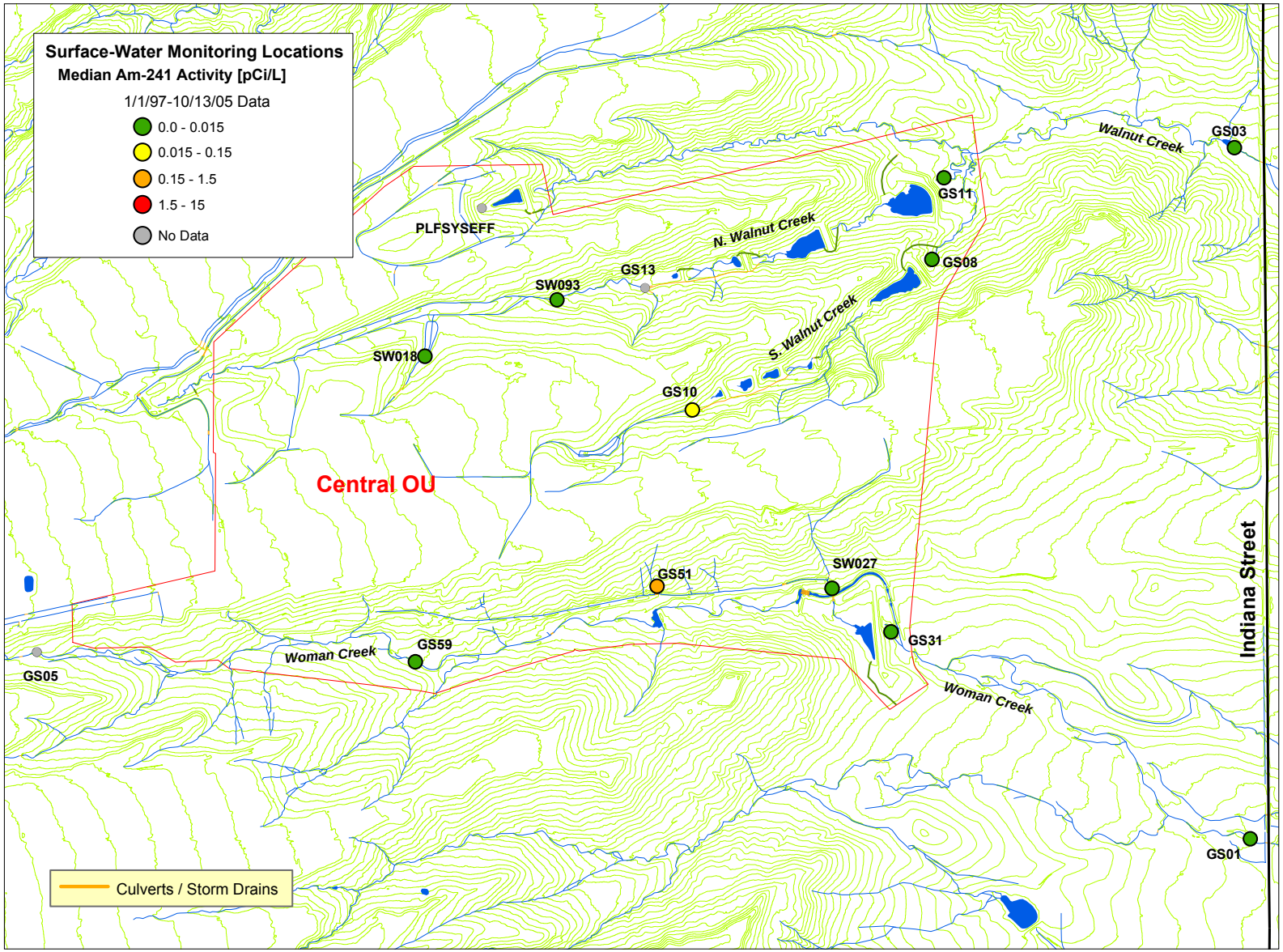
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	**164**	**0.001**	**0.008**	**0.054**
GS03	**258**	**0.006**	**0.018**	**0.066**
GS05	NA	NA	NA	NA
GS08	**118**	**0.006**	**0.015**	**0.275**
GS10	**259**	**0.057**	**0.193**	**8.39**
GS11	**88**	**0.003**	**0.010**	**0.047**
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 42. Post-Closure Summary Statistics for Am-241 Analytical Results (October 13, 2005−December 31, 2010)

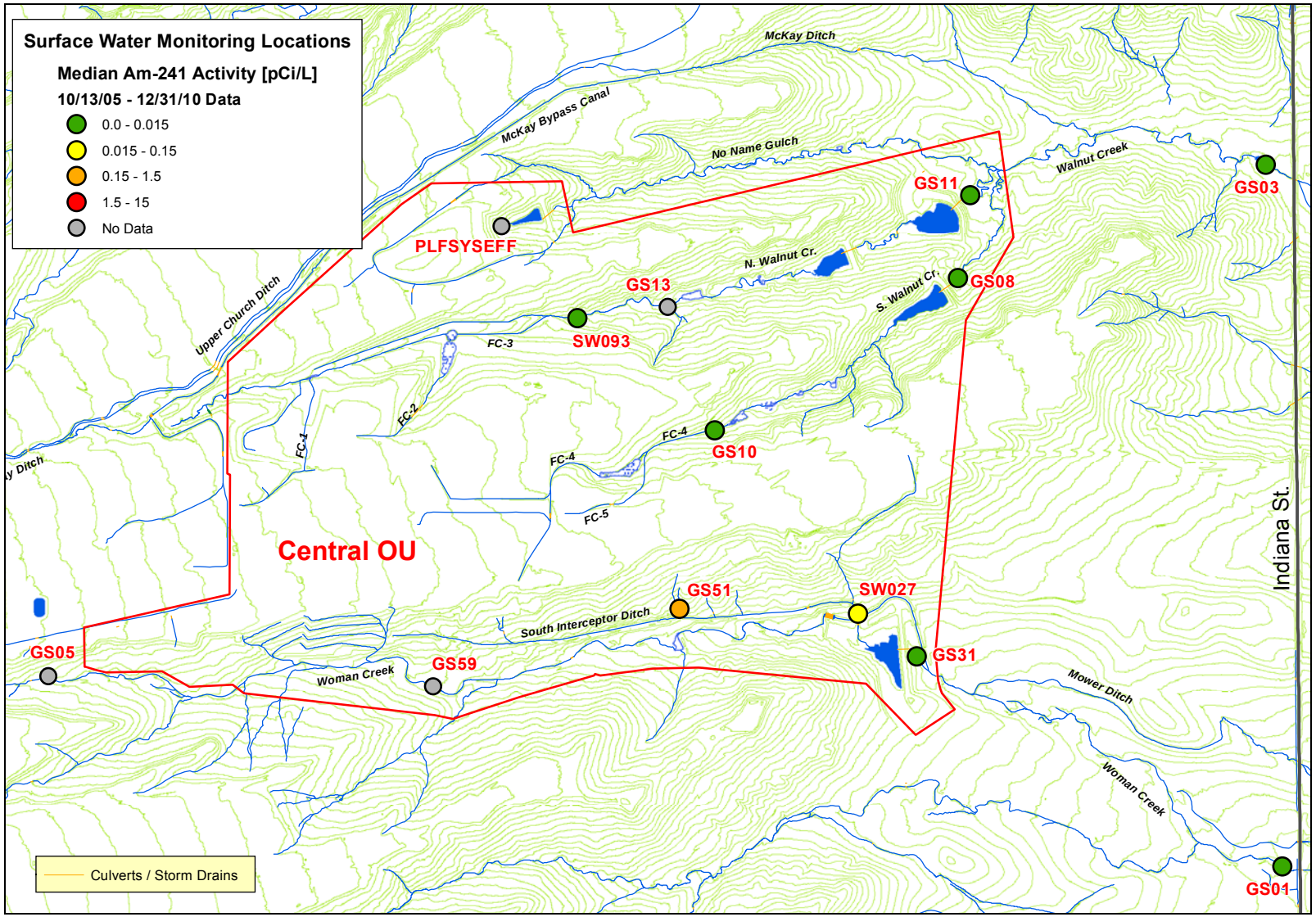
Location	Samples (N)	Median (pCi/L)	85th Percentile (pCi/L)	Maximum (pCi/L)
GS01	**82**	**0.001**	**0.007**	**0.057**
GS03	**58**	**0.002**	**0.007**	**0.027**
GS05	NA	NA	NA	NA
GS08	**26**	**0.001**	**0.009**	**0.012**
GS10	**87**	**0.006**	**0.027**	**0.074**
GS11	**29**	**0.003**	**0.005**	**0.027**
GS13	NA	NA	NA	NA
GS31	**10**	**0.003**	**0.006**	**0.008**
GS51	16	0.198	1.12	3.03
GS59	NA	NA	NA	NA
PLFSYSEFF	NA	NA	NA	NA
SW027	**9**	**0.016**	**0.048**	**0.053**
SW093	**83**	**0.007**	**0.019**	**0.357**

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



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

Figure 129. Median Am-241 Activities for CY 1997—October 13, 2005



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

Figure 130. Post-Closure Median Am-241 Activities

Table 43 and Table 44 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. Recent observations also indicate that SW093 is periodically influenced by surface seepage from the SPPTS hillside area. In addition, the measurements at GS10 and SW093 are influenced by contributions of naturally occurring U in groundwater and hydrologic changes post-closure. These U concentrations can also be seen in samples collected at downstream locations GS11, GS08, and GS03. Figure 131 and Figure 132 show median total U activities for pre- and post-closure, respectively.

Table 43. Summary Statistics for Total U Analytical Results in CY 1997—October 13, 2005

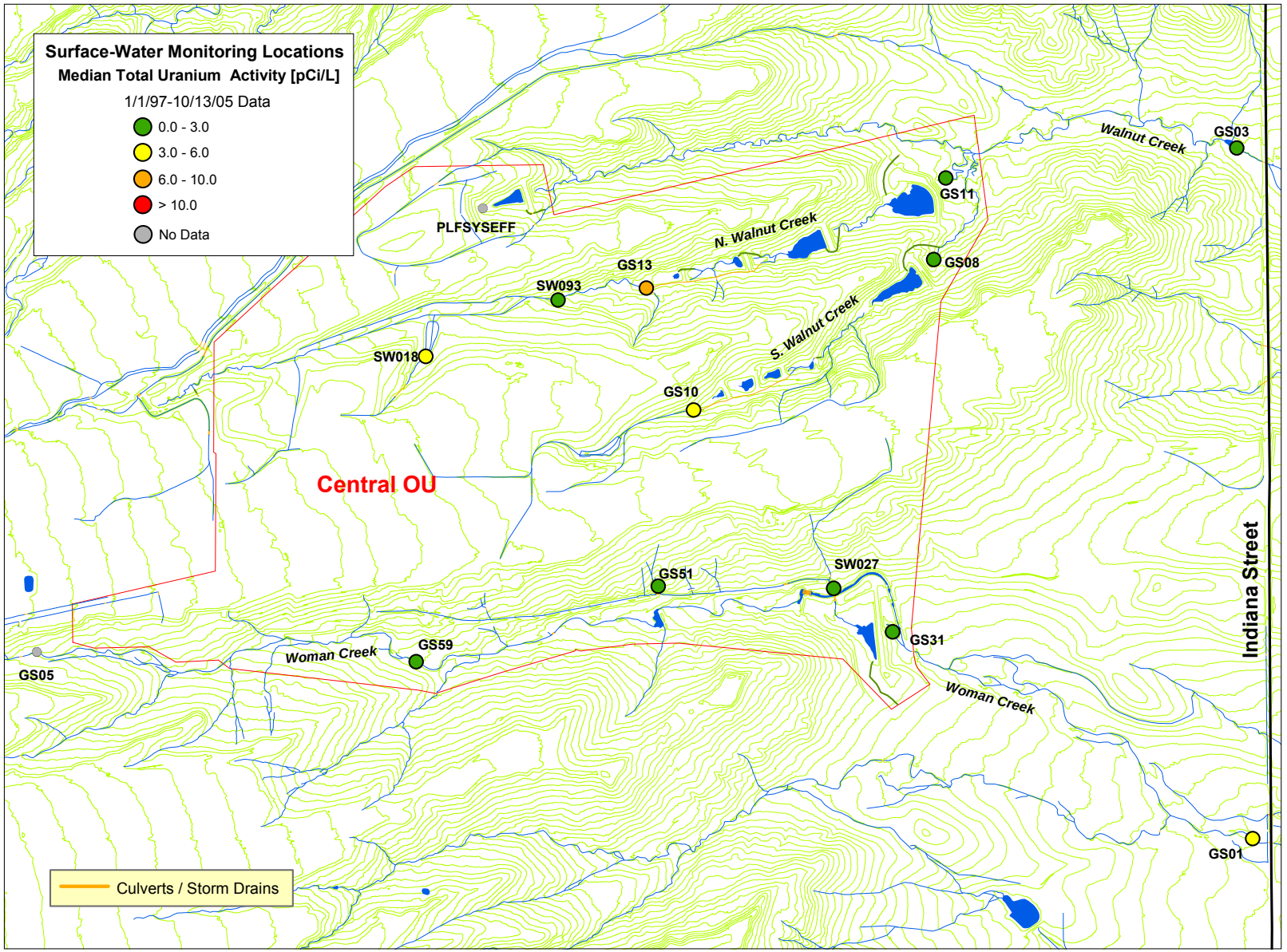
Location	Samples (N)	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
GS01	**53**	**4.29**	**6.51**	**11.9**
GS03	**78**	**2.37**	**4.48**	**7.64**
GS05	NA	NA	NA	NA
GS08	**118**	**1.83**	**3.09**	**9.88**
GS10	**266**	**4.48**	**7.15**	**20.5**
GS11	**89**	**3.00**	**4.29**	**5.62**
GS13	68	11.7	17.2	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 44. Post-Closure Summary Statistics for Total U Analytical Results (October 13, 2005−December 31, 2010)

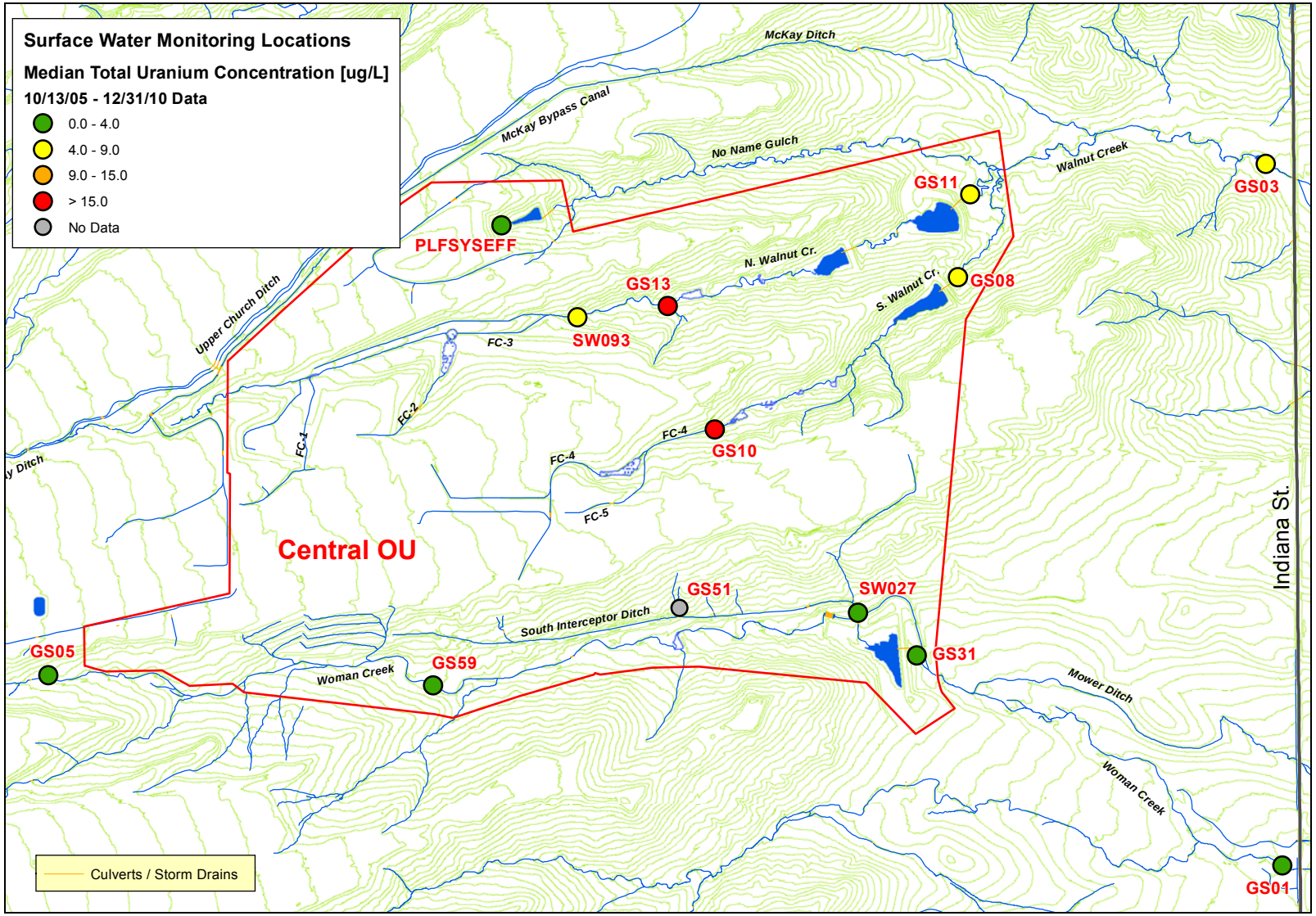
Location	Samples (N)	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
GS01	**82**	**3.69**	**6.54**	**9.09**
GS03	**58**	**5.54**	**8.29**	**10.2**
GS05	41	0.72	1.48	4.67
GS08	**26**	**8.83**	**13.5**	**15.1**
GS10	**87**	**16.5**	**22.8**	**41.9**
GS11	**29**	**6.57**	**10.1**	**11.8**
GS13	69	19.0	43.3	63.6
GS31	**10**	**2.66**	**5.19**	**5.66**
GS51	NA	NA	NA	NA
GS59	40	1.11	2.16	7.01
PLFSYSEFF	21	1.80	6.87	11.8
SW027	**9**	**3.36**	**6.08**	**7.07**
SW093	**83**	**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 131. Median Total U Activities for CY 1997—October 13, 2005



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

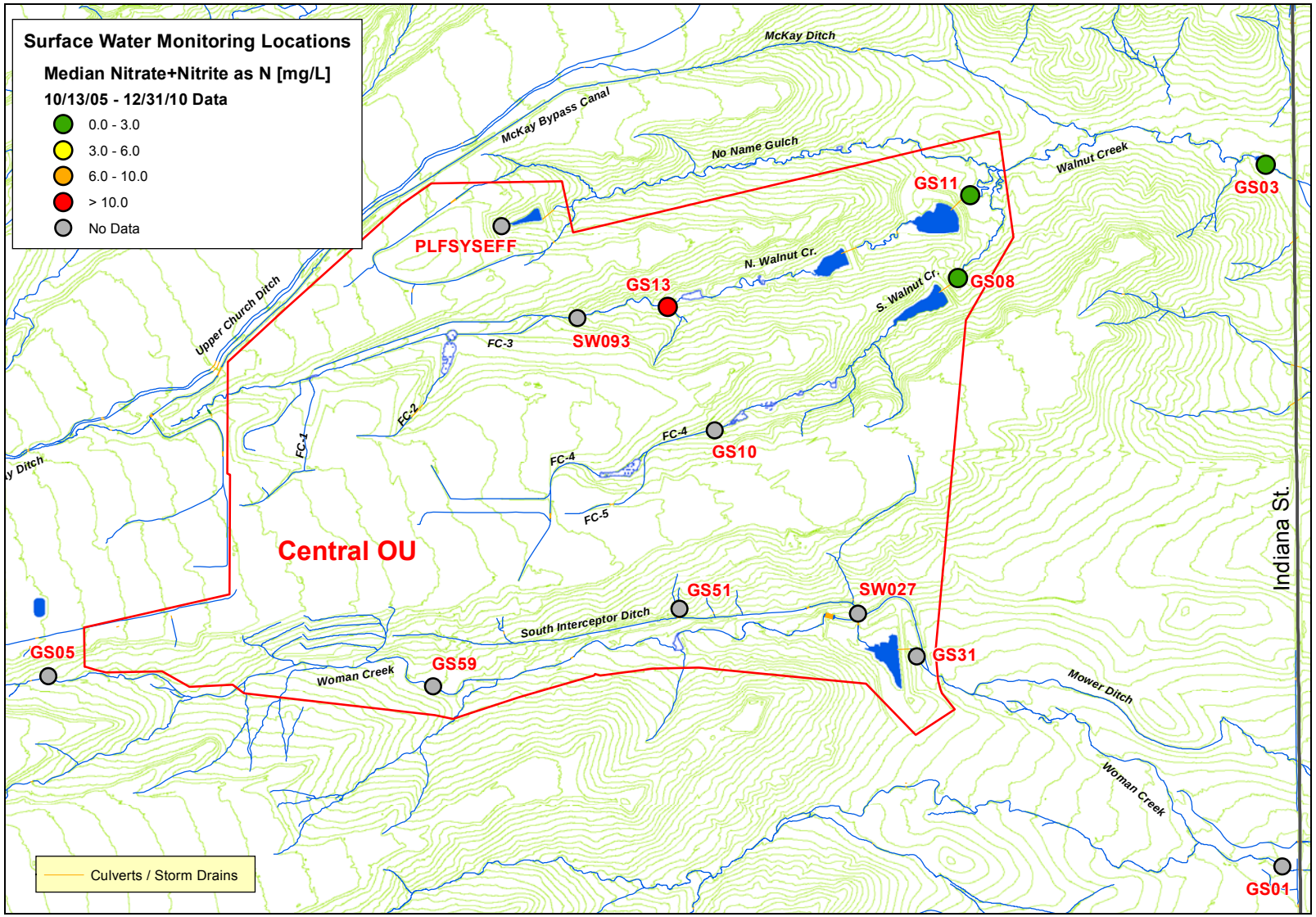
Figure 132. Post-Closure Median Total U Activities

Table 45 and Figure 133 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 groundwater associated with the SPPTS.

Table 45. Post-Closure Summary Statistics for Nitrate+Nitrite as Nitrogen Analytical Results (October 13, 2005−December 31, 2010)

Location	Samples (N)	Median (mg/L)	85th Percentile (mg/L)	Maximum (mg/L)
GS03	**36**	**0.30**	**3.59**	**6.55**
GS08	**26**	**0.11**	**0.34**	**0.73**
GS11	**29**	**1.62**	**5.95**	**8.20**
GS13	51	28.0	71.0	100

Notes: Bold type = POC or POE



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

Figure 133. Post-Closure Median Nitrate+Nitrite as Nitrogen Concentrations

Table 46 and Table 47 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 134 and Figure 135 present pre- and post-closure average Am/Pu ratios, respectively.

Table 46. Average Pu/Am Ratios for Analytical Results in CY 1997—October 13, 2005

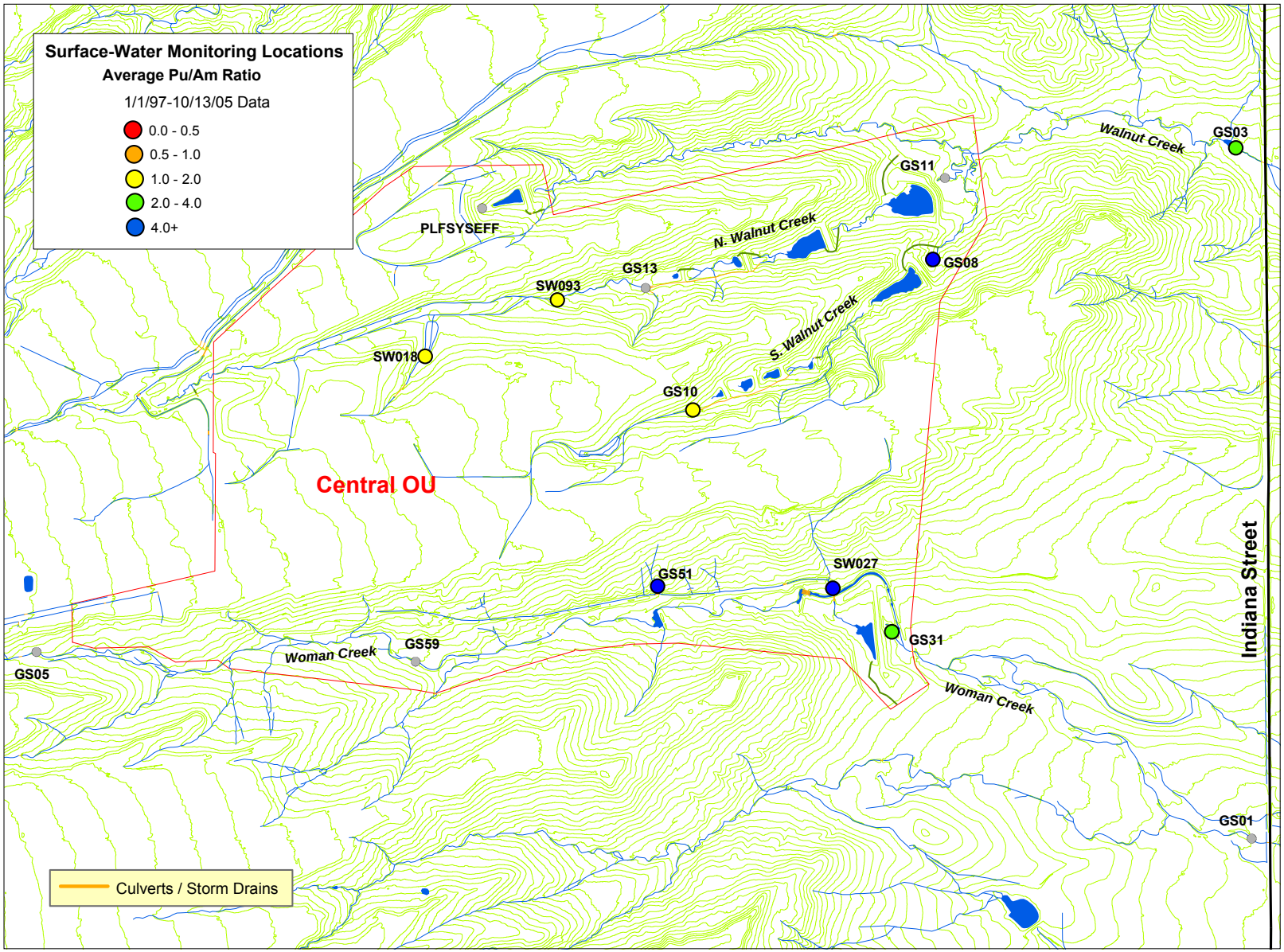
Location	Samples (N)[a]	Average Pu/Am Ratio
GS01	**1**	**1.5**
GS03	**14**	**2.1**
GS05	NA	NA
GS08	**5**	**8.9**
GS10	**196**	**1.3**
GS11	*	*
GS13	NA	NA
GS31	**4**	**3.9**
GS51	24	4.6
GS59	*	*
PLFSYSEFF	NA	NA
SW027	**26**	**4.9**
SW093	**95**	**1.8**

[a] Number of samples in which both Pu and Am activities 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 47. Post-Closure Average Pu/Am Ratios for Analytical Results (October 13, 2005−December 31, 2010)

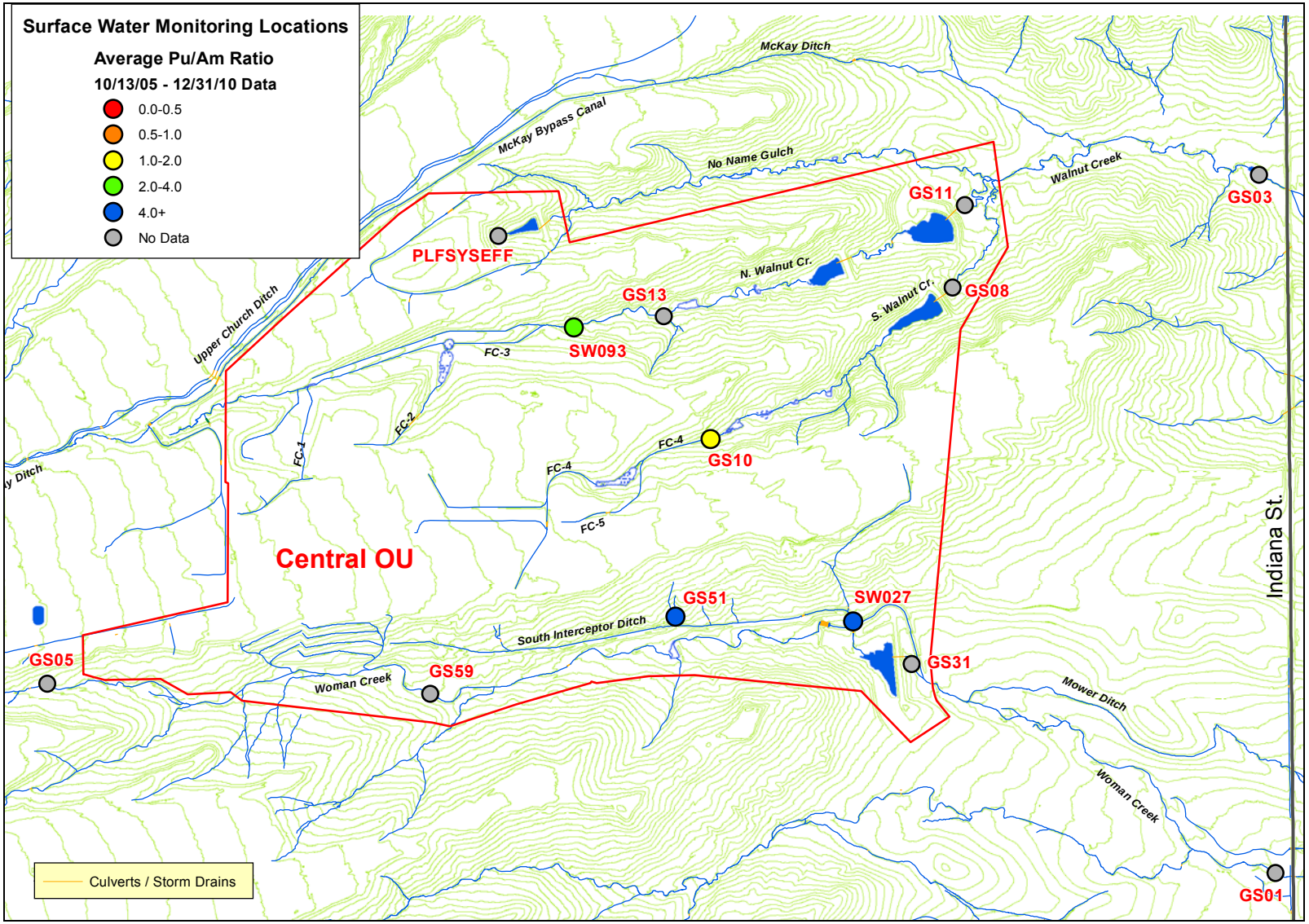
Location	Samples (N)[a]	Average Pu/Am Ratio
GS01	*	*
GS03	*	*
GS05	NA	NA
GS08	*	*
GS10	**17**	**1.2**
GS11	*	*
GS13	NA	NA
GS31	*	*
GS51	16	5.5
GS59	NA	NA
PLFSYSEFF	NA	NA
SW027	**5**	**5.2**
SW093	**12**	**2.1**

[a] Number of samples in which both Pu and Am activities 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 134. Average Pu/Am Ratios for CY 1997—October 13, 2005



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

Figure 135. 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 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."[16] 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 48, Table 49, Table 50, Table 51, Table 52, and Table 53 present summary statistics for the POE metals. All three POEs generally show reduced metals concentrations post-closure.

Table 48. 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 49. Post-Closure Summary Statistics for POE Metals Results from GS10 (October 13, 2005−December 31, 2010)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	87	100.0%	0.50	0.50	0.50
Dissolved Cd	87	92.0%	0.06	0.06	0.34
Total Cr	87	78.2%	0.50	1.36	7.10
Dissolved Ag	87	98.9%	0.10	0.10	0.20

Table 50. 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

[16] 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 51. Post-Closure Summary Statistics for POE Metals Results from SW027 (October 13, 2005−December 31, 2010)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	9	100.0%	0.50	0.50	0.50
Dissolved Cd	8	100.0%	0.06	0.06	0.06
Total Cr	9	55.6%	1.00	1.77	2.15
Dissolved Ag	8	100.0%	0.10	0.10	0.10

Notes: NA = not applicable

Table 52. 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 53. Post-Closure Summary Statistics for POE Metals Results from SW093 (October 13, 2005−December 31, 2010)

Analyte	Samples (N)	Nondetect	Median (µg/L)	85th Percentile (µg/L)	Maximum (µg/L)
Total Be	83	100.0%	0.50	0.50	0.50
Dissolved Cd	83	91.6%	0.06	0.06	0.24
Total Cr	83	60.2%	1.00	1.90	25.7
Dissolved Ag	83	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 RFLMA POEs and POCs.[17] 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.

[17] This 2010 report includes slight revisions to the previously reported 2009 loads.

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 54.[18] A detailed description of the method for load estimation is given in Appendix B.[19]

Table 54. 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.[20]

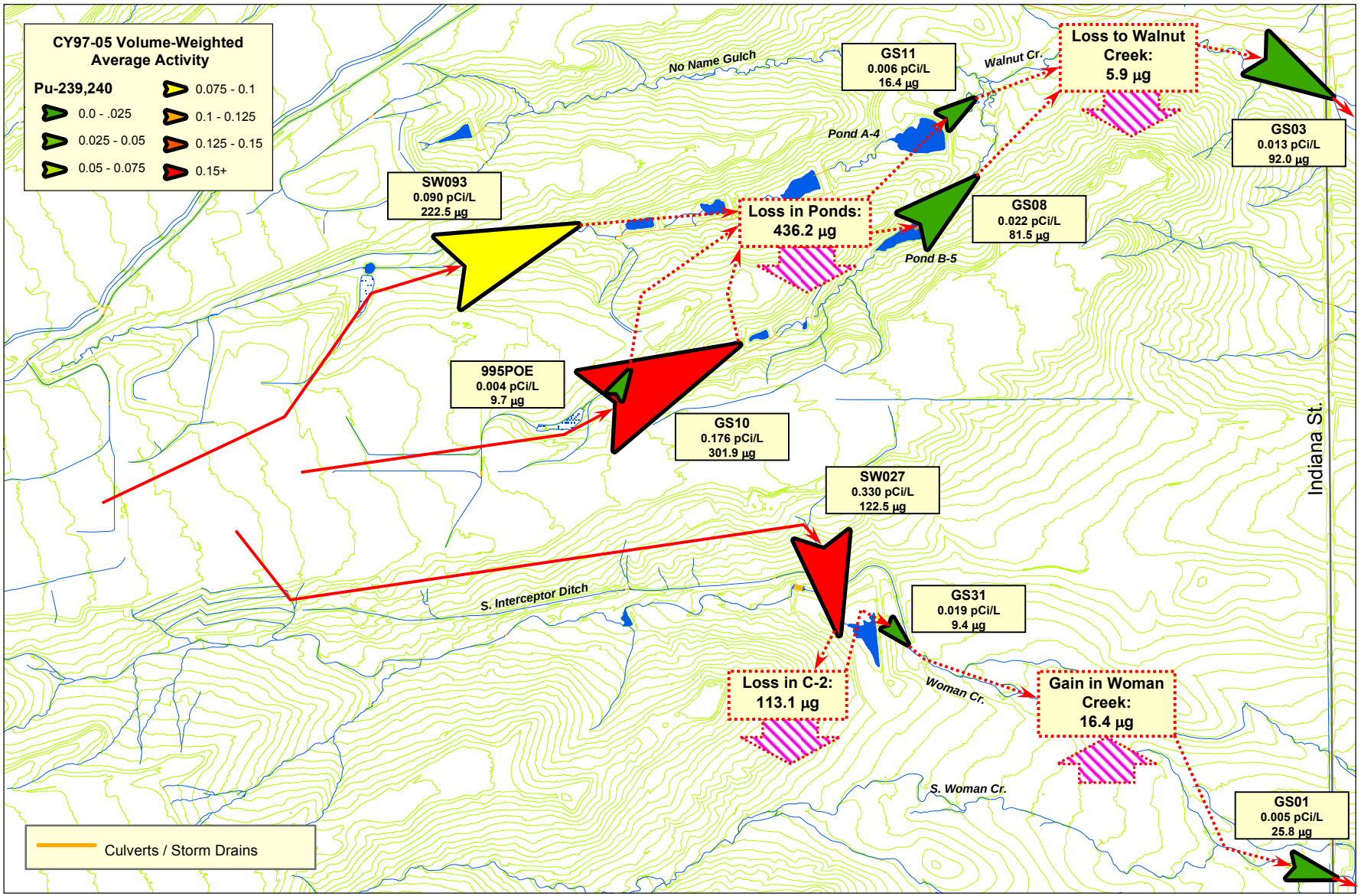
Site and Refuge Area

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; therefore, only CY 2003−2010 data are shown. The following points are noted:

- Figure 136, Figure 137, Figure 138, and Figure 139 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 between 80 percent and 98 percent for all Walnut Creek locations affected directly by the former IA. Similarly, activity has been reduced between 23 percent and nearly 100 percent. For lower Woman Creek (GS01), however, loads are not reduced. This is likely due to transport of diffuse, low-level contamination in the much larger flow volumes measured at GS01, especially during CY 2007 and CY 2010; GS01 is not significantly affected by the former IA. GS01 post-closure volume-weighted average Pu and Am activities of 0.008 and 0.004 pCi/L, respectively, are significantly below the 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 significantly improved water quality.
- Figure 140 and Figure 141 show a measurable increase in average annual total U concentration in Walnut Creek post-closure (15 percent–170 percent increase). 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 stream flows has actually resulted in decreased total

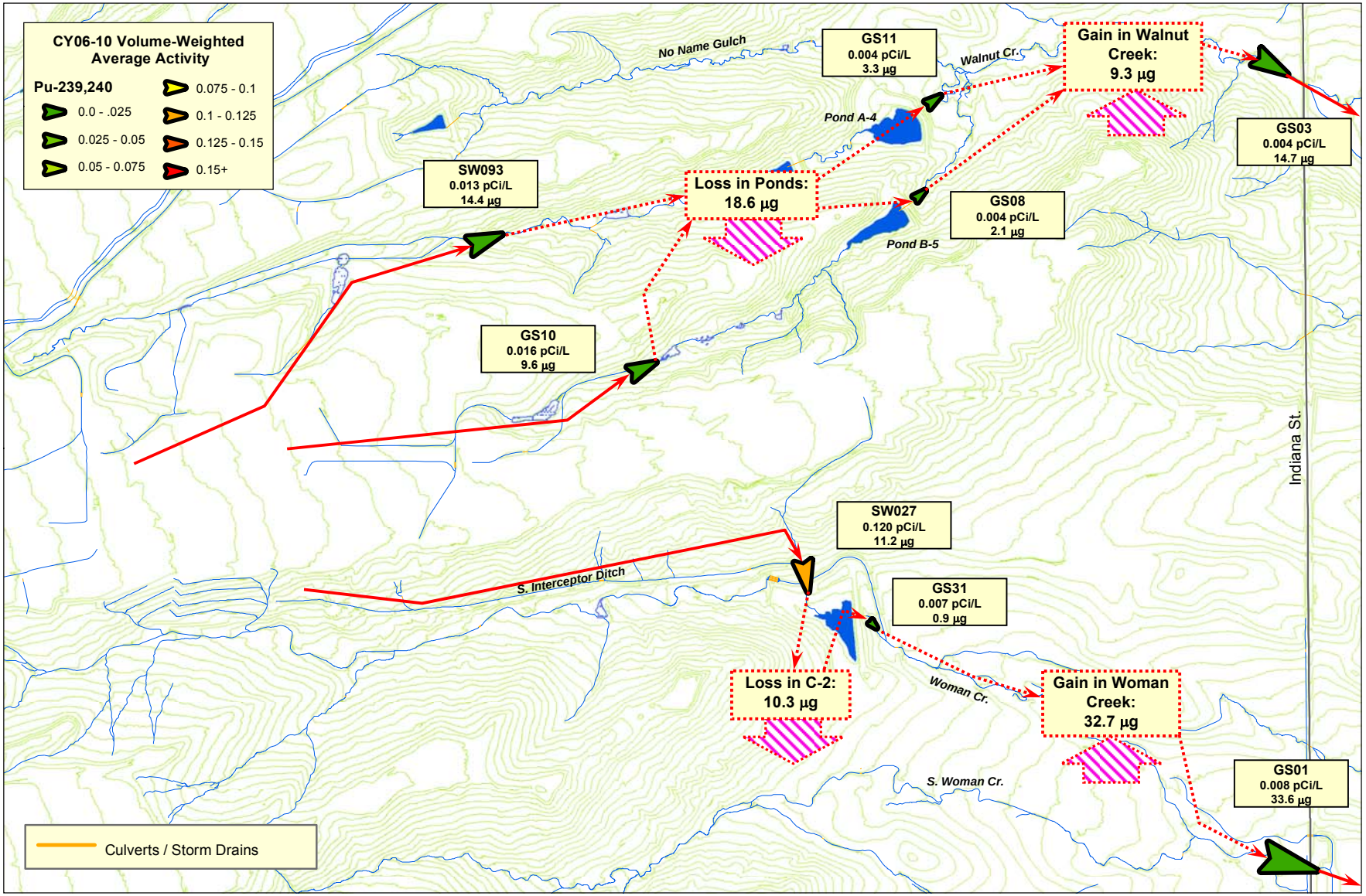
[18] In the following tables and plots, values are rounded for presentation.
[19] Data are generally presented at varying precision for presentation. Accuracy should not be inferred; both analytical and flow measurement error have not been quantified in this report.
[20] The U-234 conversion factor was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

U loads (10 percent–72 percent reduction) in Walnut Creek at all locations except GS10 (8 percent increase). For lower Woman Creek (GS01), loads and concentrations have changed to a lesser extent (20 percent and 19 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.



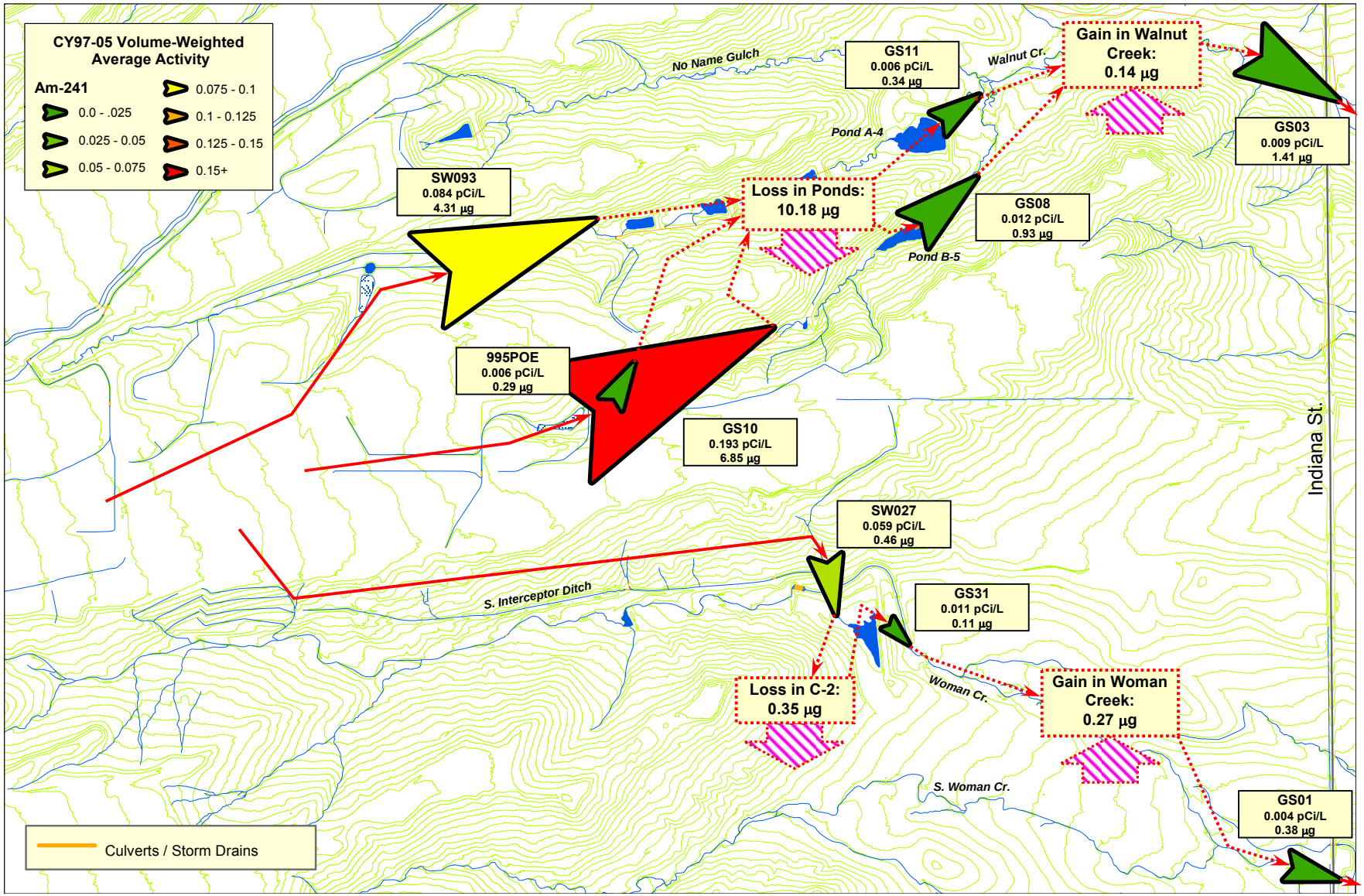
Note: Location symbols are displayed proportional to calculated average annual load and colored according to activity ranges in legend.

Figure 136. Relative Average Annual Pu Loading Schematic: CY 1997−2005



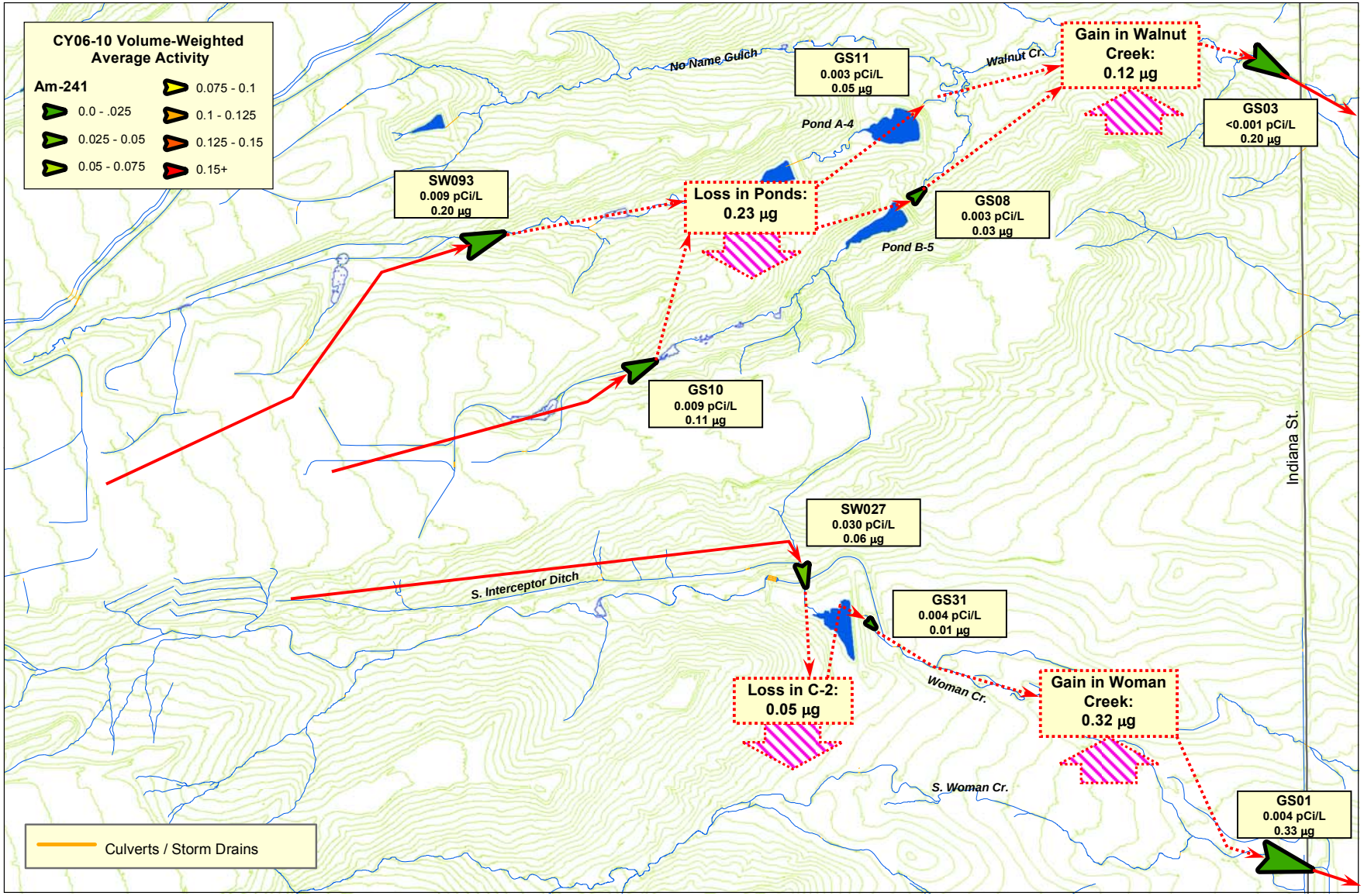
Note: Location symbols are displayed proportional to calculated average annual load and colored according to activity ranges in legend.

Figure 137. Relative Average Annual Pu Loading Schematic: CY 2006−2010



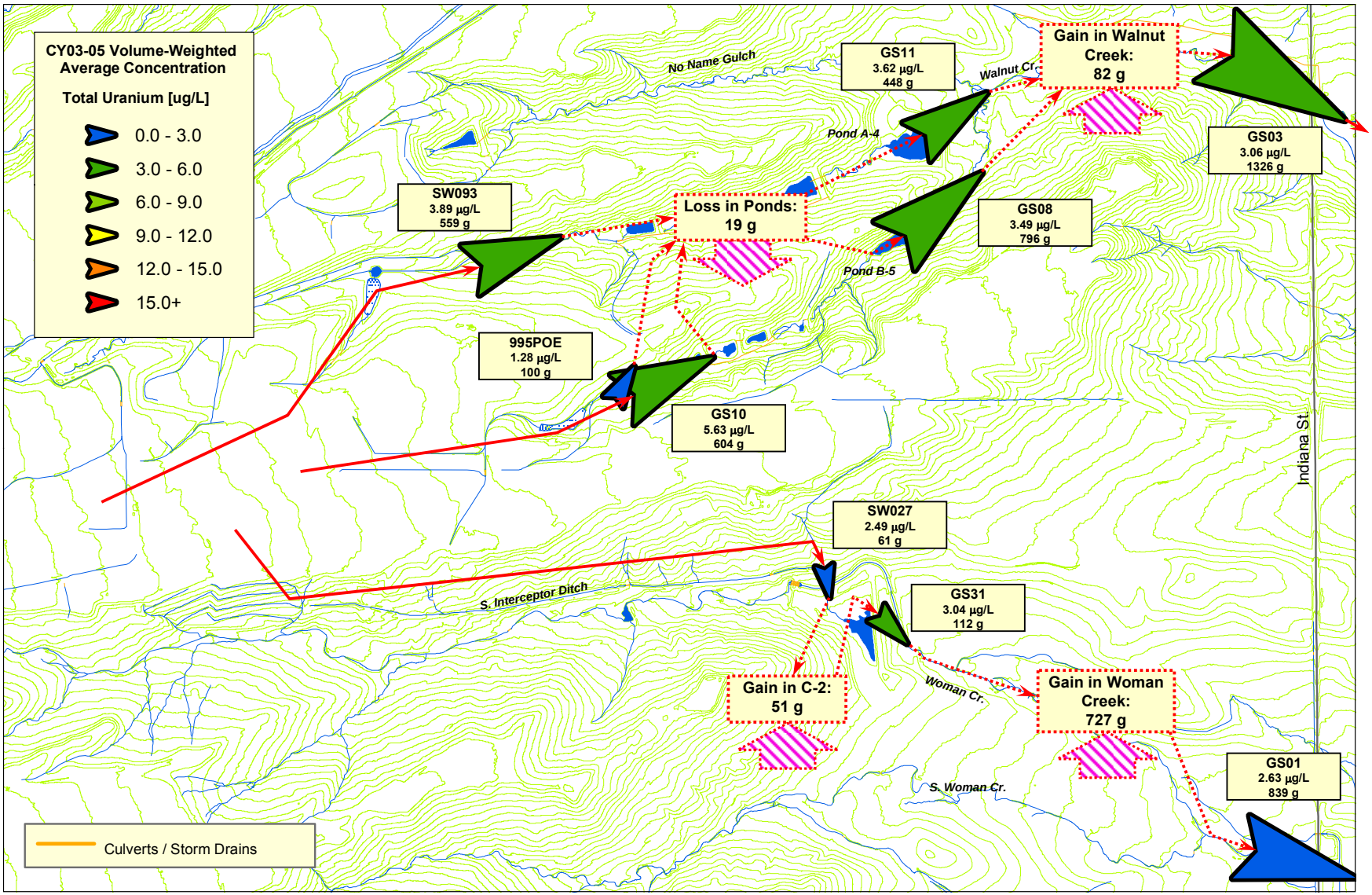
Note: Location symbols are displayed proportional to calculated average annual load and colored according to activity ranges in legend.

Figure 138. Relative Average Annual Am Loading Schematic: CY 1997−2005



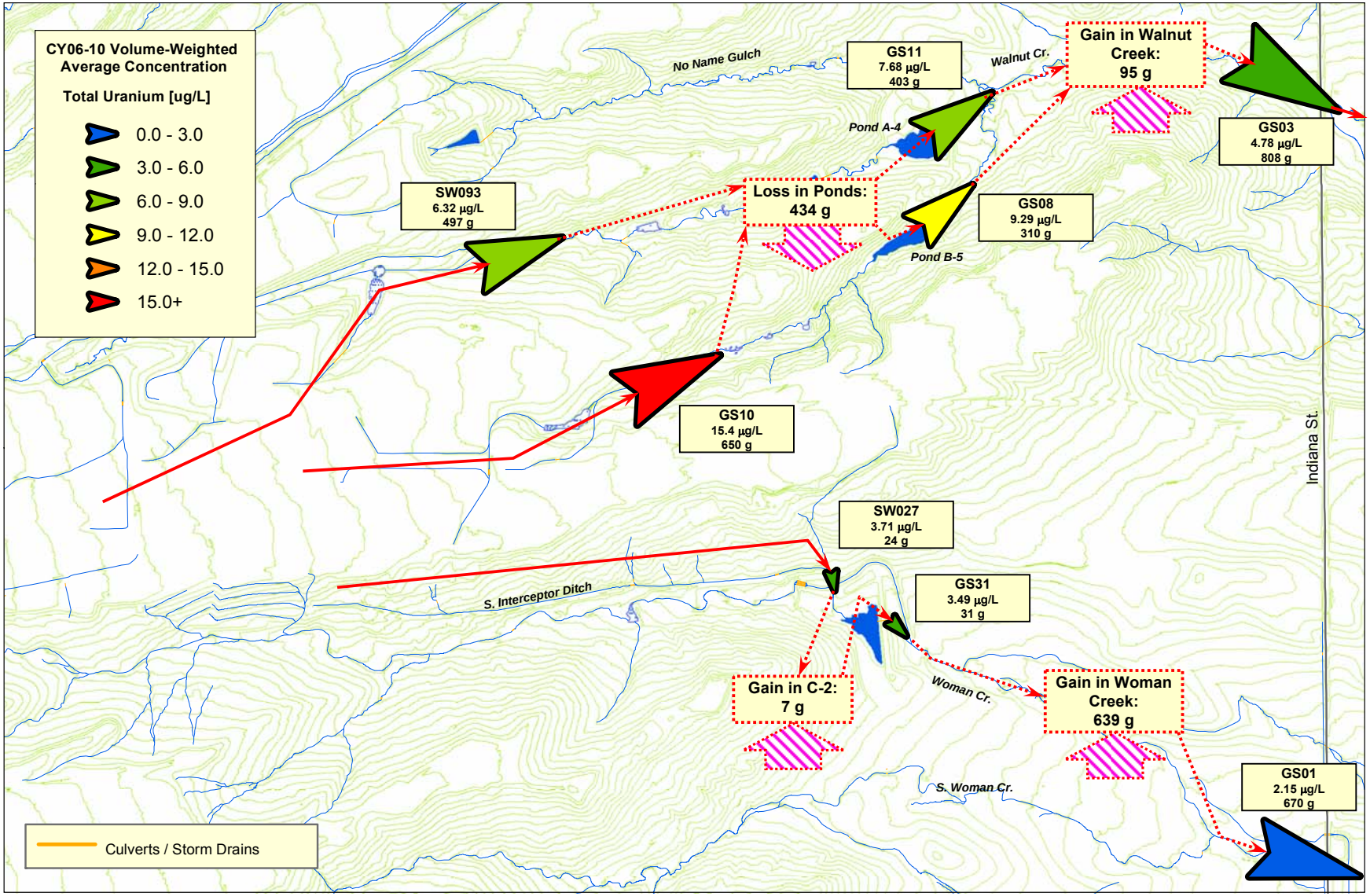
Note: Location symbols are displayed proportional to calculated average annual load and colored according to activity ranges in legend.

Figure 139. Relative Average Annual Am Loading Schematic: CY 2006−2010



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

Figure 140. 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 141. Relative Average Annual Total U Loading Schematic: CY 2006−2010

Indiana Street POCs

This section summarizes the calculated Pu and Am loads from Walnut and Woman Creeks at Indiana Street. Figure 142, Figure 143, Figure 144, Figure 145, Figure 146, Figure 147, and Figure 148, as well as Table 55 and Table 56 present the load data. The following points are noted:

- Walnut Creek accounts for nearly 80 percent of both the Pu (Figure 144) and Am (Figure 146) loads at Indiana Street pre-closure. However, post-closure these proportions are essentially reversed as a result of 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 142).
- Figure 143 and Figure 145 show a significant post-closure reduction in both Pu and Am loads in Walnut Creek at Indiana Street (84 percent and 86 percent, respectively).
- The somewhat higher CY 2007 and CY 2010 Pu and Am loads in Woman Creek at Indiana Street (Figure 143 and Figure 145) can be attributed to high flow volumes at GS01.[21] Post-closure average annual volume-weighted Pu and Am activities at GS01 are 0.008 and 0.004 pCi/L, respectively; these activities are within the analytical measurement error range.
- Walnut Creek accounts for 61 percent of the pre-closure and 55 percent of the post-closure U loads at Indiana Street (Figure 148). Although U concentration has increased in Walnut Creek post-closure, reduced flow volumes have resulted in decreased average annual loads comparable to pre-closure loads.

[21] 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.

Table 55. Off-Site Pu and Am Loads from Walnut and Woman Creeks: CY 1997–2010

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
2010	46.9	70.6	117.5	0.71	0.78	1.49
Total	901.3	400.2	1,301.4	13.66	5.07	18.73

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.

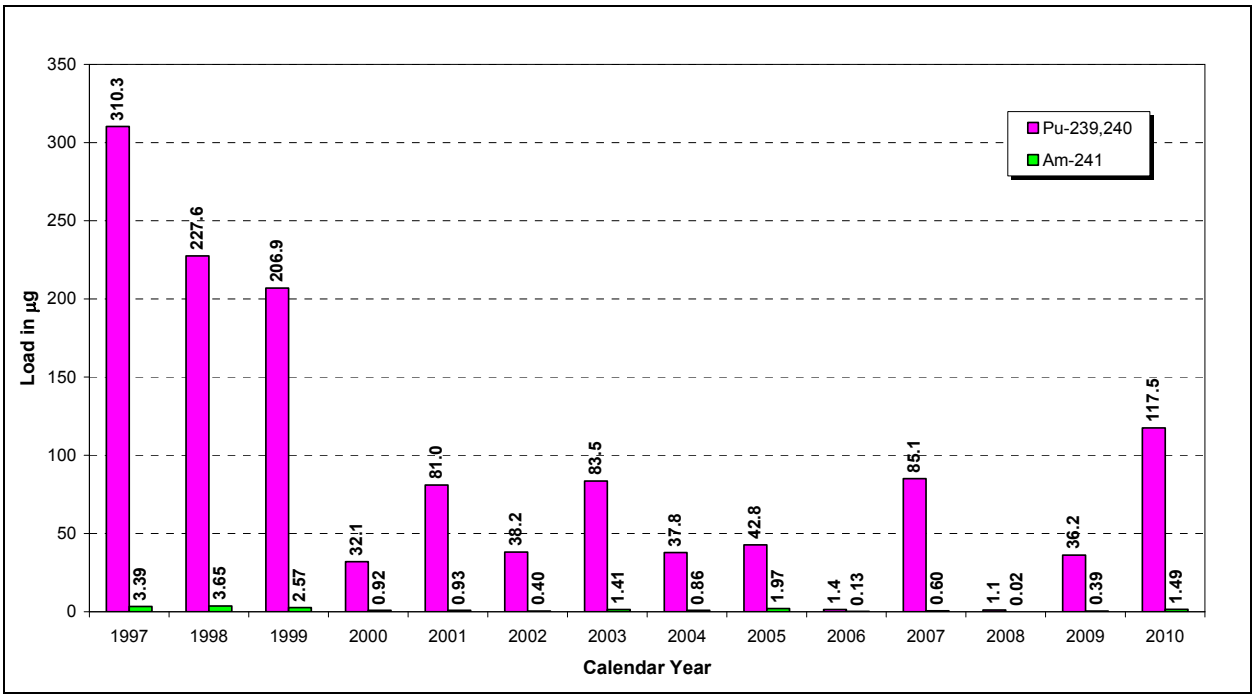


Figure 142. Combined Annual Pu and Am Loads from Walnut and Woman Creeks: CY 1997–2010

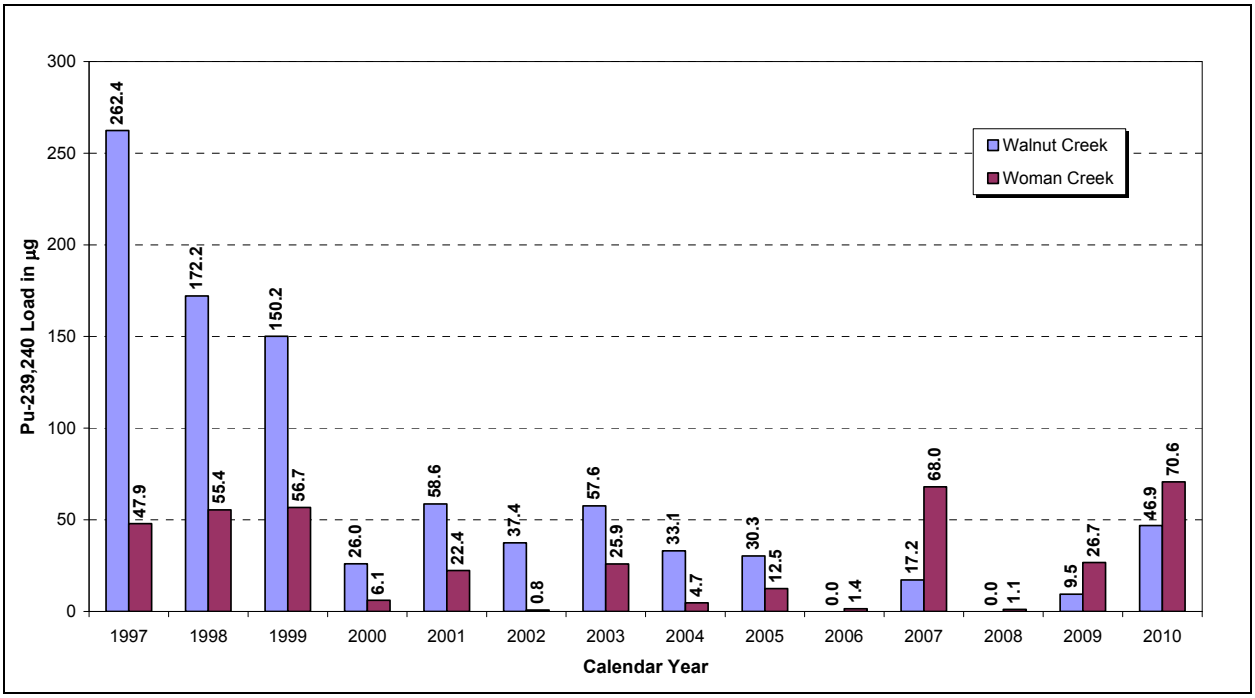
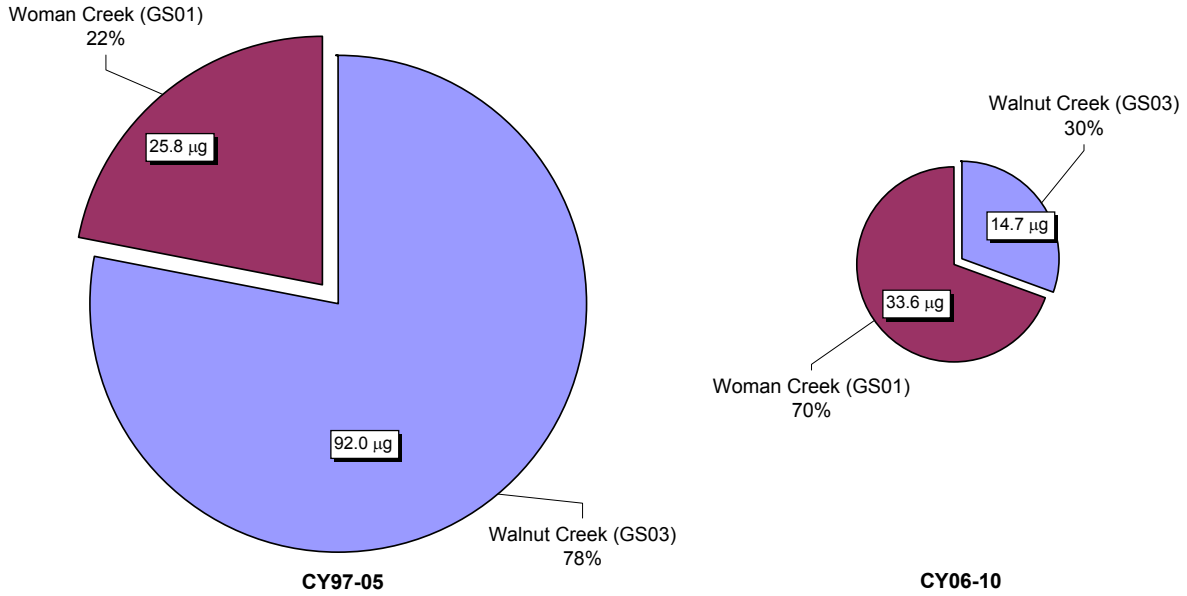


Figure 143. Annual Pu Loads from Walnut and Woman Creeks: CY 1997–2010



Note: pie chart diameters relative to total load

Figure 144. Relative Average Annual Pu Load Totals from Walnut and Woman Creeks

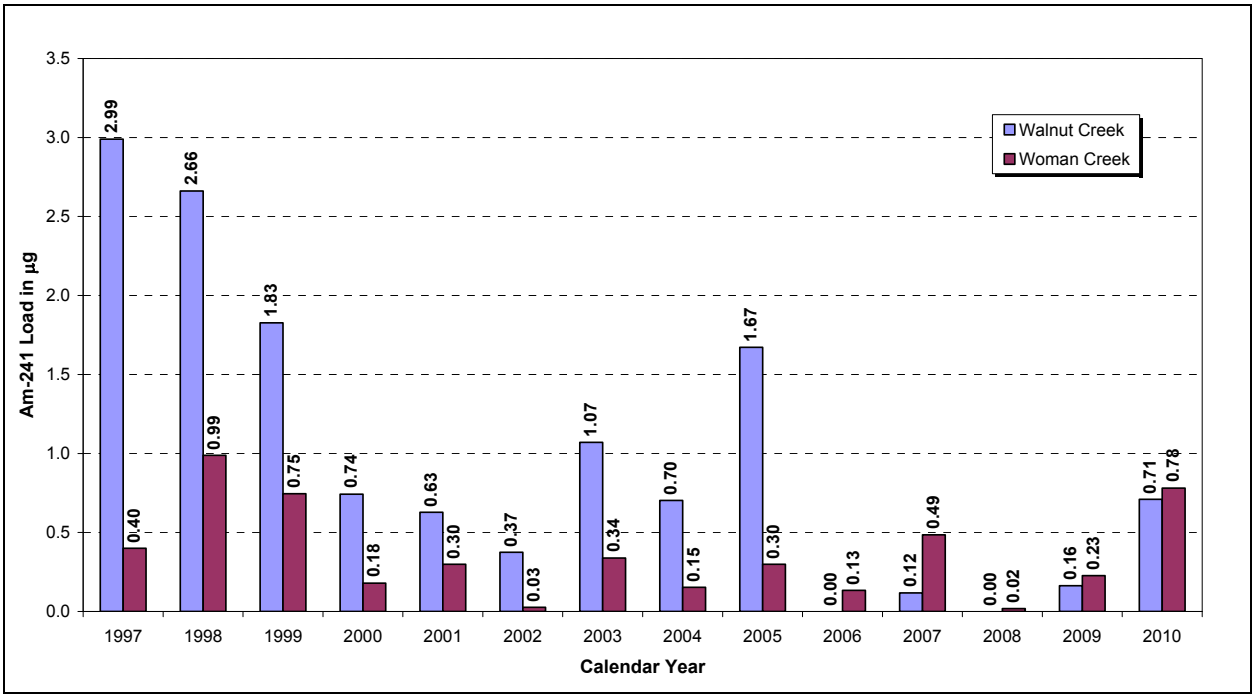
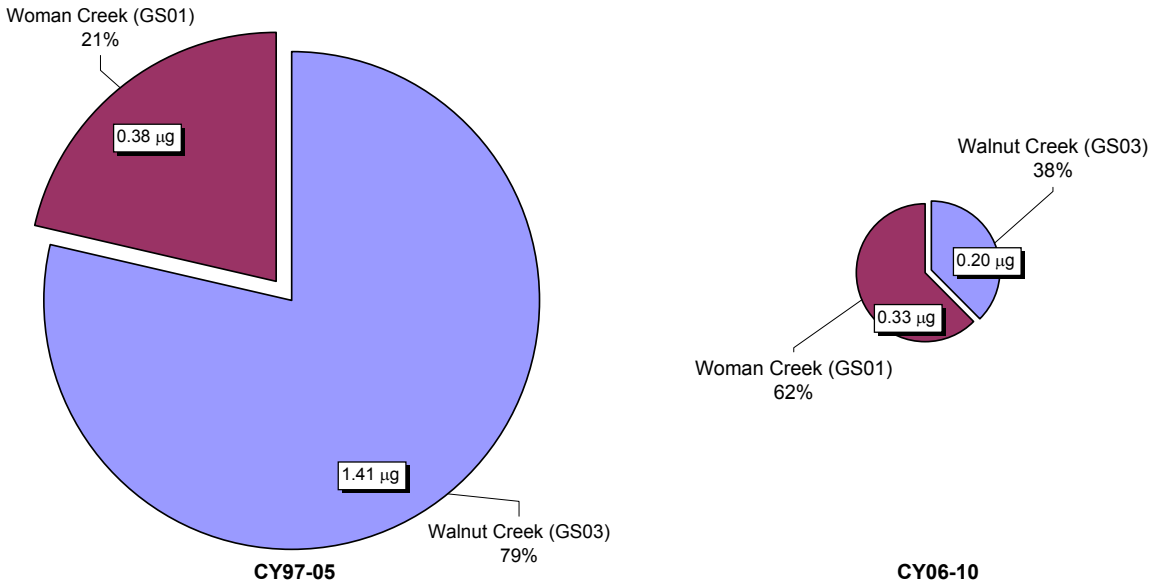


Figure 145. Annual Am Loads from Walnut and Woman Creeks: CY 1997–2010



Note: pie chart diameters relative to total load

Figure 146. Relative Average Annual Am Load Totals from Walnut and Woman Creeks

Table 56. Total U Loads from Walnut and Woman Creeks: CY 2003−2010

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
2010	2,311	1,162	3,473
Total	8,017	5,864	13,881

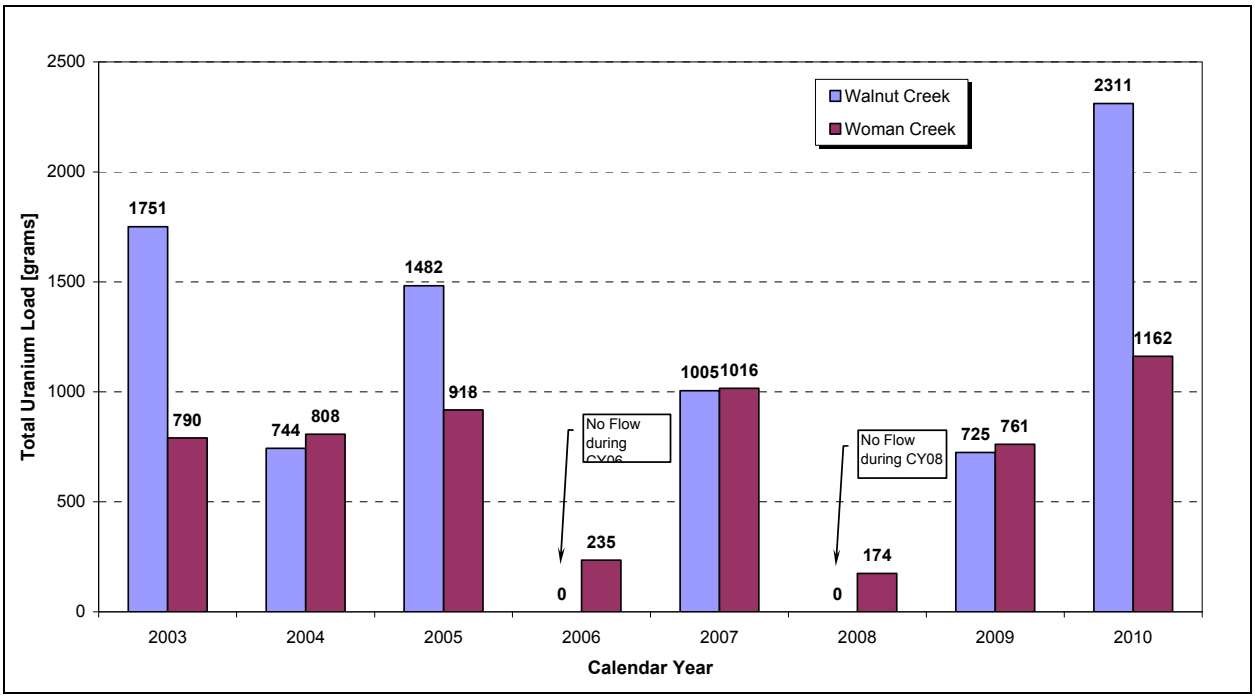


Figure 147. Annual Total U Loads from Walnut and Woman Creeks: CY 2003–2010

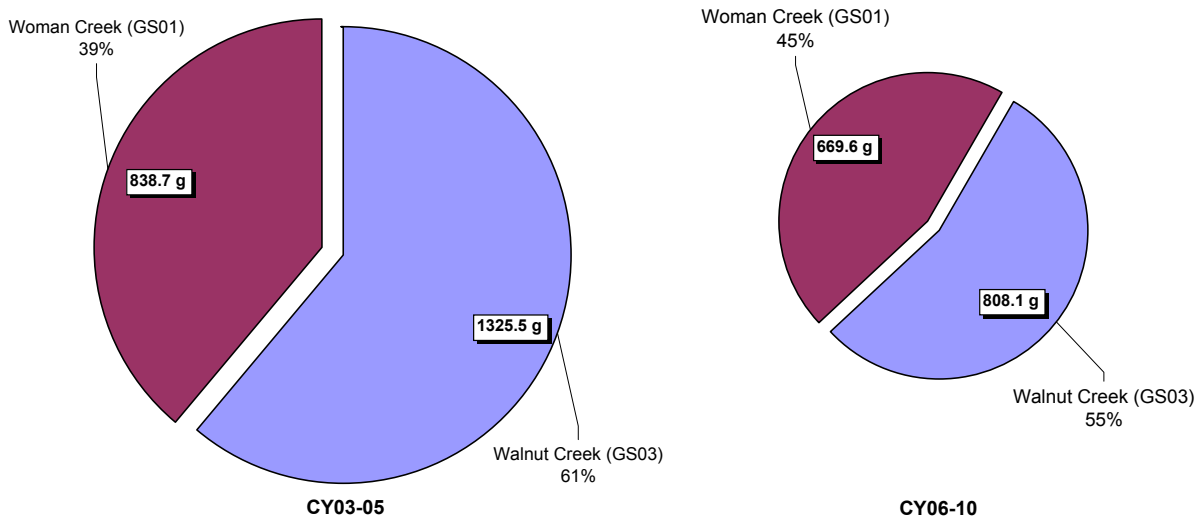


Figure 148. Relative Average Annual Total U Load Totals from Walnut and Woman Creeks

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 57, Table 58, and Table 59 and are depicted on Figure 149, Figure 150, Figure 151, Figure 152, Figure 153, Figure 154, and Figure 155. Total U data collection at GS03 began on November 5, 2002; thus, only CY 2003−2010 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 150 and Figure 152). The significant annual variability in Pu and Am loads is due mostly to water quality variation pre-closure. Post-closure, variation is due to large runoff variation 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 149). 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 152). The measurable increase in CY 2010 loads is primarily due to large flow volumes and not an increase in activity.
- Annual Pu and Am loads for all locations have been reduced post-closure (Figure 150 and Figure 152) 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 80 percent and 97 percent.

- Pre-closure Pu and Am loads from Pond B-5 are significantly greater than loads from Pond A-4 (Table 57 and Table 58), a result of both higher activities and larger discharge volumes. Post-closure loads from Pond A-4 are slightly greater than from Pond B-5. Post-closure load reductions range between 80 percent and 97 percent.
- Total Pu loads from Ponds A-4 and B-5 for the entire period of 1997 through 2010 are marginally greater than the loads at GS03 (Table 57), suggesting a small net loss of load to the Walnut Creek streambed below Ponds A-4 and B-5. This small loss may simply be an artifact of analytical measurement error.
- Total Am loads from Ponds A-4 and B-5 for the entire period of 1997 through 2010 are marginally less than the loads at GS03 (Table 58), indicating a net gain of load from tributaries and the Walnut Creek streambed below Ponds A-4 and B-5. This gain may simply be an artifact of analytical measurement error.
- Total U loads from Ponds A-4 and B-5 are slightly less than the loads at GS03 (Figure 155), indicating a small net gain of load from tributaries and seeps in Walnut Creek below Ponds A-4 and B-5. Post-closure reductions in U loads range between 10 percent and 61 percent depending on location; U load at GS03 has been reduced 39 percent.

Table 57. Pu Loads at GS03, GS08, and GS11: CY 1997–2010

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	2.3	3.0	5.3	9.5
2010	6.4	5.4	11.9	46.9
Total	164.5	744.2	908.6	901.3

Table 58. Am Loads at GS03, GS08, and GS11: CY 1997–2010

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	0.09	0.02	0.11	0.16
2010	0.14	0.11	0.25	0.71
Total	3.33	8.51	11.84	13.66

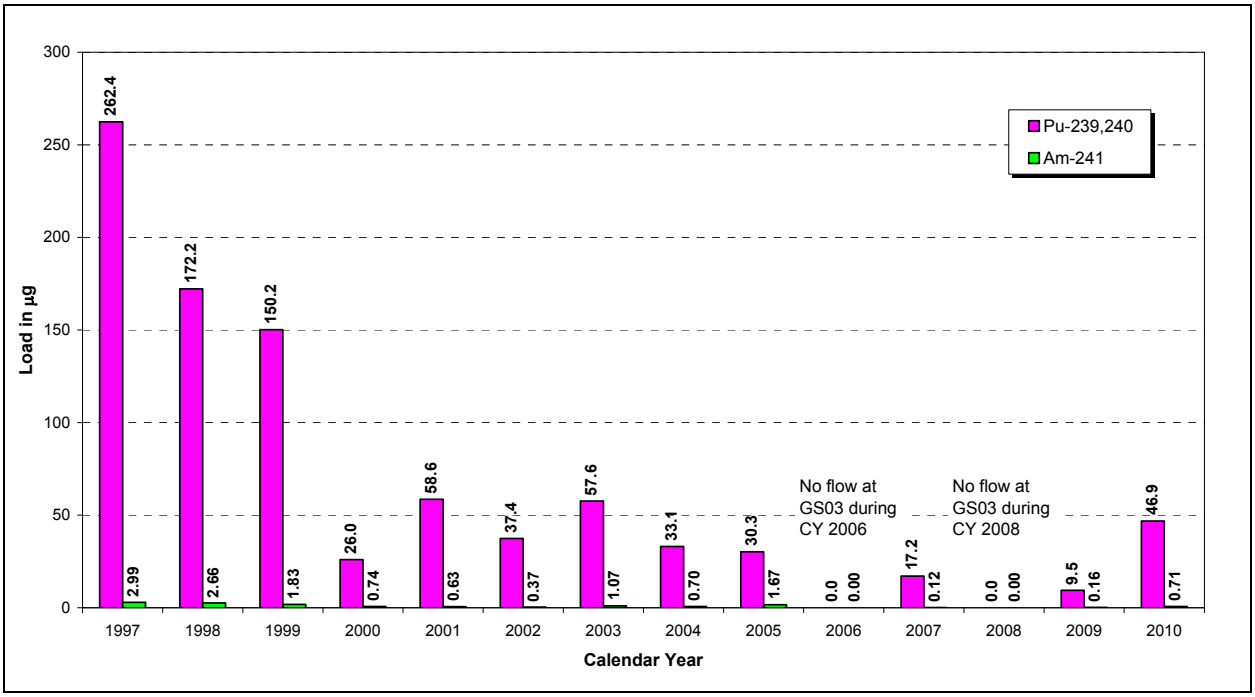


Figure 149. Annual Pu and Am Loads at GS03: CY 1997–2010

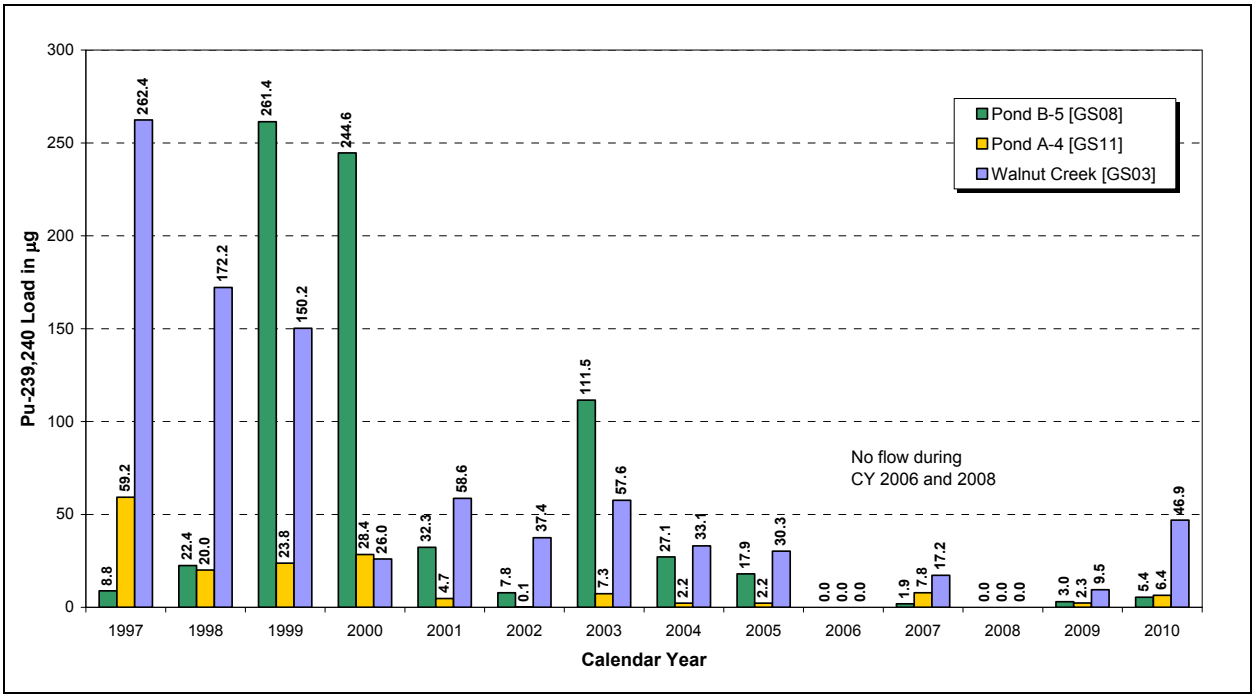
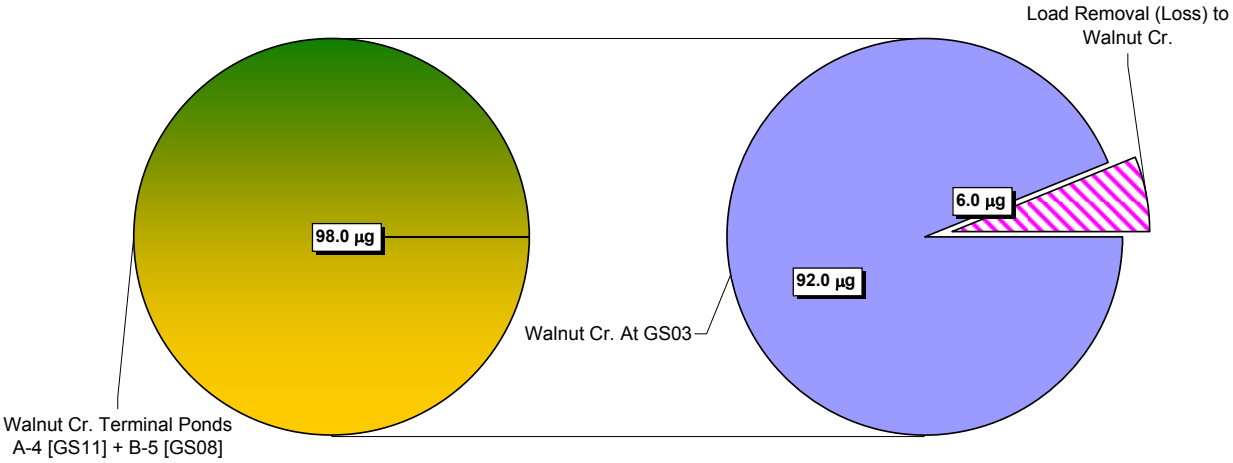
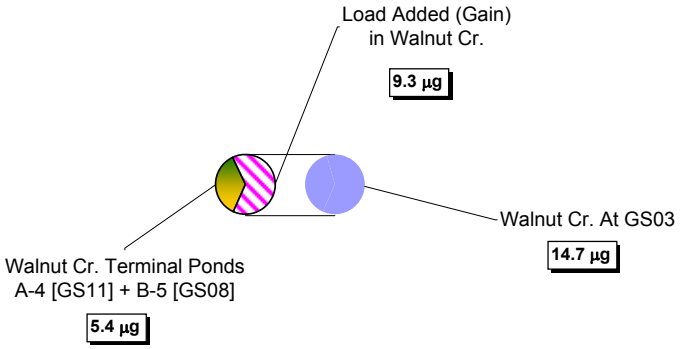


Figure 150. Annual Pu Loads at GS03, GS08, and GS11: CY 1997–2010



CY97-05



CY06-10

Note: pie chart diameters relative to total load

Figure 151. Relative Average Annual Pu Load Totals at GS03, GS08, and GS11

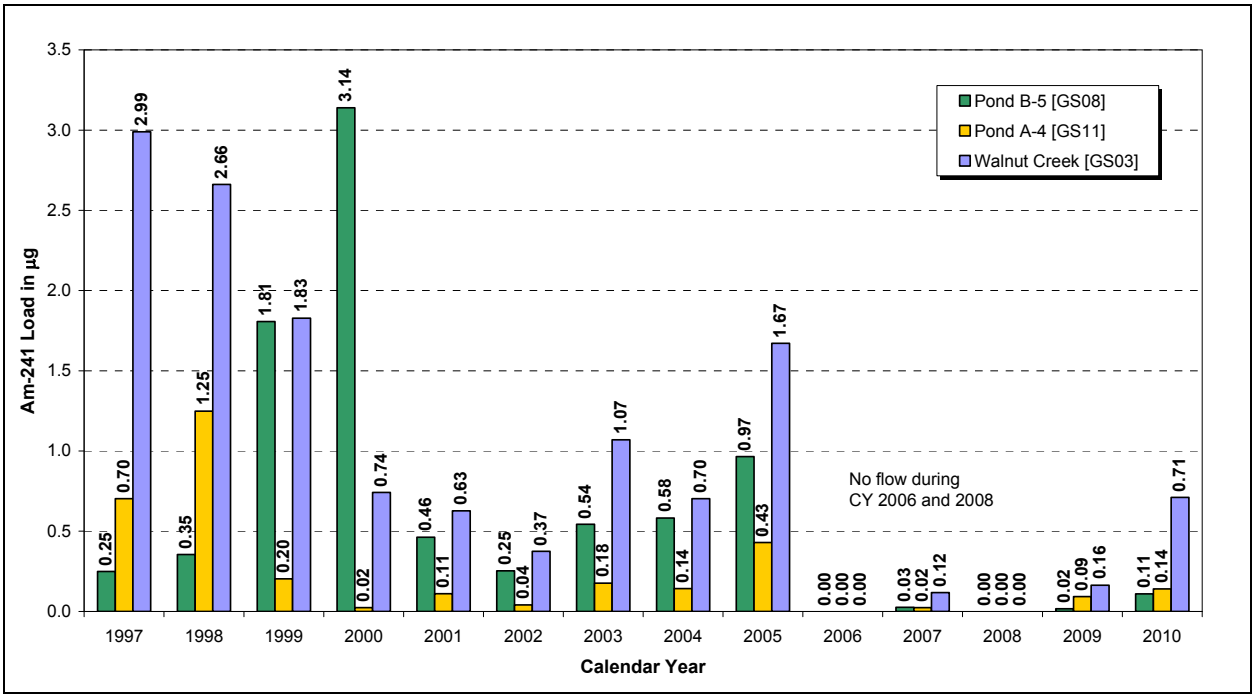
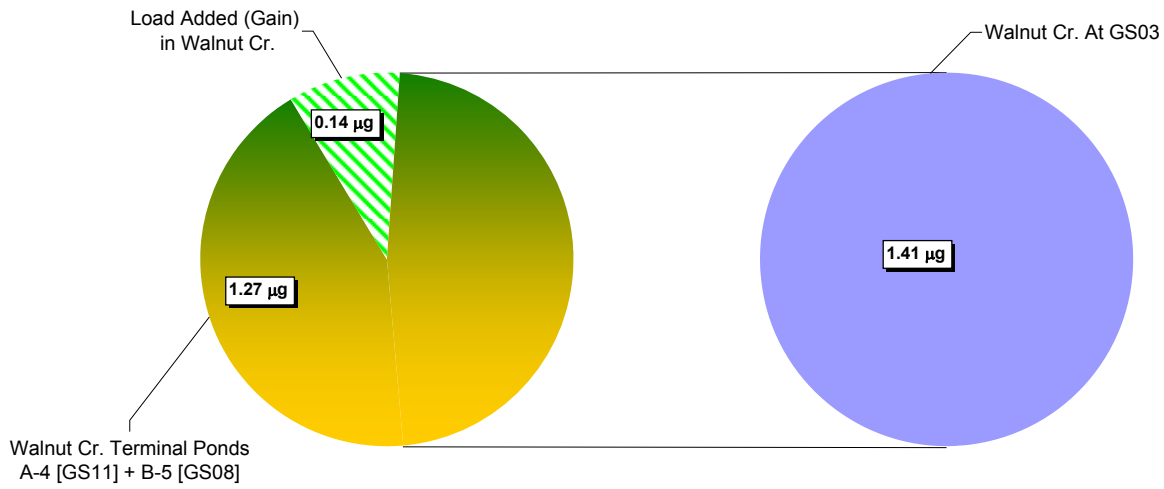


Figure 152. Annual Am Loads at GS03, GS08, and GS11: CY 1997–2010



Note: pie chart diameters relative to total load

Figure 153. Relative Average Annual Am Load Totals at GS03, GS08, and GS11

Table 59. Total U Loads at GS03, GS08, and GS11: CY 2003−2010

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	405	322	728	725
2010	1,199	746	1,945	2,311
Total	3,360	3,937	7,298	8,017

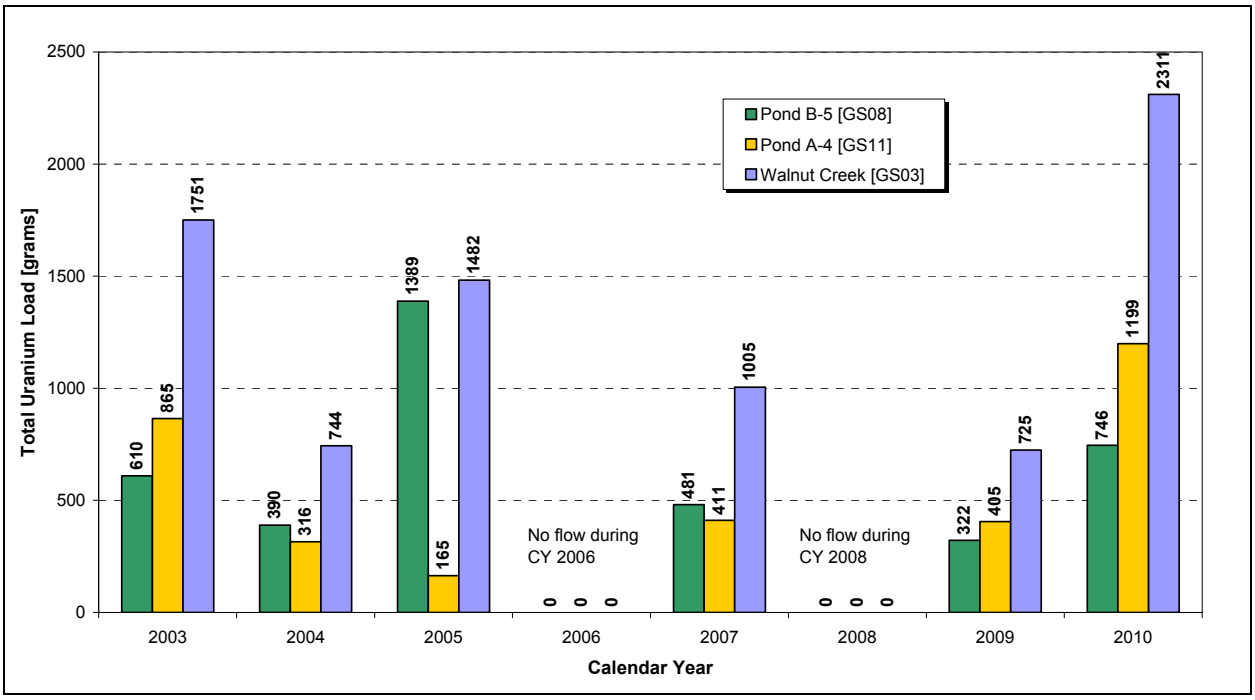


Figure 154. Annual Total U Loads at GS03, GS08, and GS11: CY 2003−2010

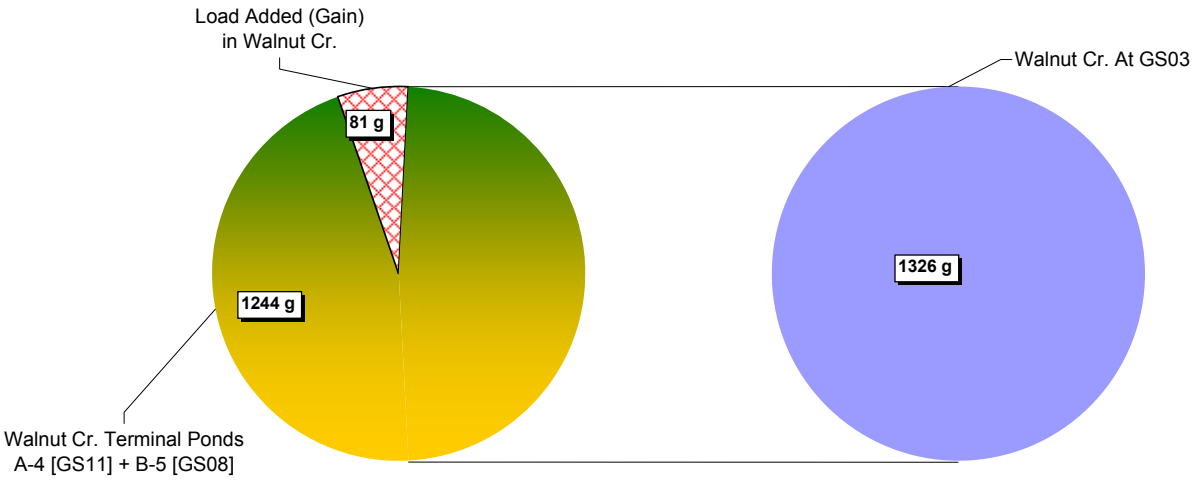


Figure 155. Relative Average Annual Total U Load Totals at GS03, GS08, and GS11

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 60, Table 61, and Table 62, and depicted on Figure 156, Figure 157, Figure 158, Figure 159, Figure 160, Figure 161, and Figure 162. Total U data collection began at GS01 on February 3, 2003; therefore, only CY 2003−2010 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 157 and Figure 159). 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 156). During CY 2007 and CY 2010, there is a measurable load increase compared to adjacent years. 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 60 and Figure 158), indicating a gain of load from the Woman Creek drainage. Post-closure, Pond C-2 accounts for less than 3 percent of the Pu load at GS01.
- Total Am loads from Pond C-2 are less than the loads at GS01 (Table 61 and Figure 160), also indicating a gain of load from the Woman Creek drainage. Post-closure, Pond C-2 accounts for approximately 3 percent of the Am load at GS01.
- Total U load for CY 2003−2010 from Pond C-2 is significantly less than the load at GS01 (Table 62 and Figure 162), indicating a gain of load most likely from naturally occurring U in the Woman Creek drainage. Post-closure, Pond C-2 accounts for less than 5 percent of the U load at GS01.

Table 60. Pu Loads at GS01 and GS31: CY 1997–2010

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
2010	0.4	70.6
Total	89.0	400.2

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 61. Am Loads at GS01 and GS31: CY 1997–2010

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
2010	0.02	0.78
Total	1.00	5.07

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.

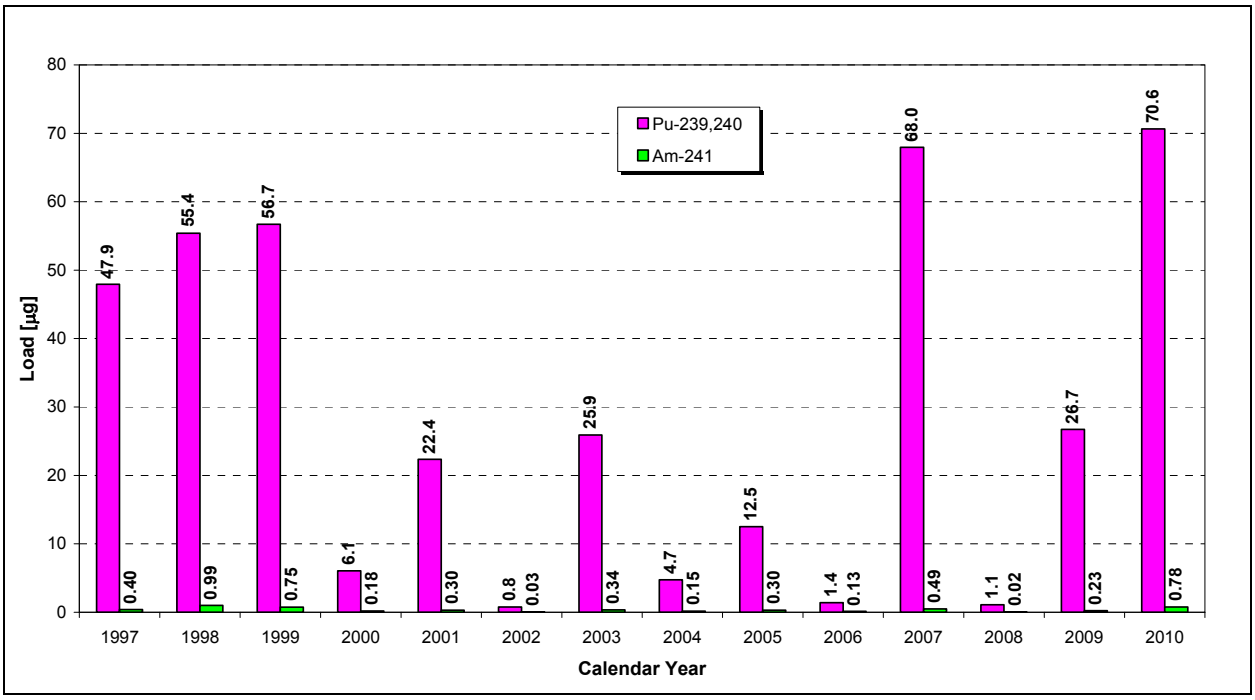


Figure 156. Annual Pu and Am Loads at GS01: CY 1997–2010

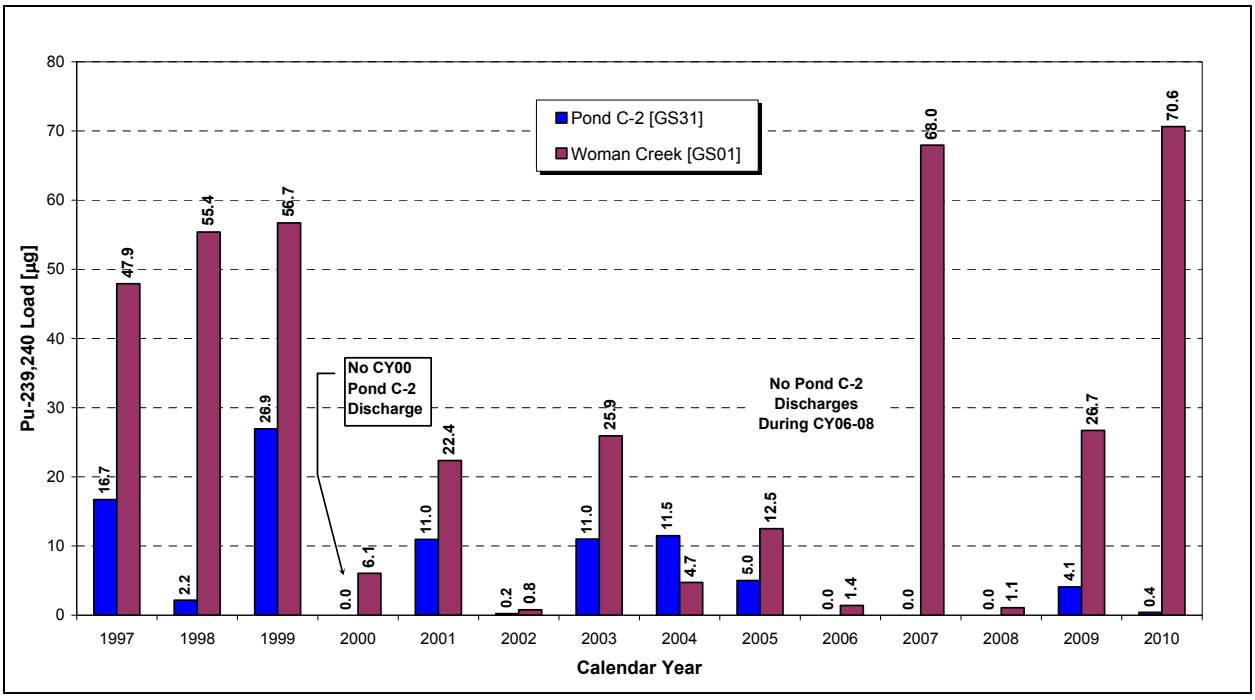
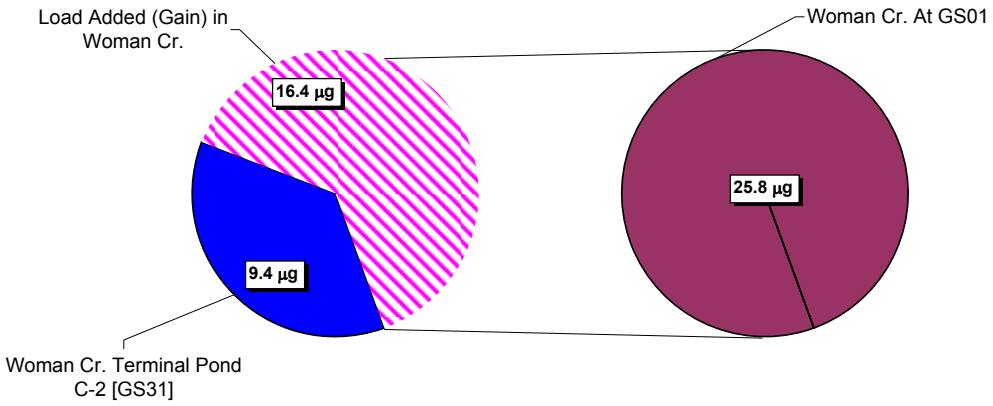
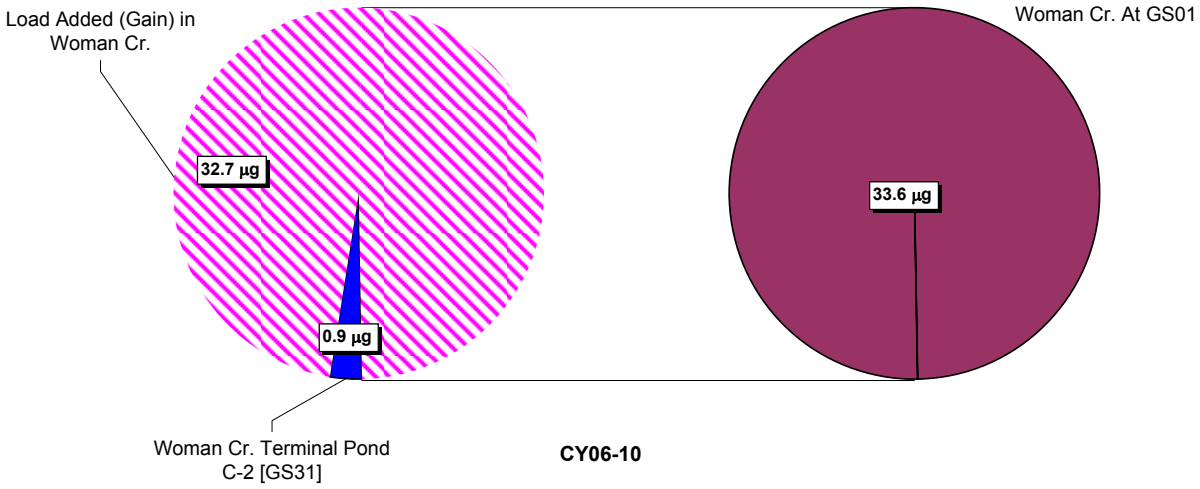


Figure 157. Annual Pu Loads at GS01 and GS31: CY 1997–2010





Note: pie chart diameters relative to total load

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

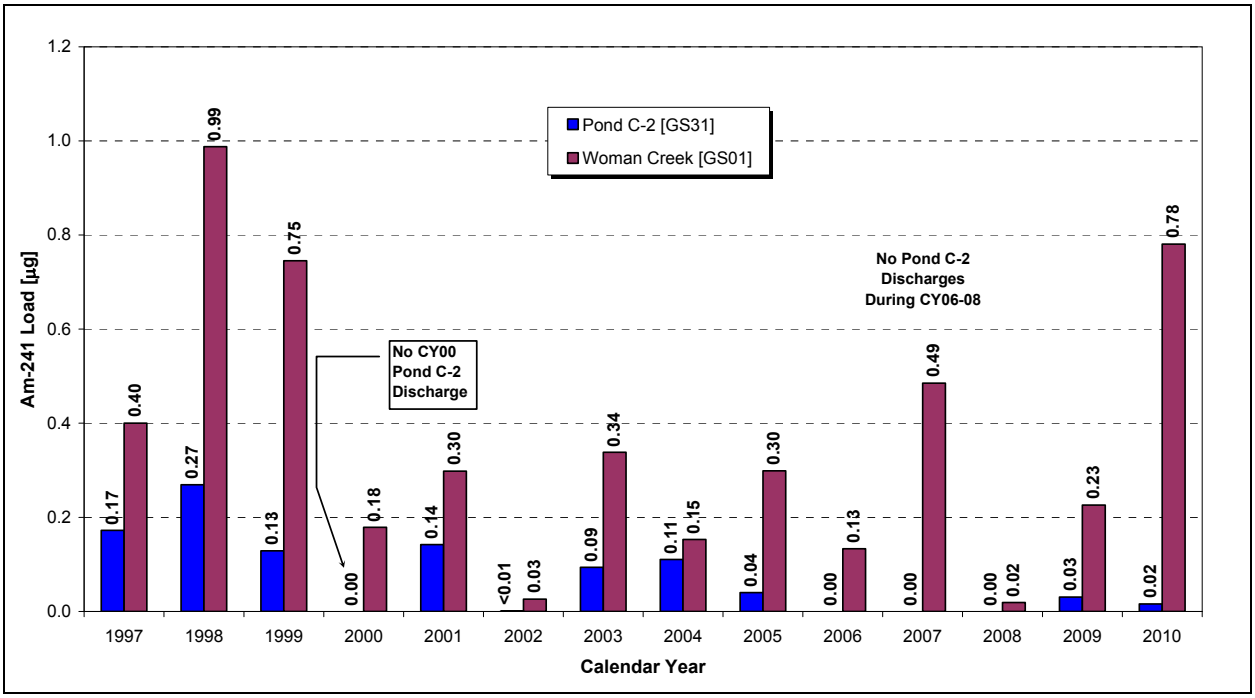
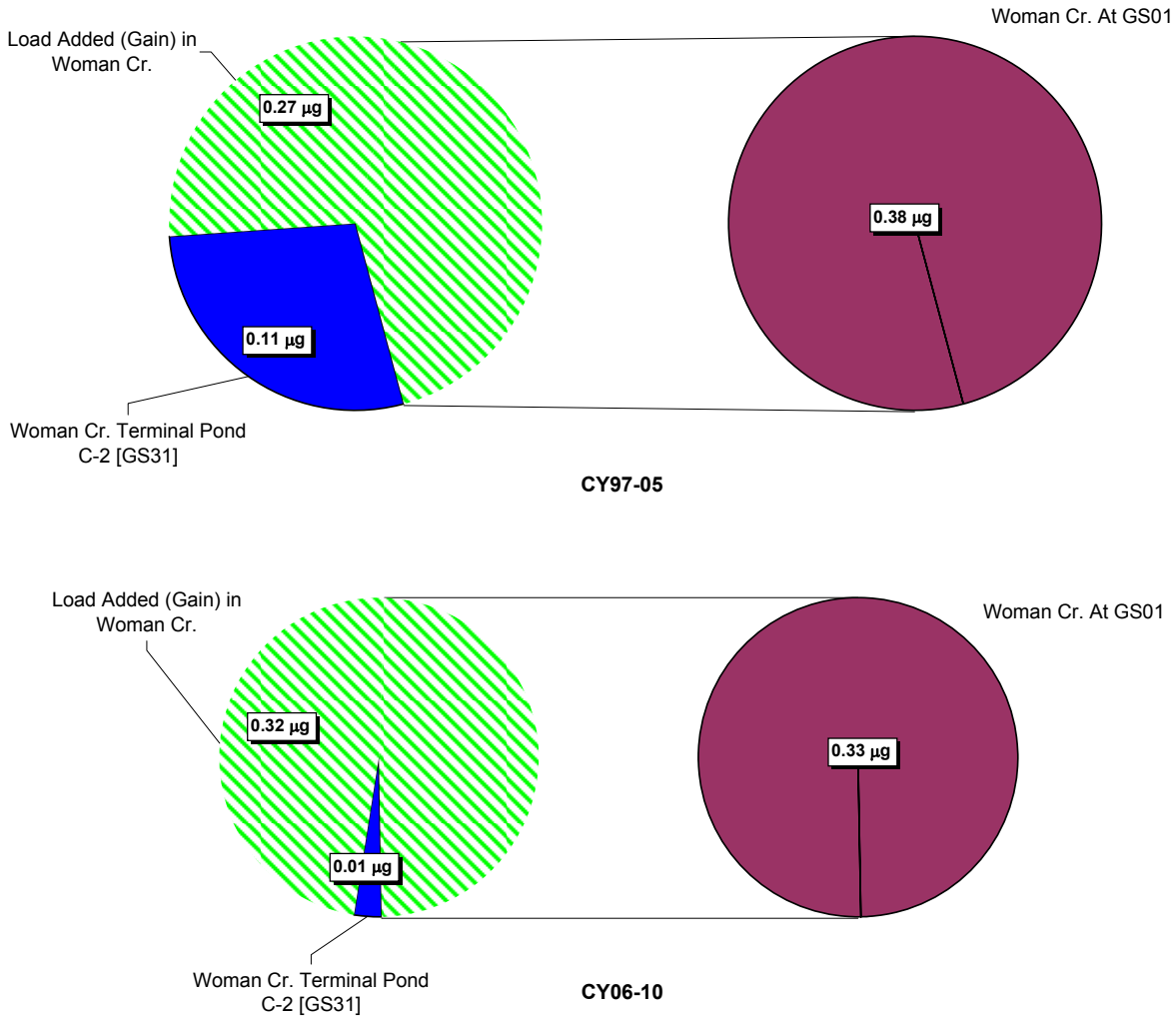


Figure 159. Annual Am Loads at GS01 and GS31: CY 1997–2010



Note: pie chart diameters relative to total load

Figure 160. Relative Average Annual Am Load Totals at GS01 and GS31

Table 62. Total U Loads at GS01 and GS31: CY 2003−2010

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
2010	61	1,162
Total	492	5,864

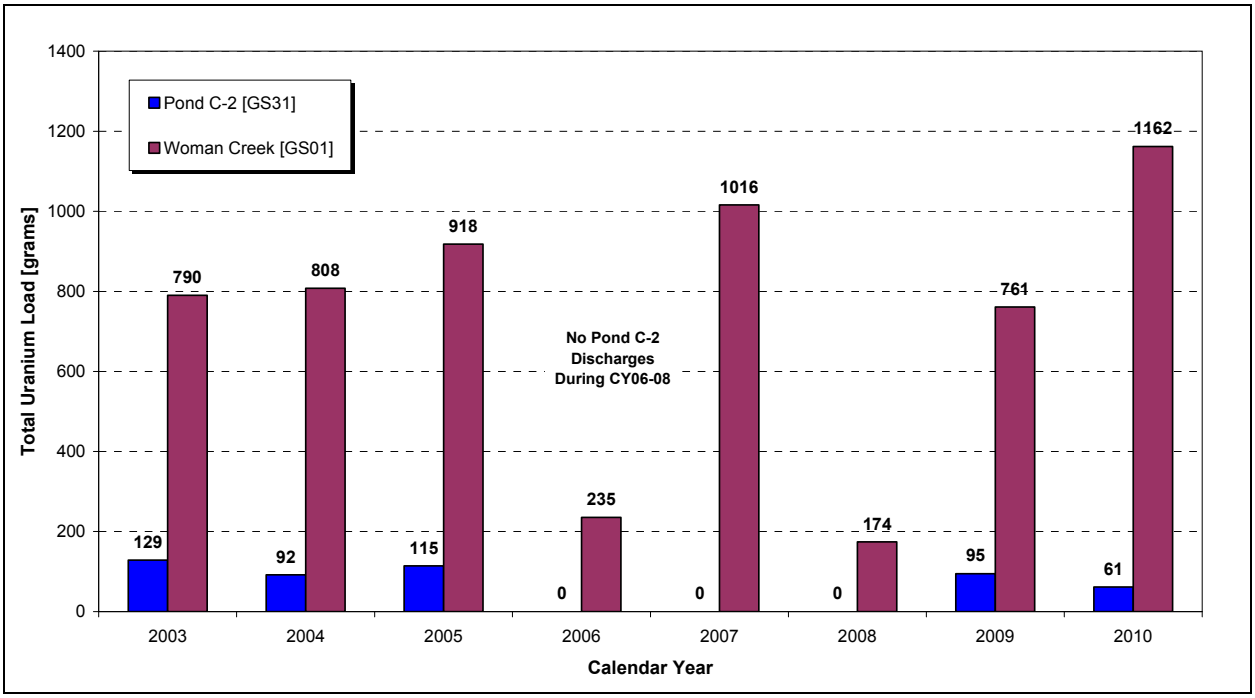


Figure 161. Annual Total U Loads at GS01 and GS31: CY 2003−2010

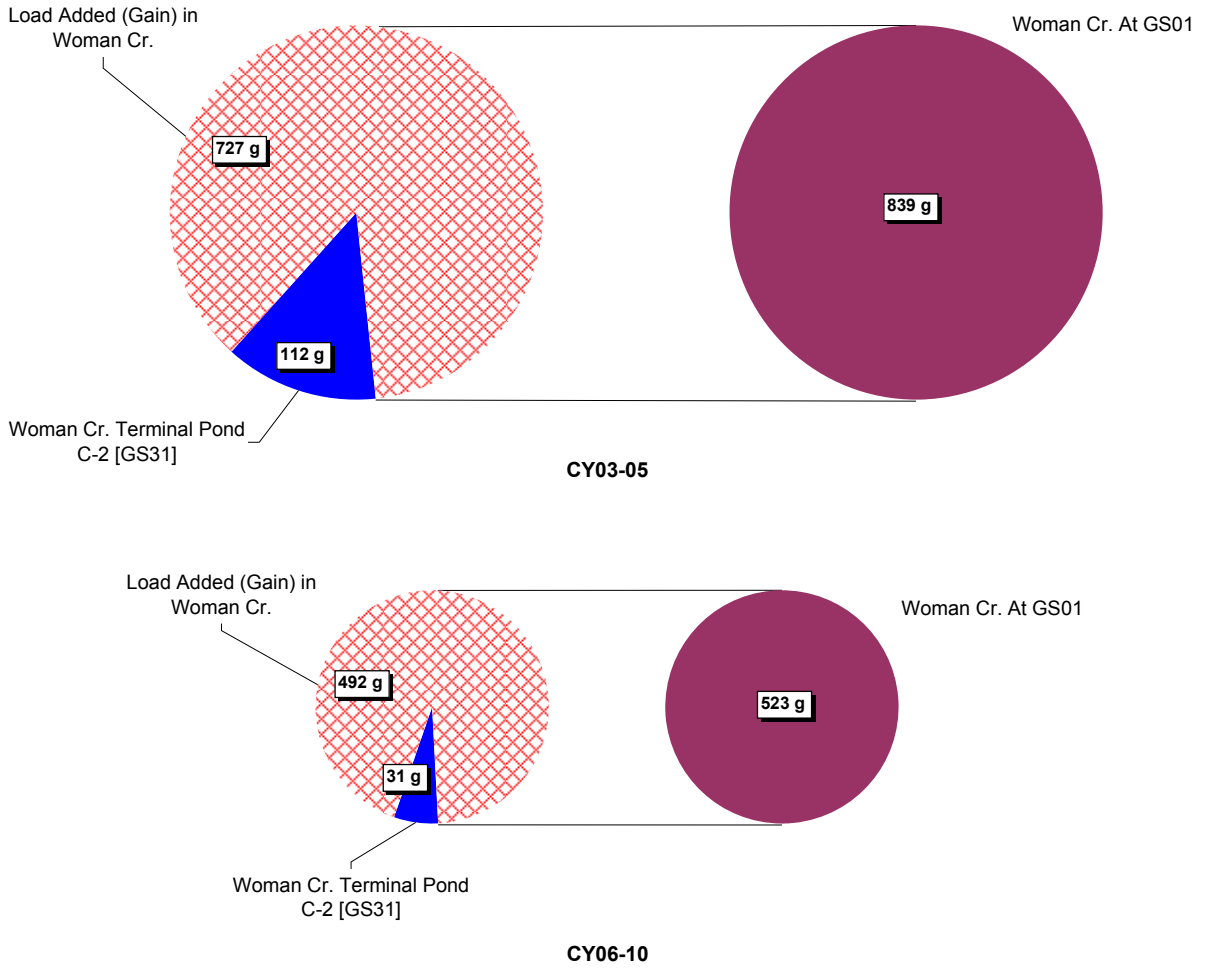


Figure 162. Relative Average Annual Total U Load Totals at GS01 and GS31

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 63 and Table 64, and depicted on Figure 163, Figure 164, Figure 165, Figure 166, Figure 167, and Figure 168. The following points are noted:

- Annual Pu and Am loads vary significantly year to year (Figure 163 and Figure 165). A general reduction in Pu and Am loads is noted during active closure, with a significant reduction post-closure due to the reduction of 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 164) pre-closure. 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 53 percent of the post-closure Pu load due to larger discharge volumes, and not higher Pu activity. Post-closure Pu loads from the terminal ponds have been reduced 94 percent overall.

- Pond B-5 accounts for most (67 percent) of the Am load from the terminal ponds (Figure 166). 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 57 percent of the post-closure Am load due to larger discharge volumes, and not higher Am activity. Post-closure Am loads from the terminal ponds have been reduced 93 percent overall.
- Pond A-4 accounts for a slim majority (46 percent) of the total U loads from the terminal ponds (Figure 168) pre-closure. Comparable proportions are noted post-closure. Post-closure U loads from the terminal ponds have been reduced 45 percent overall.

Table 63. Pu and Am Loads from Terminal Ponds A-4, B-5, and C-2: CY 1997–2010

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	2.3	3.0	4.1	0.09	0.02	0.03
2010	6.4	5.4	0.4	0.14	0.11	0.02
Total	164.5	744.2	89.0	3.33	8.51	1.00

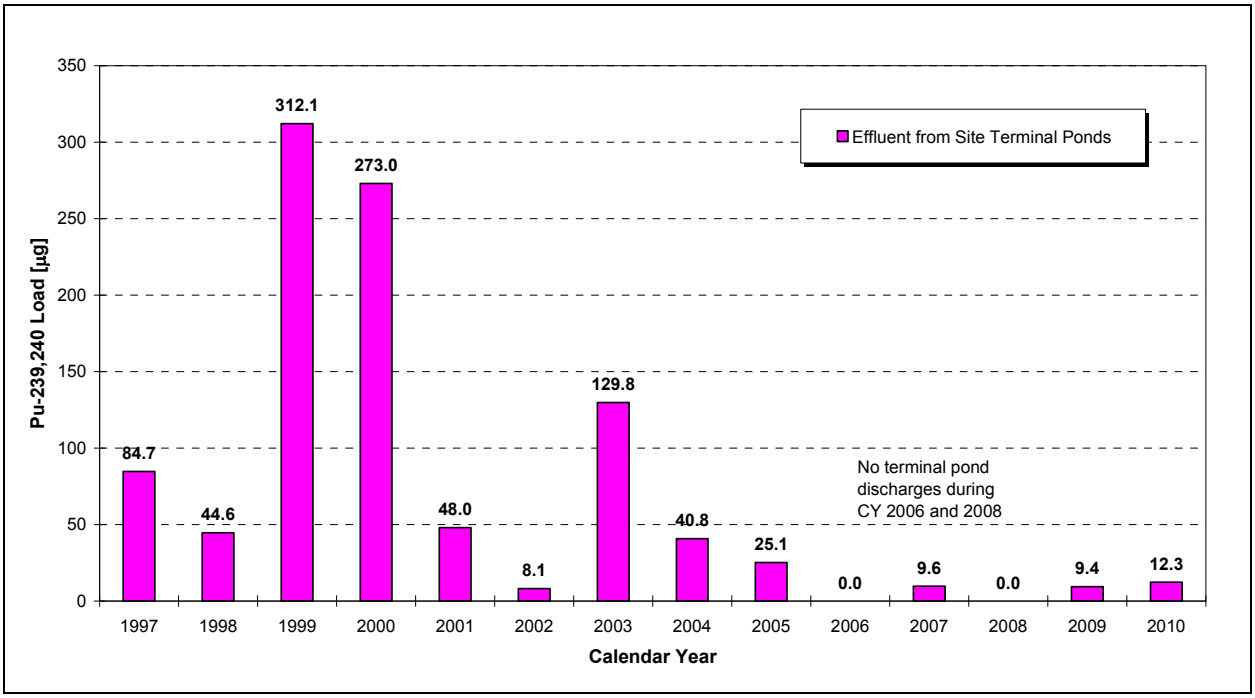
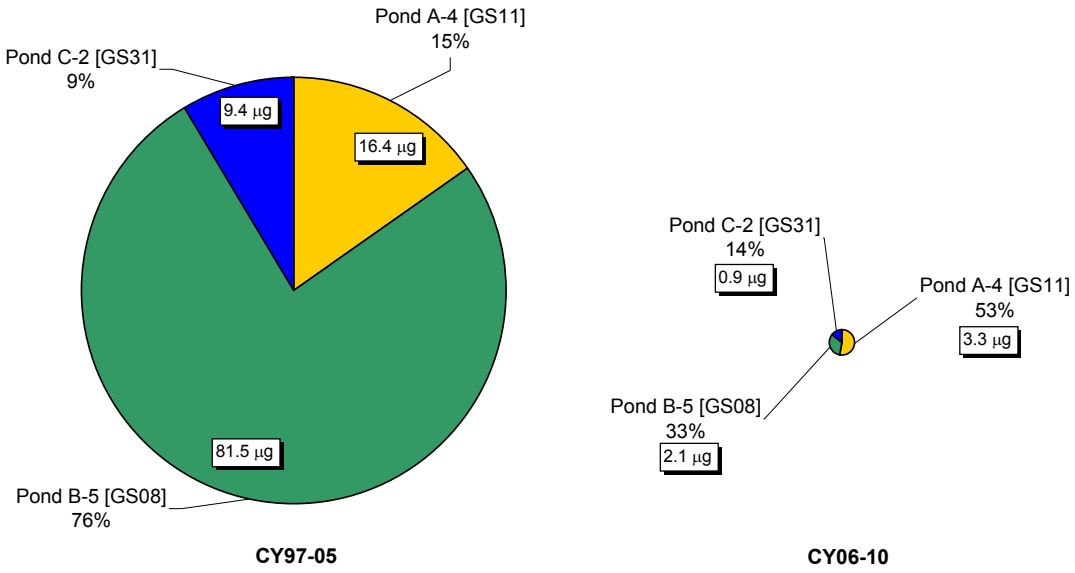


Figure 163. Annual Pu Loads from Terminal Ponds A-4, B-5, and C-2: CY 1997–2010



Note: pie chart diameters relative to total load

Figure 164. Relative Average Annual Pu Load Totals from Terminal Ponds A-4, B-5, and C-2

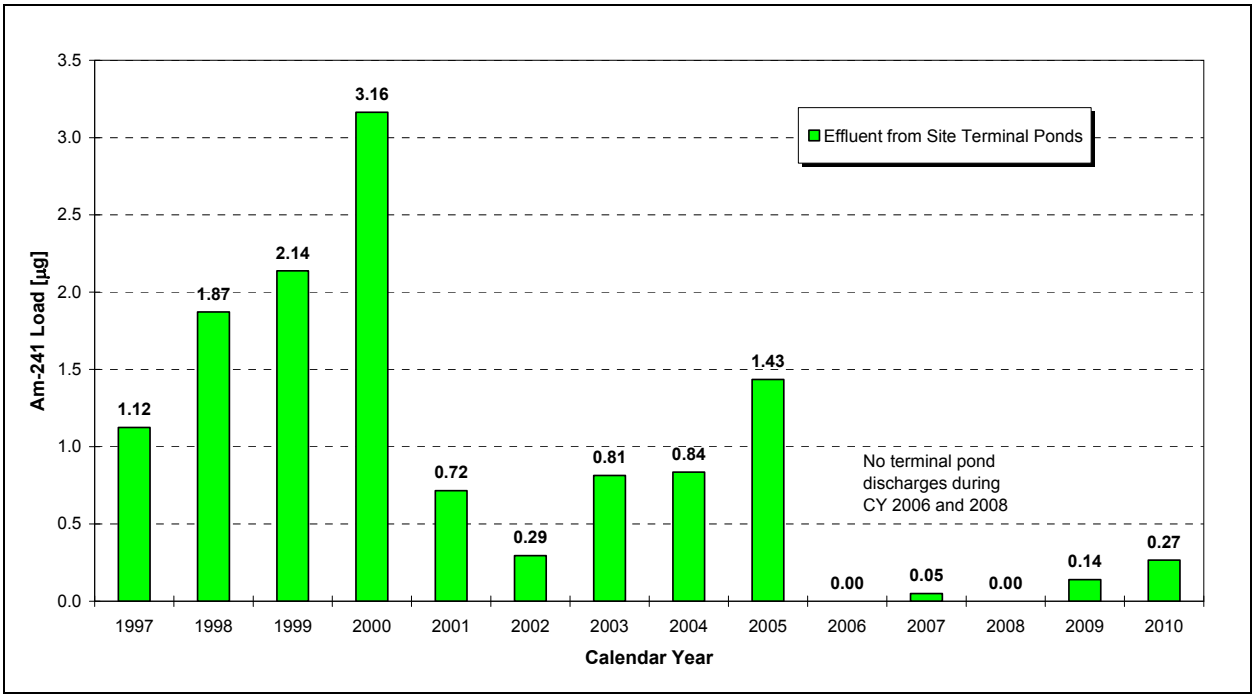
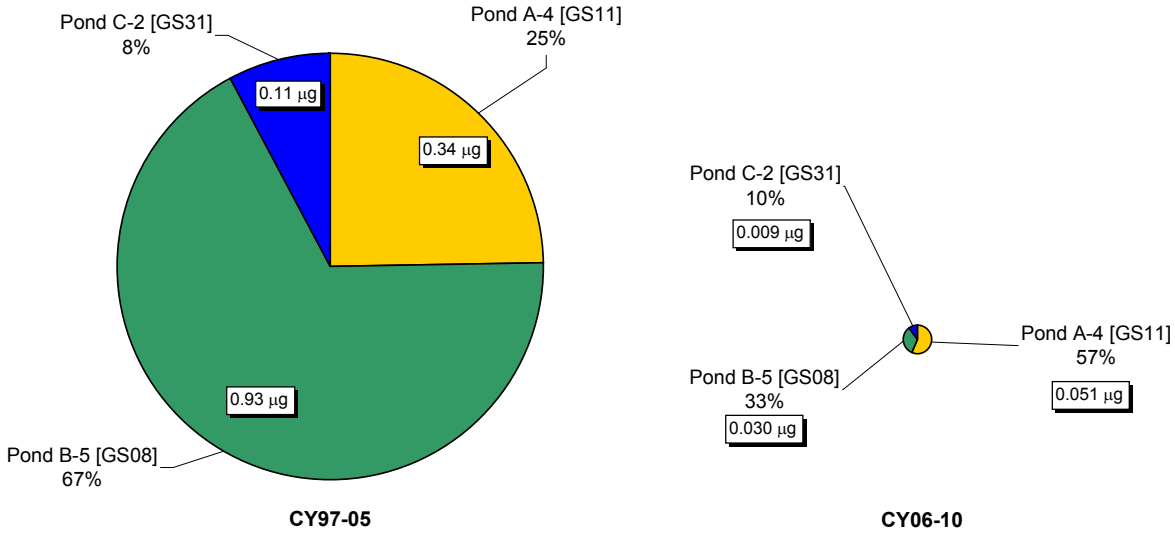


Figure 165. Annual Am Loads from Terminal Ponds A-4, B-5, and C-2: CY 1997–2010



Note: pie chart diameters relative to total load

Figure 166. Relative Average Annual Am Load Totals from Terminal Ponds A-4, B-5, and C-2

Table 64. Total U Loads from Terminal Ponds A-4, B-5, and C-2: CY 1997–2010

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	405	322	95
2010	1,199	746	61
Total	7,742	6,981	1,195

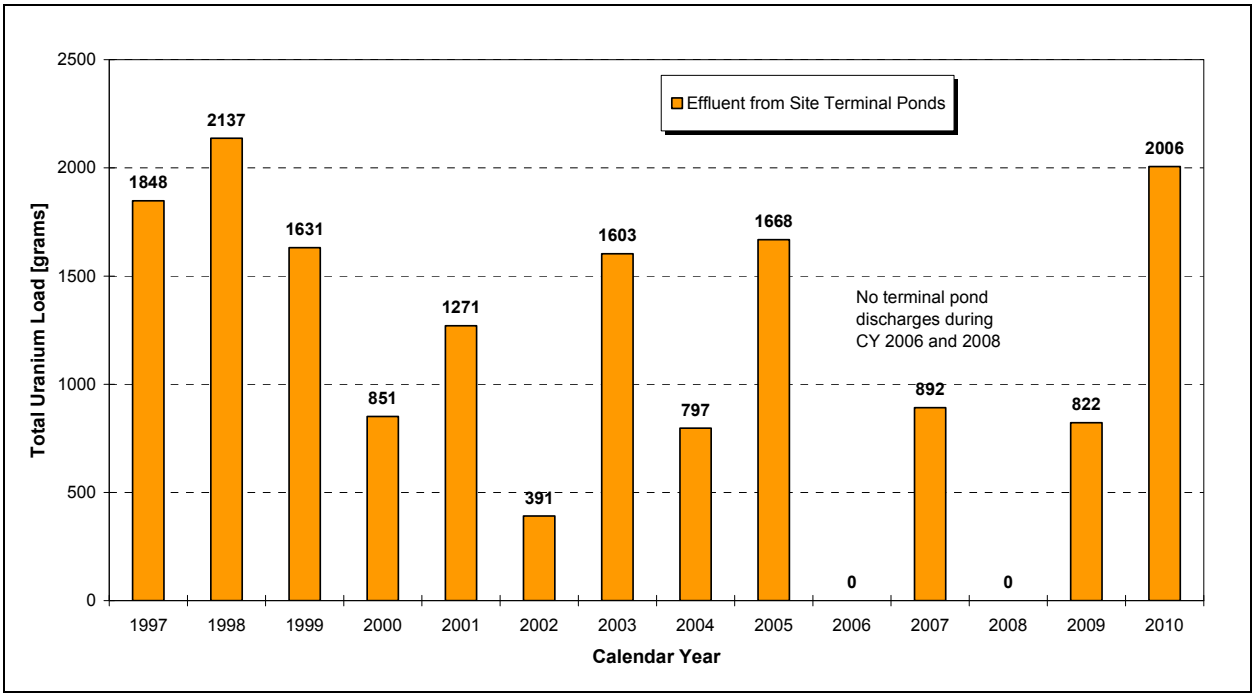


Figure 167. Annual Total U Loads from Terminal Ponds A-4, B-5, and C-2: CY 1997–2010

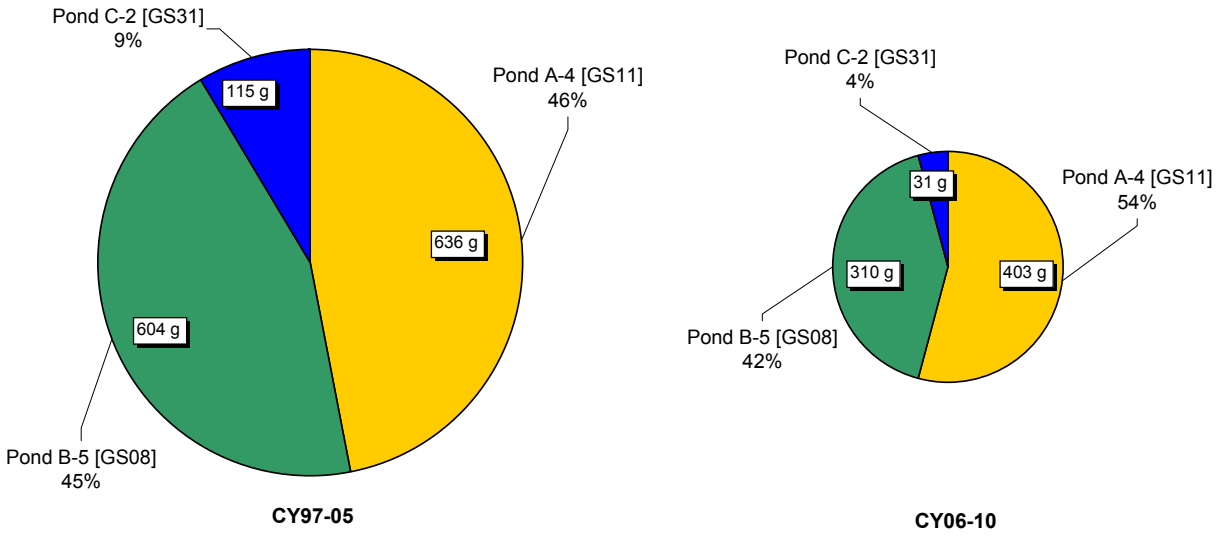


Figure 168. Relative Average Annual Total U Load Totals from Terminal Ponds A-4, B-5, and C-2

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 65, Table 66, and Table 67, and are depicted on Figure 169, Figure 170, Figure 171, Figure 172, Figure 173, Figure 174, Figure 175, and Figure 176. 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 65 shows GS10 with the highest influent Pu load for CY1997-2010. Post-closure Pu loads at GS10 have been reduced 97 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 169). With the implementation of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2006−2010. Post-closure influent and effluent loads have been reduced by 95 percent and 94 percent, respectively.
- Table 66 shows GS10 with the highest influent Am load for CY1997−2010. Post-closure Am loads at GS10 have been reduced 98 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 171). 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 2006−2010. Post-closure influent and effluent loads have been reduced by 97 percent and 94 percent, respectively.

- Pre-closure annual Pu and Am loads vary significantly year to year (Figure 169 and Figure 171), primarily due to streamflow volume and solids transport variation. Post-closure loads show less variability.
- Pre-closure (Figure 173), 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 174), GS10 shows both the highest average annual concentration and load. Although 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 14 percent.
- Pre-closure (Figure 173), 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 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 43 percent.

Table 65. Pu Load Summary for the A- and B-Series Ponds: CY 1997–2010

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
Total	86.9	2,765.4	2,075.0	744.2	164.5

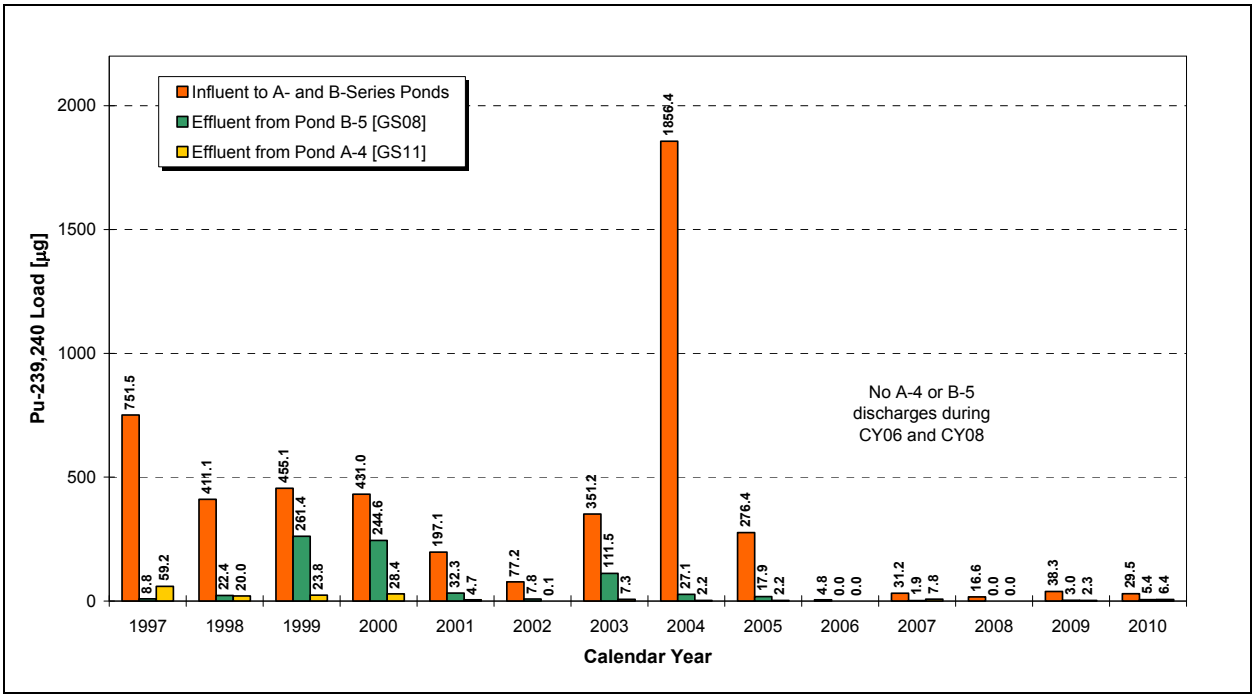
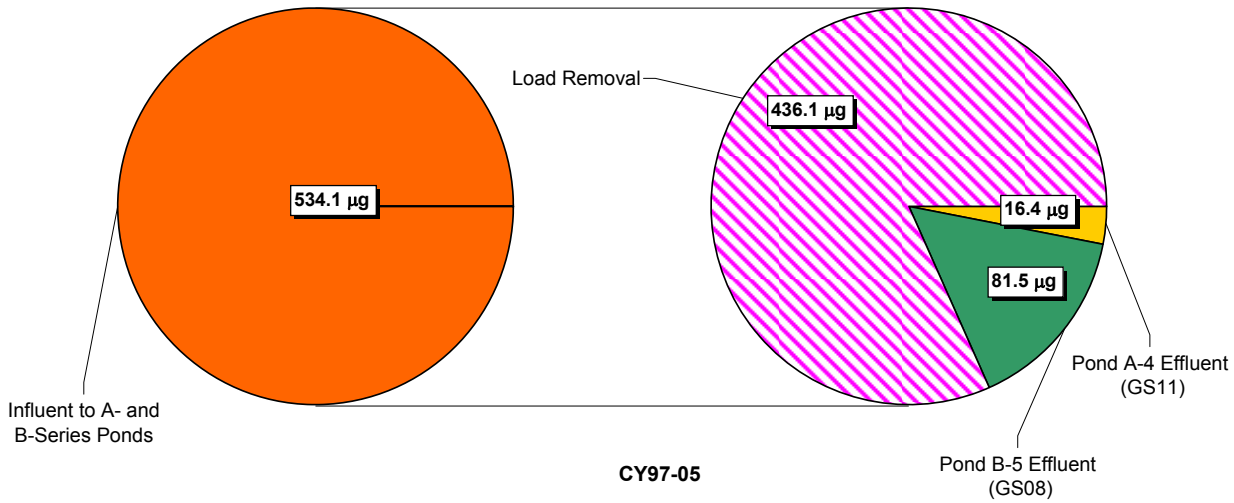
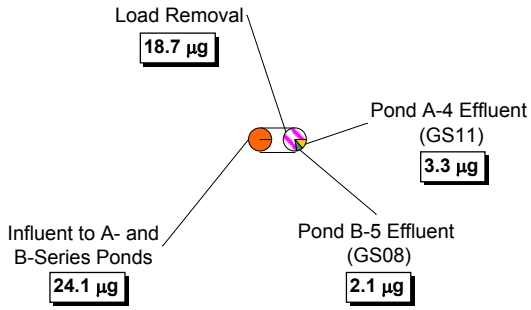


Figure 169. Annual Pu Loads for the A- and B-Series Ponds: CY 1997–2010





Note: pie chart diameters relative to total load

Figure 170. Relative Average Annual Pu Load Totals for the A- and B-Series Ponds

Table 66. Am Load Summary for the A- and B-Series Ponds: CY 1997–2010

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
Total	2.65	62.19	39.80	8.51	3.33

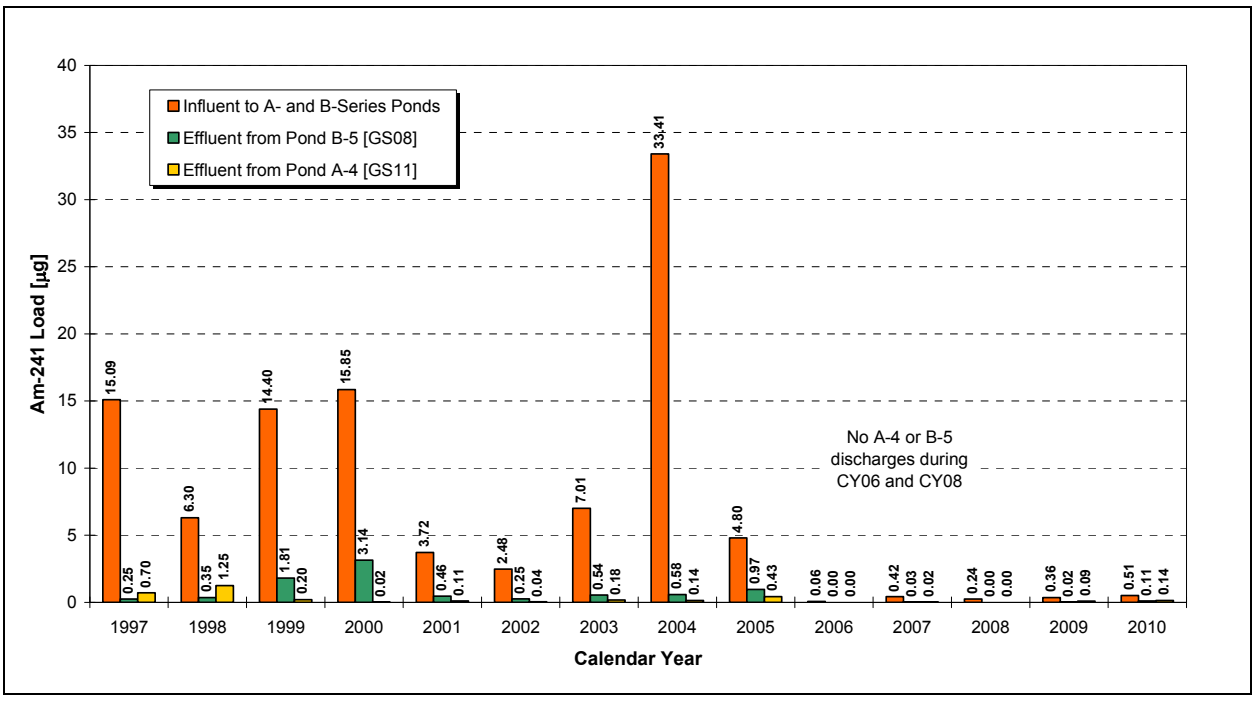
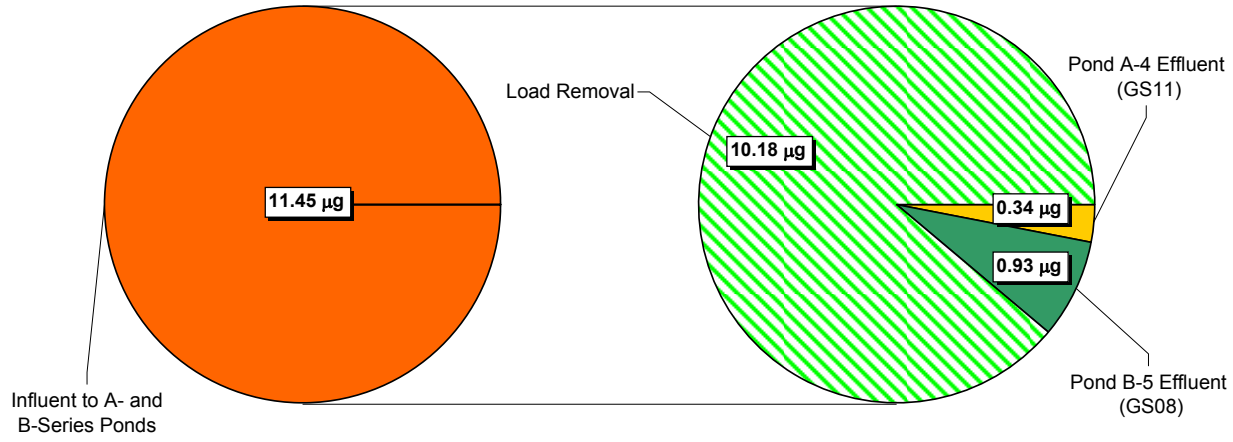
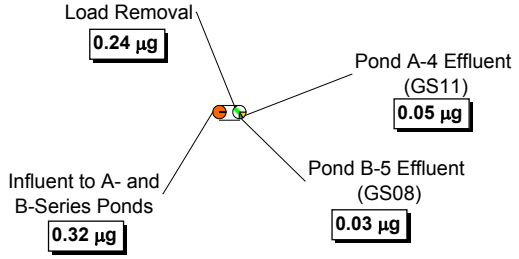


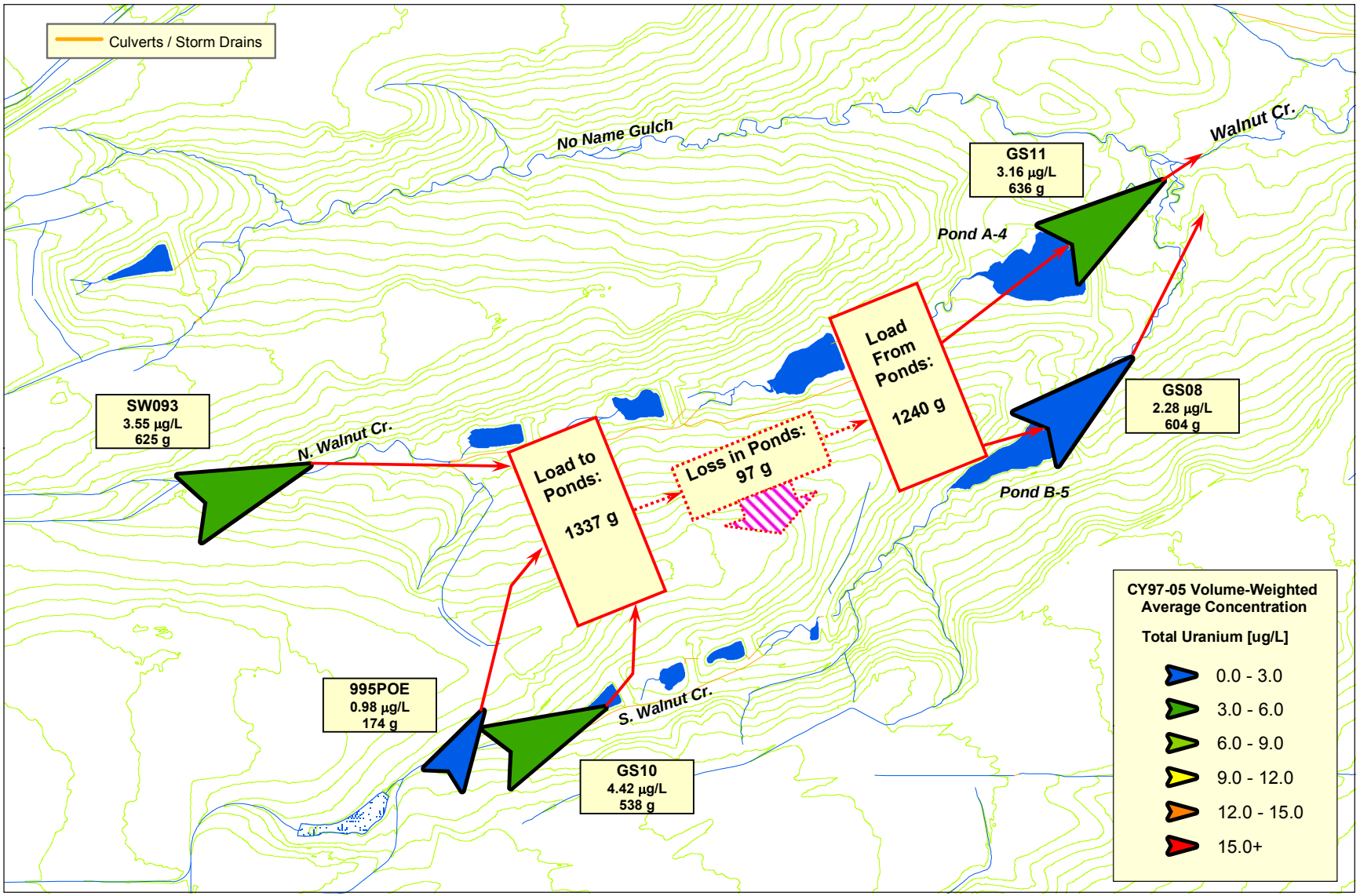
Figure 171. Annual Am Loads for the A- and B-Series Ponds: CY 1997–2010





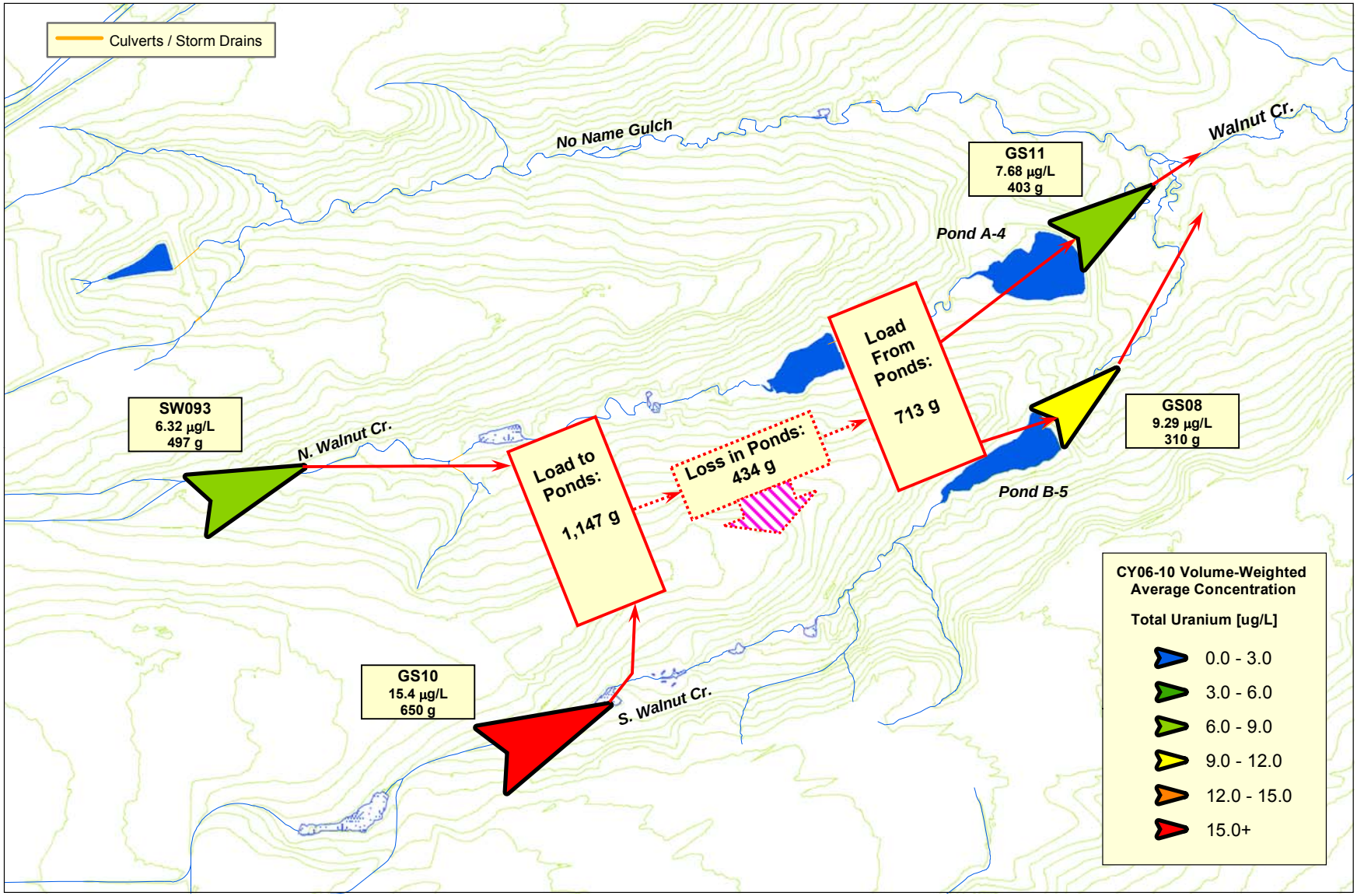
Note: pie chart diameters relative to total load

Figure 172. 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 173. 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 174. Relative Average Annual Total U Loading Schematic for the A- and B-Series Ponds: CY 2006–2010

Table 67. Total U Load Summary for the A- and B-Series Ponds: CY 1997–2010

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	405
2010	0 WWTP removed	1,158	1,047	746	1,199
Total	1,569	8,095	8,108	6,981	7,742

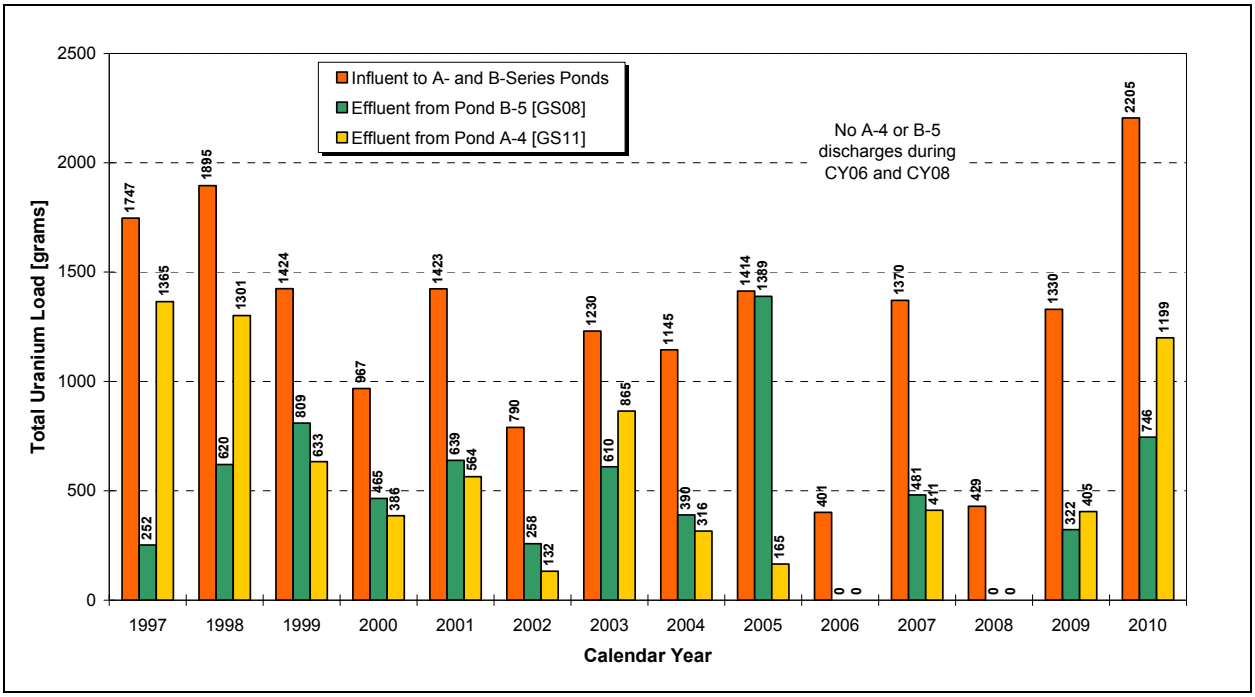
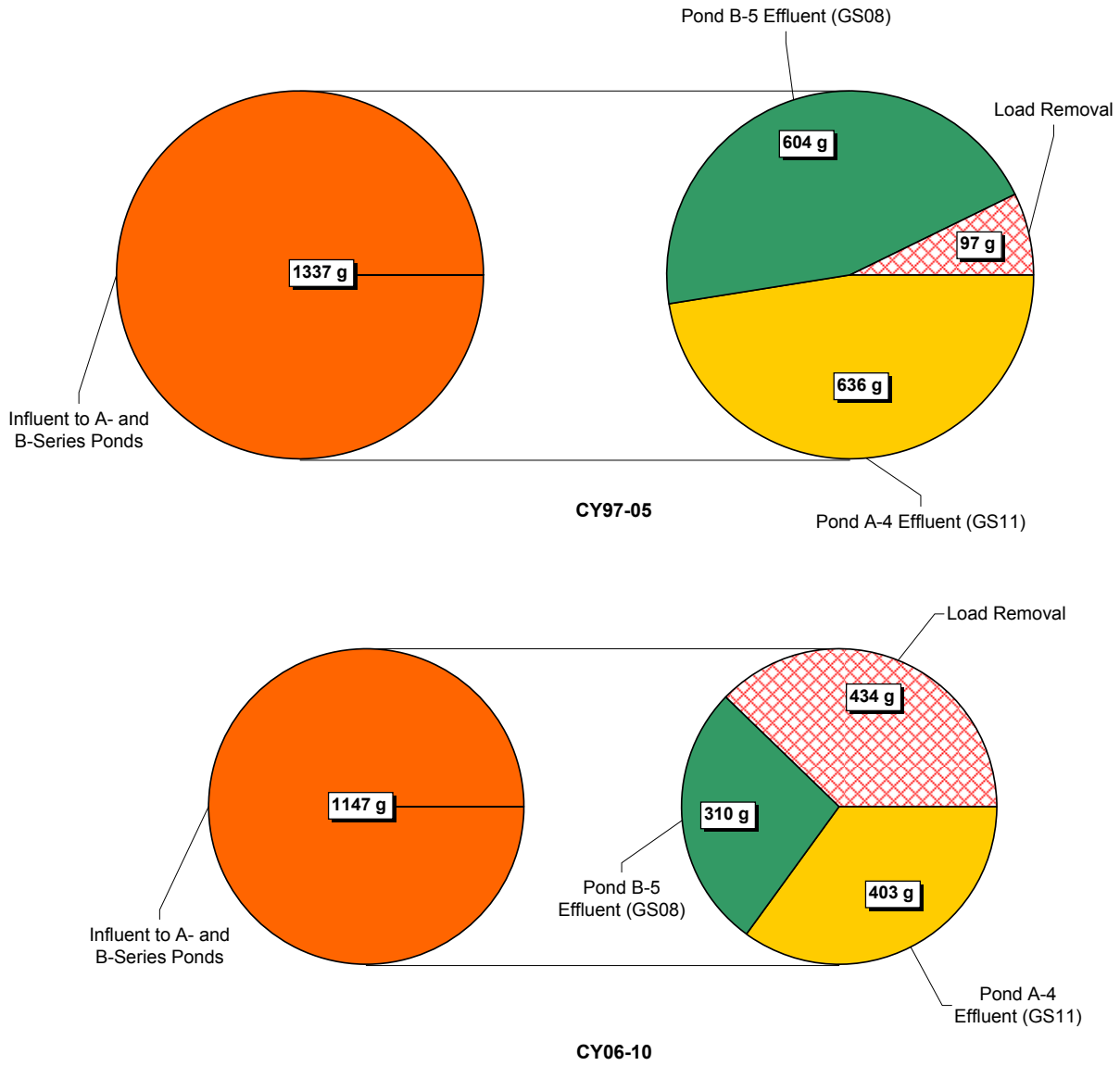


Figure 175. Annual Total U Loads for the A- and B-Series Ponds: CY 1997–2010



Note: pie chart diameters relative to total load

Figure 176. 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 68, Table 69, and Table 70, and depicted on Figure 177, Figure 178, Figure 179, Figure 180, Figure 181, Figure 182, Figure 183, and Figure 184. 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 177 and Figure 179). 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 2005−2010. Post-closure influent and effluent Pu loads have been reduced by 91 percent and 90 percent, respectively. Similarly, Post-closure influent and effluent Am loads have been reduced by 87 percent and 91 percent, respectively.

- Annual total U loads also vary significantly year to year (Figure 183). Post-closure influent and effluent U loads have been reduced by 69 percent and 73 percent, respectively.
- There is a measurable pre-closure average annual total U load gain in Pond C-2 (Figure 181). This is likely due to seepage with naturally occurring U entering Pond C-2 from the Woman Creek Diversion Canal. Post-closure, there is a similar gain in total U in Pond C-2.

Table 68. Pu Load Summary for Terminal Pond C-2: CY 1997–2010

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
Total	1,157.9	89.0

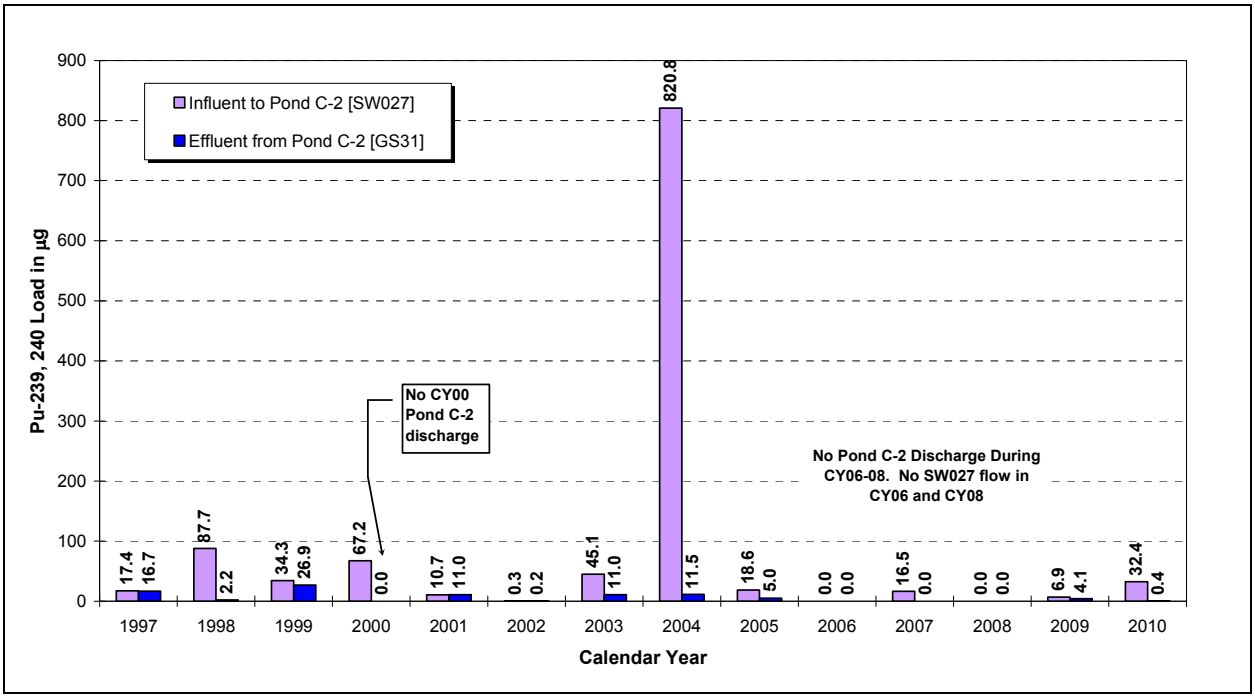
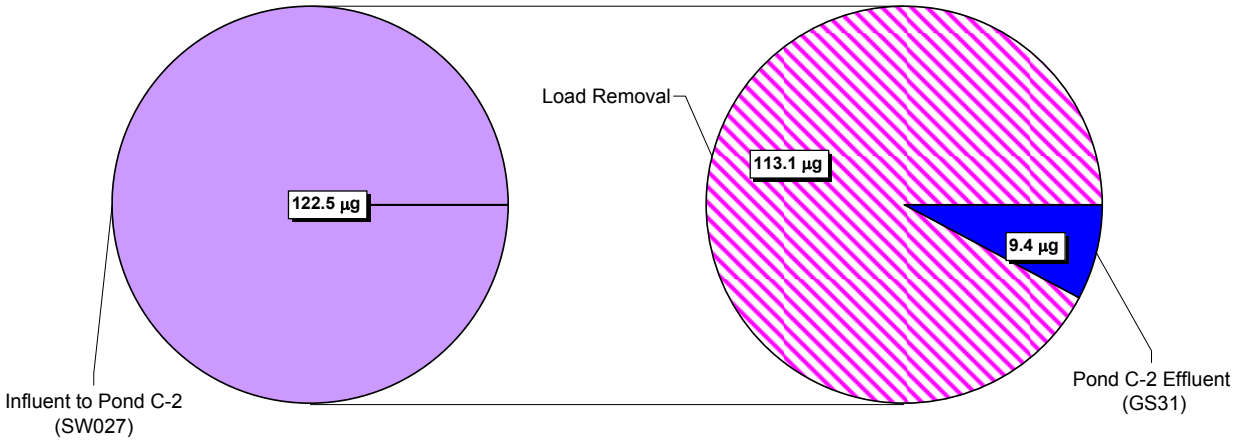
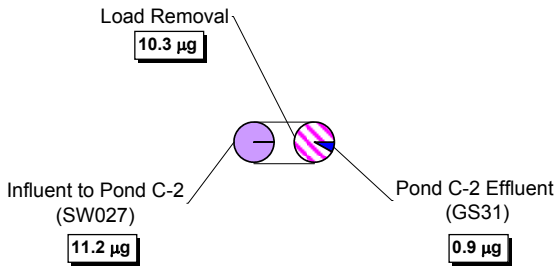


Figure 177. Annual Pu Loads for Pond C-2: CY 1997–2010



CY97-05



CY06-10

Note: pie chart diameters relative to total load

Figure 178. Relative Average Annual Pu Load Totals for Pond C-2

Table 69. Am Load Summary for Terminal Pond C-2: CY 1997–2010

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
Total	4.39	1.00

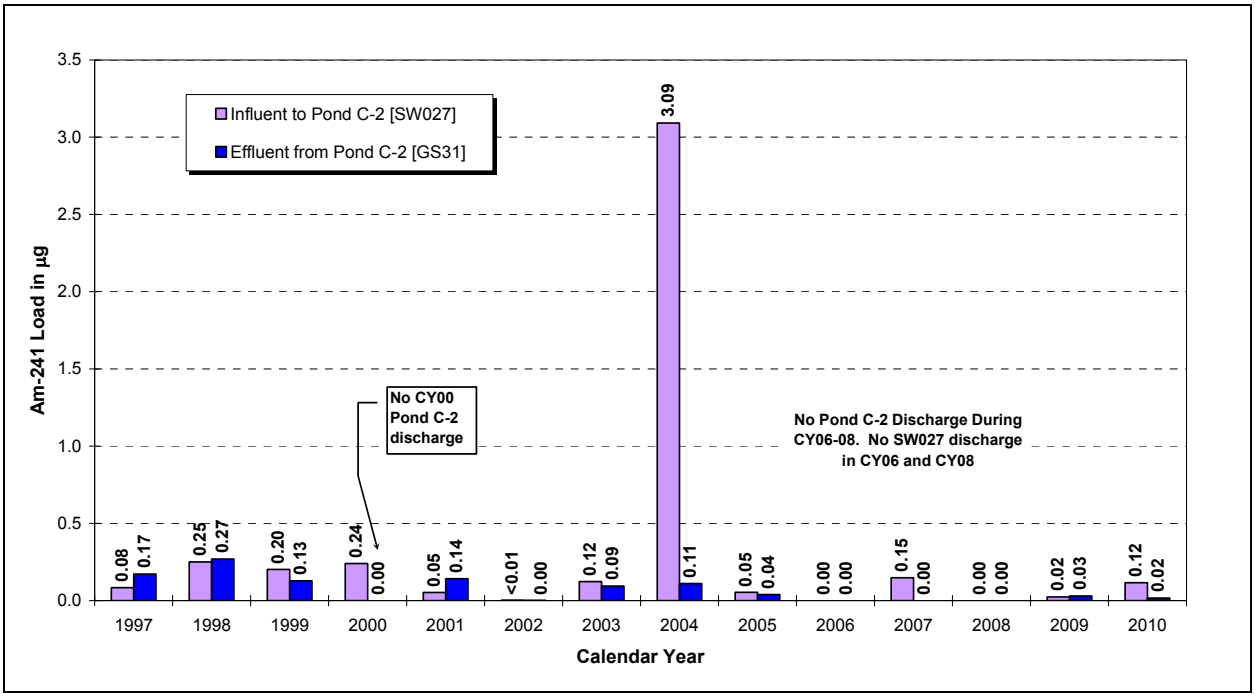
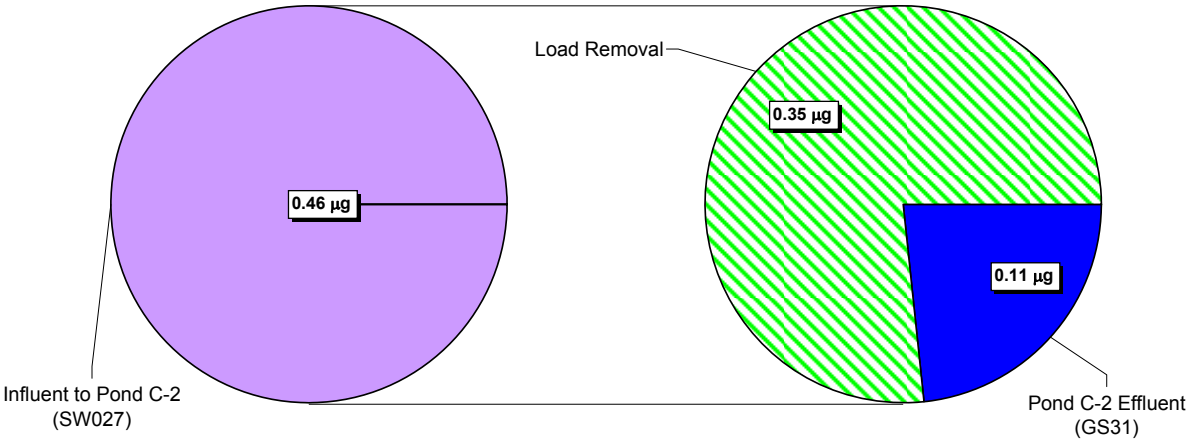


Figure 179. Annual Am Loads for Pond C-2: CY 1997–2010

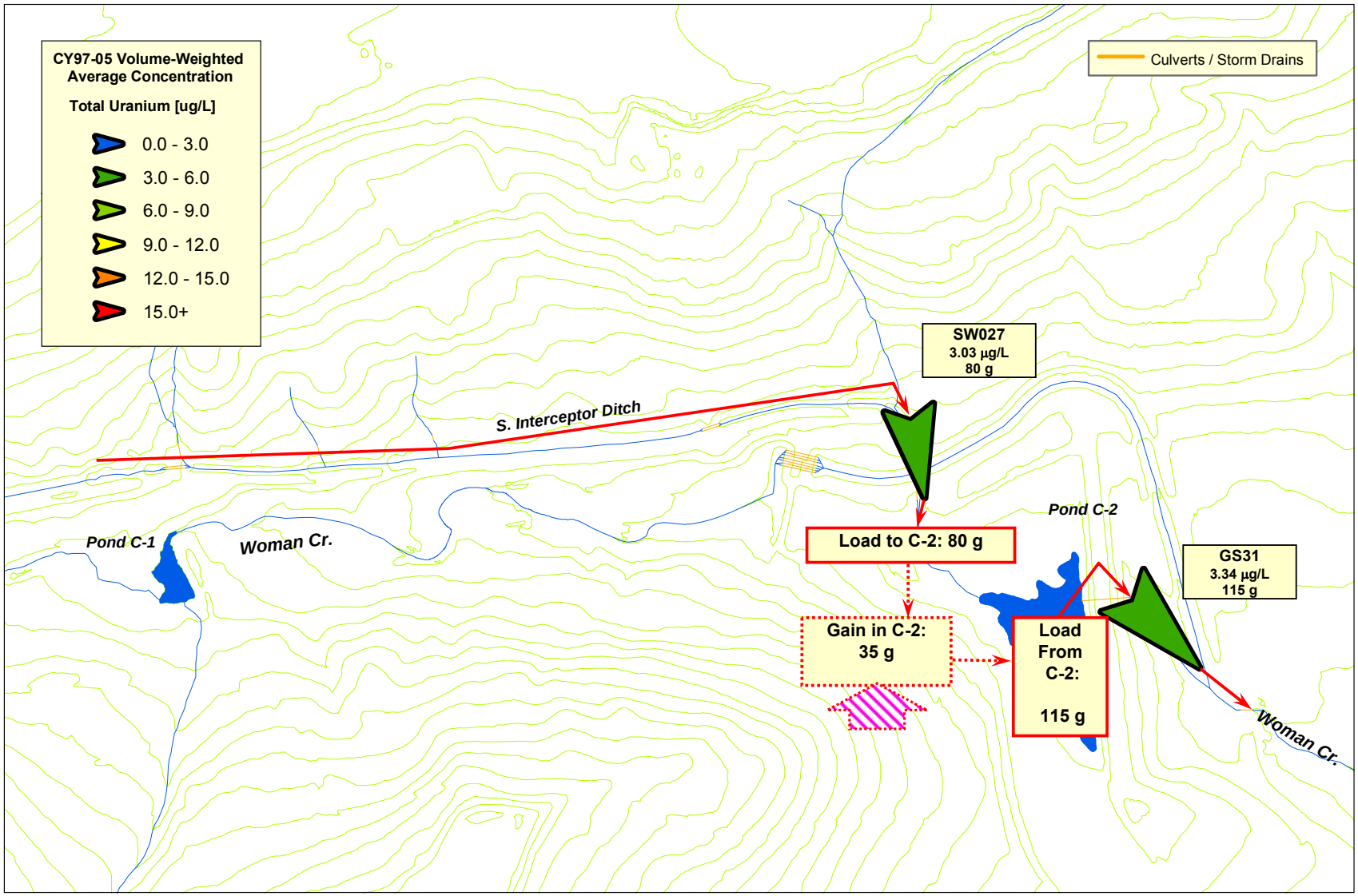


Note: pie chart diameters relative to total load

Figure 180. Relative Average Annual Am Load Totals for Pond C-2

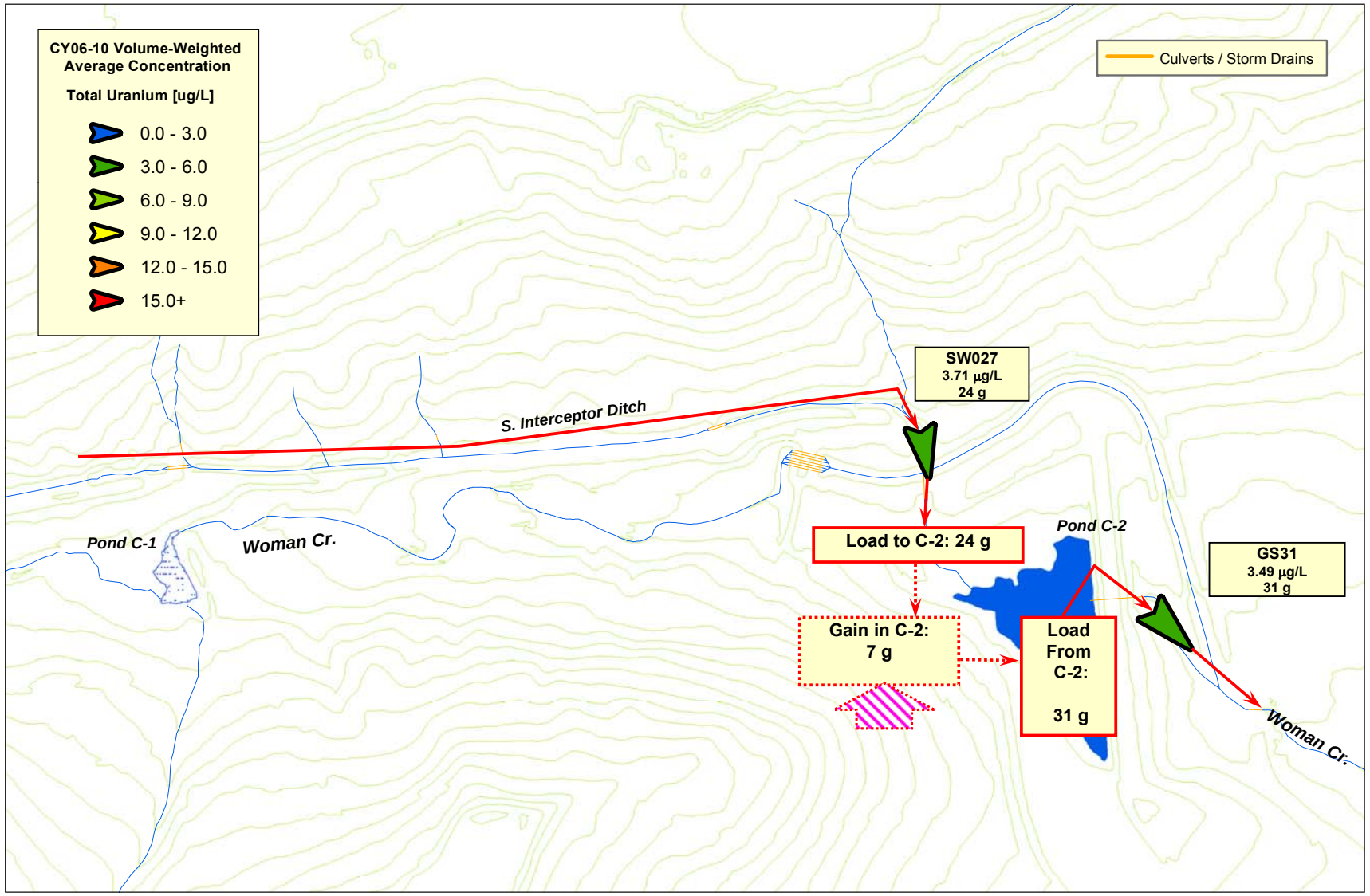
Table 70. Total U Load Summary for Terminal Pond C-2: CY 1997–2010

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
2010	70	61
Total	840	1,195



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

Figure 181. 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 182. Relative Average Annual U Loading Schematic for Pond C-2: CY 2006–2010

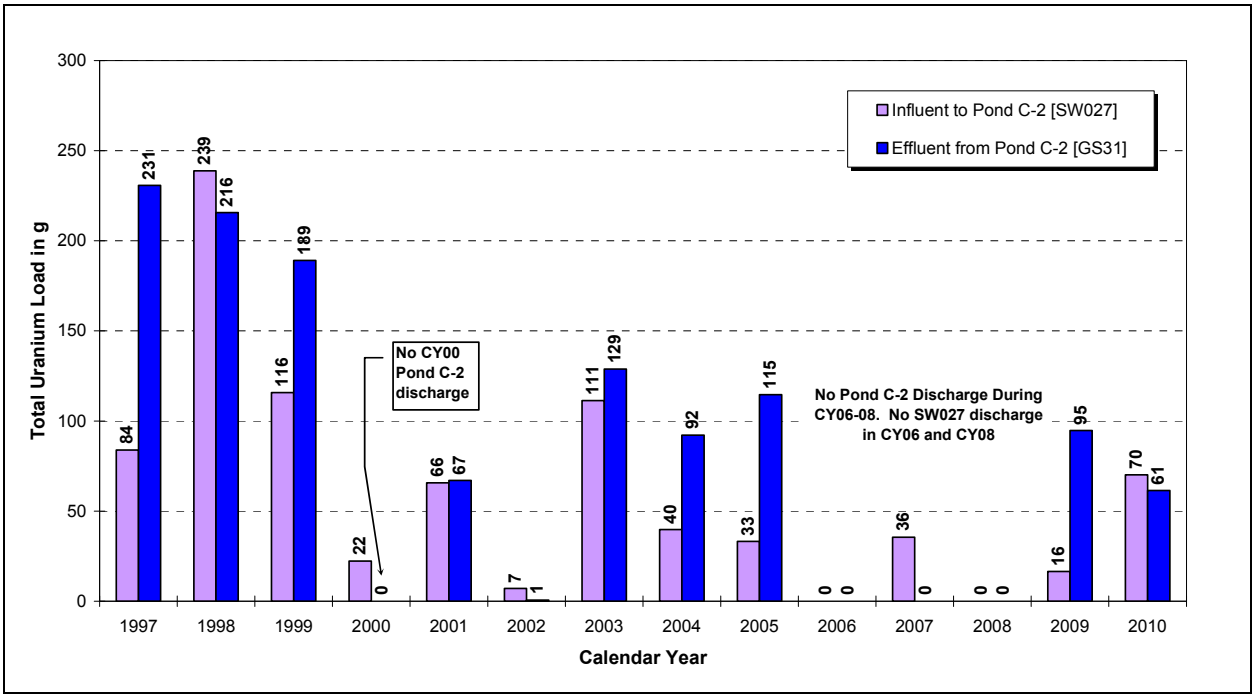
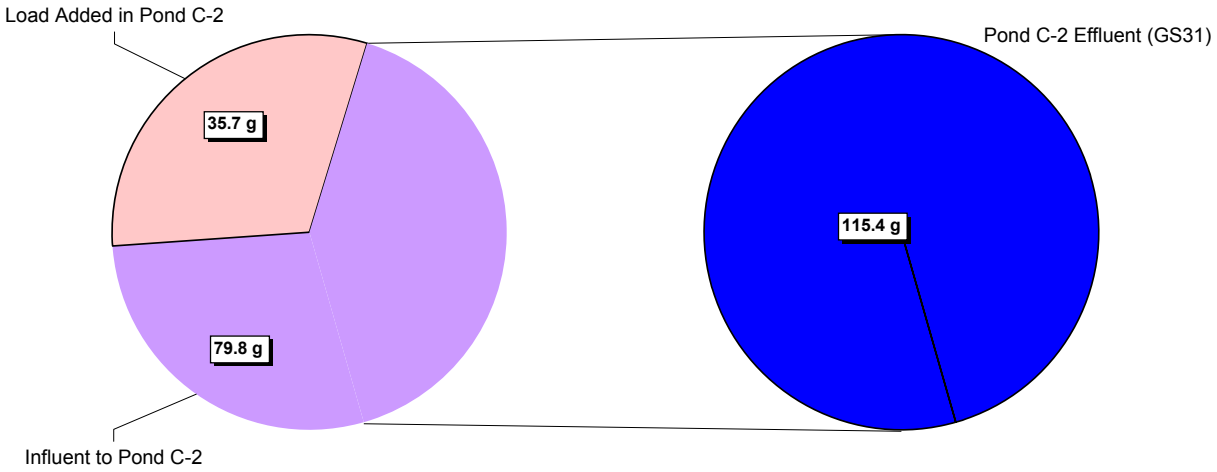


Figure 183. Annual Total U Loads for Pond C-2: CY 1997–2010



Note: pie chart diameters relative to total load

Figure 184. Relative Average Annual Total U Load Totals for Pond C-2

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 71 and Table 72 and are depicted on Figure 185, Figure 186, Figure 187, Figure 188, Figure 189, Figure 190, Figure 191, Figure 192, Figure 193, and Figure 194. 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 185). With the implementation of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2006−2010. Post-closure Pu loads have been reduced by 95 percent.
- 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 187). With the implementation of remedial actions, erosion controls, revegetation, and soil stabilization, a significant reduction is noted for CY 2006−2010. Data from SW093 in CY 2005 (Figure 192) also clearly show that the B771 pathway elimination was successful. Post-closure Am loads have been reduced by 97 percent.
- South Walnut Creek accounts for a majority (47 percent) of the Pu load from the COU (Figure 186) 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 (41 percent) of Pu load; this is attributed to larger streamflow volumes and not significantly higher activities.
- South Walnut Creek accounts for a majority (60 percent) of the Am load from the COU (Figure 188) 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 (55 percent) of the Am loads; this is attributed to larger streamflow volumes and not significantly higher activities.
- Annual total U loads are more consistent year to year (Figure 193). 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 is due to large flow volumes and not a significant increase in U concentration. Post-closure U loads have been reduced by 17 percent.
- Pre-closure total U loads are fairly evenly divided (44 percent to 50 percent) between North and South Walnut Creeks (Figure 194). Post-closure, proportions are similar.

Table 71. COU Pu and Am Loads: CY 1997–2010

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
Total	2,075.0	2,765.4	86.9	1,157.9	39.80	62.19	2.65	4.39

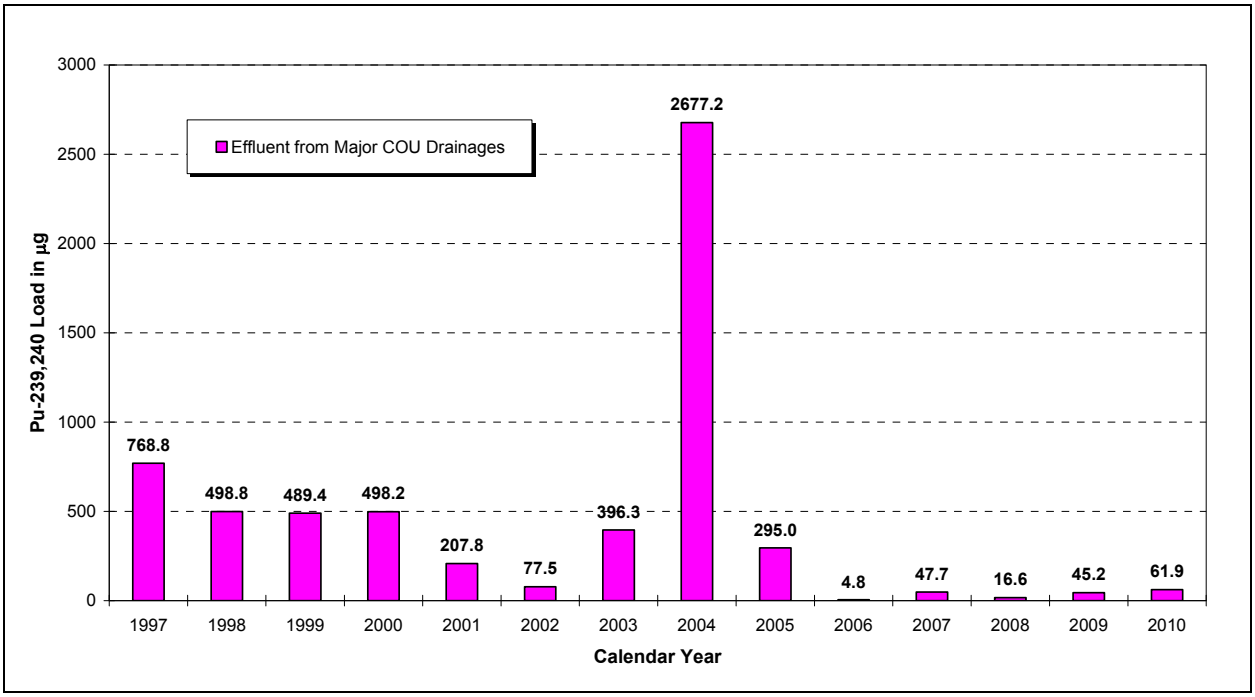
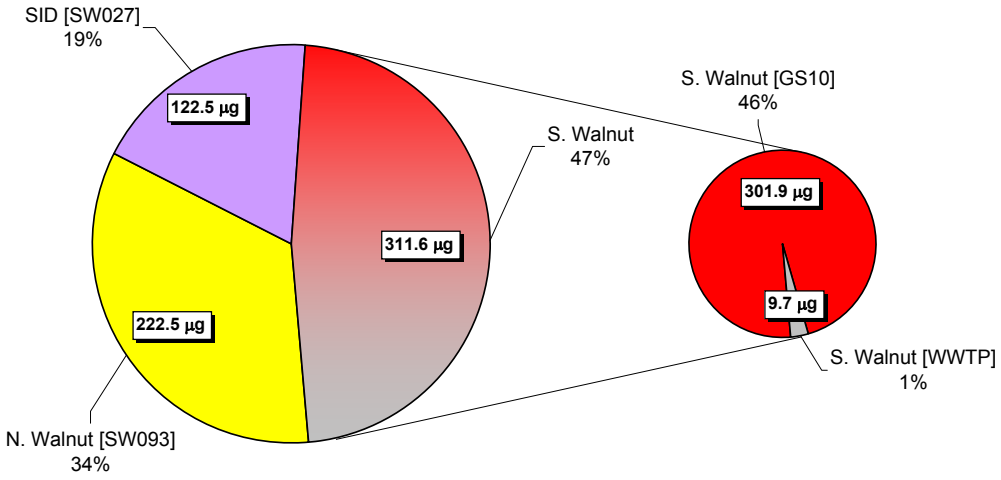
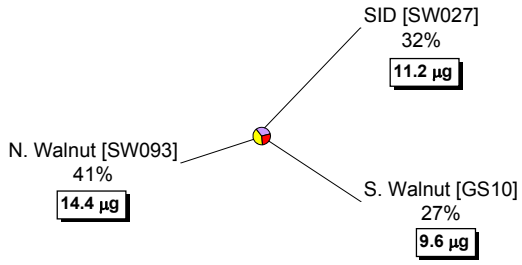


Figure 185. Combined Annual Pu Loads from Major COU Drainages and Former WWTP: CY 1997–2010





Note: pie chart diameters relative to total load

Figure 186. Relative Average Annual Pu Load Totals from Major COU Drainages and Former WWTP

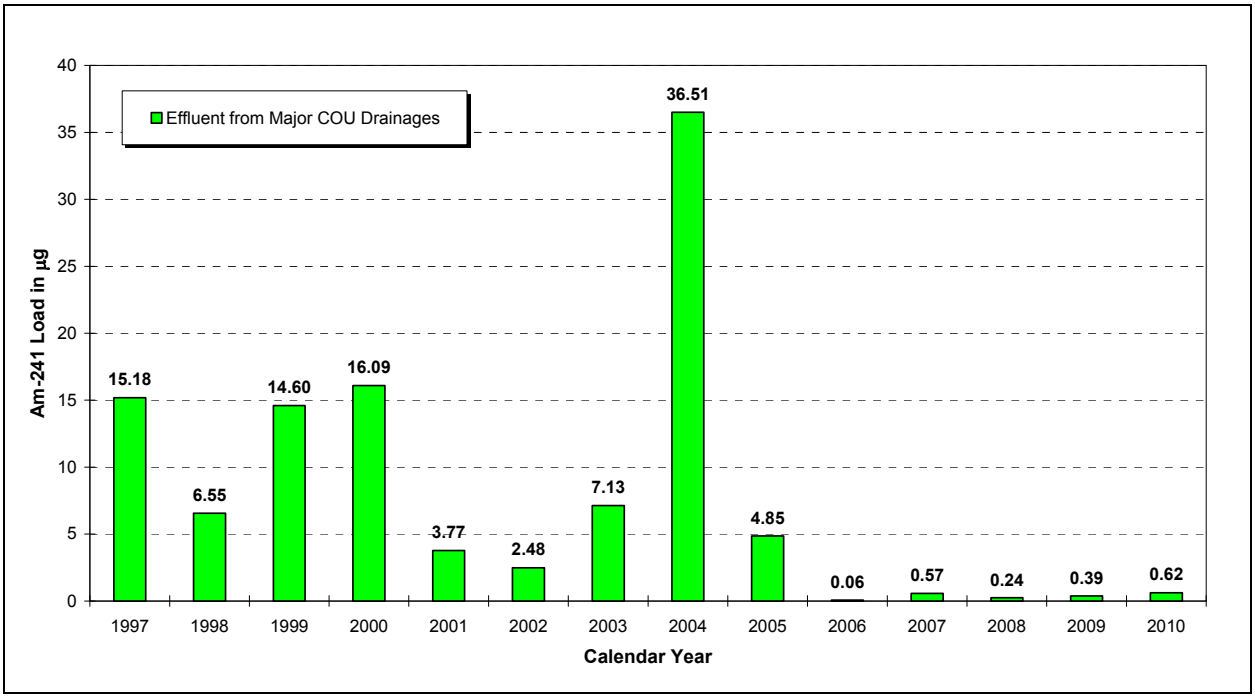
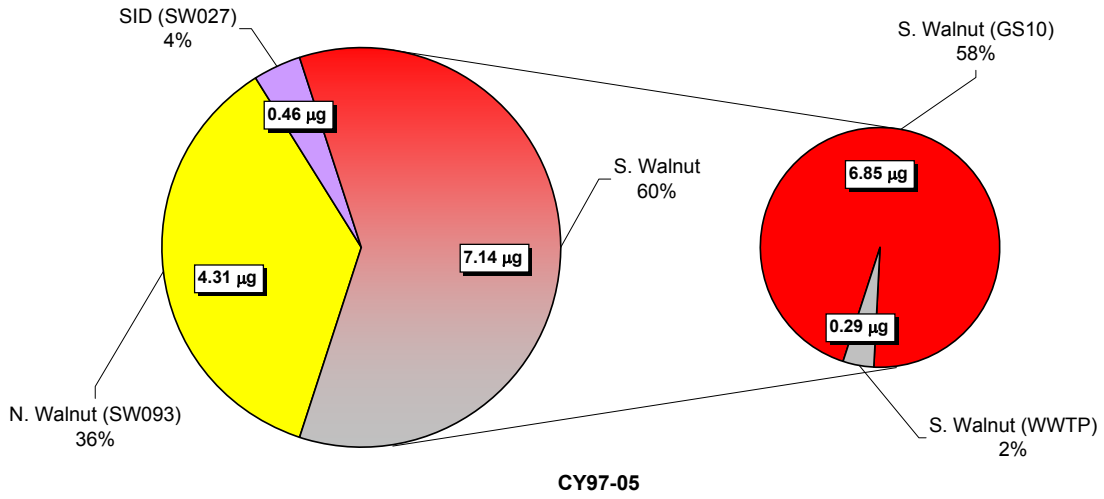
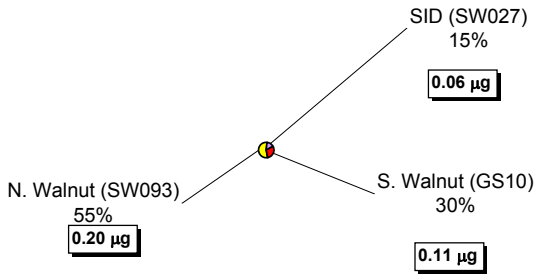


Figure 187. Annual Am Loads from Major COU Drainages and WWTP: CY 1997–2010





Note: pie chart diameters relative to total load

Figure 188. Relative Average Annual Am Load Totals from Major COU Drainages and WWTP

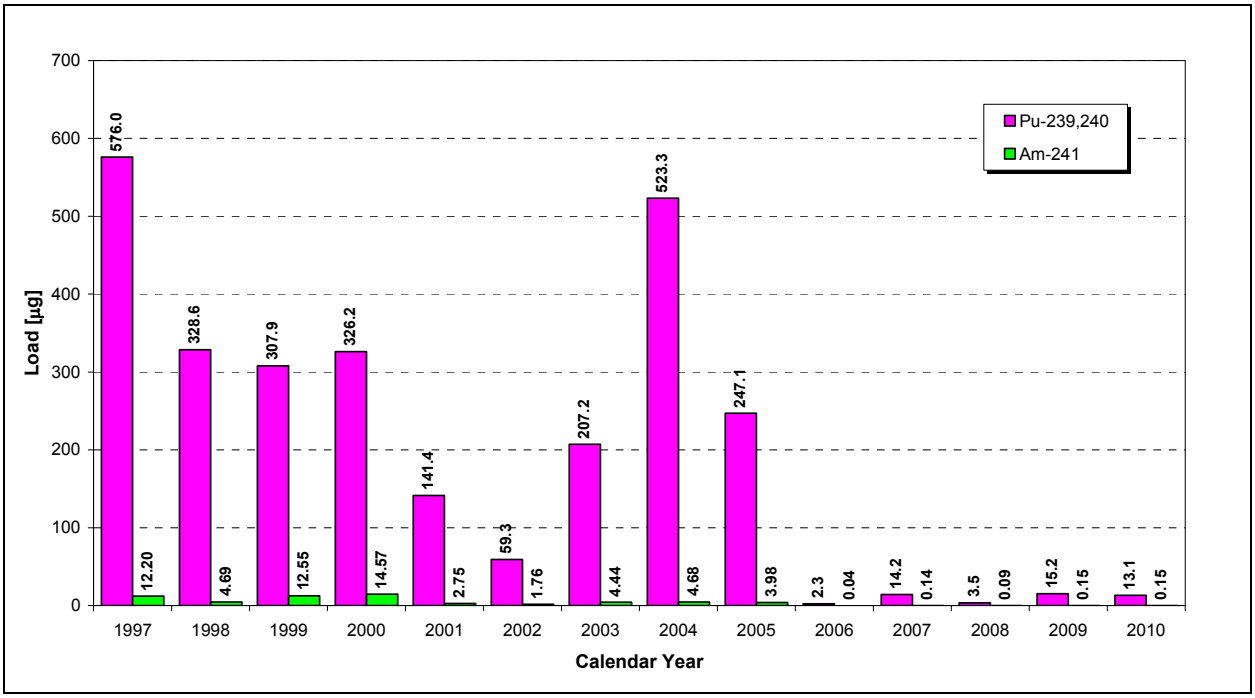


Figure 189. Annual Pu and Am Loads at GS10: CY 1997–2010

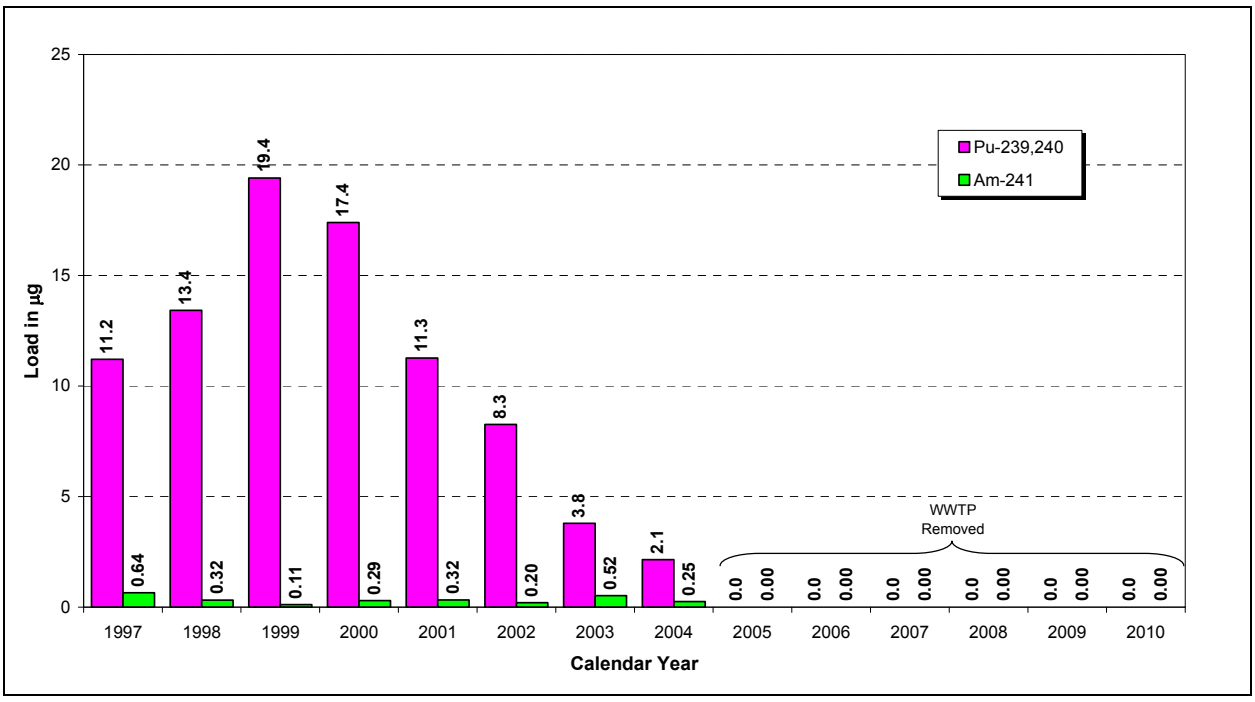


Figure 190. Annual Pu and Am Loads at the WWTP: CY 1997–2010

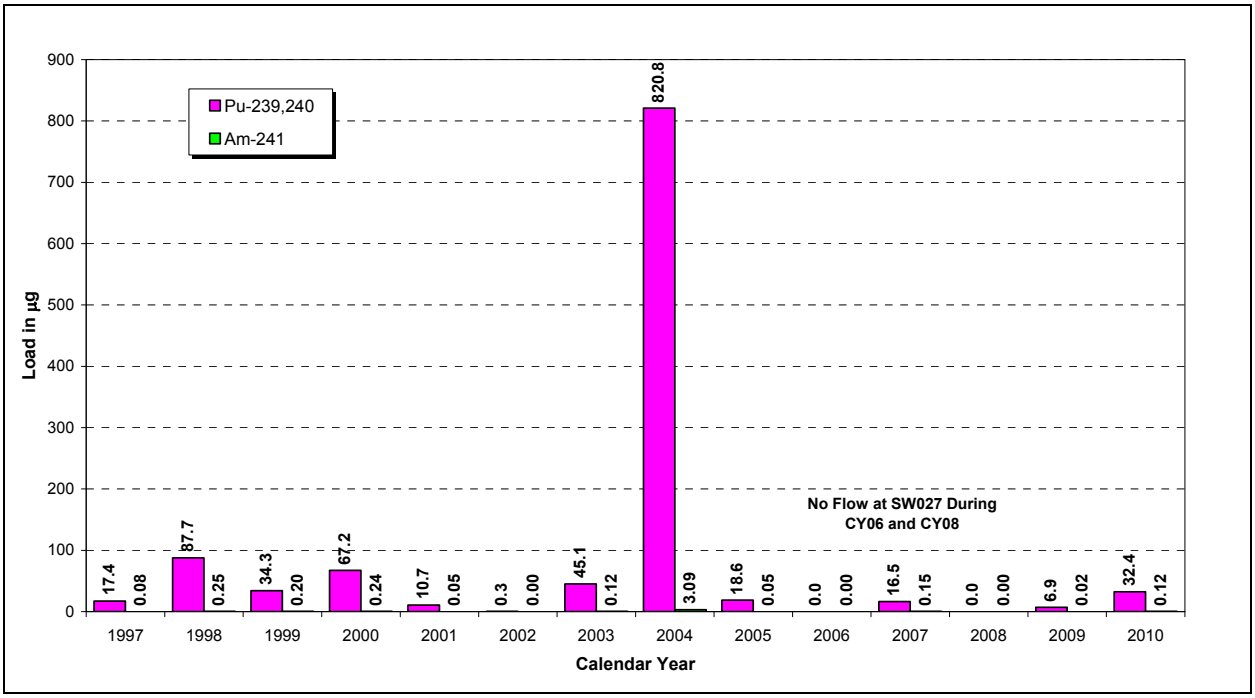


Figure 191. Annual Pu and Am Loads at SW027: CY 1997–2010

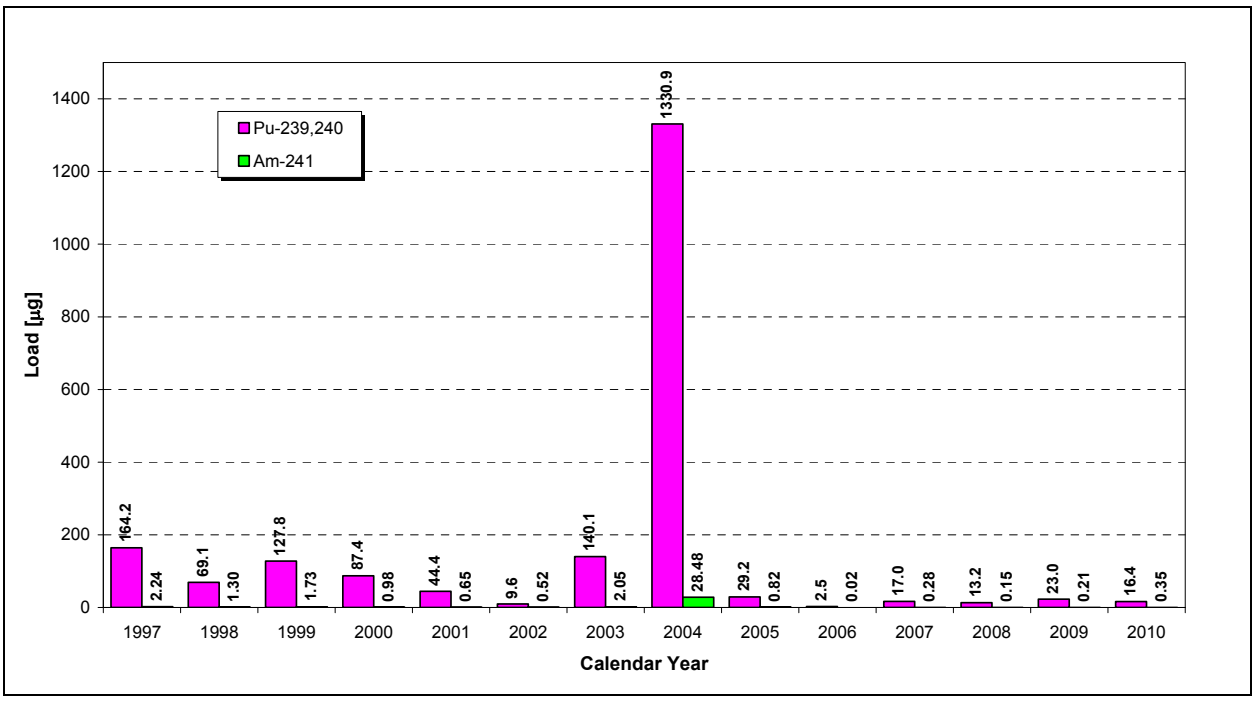


Figure 192. Annual Pu and Am Loads at SW093: CY 1997–2010

Table 72. COU Total U Loads: CY 1997–2010

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
2010	1,047	1,158	0; WWTP removed	70
Total	8,108	8,095	1,569	840

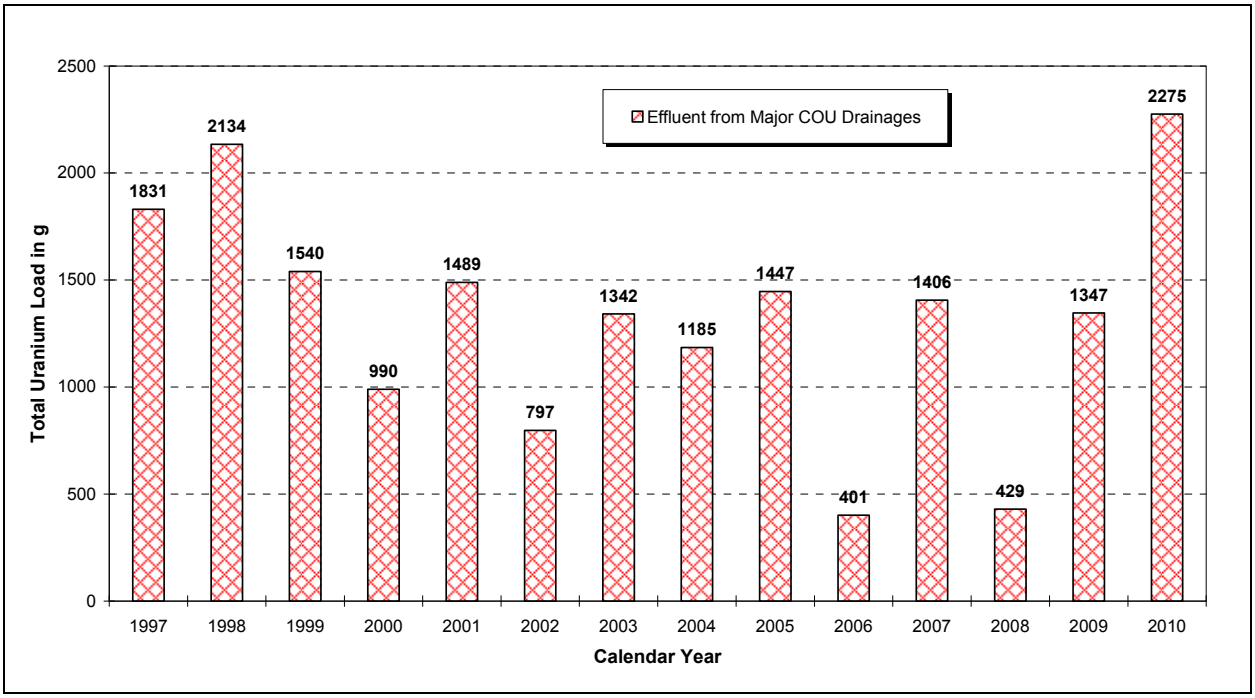


Figure 193. Annual Total U Loads from Major COU Drainages and Former WWTP: CY 1997–2010

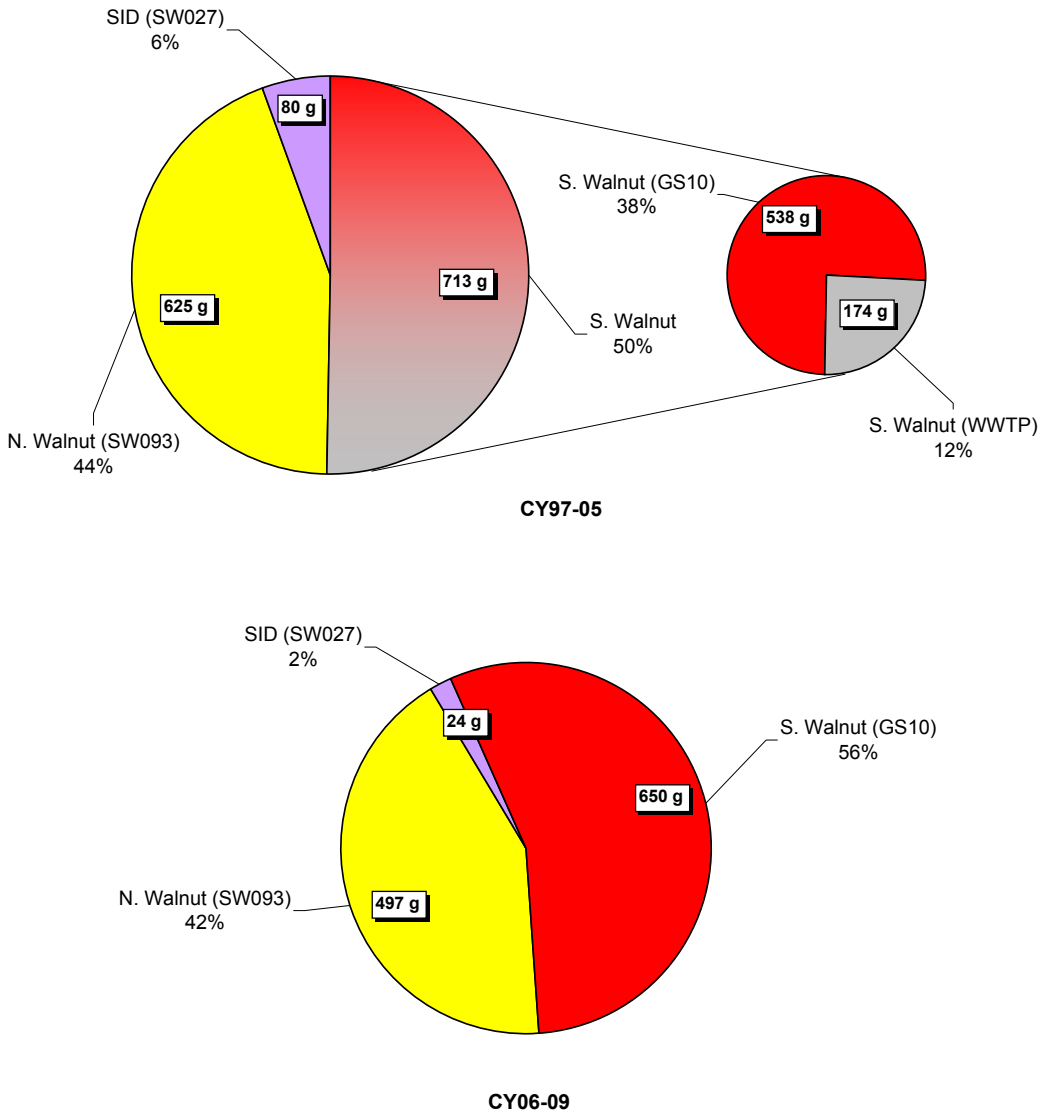


Figure 194. Relative Average Annual Total U Loads from Major COU Drainages and Former WWTP

3.1.5 Groundwater Data Interpretation and Evaluation

This section provides a summary of groundwater monitoring performed in 2010, separated into RFLMA-required and non-RFLMA-required. A discussion of groundwater conditions during 2010, 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 2010

Routine activities of the groundwater monitoring program in 2010 included sample collection, water-level measurement, groundwater treatment system maintenance, and well maintenance.