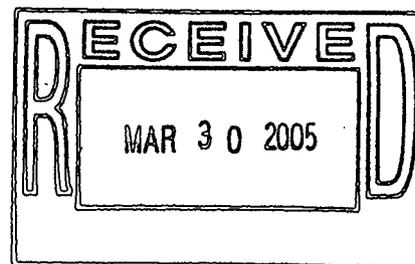


05-RF-00087

**Final Source Evaluation Report for
Points of Evaluation GS10, SW027, and SW093
Water Year 2004**

December 2004

**U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado**



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ACRONYMS

| Acronym | Description |
|-------------------|--|
| ac-ft | acre-feet |
| Ag | gold |
| ALF | Action Level and Standards Framework |
| Am | americium |
| AME | Actinide Migration Evaluation |
| Aoi | Analyte of Interest |
| As | arsenic |
| Ba | barium |
| Be | beryllium |
| BMP | Best Management Practice |
| BZ | Buffer Zone |
| CaCO ₃ | calcium carbonate |
| CCA | Configuration Control Authority |
| Cd | cadmium |
| CDPHE | Colorado Department of Public Health and Environment |
| CERCLA | Comprehensive Environmental Response, Compensation & Liability Act - "Superfund" |
| cfs | cubic feet per second |
| Cl | chlorine |
| cmp | corrugated metal pipe |
| Co | cobalt |
| CO ₂ | carbon dioxide |
| Cr | chromium |
| Cu | copper |
| D&D | Decontamination and Decommissioning |
| DER | Duplicate Error Ratio - calculated for real/duplicate radionuclide analyses |
| DOE | Department of Energy |
| DQO | Data Quality Objective |
| E | East |
| EPA | Environmental Protection Agency |
| ER | Environmental Remediation |

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| | |
|------------------|--|
| Fe | iron |
| FIDLER | Field Instrument for the Detection of Low Energy Radiation |
| g | gram |
| GIS | Geographic Information System |
| GPS | Global Positioning Systems |
| HCO ³ | bicarbonate |
| Hg | mercury |
| HRR | Historical Release Report |
| IA | Industrial Area |
| IAG | Interagency Agreement |
| IDLH | Imminent Danger to Life and Health |
| IHSS | Individual Hazardous Substance Site(s) |
| IM | Interim Measure |
| IMP | Integrated Monitoring Plan |
| IRA | Interim Remedial Action |
| ITS | Interceptor Trench System |
| K | potassium |
| K-H | Kaiser Hill Co., LLC |
| Li | lithium |
| LTL | Lower Tolerance Limit |
| MDA | Minimum Detectable Activity |
| MDL | Method Detection Limit |
| mg/L | milligrams per liter |
| Mo | molybdenum |
| N | North |
| NA | not applicable |
| Na | sodium |
| Ni | nickel |
| NO ³ | nitrate |
| NPDES | National Pollutant Discharge Elimination System |
| NSD | New Source Detection |
| NSQ | Non-Sufficient Quantity |
| NTU | Nephelometric Turbidity Unit |
| P | phosphorus |
| PA | Protected Area |
| pCi/g | picoCurie per gram |
| pCi/L | picoCurie per liter |
| PNNL | Pacific Northwest National Laboratory |
| POC | Point of Compliance |
| POE | Point of Evaluation |
| POTW | Publicly Owned Treatment Works |
| Pu | plutonium |
| RCRA | Resource Conservation Recovery Act |
| RFCA | Rocky Flats Cleanup Agreement |
| RFSS | Rocky Flats Closure Site Services |
| RFETS | Rocky Flats Environmental Technology Site |
| FFO | Rocky Flats Field Office |
| RFPO | Rocky Flats Project Office |
| R/FS | Remedial Investigation/Feasibility Study |
| RMRS | Rocky Mountain Remediation Services |
| RPD | Relative Percent Difference |

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| | |
|-----------------|---|
| S | South |
| Sb | antimony |
| Se | selenium |
| SID | South Interceptor Ditch |
| Sn | tin |
| SO ⁴ | sulfate |
| SPCC | Spill Prevention Control and Counter-Measures |
| Sr | strontium |
| SSOC | Safe Sites of Colorado |
| SWD | Soil & Water Database |
| Tl | thallium |
| TSS | total suspended solids |
| U | uranium |
| ug | microgram |
| ug/L | microgram per liter |
| URS | URS Corporation |
| USFWS | United States Fish & Wildlife Services |
| UTL | Upper Tolerance Limit |
| UV | ultraviolet |
| V | vanadium |
| W | West |
| WQ | Water Quality |
| WWTP | Waste Water Treatment Plant |
| WY | Water Year |
| Zn | zinc |

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1. EXECUTIVE SUMMARY

Rocky Flats Environmental Technology Site personnel have completed the most recent source evaluation related to the possible cause(s) of reportable 30-day moving average values for plutonium (Pu) and americium (Am)¹ at the Rocky Flats Cleanup Agreement (RFCA; CDPHE et al, 1996) Points of Evaluation (POE) monitoring locations GS10, SW027, and SW093 (Figure 1-1). This report provides evaluations for observations through Water Year 2004 (WY2004) and does not include summaries of more recent elevated americium observations after September 2004 at sampling location SW093. Those elevated observations will be reviewed and reported in a pending supplemental addendum to this document. The reportable values for WY04 may be summarized as follows:

- First reported on June 17, 2004 (04-DOE-00430), reportable values were observed at the POE monitoring location on S. Walnut Creek upstream of the B-Series Ponds (referred to as GS10) during the period February 20, 2004 through August 4, 2004.
- First reported on September 17, 2004 (04-DOE-00689), reportable values were observed at the POE monitoring location on the South Interceptor Ditch upstream of Pond C-2 (referred to as SW027) during the period June 22, 2004 through August 18, 2004.
- First reported on July 7, 2004 (04-DOE-00490), reportable values were observed at the POE monitoring location on N. Walnut Creek upstream of the A-Series Ponds (referred to as SW093) during the period April 11, 2004 through July 23, 2004.

When reportable values are measured at a POE, RFCA requires the Department of Energy (DOE) to notify the RFCA parties and submit a plan for "source evaluation". RFCA requires a source evaluation for POEs when specific constituents are measured above Action Levels; this Report fulfills that requirement.²

This Source Evaluation Report includes data collection and evaluation as outlined in the respective source evaluation plan letters (GS10, 7/1/04, 04-DOE-00489; SW027, 9/17/04, 04-DOE-00689; SW093, 7/22/04, 04-DOE-00544). This report also builds on the results of the previously completed Source Evaluation Reports:

- GS10 (RMRS, 1997b, 1997c, 1998a, 1999a, and 2001d);
- SW027 (RMRS, 1998c and 2001b); and
- SW093 (RMRS, 1997b, 1997c, 1998a, and 1999b; URS, 2003b).

For this report Site personnel have extensively evaluated environmental data and assessed Site activities. Site personnel conclude that the likely sources of the reportable 30-day moving average values at GS10, SW027, and SW093 are the following:

- Based on the details regarding recent Site activities, it is concluded that various Decontamination & Decommissioning (D&D), demolition, construction, ER, and excavation operations resulted in increased

¹ In this report, 'plutonium' or 'Pu' refers to Pu-239,-240 and 'americium' or 'Am' refers to Am-241.

² The RFCA requires reporting "when contaminant concentrations in Segment 5 exceed the Table 1 action levels" and that "source evaluation will be required". Further, RFCA states "if mitigating action is appropriate, the specific actions will be determined on a case-by-case basis, but must be designed such that surface water will meet applicable standards at the POCs" (Points of Compliance).

transport of low-level contamination associated with suspended solids in surface water that are likely to have resulted in the recent reportable values measured at the GS10, SW027, and SW093.

- A shift in Pu/Am¹ ratios toward a higher relative abundance of Pu at GS10, SW027, and SW093 in WY04 suggest increased actinide contribution from areas with higher Pu/Am ratios, such as the 903 Pad/Lip and B779 areas.
- The loading analysis also indicates that the 903 Pad/Lip and B779 areas were the largest contributors of recent Pu and Am loads to GS10, SW027, and SW093.
- Pu and Am suspended solids activities at GS10 show no change in WY04. In conjunction with the increased activities at GS10, this suggests increased transport of suspended solids with contamination similar to past years, and not a significant new source term.
- Pu and Am suspended solids activities at SW027 and SW093 show a significant increase in WY04. In conjunction with the increased activities at these locations, this suggests the increased contribution of relatively more contaminated areas, and/or sediment transport from previously non-contributing areas or source terms. For roughly the same period, similar patterns are noted for samples collected at locations monitoring the 903 Pad/Lip and B779 areas.
- WY04 turbidities (as an indication of total suspended solids [TSS]) at GS10, SW027, and SW093 relative to flow rate are generally higher than for WY03 and prior data. This suggests that soils in these drainages are more susceptible to transport for a given flow rate than for previous years. Similarly, WY04 TSS data at these locations also show higher values relative to flow rate than for previous years. A similar relationship is noted for samples collected at locations monitoring the 903 Pad/Lip and B779 areas, prior to the implementation of enhanced erosion controls. These patterns suggest that the recent higher activities at the POEs may be the result, at least in part, of the increased transport of legacy contamination associated with soil and sediment, and not any new source contribution.
- Targeted erosion controls have proven to be effective in reducing sediment transport and associated contamination at selected locations. This is especially true for monitoring locations upstream of the POEs and nearer to the source terms. Data evaluation also suggests that the enhanced BMPs have been effective at reducing both runoff and erosion. As soils stabilize and vegetation is reestablished, continued water-quality improvement is expected.

The Site is implementing an aggressive program of erosion control to prevent the movement of soils and sediments and to protect storm water and surface-water quality. The increased activities of building removal and soil disturbance require rigorous erosion control methods. A number of control methods are currently being used, from straw bales and wattles to soil tackifiers and erosion blankets. Ultimately, disturbed sites are revegetated.

Immediately following confirmation of reportable values at GS10, SW027, and SW093, a preliminary loading analysis was performed that identified multiple subdrainages as contributors to these POEs. Since the majority of Pu and Am is transported in surface water attached to particulate matter (suspended solids), a number of erosion controls have been added to these Site drainages. To augment the preexisting erosion methods the Site has been routinely using, additional controls were installed in these subdrainages starting in June 2004. Localized controls in ditches have been added in the form of straw wattles, straw bales, and silt fences. Area controls have been applied to disturbed soils in the form of erosion matting, hydromulch and seed, and tackifier (in many cases exclusion boundaries have been established to prevent vehicle traffic). These erosion controls have been installed throughout the POE drainages based on field walkdowns and monitoring data analysis identifying areas of sediment transport and specifically for projects likely to impact surface water.

The Site's proposed course of action includes: (1) continuing observation (routine monitoring), and (2) installation and maintenance of enhanced erosion controls in the drainage areas upstream of GS10 as part of the overall Closure process. Effective Best Management Practices (BMPs), such as the use of the existing terminal ponds to clarify stormwater of potentially-contaminated sediment and particulate matter, will also be

continued. Specifically, the Department of Energy (DOE) and the Kaiser-Hill (K-H) Team propose the following actions as the path forward:

- Continued observation and ongoing data interpretation to provide better understanding of actinide transport directly related to the operation of the Site automated surface-water monitoring network and the effectiveness of erosion controls;
- Implementation and maintenance of enhanced erosion controls as an integral part of Site Closure;
- Continued use of the existing retention ponds as an effective BMP to clarify stormwater containing potentially contaminated sediment and particulate matter; and
- Continued reporting as appropriate.

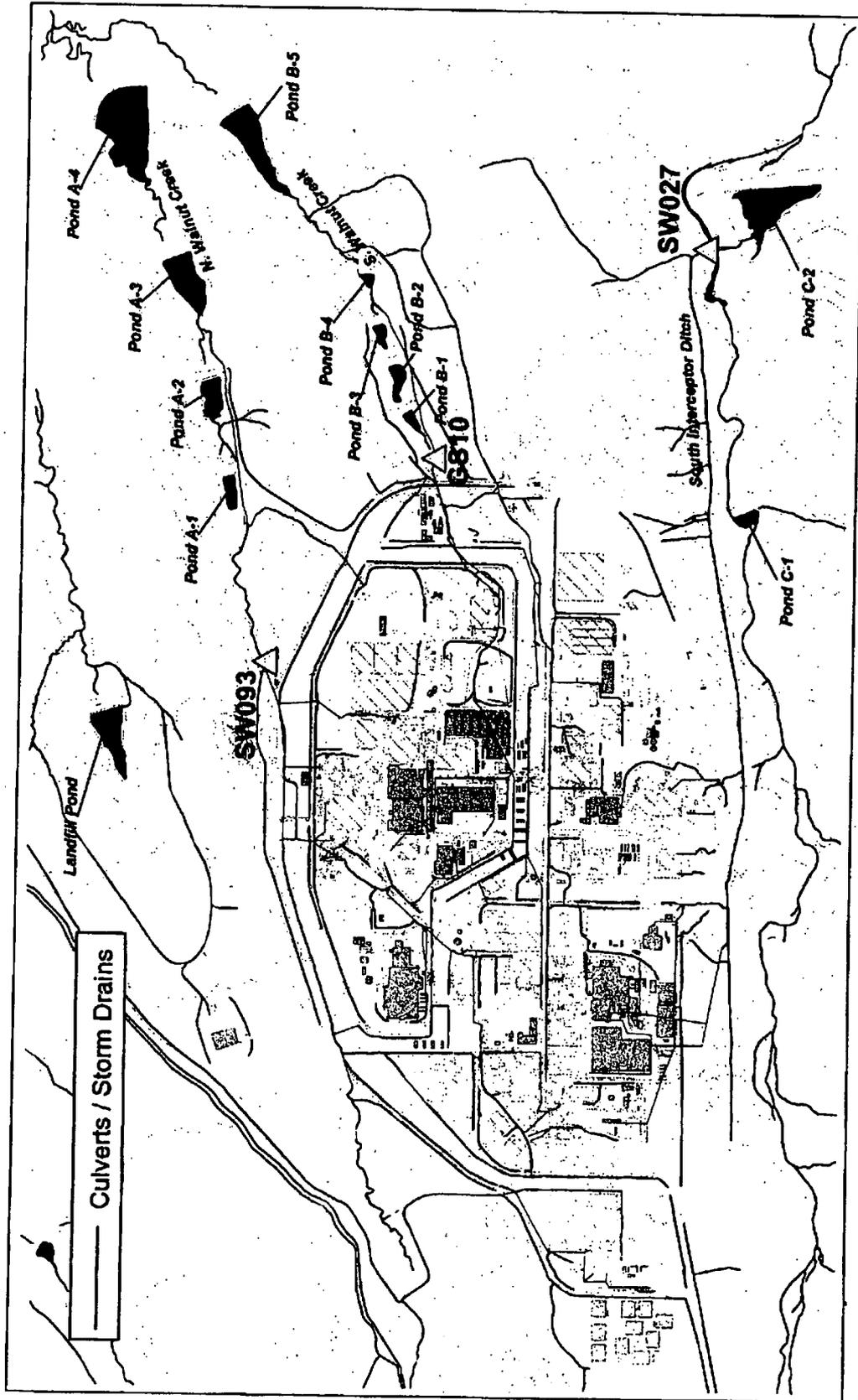


Figure 1-1. Location Map for RFCA Points of Evaluation.

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2. SOURCE EVALUATION FOR POE GS10

The following source evaluation is provided in accordance with the *Final Rocky Flats Cleanup Agreement* (RFCA) (CDPHE et al., 1996) (Attachment 5, §2.4(B)) under "Action Determinations". The RFCA requires reporting "when contaminant concentrations in Segment 5 exceed the Table 1 action levels" and that "source evaluation will be required". Further, RFCA states "if mitigating action is appropriate, the specific actions will be determined on a case-by-case basis, but must be designed such that surface water will meet applicable standards at the POCs".

Specifically, this source evaluation addresses the Site notification(s) of reportable 30-day moving average values for Pu and Am water-quality results at the POE monitoring location GS10, located just above Pond B-1 in South Walnut Creek. Reportable values for Pu were measured for the period 2/20 through 8/4/04 inclusive, using validated data. Additional data recently received but not validated may extend the Pu event through 8/29/04. Reportable values for Am were also measured for the periods 2/20 through 5/9, 5/19 through 5/21, and 7/27 through 8/4/04 inclusive, using validated data. Additional data recently received but not validated may extend the Am event through 8/18/04. The end of the reportable period(s) will be determined when the Site receives subsequent analytical results.

This evaluation for Walnut Creek monitoring station GS10 covers data received through 10/6/04. The following are included in this section:

- Evaluation of ongoing automated surface-water monitoring within the GS10 drainage
- Estimation of actinide loads within the GS10 drainage area
- Evaluation of water-quality trends and correlations within the GS10 drainage area
- A brief discussion of implemented erosion controls, and
- A brief assessment of D&D, ER, and Site Closure projects

2.1 HYDROLOGY

South Walnut Creek Flow Controls

All IA surface-water runoff that flows into North Walnut Creek, South Walnut Creek, or the SID is collected by a system of stormwater retention ponds. The ponds serve three main purposes for surface-water management: (1) storm water retention and settling of sediments, (2) water storage for sampling prior to release, and (3) emergency spill control in those instances where a spill cannot be adequately managed without use of the ponds.

GS10 is the POE for IA surface-water flows to South Walnut Creek. Surface water in South Walnut Creek is routed through the B-Series Ponds (Figure 2-1). Steps in the water collection and transfer process are briefly outlined as follows:

1. Runoff from the south-central IA flows through the Central Avenue Ditch past monitoring location SW022, and then past GS10 (during high runoff periods, some water in the Central Avenue Ditch overflows to a large cnp and flows directly to GS10; shown by the blue line in Figure 2-1).
2. Runoff from the central IA flows directly to GS10.
3. Runoff from GS10 then flows downstream through conveyance structures, through Pond B-4, and then to Pond B-5 where it is detained, and
4. Water detained in Pond B-5 is discharged periodically in batches to Walnut Creek.

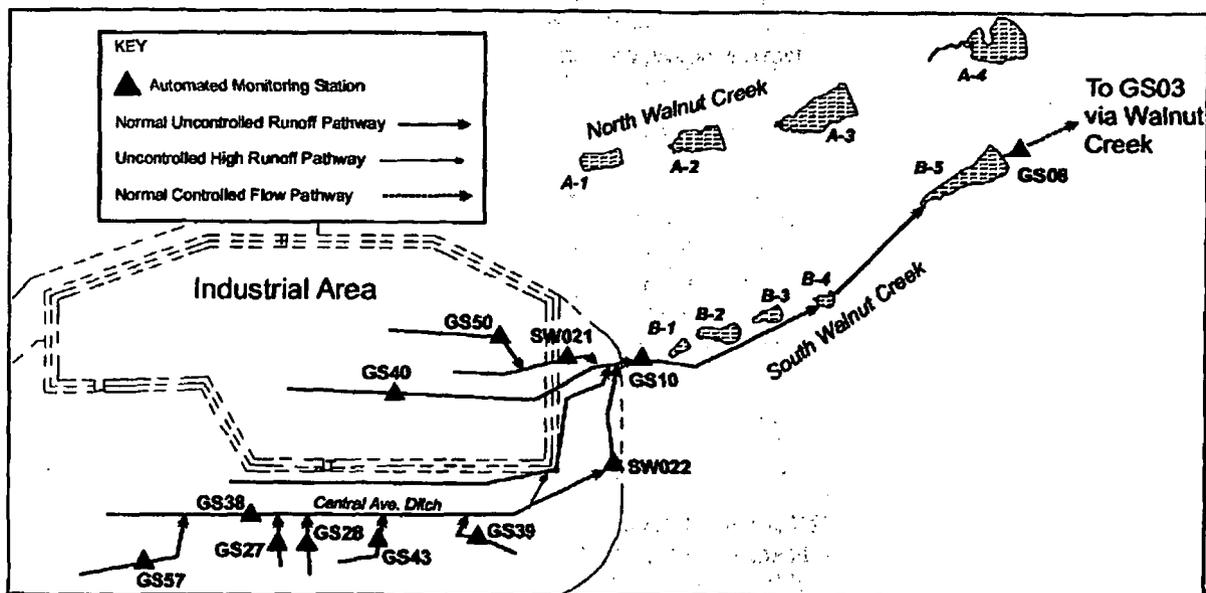


Figure 2-1. Hydrologic Routing Diagram for POE GS10 (WY03-04).

As indicated above, all of the IA runoff that flows into South Walnut Creek is ultimately routed to Pond B-5, detained, and sampled prior to being released to lower Walnut Creek. There is no source of IA runoff to South Walnut Creek that can enter lower Walnut Creek without first passing through the pond system for subsequent batch discharge from Pond B-5.³

2.2 GS10 MONITORING RESULTS

As specified in the IMP, Site personnel evaluate 30-day moving average values⁴ for selected radionuclides at POE surface-water monitoring location GS10. Recent evaluations of water-quality measurements at POE GS10 showed reportable values for Pu and Am requiring notification and source evaluation under the RFCA ALF. Results for recent 30-day moving average values using available data at GS10 are summarized below in Table 2-1 and are shown on Figure 2-2.

³ A gate structure exists immediately below SW022 that can be configured to allow Central Avenue Ditch water to flow directly to Pond B-5. However, this gate is normally configured to direct flows to GS10.

⁴ The method for calculating 30-day averages is given in Appendix B.1 - Analytical Data Evaluation Methods in the RFETS Automated Surface-Water Monitoring: WY03 Annual Report (URS, 2004).

Table 2-1. Recent Water-Quality Information from GS10 (Validated and Unvalidated Data).

| Location | Parameter | Date(s) of 30-Day Average Requiring Reporting | Date(s) of Maximum 30-Day Average | Maximum 30-Day Average (pCi/l) | Volume-Weighted Average for Water Year ⁵ (pCi/l) |
|----------|------------|---|-----------------------------------|--------------------------------|---|
| GS10 | Pu-239,240 | 2/20 – 8/29/04 | 8/15 – 8/18/04 | 0.63 | WY04 ⁶ : 0.382 |
| GS10 | Am-241 | 2/20 – 5/9/04; 5/19 – 5/21/04; 7/27 – 8/18/04 | 4/10/04 | 0.26 | WY04 ⁶ : 0.153 |

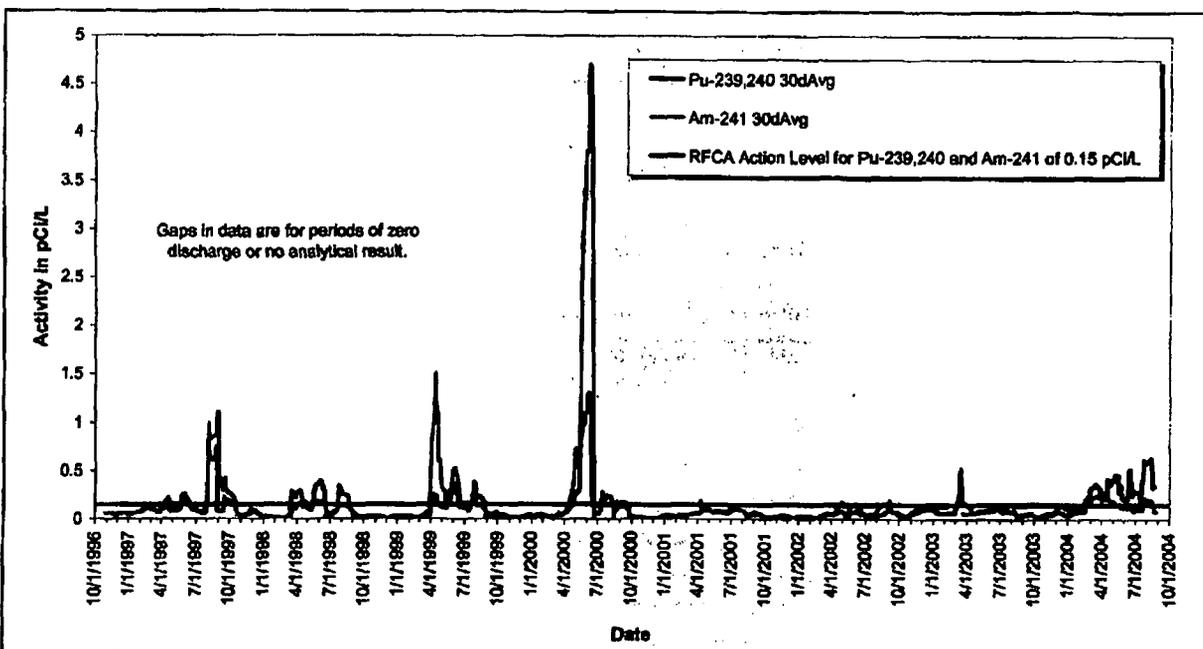


Figure 2-2. POE Monitoring Station GS10: 30-Day Volume-Weighted Average Values for Pu and Am Activities (10/1/196 – 8/29/04).

The analytical results for the composite samples collected around the period of reportable values have been validated through 8/4/04. A review of historical GS10 monitoring data shows that these results are somewhat higher than usual, though not as high as results associated with previous reportable periods. It should be noted that sample results greater than 0.15 pCi/L during WY04 were more frequent than in previous years, when reportable periods were due to higher, less frequent results. During the period of continuous flow-paced monitoring under RFCA, there have been multiple occurrences of reportable 30-day average values for both analytes (Figure 2-2). The reportable measurements generally occur during periods of increased stormwater runoff in the spring and summer months (Figure 2-3), with higher results generally occurring for larger runoff events when more solids are transported. Individual composite-sample results for GS10 are listed in Table 2-2 and plotted in Figure 2-4 for the period of interest.

⁵ A Water Year is defined as the period from October 1 through September 30. The term water year is abbreviated as WY; e.g. Water Year 2003 is WY03.

⁶ Through 8/29/04

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Table 2-2. WY04 Composite Sample Analytical Results for GS10 Reportable Periods.

| Composite Sample Period | Pu-239,240 (pCi/l) | | Am-241 (pCi/l) | | Composite Sample Volume (Liters) | S. Walnut Cr. Discharge Volume During Sample Period (MG) |
|-------------------------|--------------------|-----------|----------------|-----------|----------------------------------|--|
| | Result | Error (±) | Result | Error (±) | | |
| 12/29/03 – 2/20/04 | 0.084 | 0.034 | 0.111 | 0.042 | 8.0 | 0.78 |
| 2/20 – 3/8/04 | 0.403 | 0.105 | 0.262 | 0.074 | 10.8 | 0.66 |
| 3/8 – 4/3/04 | 0.159 | 0.050 | 0.135 | 0.048 | 20.8 | 1.26 |
| 4/3 – 4/11/04 | 0.303 | 0.083 | 0.288 | 0.078 | 14.6 | 2.03 |
| 4/11 – 4/22/04 | 0.095 | 0.036 | 0.025 | 0.020 | 7.2 | 0.99 |
| 4/22 – 4/23/04 | 1.320 | 0.309 | 0.282 | 0.080 | 10.2 | 1.34 |
| 4/23 – 4/26/04 | 0.160 | 0.052 | 0.099 | 0.041 | 7.8 | 1.18 |
| 4/26 – 5/3/04 | 0.559 | 0.143 | 0.198 | 0.063 | 7.6 | 1.05 |
| 5/3 – 5/13/04 | 0.220 | 0.067 | 0.119 | 0.043 | 9.6 | 0.97 |
| 5/13 – 6/14/04 | 0.196 | 0.060 | 0.119 | 0.043 | 7.2 | 0.82 |
| 6/14 – 6/18/04 | 0.636 | 0.156 | 0.154 | 0.058 | 22.0 | 1.16 |
| 6/18 – 8/21/04 | 0.620 | 0.153 | | | 7.4 | 21.2 |
| 6/21 – 8/28/04 | 0.080 | 0.032 | 0.061 | 0.030 | 22.0 | 2.78 |
| 6/28 – 6/30/04 | 0.626 | 0.155 | 0.260 | 0.076 | 11.6 | 0.77 |
| 6/30 – 7/22/04 | 0.053 | 0.025 | 0.029 | 0.021 | 7.2 | 0.46 |
| 7/22 – 7/24/04 | 0.837 | 0.204 | 0.276 | 0.081 | 22.0 | 1.95 |
| 7/24 – 8/5/04 | 0.032 | 0.020 | 0.044 | 0.024 | 8.4 | 0.48 |
| 8/5 – 8/19/04 | 0.629 | 0.155 | 0.109 | 0.043 | 22.0 | 2.51 |
| 8/19 – 8/30/04 | 0.040 | 0.025 | 0.050 | 0.027 | 8.4 | 0.53 |

Notes: Activities greater than the Action Level are indicated in red. Action Levels apply only to 30-day averages and the selective formatting in this table is provided for reference only. Unvalidated data are italicized.

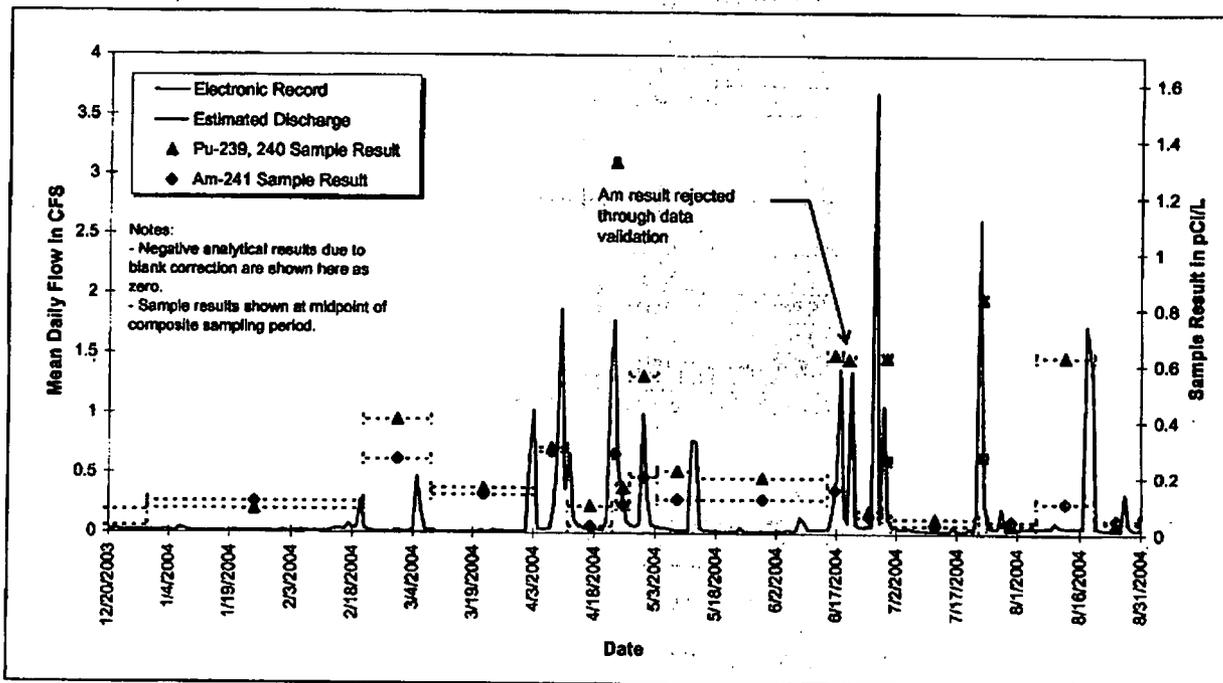


Figure 2-3. Monitoring Station GS10 Hydrograph with Individual Sample Results and Sample Period Bars: 12/29/03 – 8/30/04.

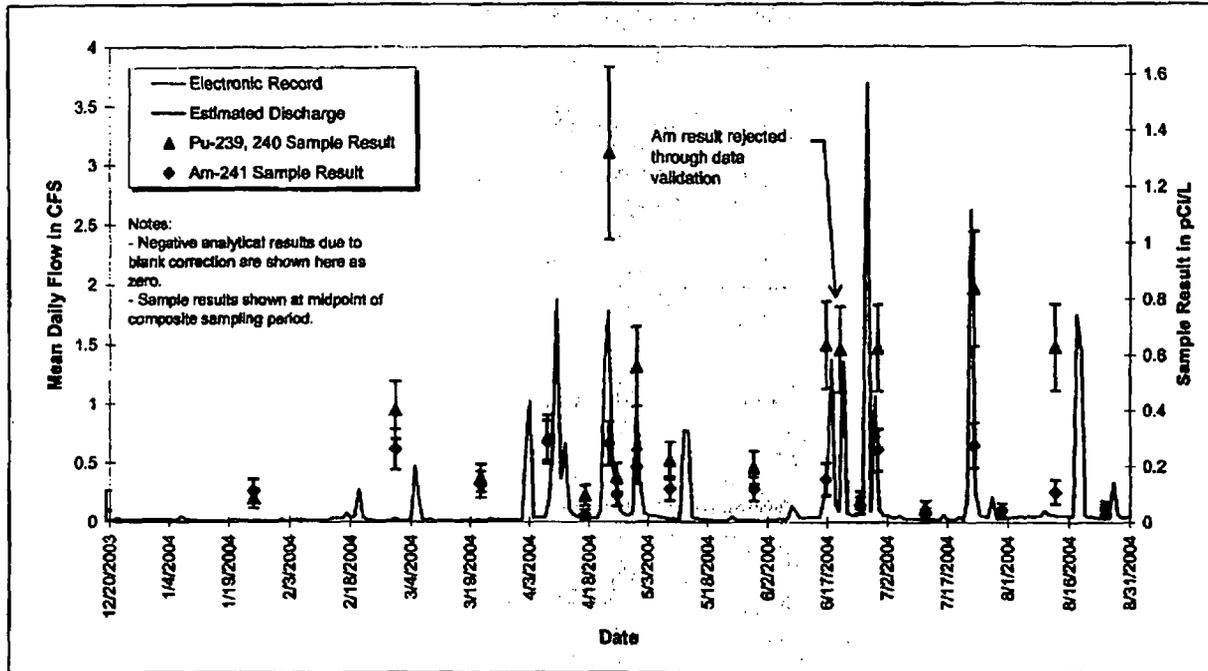


Figure 2-4. Monitoring Station GS10 Hydrograph with Individual Sample Results and Error Bars: 12/29/03 – 8/30/04.

All water monitored at GS10 flows to Pond B-5 and eventually is batch discharged to lower Walnut Creek.⁷ Pre-discharge samples of the water in Pond B-5 indicated acceptable water quality prior to all planned discharges during the reportable periods. All Pu and Am analytical results from composite samples collected at POC monitoring station GS08 (Pond B-5 outfall; Figure 2-1) during the February/March, May, and July 2004 Pond B-5 discharges were well below 0.15 pCi/L (Figure 2-5), and there were no reportable 30-day average values. Analytical results from GS08 for the September/October (9/23 - 10/7/04) B-5 discharge had not been received by the Site as of 10/6/04. This discharge included flows from GS10 during the period 8/3 - 10/7/04.

All water discharged from Pond B-5 to Walnut Creek subsequently flows through RFCA POC GS03 at the eastern Site boundary. Pu and Am analytical results from composite samples collected at GS03 during the February/March, May, and July 2004 Pond B-5 discharges were all well below 0.15 pCi/L (Figure 2-6), and there were no reportable 30-day average values. Analytical results from GS03 for the September/October Pond B-5 discharge had not been received by the Site as of 10/6/04.

⁷ Some Pond B-5 water is occasionally pump transferred to Pond A-4.

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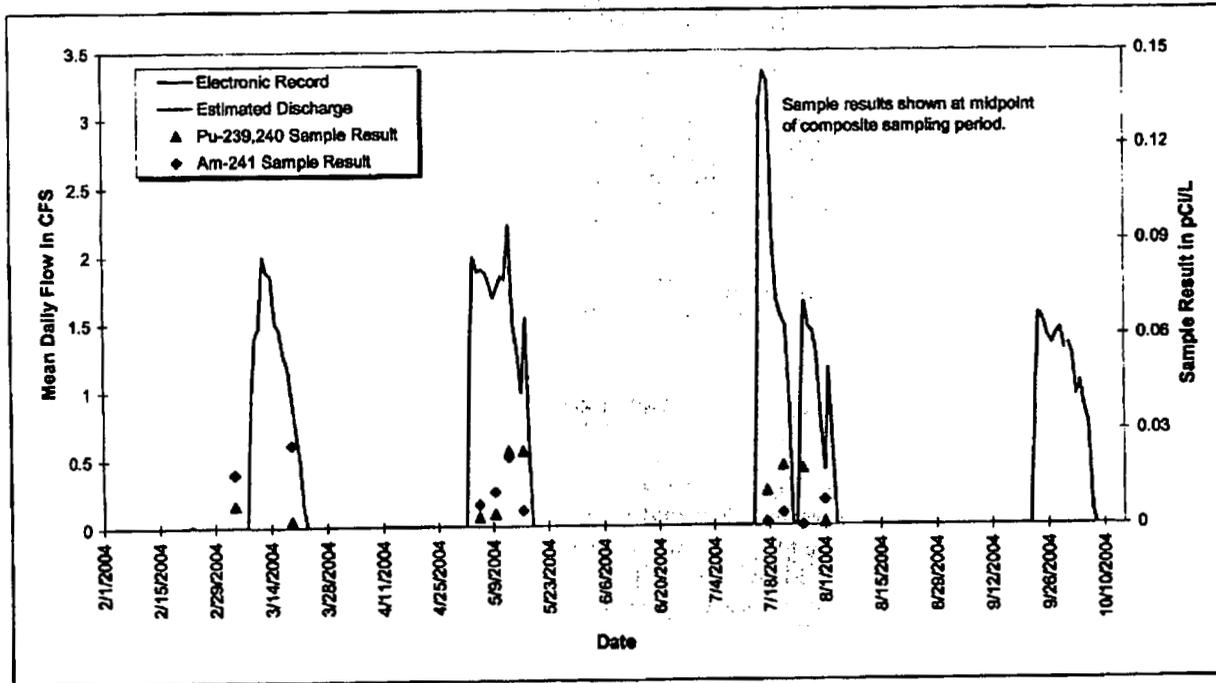


Figure 2-5. Monitoring Station GS08 Hydrograph with Individual Sample Results: 2/1/04 – 10/15/04.

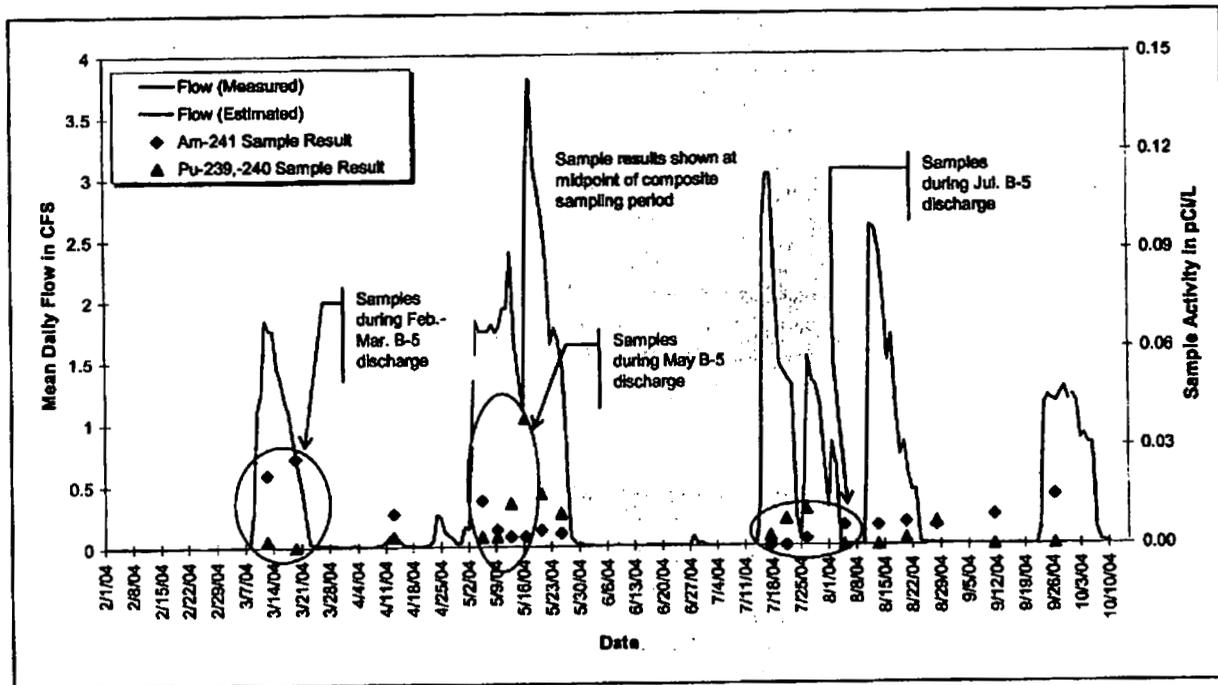


Figure 2-6. Monitoring Station GS03 Hydrograph with Individual Sample Results: 2/1/04 – 10/10/04.

2.3 DATA SUMMARY AND ANALYSIS

The following data evaluation for GS10 includes all surface-water data available as of 10/6/04. Monitoring data were extracted from the Site Soil-Water Database (SWD) or taken from hardcopy analysis reports for the locations of interest and subsequently reconciled against SWD. The following list describes the environmental data compilation process:

- Individual sample result values are calculated as arithmetic averages of real and field duplicate results when both results are from the same sampling event.⁸
- When available, Site-requested laboratory reruns are averaged with initial runs for the same sampling event.⁸
- Laboratory duplicate and replicate QC results are not used.
- When negative values for actinide measurement are returned from the laboratories due to blank correction, 0.0 pCi/l is used in the calculations.
- Only total radionuclide measurements are used, and
- Data that did not pass validation (rejected data) are not used.

2.3.1 Verification and Validation of Surface-Water Analytical Results

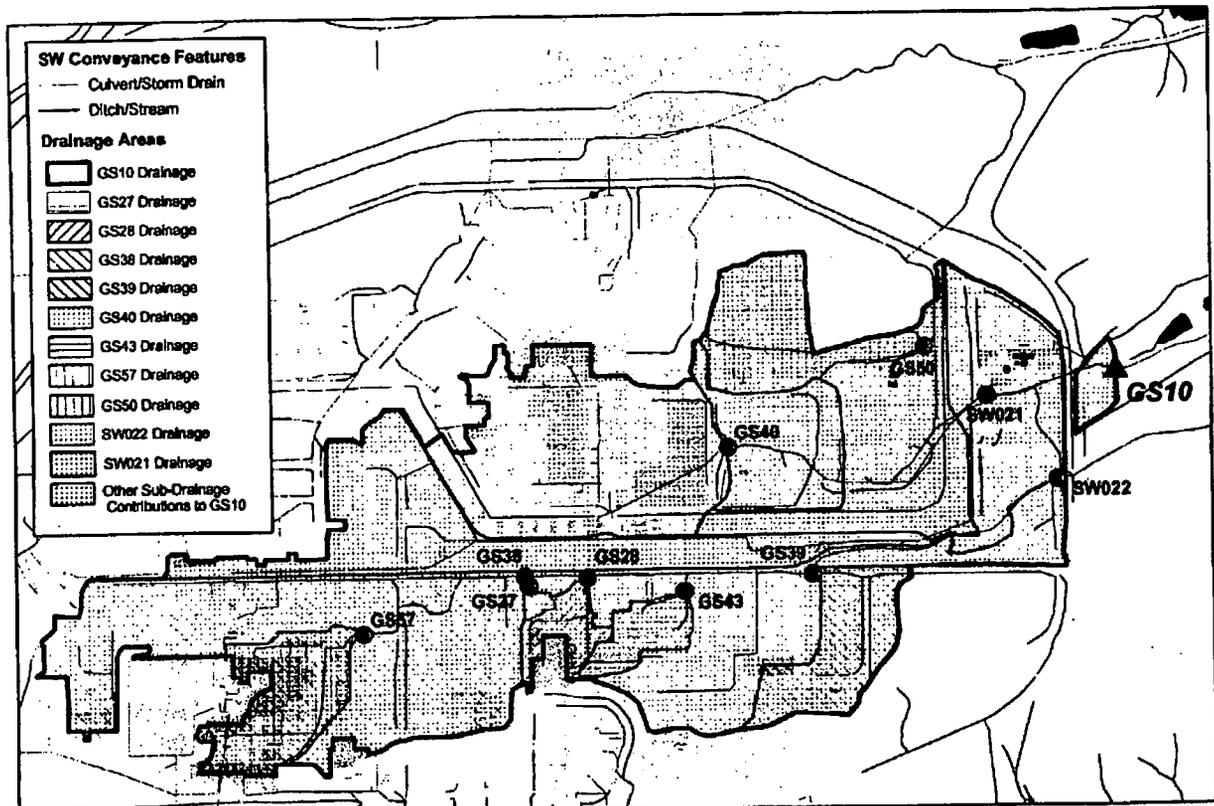
All surface-water isotopic data are either verified or validated, based on criteria determined by Analytical Services Division (ASD), or at the special request of the customer. Approximately 75% of all isotopic data are verified and the remaining 25% are validated. Validation is typically determined randomly for each subcontracted laboratory, based on the specific analytical suites. This random validation selection may or may not routinely include POE or POC locations. However, when reportable values are observed, all analytical results used in the calculations receive formal validation.

For samples collected at GS10 during the reportable periods, all isotopic data not randomly selected for validation were specifically submitted for validation at the request of Site personnel. All isotopic data package validation was performed by a subcontractor to ASD, and all packages during the reportable period through 8/4/04 were considered valid. Validation for subsequent data is pending.

2.3.2 Actinide Data Summary

Since 3/3/98, five upstream automated monitoring locations have been operating as part of the continuing source evaluation for GS10 as a response action to reportable Pu and Am measurements during WY97. These locations are GS27, GS38, GS39, GS40 and SW022 (Figure 2-7). Additionally, GS43 was installed on 6/1/99, GS50 was installed on 3/28/01, GS28 was installed on 2/19/02, GS57 was installed on 3/13/02, and SW021 was installed on 5/6/03. These stations were installed or upgraded to monitor subdrainages that are tributary to GS10. These locations are operated Source Location monitoring stations to characterize water quality and specifically measure Pu and Am loads from the respective subdrainages in an attempt to identify any discrete source areas. Summary statistics for sample results from these locations are shown in Table 2-3. The activities for GS27 are arithmetic averages since this location has historically sampled only selected storm events. Continuous flow-paced sampling is used for GS10, GS28, GS38, GS39, GS40, GS43, GS50, GS57, SW021, and SW022 and volume-weighted average activities are given in Table 2-3.

⁸ Radionuclide data pairs are averaged when the Duplicate Error Ratio (DER) is less than 1.5 (see Appendix Section B.1 - Analytical Data Evaluation Methods in the RFETS Automated Surface-Water Monitoring: WY03 Annual Report).



Note: Drainage areas have changed as the Site moves toward Closure and the land and drainage features are reconfigured. The drainage areas shown are current as of 10/6/04. The locations shown were all installed as of 5/6/03.

Figure 2-7. Automated Surface-Water Monitoring Locations and Corresponding Subdrainage Areas Tributary to GS10.

Table 2-3. Summary Statistics for Samples from GS10 and Monitoring Locations Tributary to GS10: 5/6/03 to Present.

| Sampling Location | Number of Samples | Pu-239,240 | | Am-241 | |
|-------------------|-------------------|--------------------------|-------------------------------|--------------------------|-------------------------------|
| | | Average Activity (pCi/l) | Maximum Sample Result (pCi/l) | Average Activity (pCi/l) | Maximum Sample Result (pCi/l) |
| GS10 | 37 | 0.292 | 1.32 | 0.130 ^a | 0.288 |
| GS27 | 6 | 0.273 | 1.26 | 0.067 | 0.334 |
| GS28 | 4 | 0.364 | 0.845 | 0.081 | 0.166 |
| GS38 | 18 | 0.233 | 0.598 | 0.048 | 0.202 |
| GS39 | 15 | 2.28 | 6.16 | 0.632 ^a | 0.841 |
| GS40 | 21 | 0.225 | 0.874 | 0.390 | 2.64 |
| GS43 | 10 | 0.059 | 0.219 | 0.020 | 0.052 |
| GS50 | 8 | 1.35 | 3.09 | 2.27 | 4.77 |
| GS57 | 20 | 0.023 | 0.115 | 0.010 | 0.031 |
| SW021 | 17 | 0.235 | 0.872 | 0.264 | 0.971 |
| SW022 | 16 | 0.628 | 2.34 | 0.119 | 0.308 |

Note: ^aSome results rejected through validation.

Figure 2-8 shows the average annual activities at GS10 for WY97 – WY04⁹. Due to the continuous flow-paced sampling protocols currently in place under RFCA, the more representative volume-weighted average activities are shown. It is important to note that although reportable 30-day average values occurred in WY04, the volume-weighted average is comparable to the activities for other years, with a small change toward more Pu and less Am. This suggests that actinides have been available for transport to GS10 for some time, but that the recent measurements at GS10 may be due to increased contributions from an area with higher Pu/Am ratios, such as the 903 Pad area.

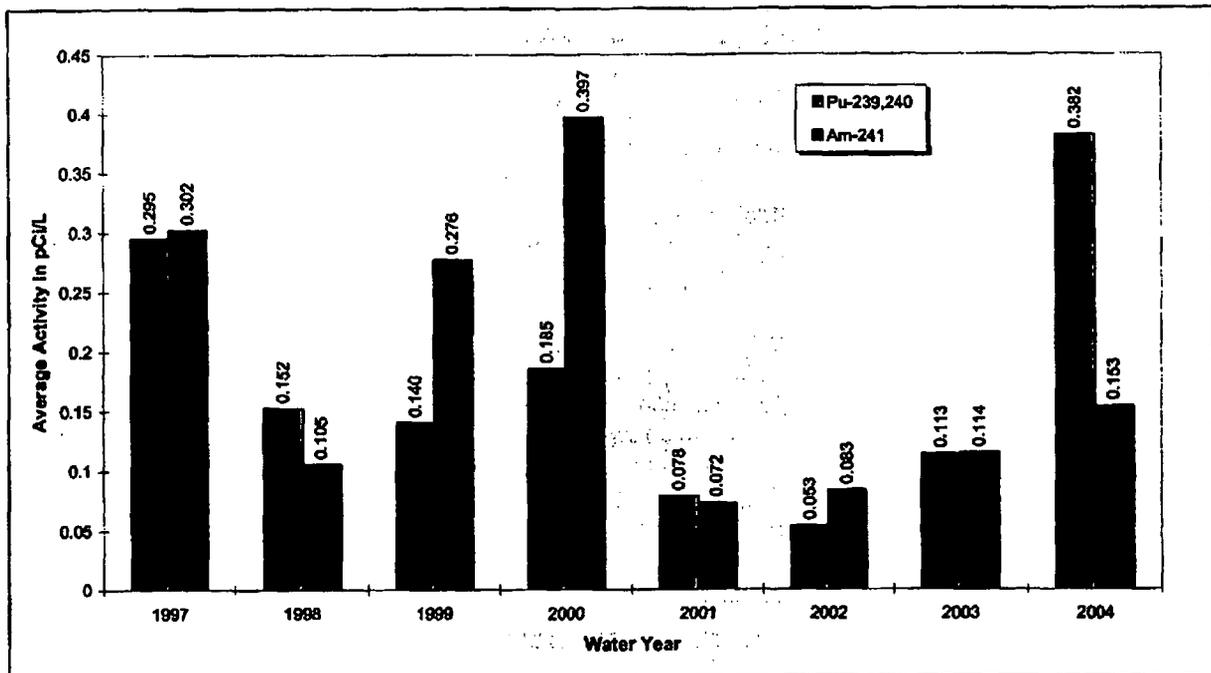


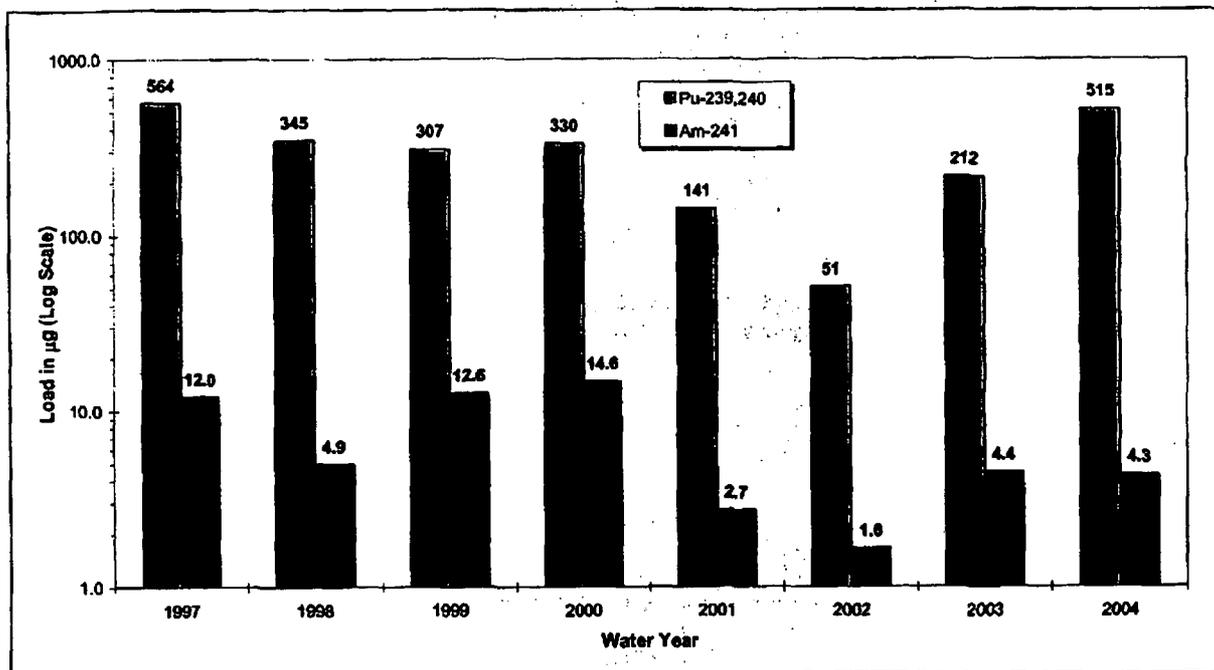
Figure 2-8. Average Annual Pu and Am Activities at GS10: WY97-04.

2.3.3 Annual GS10 Loads

Annual actinide loads for GS10 in micrograms (log-scale) are plotted in Figure 2-9 to show long term loading to GS10. For WY97-WY03, the activity for each flow-paced composite sample is multiplied by the associated discharge volume to get pCi, then converted to micrograms¹⁰ and totaled annually. The WY04 loads are comparable to the loads for previous years, with a small change toward more Pu and less Am. This suggests that actinides have been available for transport to GS10 for some time, but that the recent measurements at GS10 may be due to increased contributions from an area with higher Pu/Am ratios, such as the 903 Pad area.

⁹ For WY04 the average shown is through 8/29/04.

¹⁰ Picocuries of Pu are multiplied by 14.085 to get picograms, and divided by 10^6 to get micrograms. Similarly, picocuries of Am are multiplied by 0.292 to get picograms, and divided by 10^6 to get micrograms.



Note: Load through 8/29/04 for WY04 is plotted.

Figure 2-9. Annual Pu and Am Loads at GS10: WY97-04.

2.4 RELATIVE LOADING ANALYSIS

This loading analysis uses data from all automated monitoring locations that are tributary to GS10 (Figure 2-7). These locations are GS27, GS28, GS38, GS39, GS40, GS43, GS50, GS57, SW021, and SW022. The analysis is performed for two overlapping time periods based on the operational periods for two groups of locations. For the first period, 3/13/02 to 8/19/04, monitoring locations GS27, GS28, GS38, GS39, GS40, GS43, GS50, GS57, and SW022 were all operational. For the second period, 5/6/03 to 8/19/04, monitoring locations GS27, GS28, GS38, GS39, GS40, GS43, GS50, GS57, SW021, and SW022 were all operational.

The 100, 300, 400, 500, 600, 800, and 900 Areas all contribute runoff to SW022 via the Central Avenue Ditch. During high flows, a portion of the flow in the Central Avenue Ditch overflows to a 48-inch pipe which leads directly to South Walnut Creek, bypassing SW022, as indicated by the blue flow line in Figure 2-1. This upstream flow bypass results in the calculated load for SW022 to be an underestimate of the total Central Avenue Ditch subdrainage area contribution to GS10.

Table 2-4 gives location and drainage basin detail for the monitoring locations used in this loading analysis. The hydrologic connectivity of these locations is shown in Figure 2-1.

Table 2-4. Location and Drainage Basin Detail.

| Location Code | Location Detail | Contributing Areas |
|---------------|--|---|
| GS10 | S. Walnut Creek 40 feet upstream of the B-1 Bypass | 100, 300, 400, 500, 600, 700, 800, 900; 173.1 acres |
| GS27 | Drainage ditch NW of B884 | Area south and west of B884; 0.4 acres |
| GS28 | Ditch NW of B865 10' above Central Ave. Ditch | 800; 2.8 acres |
| GS38 | Central Avenue Ditch at 8 th Street | 100, 300, 400, 500, 600; 40.7 acres |
| GS39 | Drainage ditch north of 904 Pad | 903 Pad, 904 Pad, Contractor Yard; 8.1 acres |
| GS40 | Culvert east of 750 pad draining 700 Area to S. Walnut Creek | 700; 25.8 acres |
| GS43 | Drainage ditch NE of B886 | B886 area; 3.2 acres |
| GS50 | Ditch north of B990 | Solar Ponds area, 900; 9.3 acres |
| GS57 | Ditch NE of B444 Area | 400; 8.6 acres |
| SW021 | Pipe draining B991 area to S. Walnut Creek | B991 area; 25 acres |
| SW022 | East end of Central Avenue Ditch at Inner East Fence | 100, 300, 400, 500, 600, 800, 900; 76.1 acres |

Loads for GS10, GS28, GS38, GS39, GS40, GS43, GS50, GS57, SW021, and SW022 continuous flow-paced samples were calculated as detailed in Appendix B.1 Analytical Data Evaluation Methods in the RFETS Automated Surface-Water Monitoring: WY03 Annual Report. The load for any period is then the sum of the individual sample loads during that period.

For GS27, loads for any period are calculated by multiplying an estimated overall activity¹¹ by the corresponding discharge measured at the gage, and then converting to micrograms.¹² The following methods were selected to estimate a range of loads for GS27:

- The annual arithmetic average activity is multiplied by the corresponding measured annual discharge volume to estimate annual loads. The annual loads are then totaled for the analysis period.
- The overall seasonal arithmetic average activity is multiplied by the corresponding measured total seasonal discharge volume for each year to estimate seasonal loads. The seasonal loads are then totaled for the analysis period.
- The overall median activity is multiplied by the measured annual discharge volume to estimate annual loads. The annual loads are then totaled for the analysis period.
- The seasonal arithmetic average activity for each year is multiplied by the corresponding measured seasonal discharge volume to estimate annual loads. The annual loads are then totaled for the analysis period.

¹¹ Various methods were evaluated to estimate an overall activity at GS27. These included averages (annual, seasonal, monthly), medians (annual, seasonal, monthly), geometric means, the minimum variance unbiased estimator (MVU), and the simple estimator (Gilbert, 1987).

¹² Storm-event sampling collects samples during the rising limb of a direct runoff hydrograph following a precipitation event. The highest TSS measurements, and corresponding Pu and Am activities, are typically measured during these hydrologic conditions. Therefore, simple arithmetic average activities using these sample results would be expected to be biased high relative to the 'true' mean activity for a given location. Additionally, actinide water-quality variation tends to be lognormal, and also varies with flow rate, season, storm size, and time. Therefore, various activity estimation techniques and periods are used to calculate a range of estimated loads.

- The seasonal median activity for each year is multiplied by the corresponding measured seasonal discharge volume to estimate annual loads. The annual loads are then totaled for the analysis period.

The loads estimated for GS27 are summarized in the following analysis by using the average estimated loads from the various methods.

2.4.1 Relative Subdrainage Loads: March 13, 2002 through August 19, 2004

The loading analysis in this section uses all available data for the period 3/13/02 through 8/19/04 from GS10 and the nine upstream Source Location monitoring stations (GS27, GS28, GS38, GS39, GS40, GS43, GS50, GS57, and SW022). This loading analysis does not address the attenuation of actinides as they are transported from one monitoring location to the next. The analysis assumes that as the period of sampling is increased, the temporal effects of actinide transport will not significantly affect the relative loads from the various subdrainages. The hydrologic connectivity of these locations is shown in Figure 2-10.

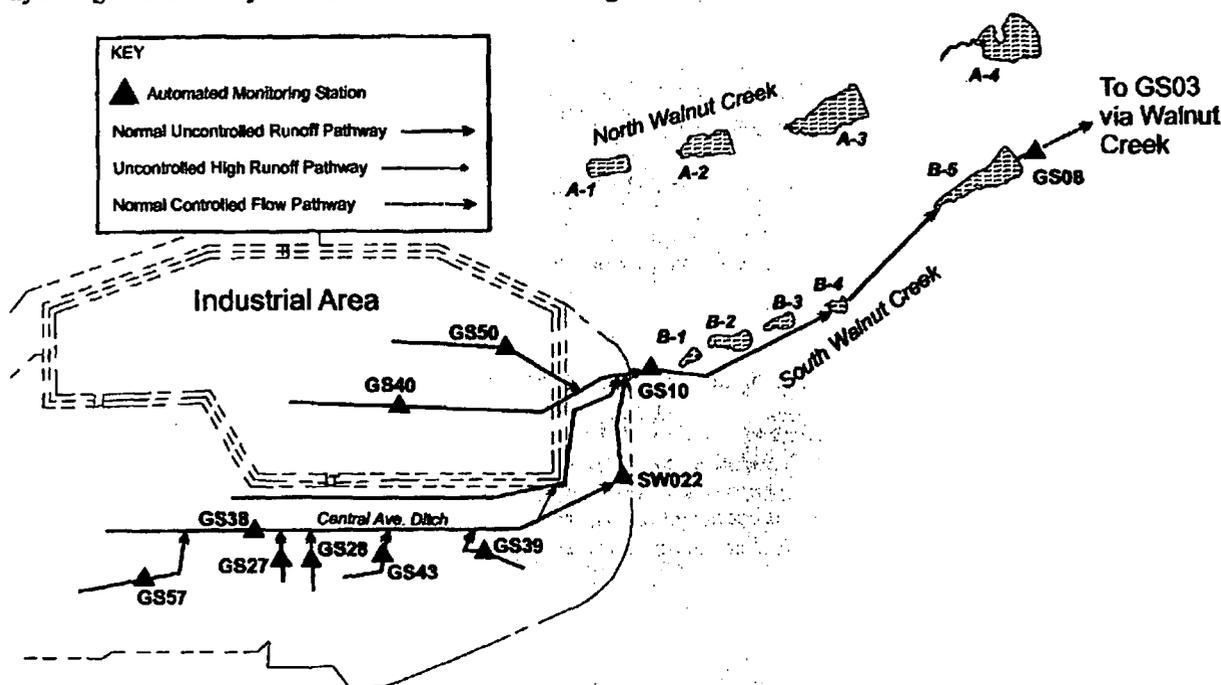


Figure 2-10. Hydrologic Connectivity of Monitoring Locations Tributary to GS10 (as of 3/13/02).

Table 2-5, Figure 2-12, and Figure 2-13 indicate that multiple subdrainages are contributing the majority of the Pu load estimated at GS10: the area directly tributary to GS38, GS39, GS40, the area directly tributary to SW022, and the area directly tributary to GS10. Additionally, analysis shows that the Pu loads from GS39 and SW022 have increased significantly in WY04 (Figure 2-16 and Figure 2-17). This suggests that recent projects impacting the GS39 and SW022 drainages, especially the 903 Pad remediation, may have negatively impacted water quality.

Table 2-5, Figure 2-14, and Figure 2-15 indicate that the GS40 subdrainage is contributing the majority of the Am load estimated at GS10. The majority of this Am load at GS40 coincided with culvert clean-out activities on the east side of the 750 Pad during WY03 (see WY02 Surface-Water Annual Report; URS, 2003b). WY04 Am loads at GS40 have decreased 60% from WY03 loads, though GS40 is still a significant contributor of Am load to GS10. Additionally, analysis shows that the Am loads from both GS39 and SW022 have increased significantly in WY04 (Figure 2-16 and Figure 2-17). This suggests that recent projects impacting the GS39 and SW022 drainages, especially the 903 Pad remediation, may have negatively impacted water quality.

Table 2-5. Comparison of Pu and Am Loads at Tributary Locations with GS10: 3/13/02 through 8/19/04.

| Location | Pu-239,240 Load in μg | Am-241 Load in μg |
|----------|----------------------------------|------------------------------|
| GS10 | 769.7 | 10.15 |

| Location | Pu-239,240 | | Am-241 | |
|------------------------------------|-----------------------|--------------------------------|-----------------------|--------------------------------|
| | Load in μg | Load as a Percent of GS10 Load | Load in μg | Load as a Percent of GS10 Load |
| GS27 | 7.6 | 1.0% | 0.04 | 0.4% |
| GS28 | 2.5 | 0.3% | 0.01 | 0.1% |
| "Area Directly Tributary to GS38" | 133.0 | 17.3% | 0.58 | 5.7% |
| GS39 | 140.0 | 18.2% | 0.83 | 8.2% |
| GS40 | 206.2 | 26.8% | 7.08 | 69.8% |
| GS43 | 1.7 | 0.2% | 0.01 | 0.1% |
| GS50 | 10.7 | 1.4% | 0.38 | 3.7% |
| GS57 | 5.4 | 0.7% | 0.05 | 0.5% |
| "Area Directly Tributary to SW022" | 85.3 | 11.1% | 0.12 | 1.2% |
| "Area Directly Tributary to GS10" | 177.4 | 23.1% | 1.04 | 10.3% |

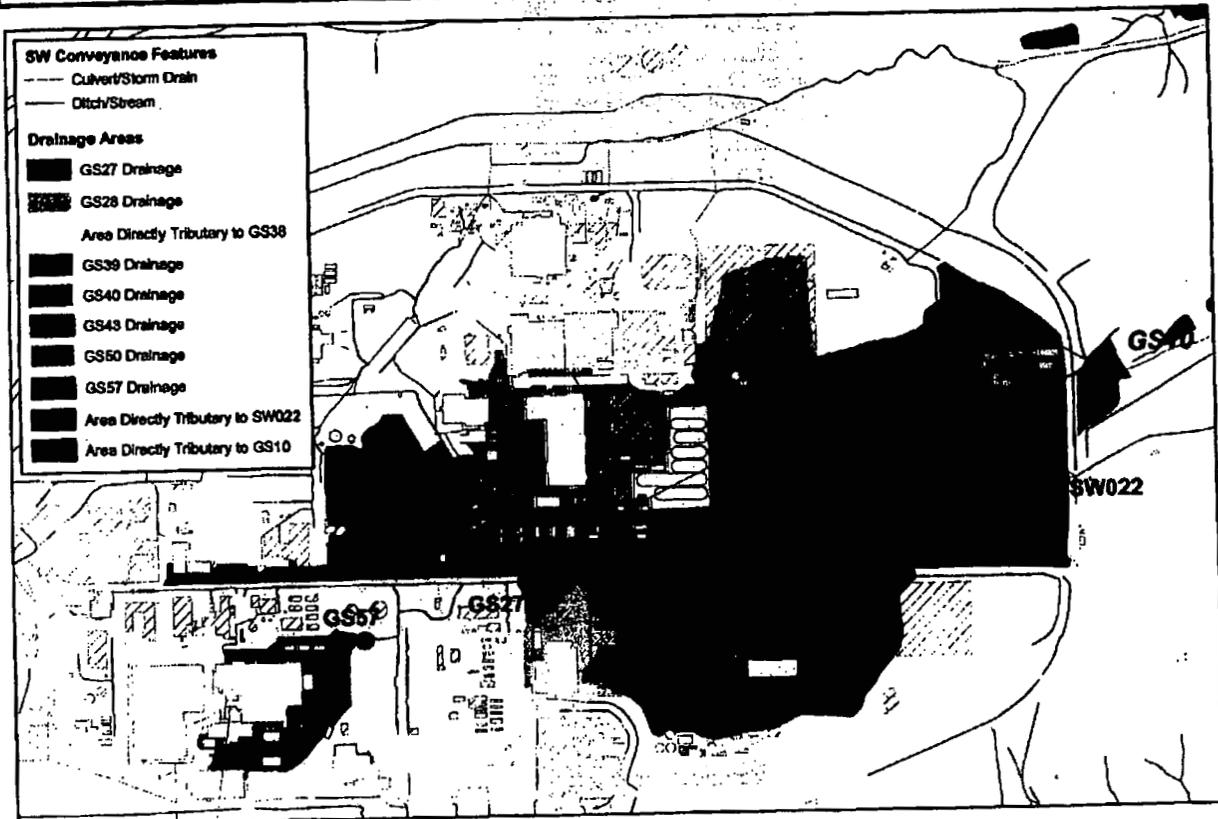


Figure 2-11. Subdrainage Map for Areas Tributary to GS10: As of 3/13/02.

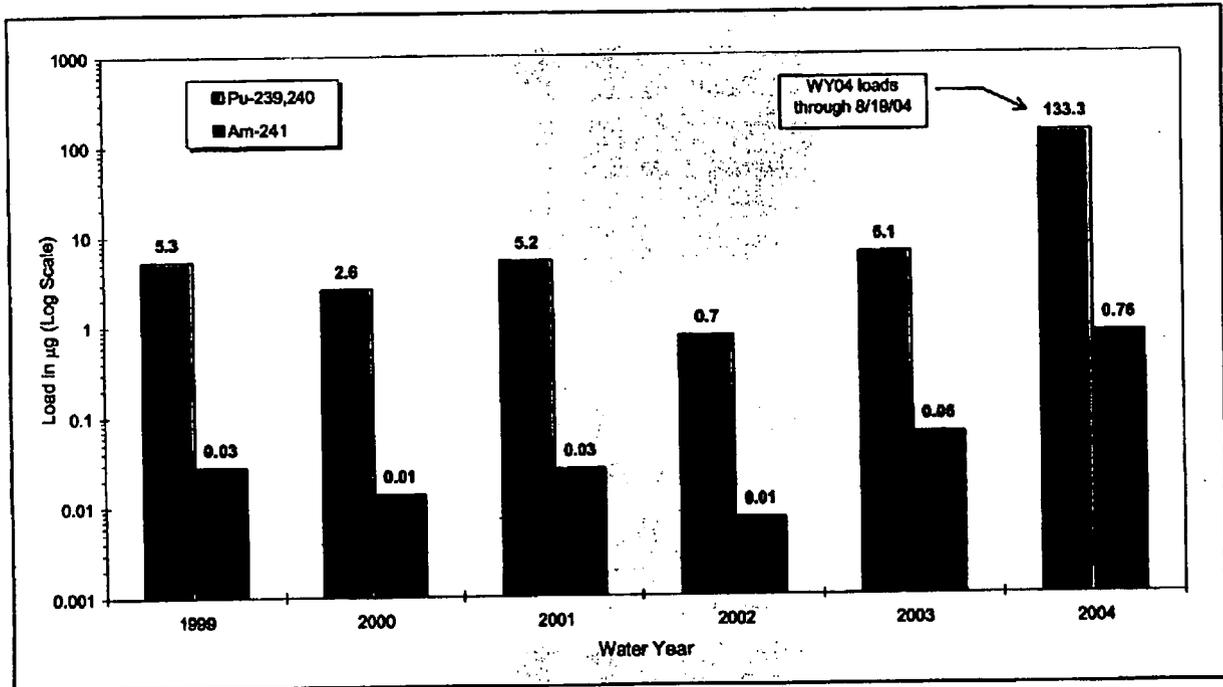


Figure 2-16. Annual Pu and Am Loads at GS39.

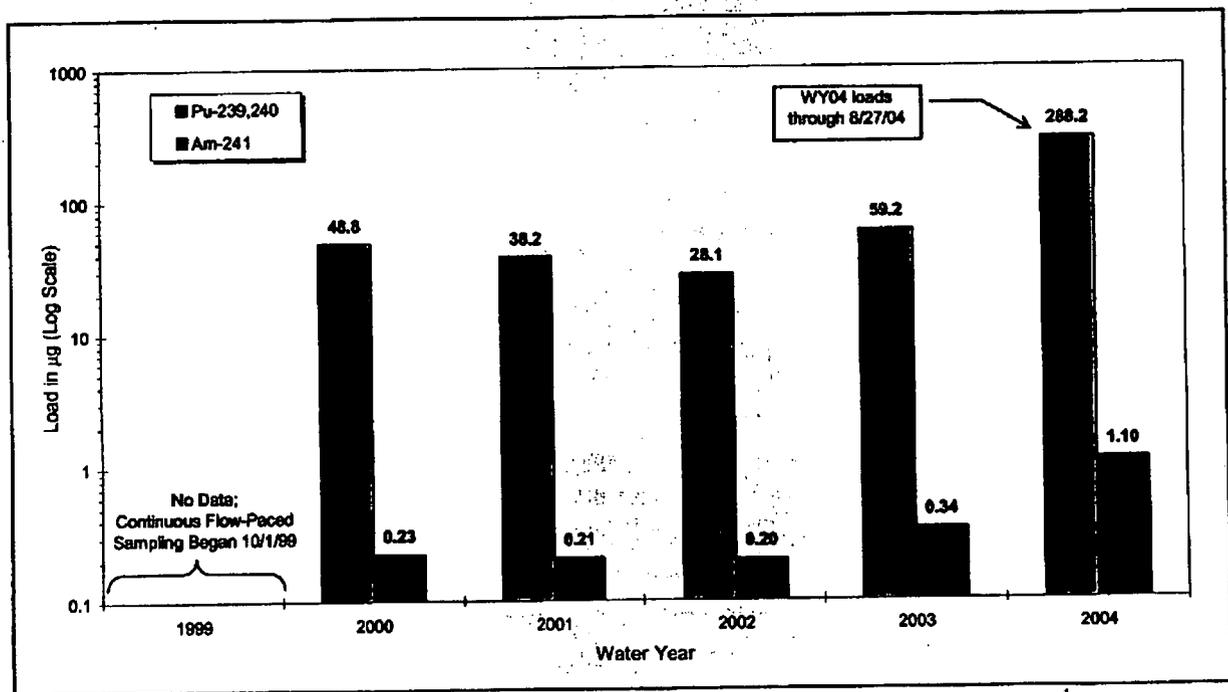


Figure 2-17. Annual Pu and Am Loads at SW022.

2.4.2 Relative Subdrainage Loads: May 6, 2003 through August 19, 2004

The loading analysis in this section uses all available data for the period 5/6/03 through 8/19/04 from GS10 and the ten upstream Source Location monitoring stations (GS27, GS28, GS38, GS39, GS40, GS43, GS50, GS57, SW021, and SW022). This loading analysis does not address the attenuation of actinides as they are transported from one monitoring location to the next. The analysis assumes that as the period of sampling is increased, the temporal effects of actinide transport will not significantly affect the relative loads from the various subdrainages. The hydrologic connectivity of these locations is shown in Figure 2-18.

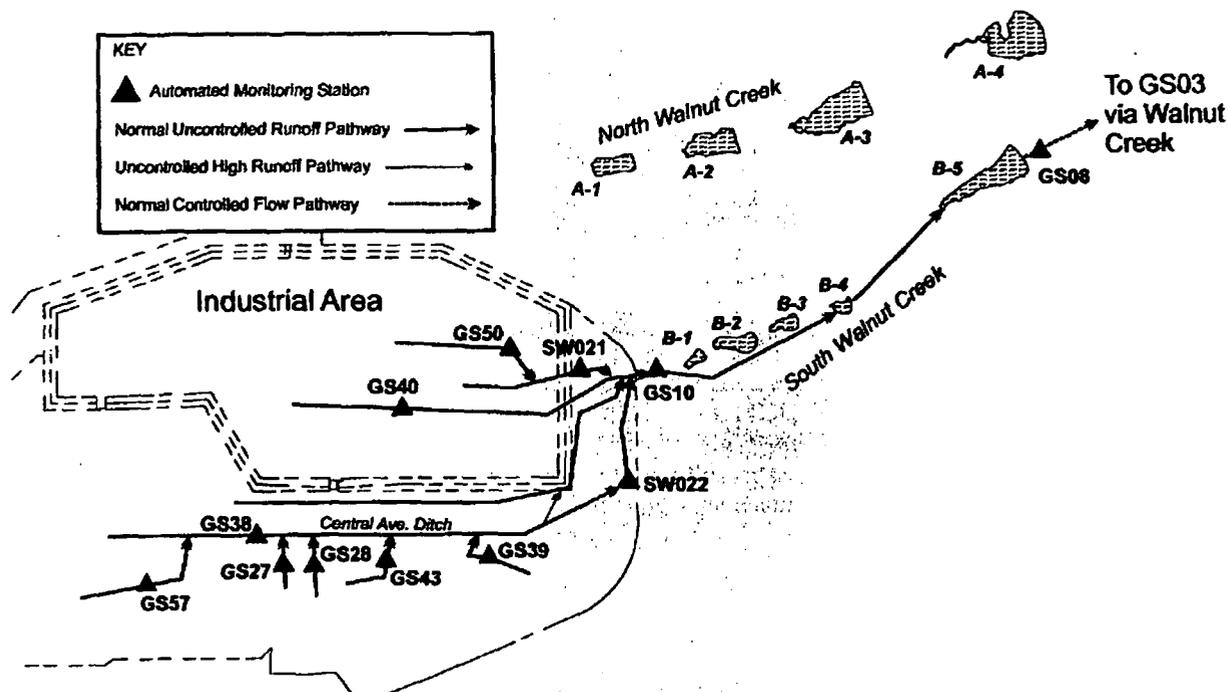


Figure 2-18. Hydrologic Connectivity of Monitoring Locations Tributary to GS10 (as of 5/6/03).

As for the previous loading analysis above, Table 2-6, Figure 2-20, and Figure 2-21 indicate that multiple subdrainages are contributing the majority of the Pu load estimated at GS10: the area directly tributary to GS38, GS39, GS40, the area directly tributary to SW022, and the area directly tributary to GS10. Additionally, analysis shows that the Pu loads from GS39 and SW022 have increased significantly in WY04 (previously in Figure 2-16 and Figure 2-17). This suggests that recent projects impacting the GS39 and SW022 drainages, especially the 903 Pad remediation, may have negatively impacted water quality.

As for the previous loading analysis above, Table 2-6, Figure 2-22, and Figure 2-23 indicate that the GS40 subdrainage is contributing the majority of the Am load estimated at GS10. The loss of Am load to the area directly tributary to GS10 is likely due to losses to the streambed downstream of the monitored subdrainages. The majority of this Am load at GS40 coincided with culvert clean-out activities on the east side of the 750 Pad during WY03 (see WY02 SW Annual Report; URS, 2003b). WY04 Am loads at GS40 have decreased 60% from WY03 loads, though GS40 is still a significant contributor of Am load to GS10. Additionally, analysis shows that the Am loads from both GS39 and SW022 have increased significantly in WY04 (Figure 2-16 and Figure 2-17). This suggests that recent projects impacting the GS39 and SW022 drainages, especially the 903 Pad remediation, may have negatively impacted water quality.

Table 2-6. Comparison of Pu and Am Loads at Tributary Locations with GS10: 5/6/03 through 8/19/04.

| Location | Pu-239,240 Load in μg | Am-241 Load In μg |
|----------|----------------------------------|------------------------------|
| GS10 | 556.2 | 5.13 |

| Location | Pu-239,240 | | Am-241 | |
|------------------------------------|-----------------------|--------------------------------|-----------------------|--------------------------------|
| | Load in μg | Load as a Percent of GS10 Load | Load in μg | Load as a Percent of GS10 Load |
| GS27 | <0.1 | <0.1% | <0.01 | <0.1% |
| GS28 | 1.7 | 0.3% | 0.01 | 0.2% |
| "Area Directly Tributary to GS38" | 75.1 | 13.5% | 0.30 | 5.8% |
| GS39 | 134.8 | 24.2% | 0.78 | 15.1% |
| GS40 | 181.1 | 32.6% | 6.50 | 127% |
| GS43 | 0.9 | 0.2% | 0.01 | 0.1% |
| GS50 | 10.4 | 1.9% | 0.36 | 7.1% |
| GS57 | 3.8 | 0.7% | 0.03 | 0.7% |
| "Area Directly Tributary to SW021" | 6.5 | 1.2% | 0.03 | 0.6% |
| "Area Directly Tributary to SW022" | 80.9 | 14.5% | 0.04 | 0.8% |
| "Area Directly Tributary to GS10" | 60.9 | 11.0% | -2.93 (loss) | -57.2% (loss) |

Notes: The 'loss' for the Area Directly Tributary to GS10 is likely due to losses of load to the streambed downstream of the monitored subdrainages.

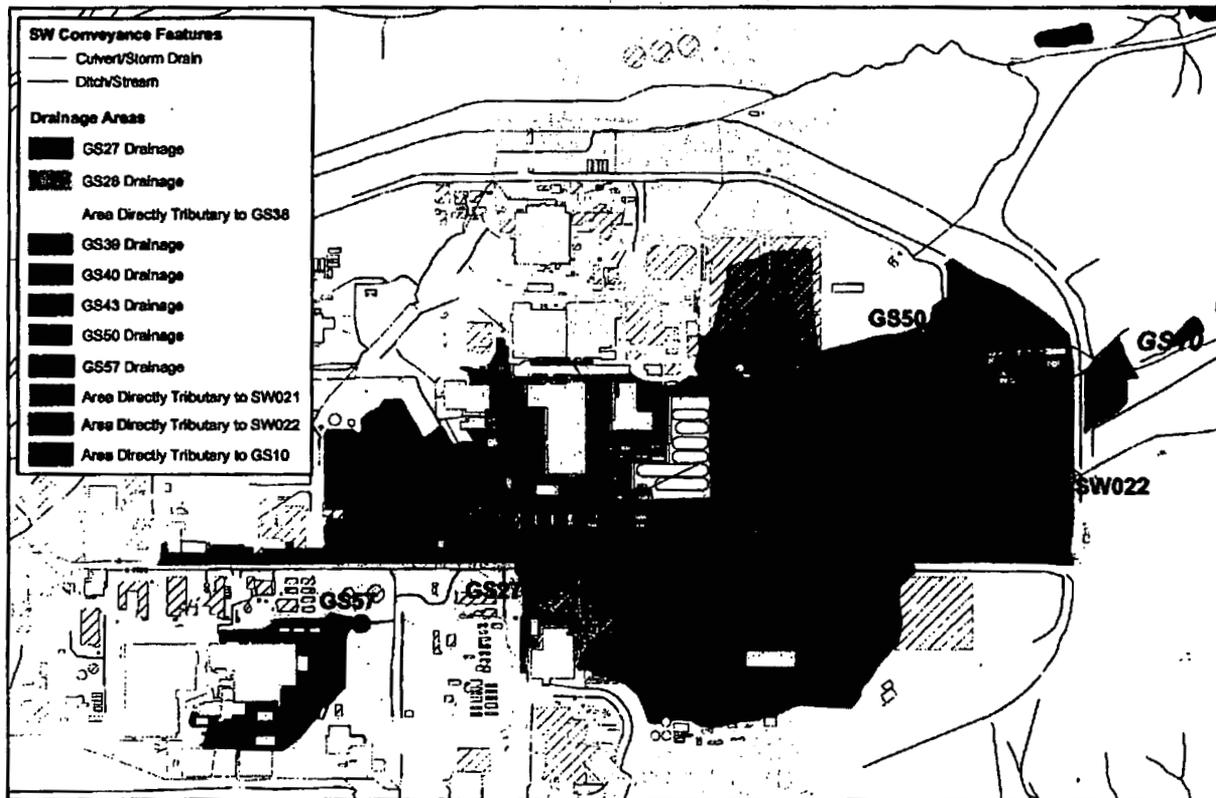


Figure 2-19. Subdrainage Map for Areas Tributary to GS10: As of 5/6/03.

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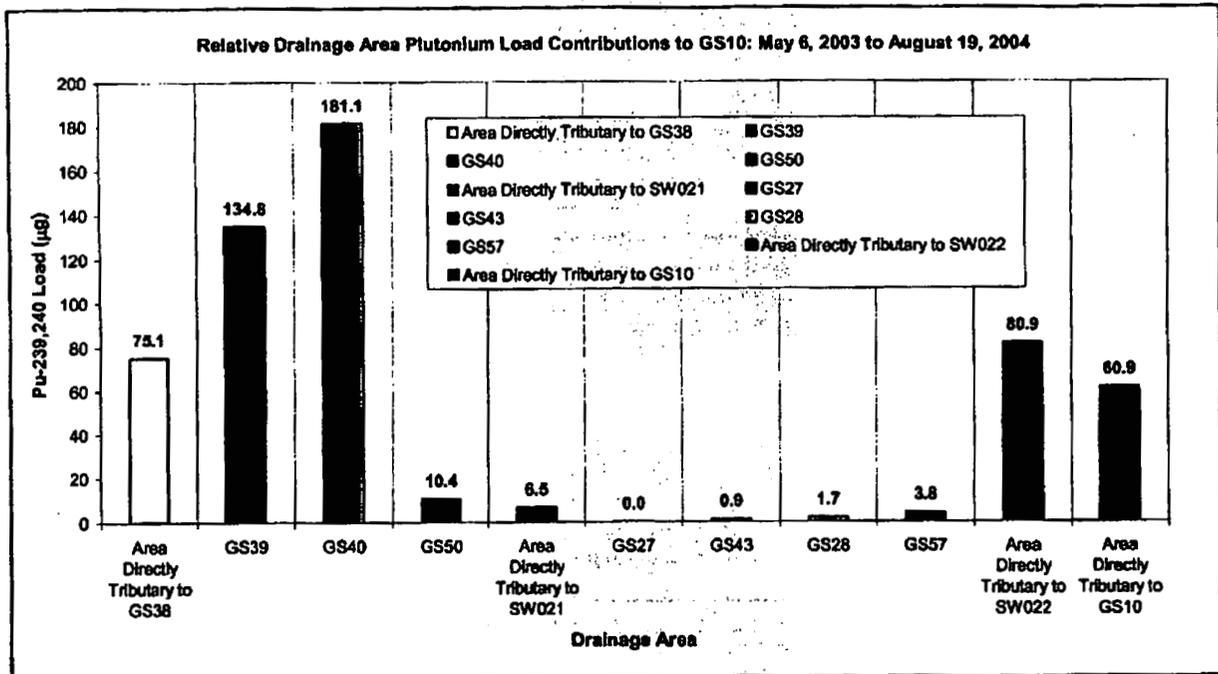


Figure 2-20. Relative Pu Load Contribution Chart for Locations Tributary to GS10: 5/6/03 through 8/19/04.

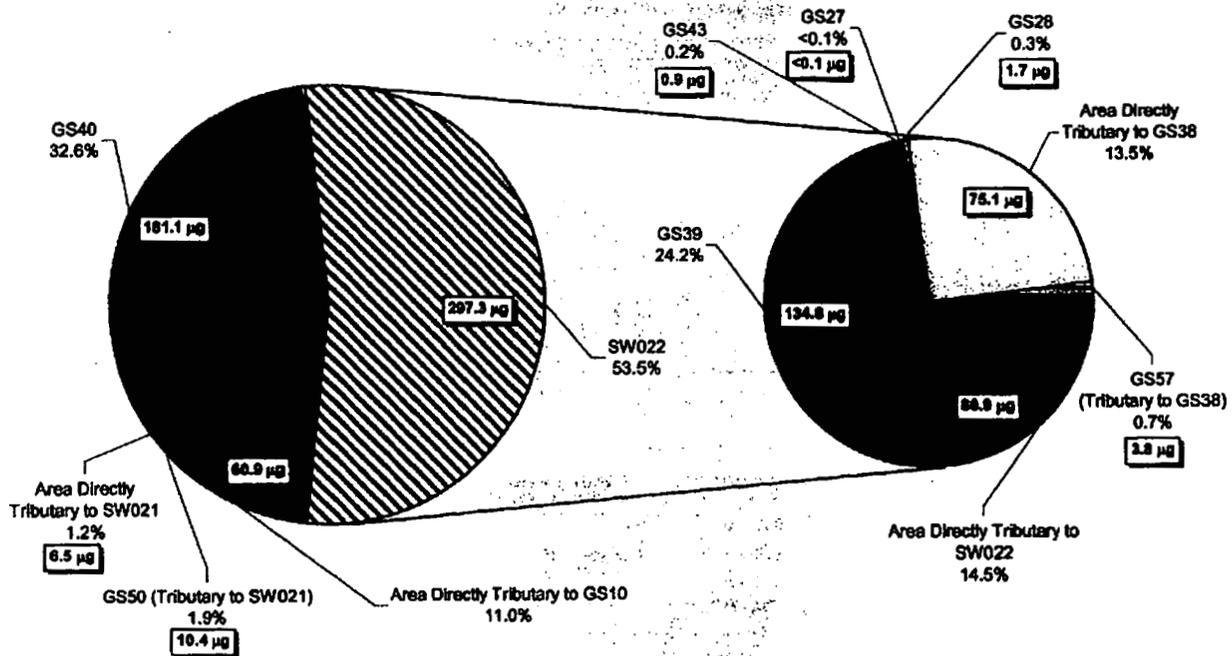


Figure 2-21. Relative Pu Load Contribution Pie for Locations Tributary to GS10: 5/6/03 through 8/19/04.

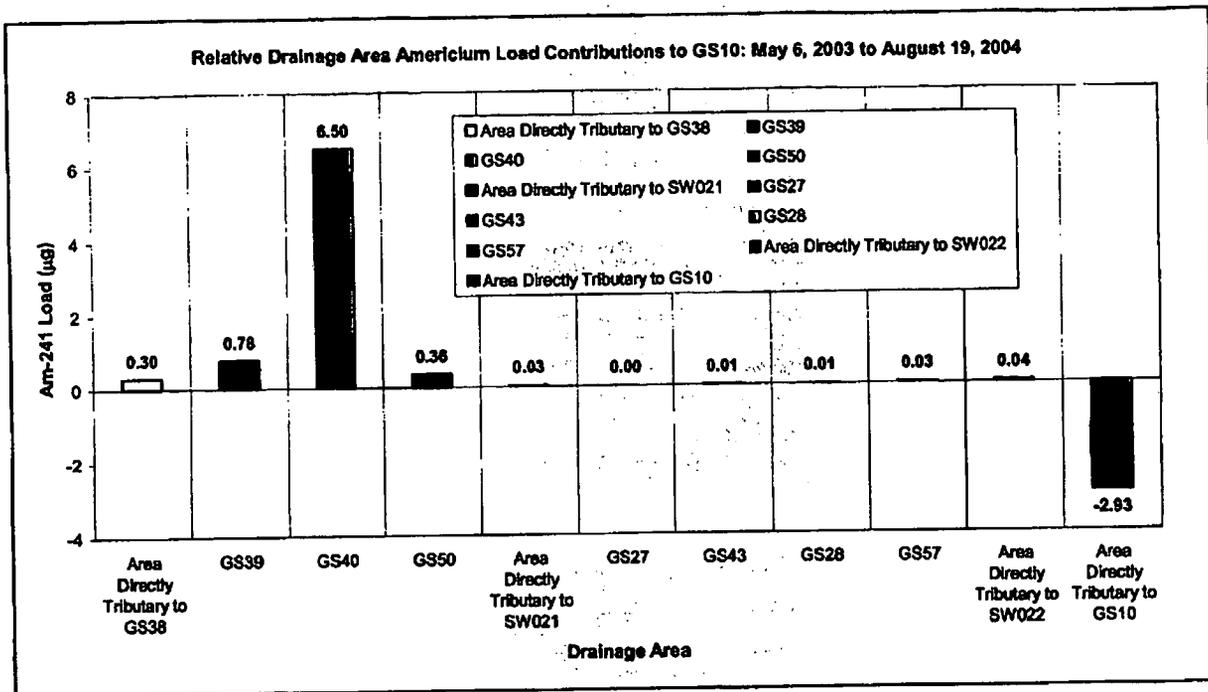


Figure 2-22. Relative Am Load Contribution Chart for Locations Tributary to GS10: 516103 through 8/19/04.

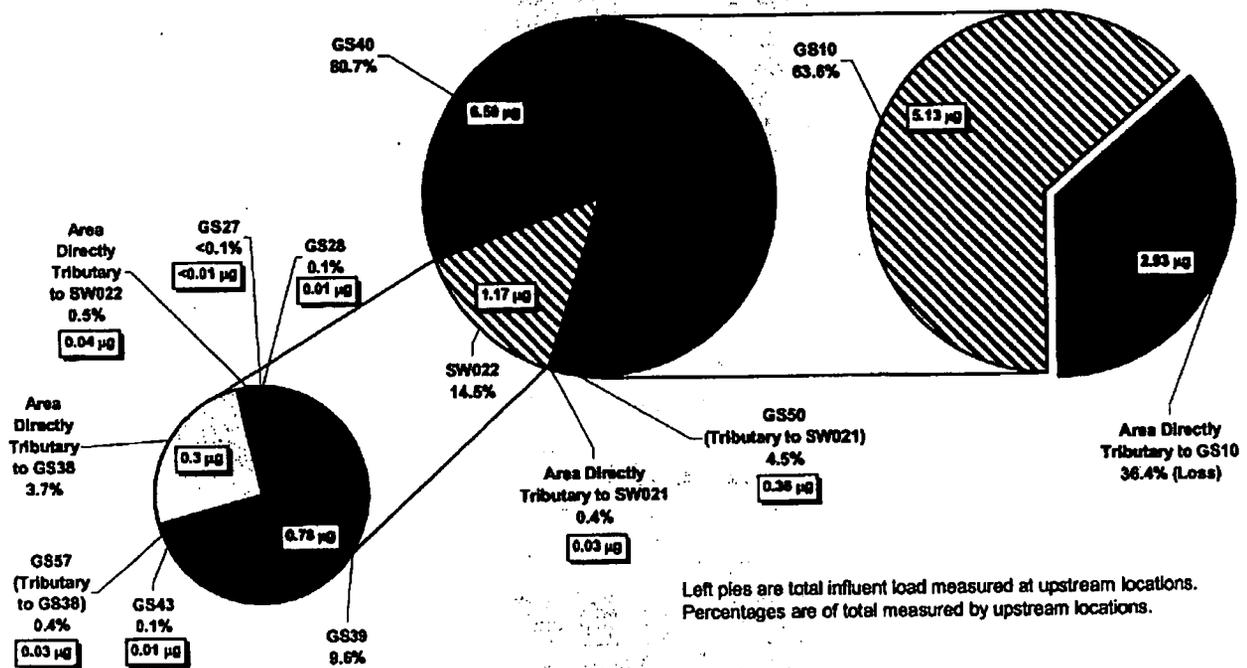


Figure 2-23. Relative Am Load Contribution Pie for Locations Tributary to GS10: 516103 through 8/19/04.

2.5 EROSION CONTROL MEASURES

The Site is implementing an aggressive program of erosion control to prevent the movement of soils and sediments and to protect storm water and surface-water quality. The increased activities of building removal and soil disturbance require rigorous erosion control methods. A number of control methods are currently being used, from straw bales and wattles to soil tackifiers and erosion blankets. Ultimately, disturbed sites are revegetated.

Immediately following confirmation of reportable values at GS10, a preliminary loading analysis was performed that also identified multiple subdrainages as contributors to GS10. The loading analysis above further confirms the following subdrainages as the dominant Pu and Am load contributors to GS10: GS38 (area directly tributary), GS39, GS40, SW022 (area directly tributary), and the area directly tributary to GS10. Since the majority of Pu and Am is transported in surface water attached to particulate matter (suspended solids), a number of erosion controls have been added to these Site drainages. To augment the preexisting erosion methods the Site has been routinely using, additional controls were installed in these subdrainages starting in June 2004 (see Figure 2-24 through Figure 2-28). Localized controls in ditches have been added in the form of straw wattles, straw bales, and silt fences. Area controls have been applied to disturbed soils in the form of erosion matting, hydromulch and seed, and tackifier (in many cases exclusion boundaries have been established to prevent vehicle traffic). These erosion controls have been installed throughout the GS10 drainage based on field walkdowns and monitoring data analysis identifying areas of sediment transport and specifically for projects likely to impact surface water.

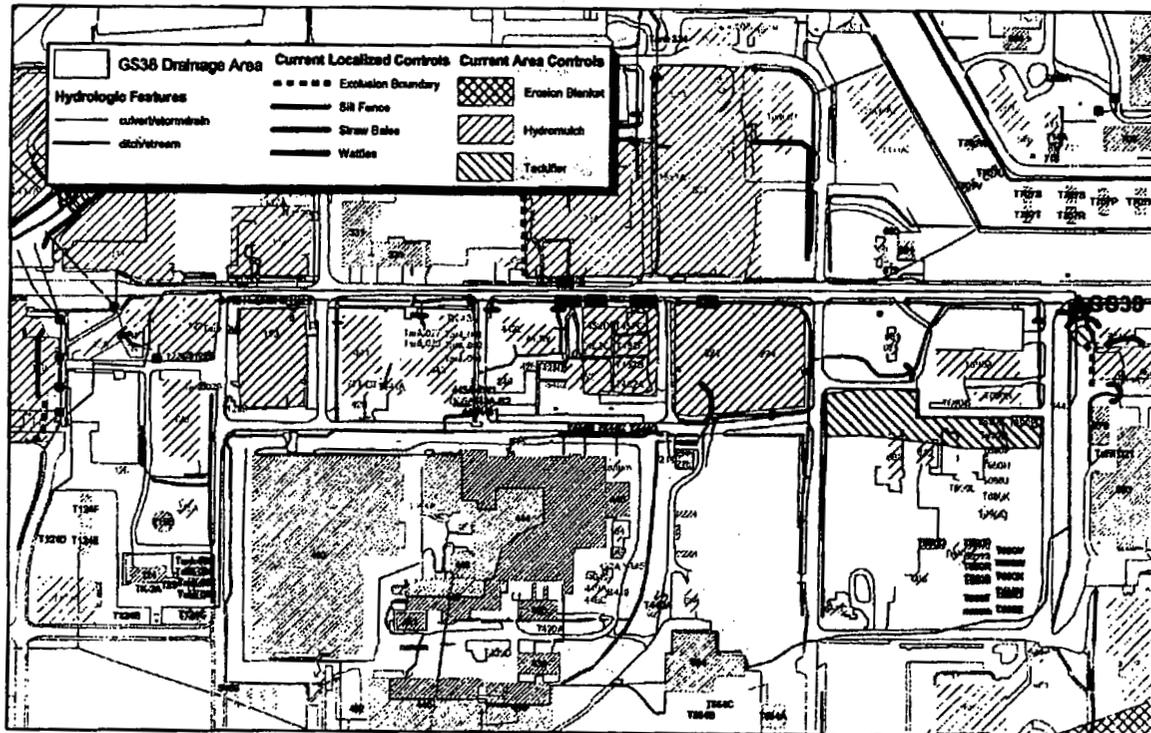


Figure 2-24. Erosion Controls In the GS38 Drainage as of 10/21/04.

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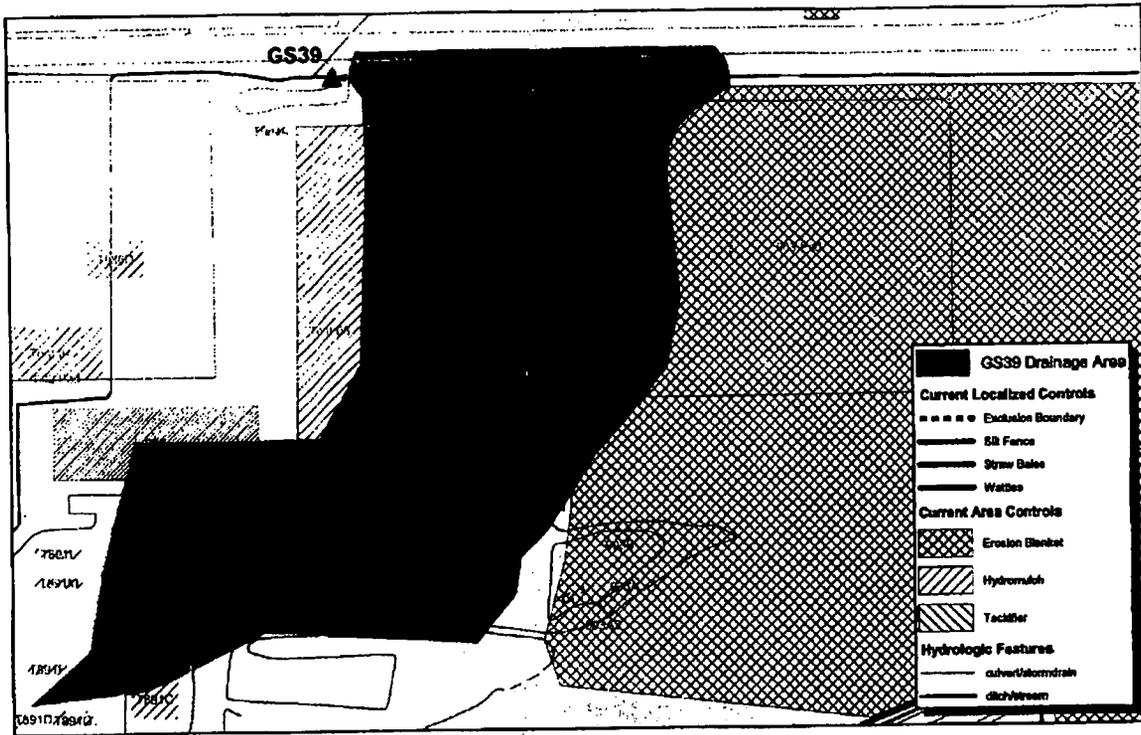


Figure 2-25. Erosion Controls In the GS39 Drainage as of 10/21/04.

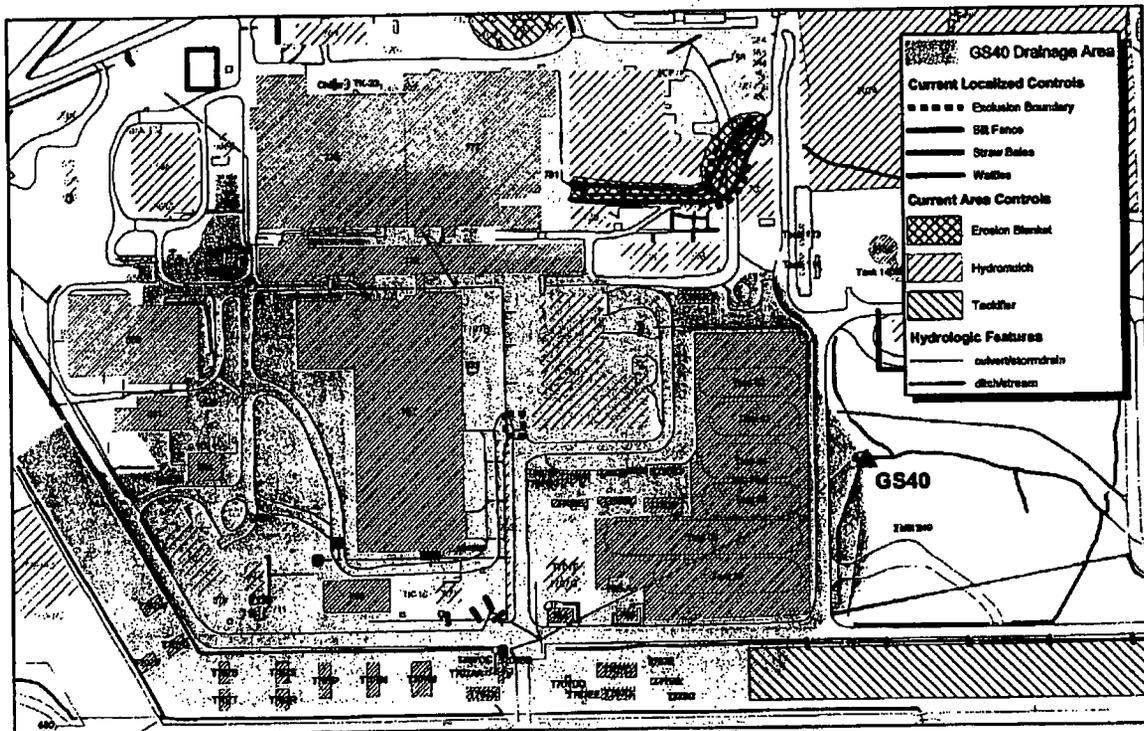


Figure 2-26. Erosion Controls In the GS40 Drainage as of 10/21/04.

35

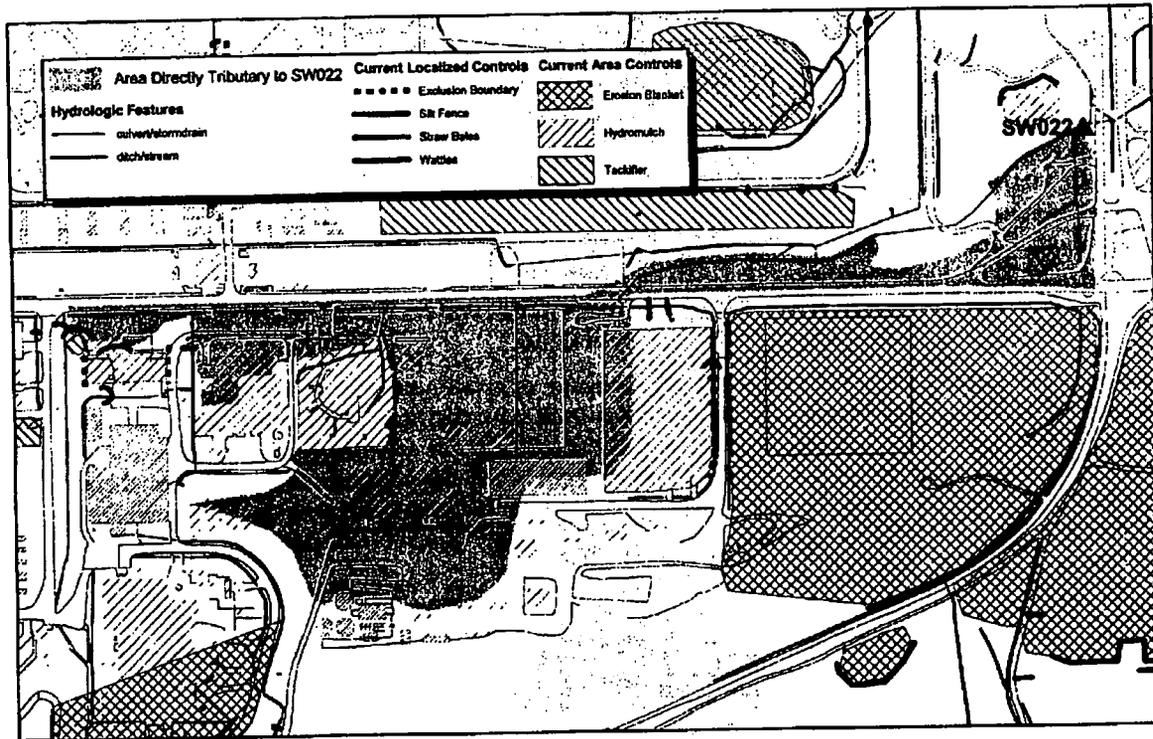


Figure 2-27. Erosion Controls in the Area Directly Tributary to SW022 as of 10/21/04.

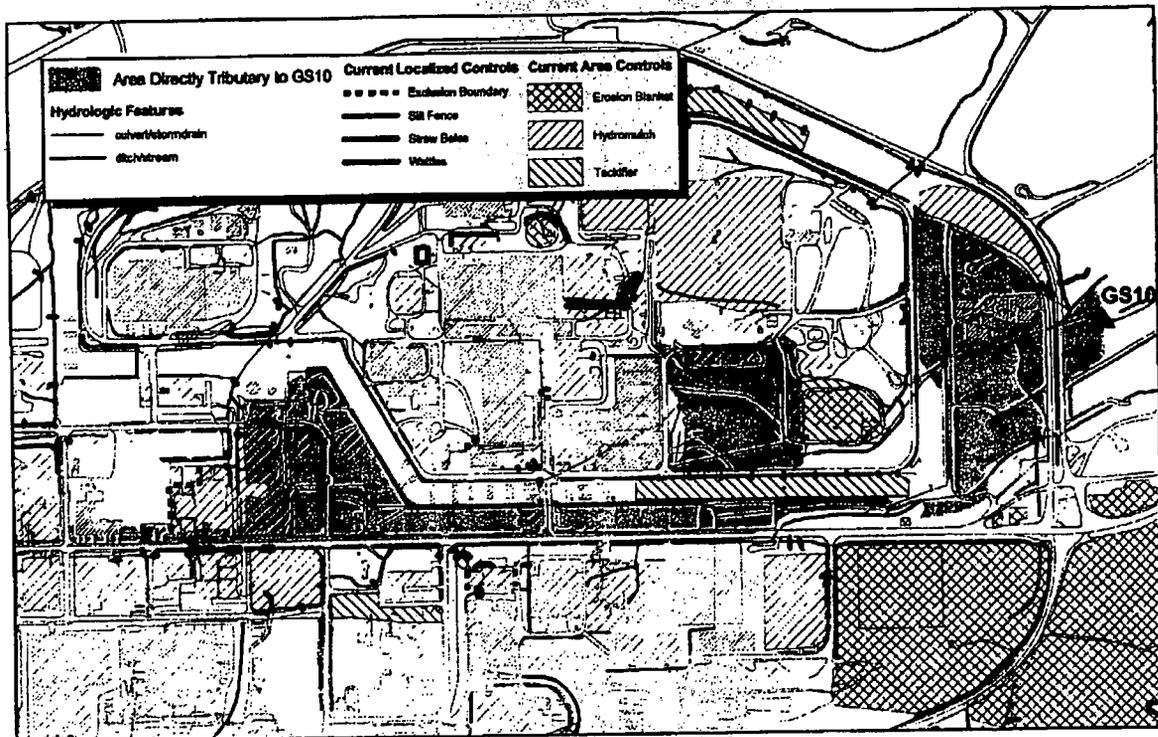


Figure 2-28. Erosion Controls in the Area Directly Tributary to GS10 as of 10/21/04.

2.6 WATER-QUALITY TRENDS AND CORRELATIONS: GS10

Higher Pu and Am activities began to be measured at GS10 starting with the composite sample for the period 2/20 – 3/8/04 (Figure 2-29). For the period 10/1/02 – 2/19/04, average Pu/Am ratios at GS10 were 0.9. For the period 2/20 – 8/29/04, average Pu/Am ratios were 2.4, suggesting that recent higher activities are from different areas or increased source contributions within existing areas than the activities for previous samples. For roughly the same period, a similar pattern is noted for samples collected at both GS39 and SW022 (Figure 2-30 and Figure 2-31). Figure 2-32 shows that the higher GS10 Pu/Am ratios are generally associated with the WY04 period of increased Pu loads at GS39 and SW022.¹³ These patterns further support the conclusion that flows from the GS39 and SW022 subdrainages have affected water quality at GS10.

Though GS40 has been noted to be a significant contributor of both Pu and Am loads to GS10, WY04 Pu loads show no significant change over WY03 loads, and Am loads have decreased (Figure 2-33). Furthermore, Figure 2-35 shows no significant change in Pu activities and a decrease in Am activities (this change is also indicated by the shift in Pu/Am ratios shown in Figure 2-34). During the WY03 period of elevated activities and loads at GS40, no reportable values were measured at GS10. This observation, coupled with the WY04 GS40 data, suggests that the recent reportable values at GS10 are significantly influenced by runoff from other areas.

No significant water-quality improvement due to erosion controls has been observed to date for GS10 (Figure 2-29). This may be caused by the continued transport of residual solids in the flow pathways downstream of the new erosion controls. However, data from both GS39 and SW022 (Figure 2-30 and Figure 2-31) show a measurable reduction in activities for the most recent data.

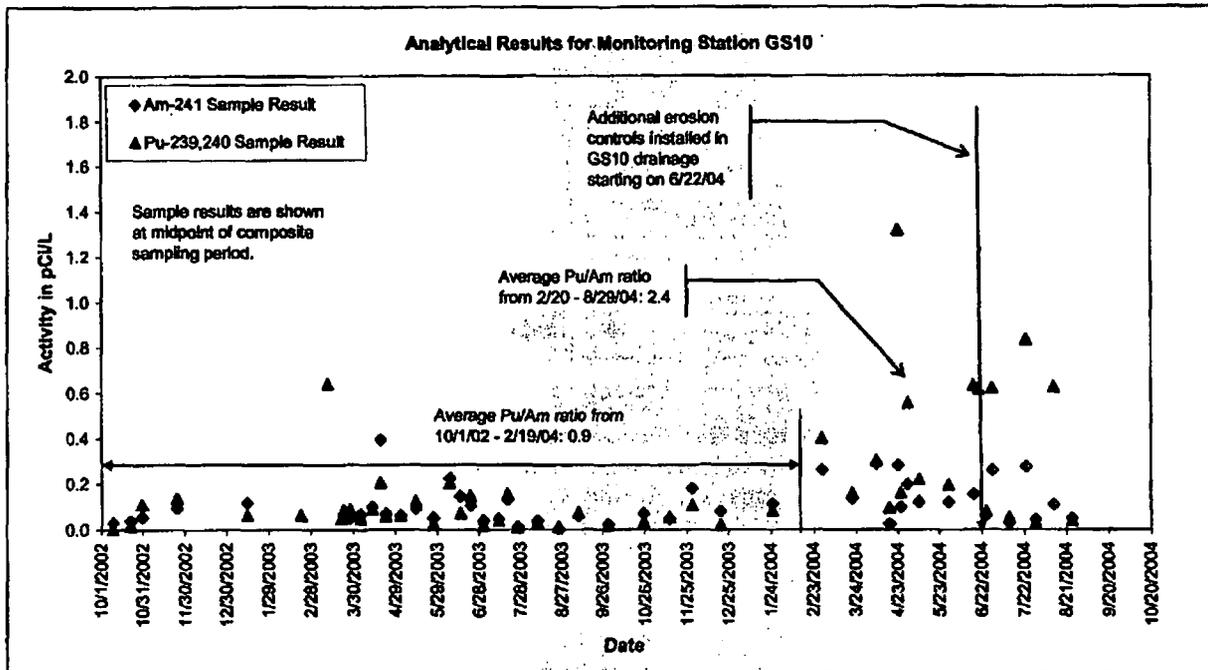


Figure 2-29. Individual Sample Results at GS10: 10/1/02- 8/29/04.

¹³ A significant portion of the load at SW022 originates with GS39. However, the loading analysis above shows that the area downstream of the monitored subdrainages (the 'area directly tributary to SW022') is also a significant load contributor.

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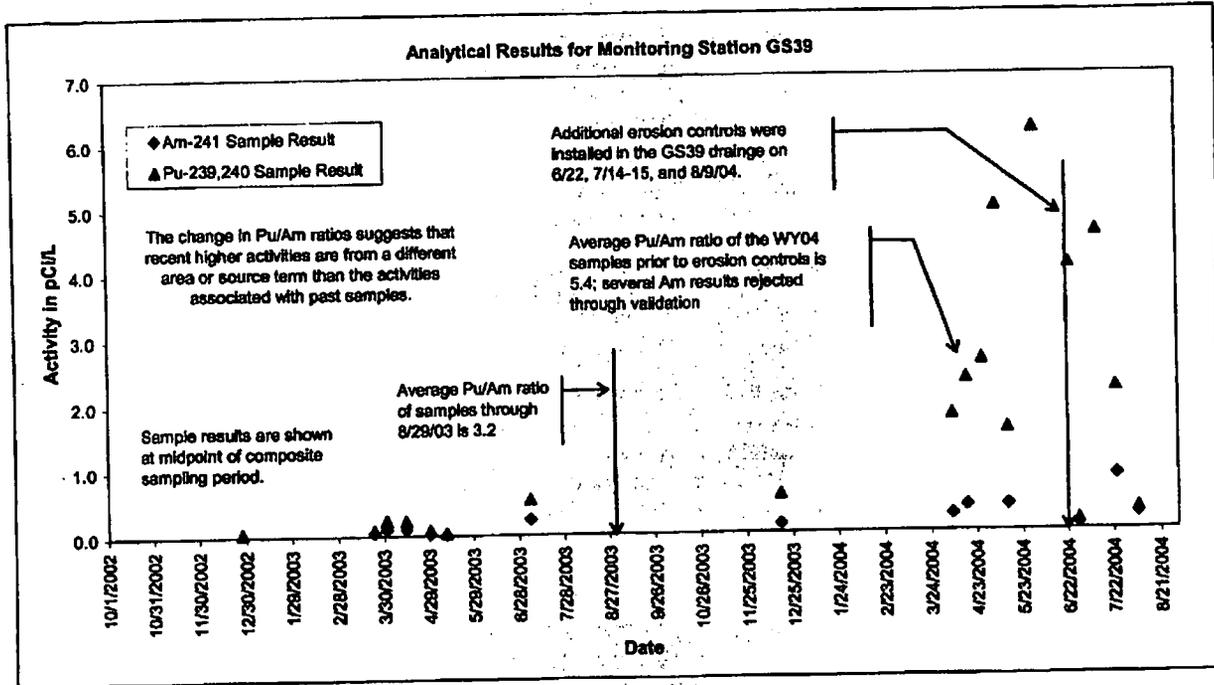


Figure 2-30. Individual Sample Results at GS39: 10/1/02- 8/19/04.

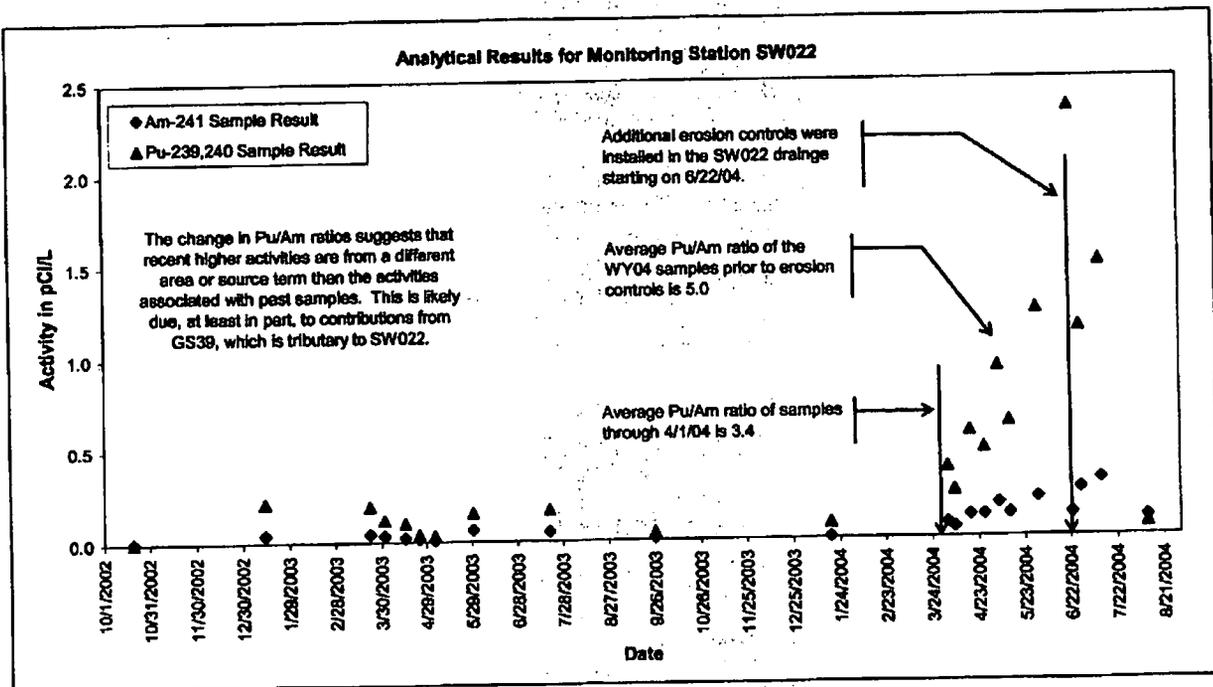


Figure 2-31. Individual Sample Results at SW022: 10/1/02- 8/26/04.

38

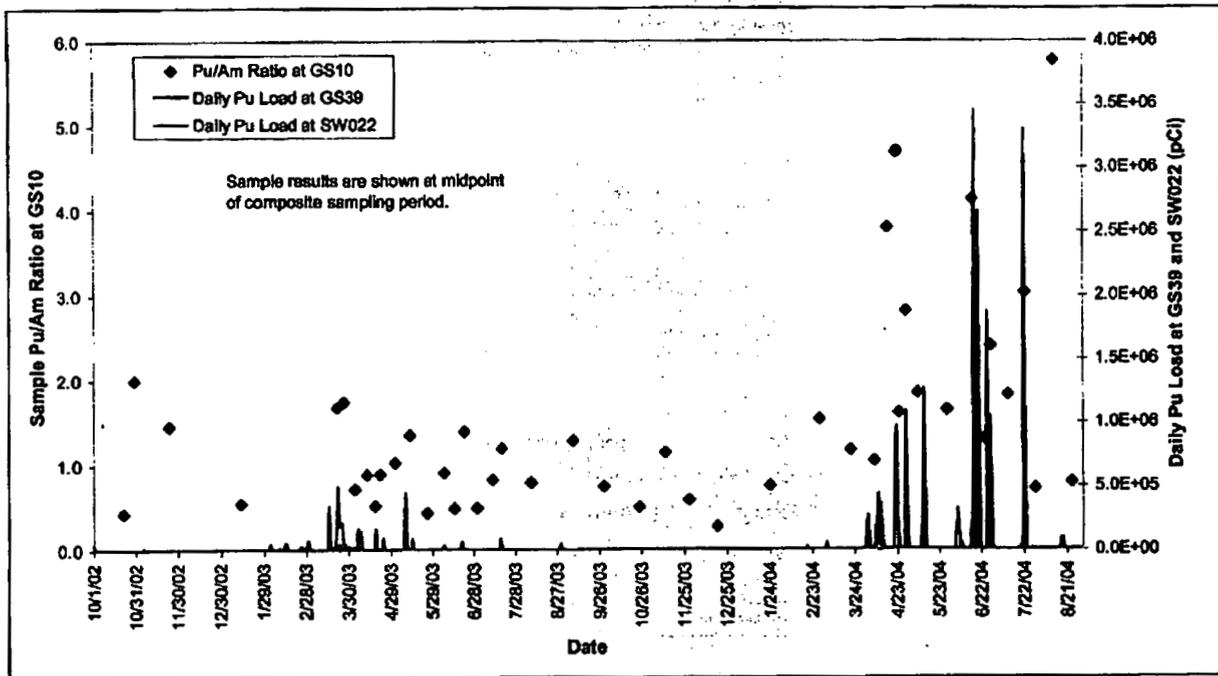


Figure 2-32. Temporal Variation of Pu/Am Ratios at GS10 with Daily Pu Loads at GS39 and SW022.

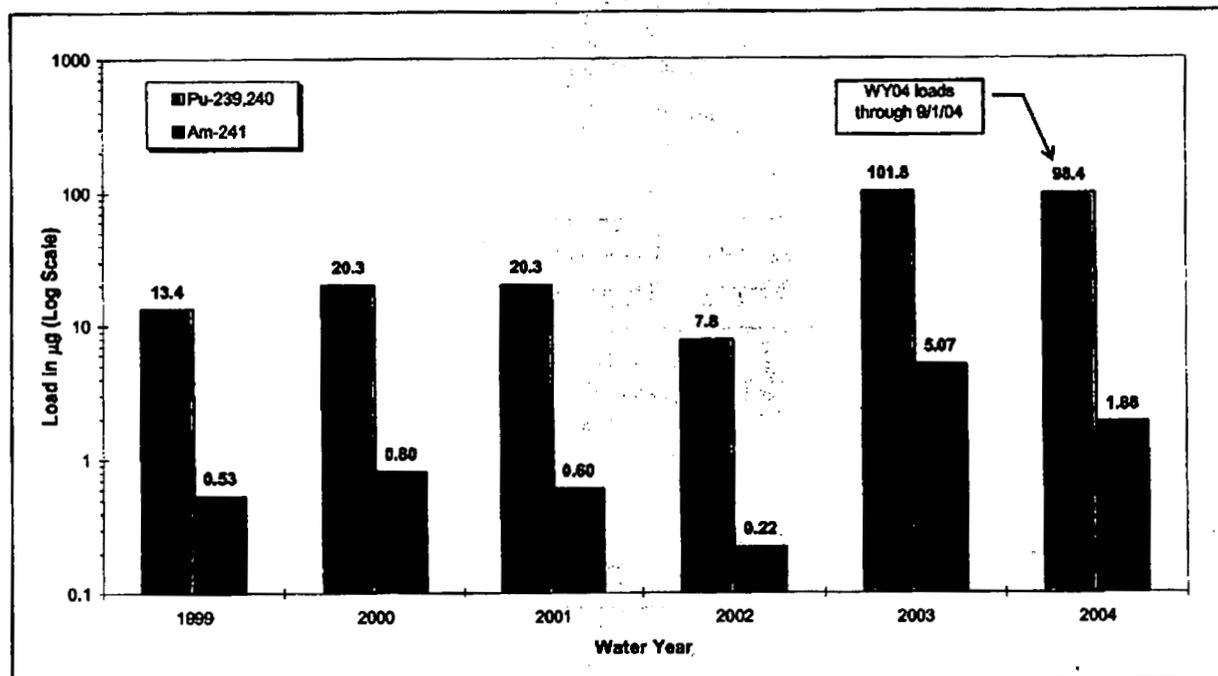


Figure 2-33. Annual Pu and Am Loads at GS40.

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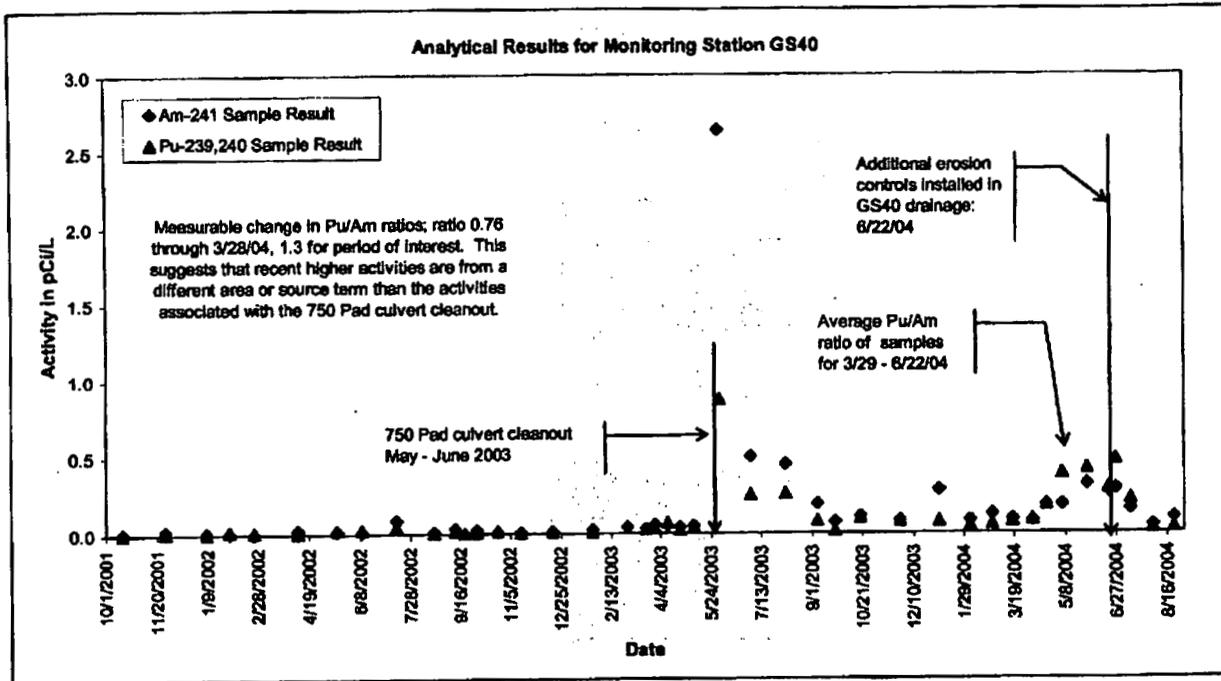


Figure 2-34. Individual Sample Results at GS40: 10/11/01- 9/11/04.

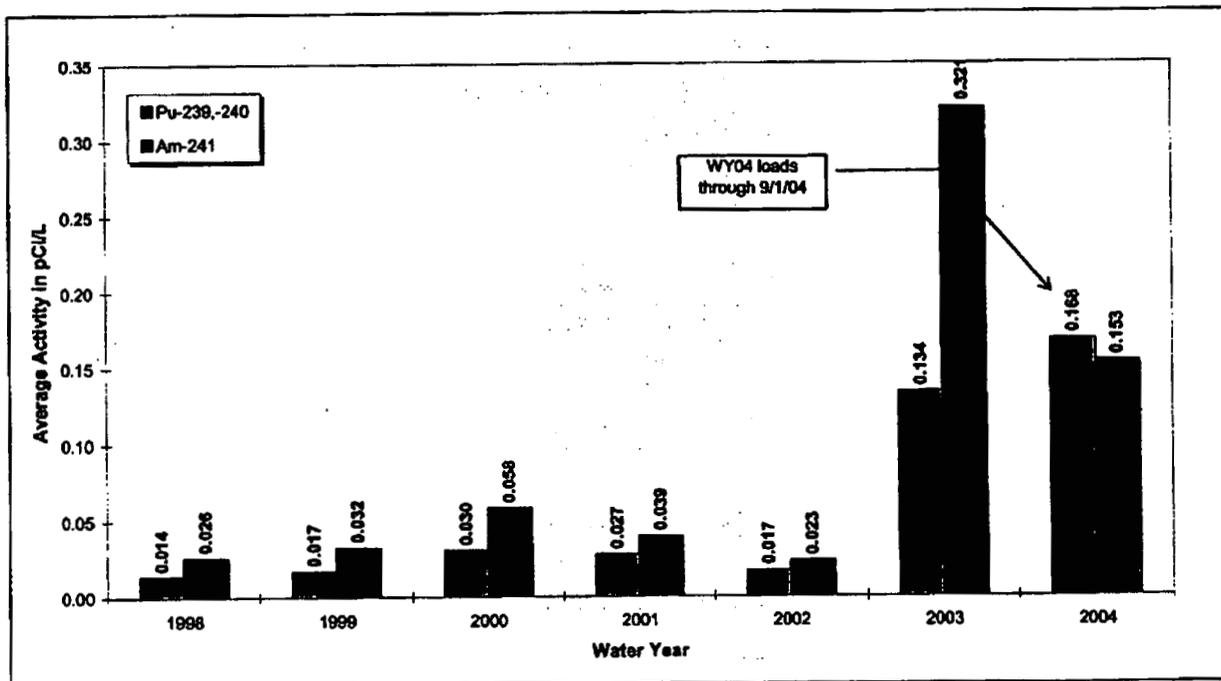


Figure 2-35. Annual Volume-Weighted Average Pu and Am Activities at GS40.

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Since Pu and Am are transported attached to suspended solids, an increase in suspended solids activity (sample activity divided by TSS concentration [pCi/g]) suggests the increased contribution of a relatively more contaminated area, and/or sediment transport from a previously non-contributing area or source term. Pu and Am suspended solids activities at GS10 show no change in WY04 (Figure 2-36). In conjunction with the increased activities, this suggests increased transport of suspended solids with contamination similar to past years, and not a significant new source term. A similar pattern is noted for samples collected at GS39 (Figure 2-37).

A moderate increase in suspended solids activity at SW022 is noted for WY04 (Figure 2-38). This is likely due to the increased contribution of relatively more contaminated suspended solids from the GS39 subdrainage. That the SW022 increase is not measured at GS10 may be due to increased transport of relatively less contaminated solids from other areas in the drainage, effectively 'diluting' the contribution from SW022.

No reduction in suspended solids activity is noted for these locations after the implementation of enhanced erosion controls, for the limited data available.

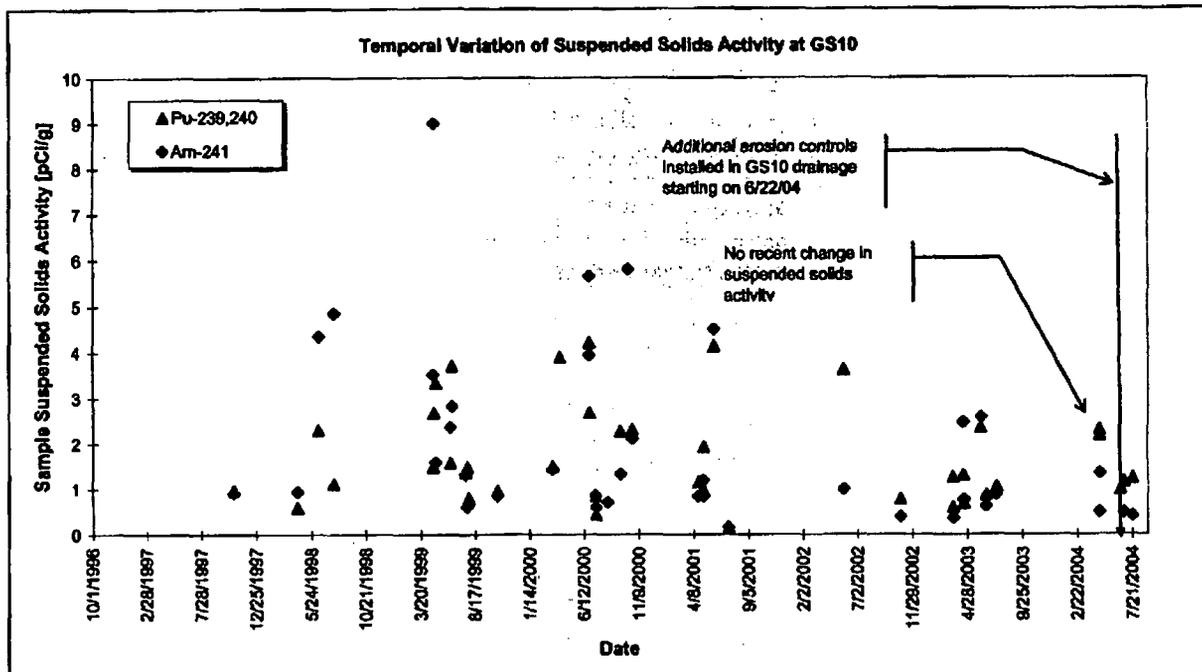


Figure 2-36. Temporal Variation of Suspended Solids Activity at GS10: All RFCA Data.

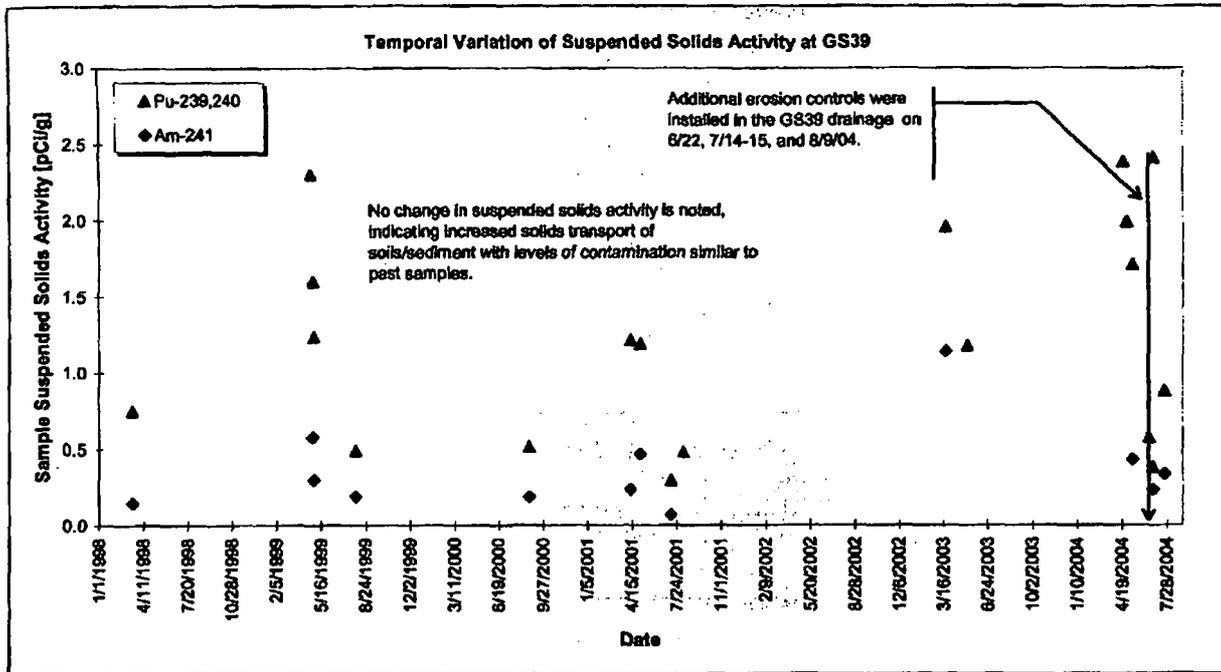
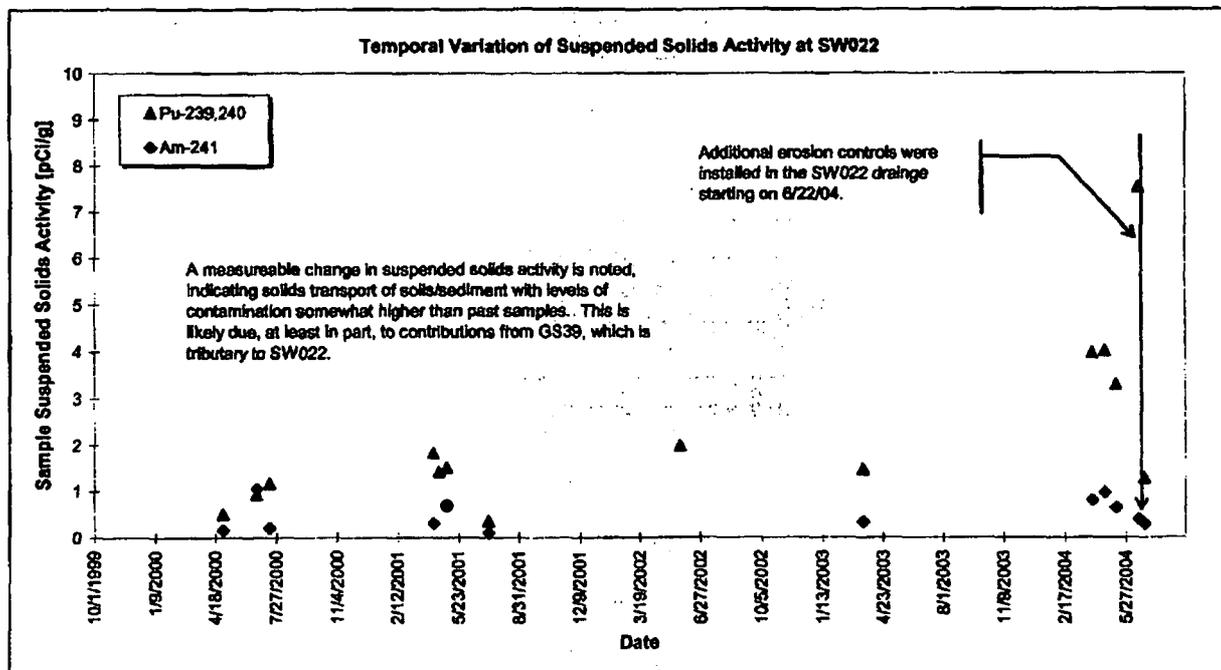


Figure 2-37. Temporal Variation of Suspended Solids Activity at GS39: All RFCA Data.



Note: Continuous flow-paced sampling began at SW022 on 10/1/99; previous samples were collected on the rising limb of a single runoff event.

Figure 2-38. Temporal Variation of Suspended Solids Activity at SW022: Continuous Flow-Paced Sample Data.

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Since Pu and Am are transported attached to suspended solids, an increase in TSS can result in corresponding increases in activity. The amount of TSS in runoff depends on a number of factors including the availability of disturbed soils (e.g. unconsolidated and unvegetated soil), storm intensity (i.e. precipitation forces), and runoff intensity (flow rates). A deviation in the typical relationship between flow rate and TSS suggests increased availability of transportable soils. Figure 2-39 shows that WY04 turbidities (as an indication of TSS) relative to flow rate are generally higher than for WY03 and prior data. This suggests that soils in the GS10 drainage are more susceptible to transport for a given flow rate than for previous years. Similarly, WY04 TSS data show higher values relative to flow rate than for previous years (Figure 2-40). A similar relationship is noted for samples collected at GS39 (Figure 2-41), and to a lesser extent SW022 (Figure 2-42), prior to the implementation of enhanced erosion controls. These patterns suggest that the recent higher activities at GS10 may be the result, at least in part, to the increased transport of legacy contamination associated with soil and sediment, and not new sources.

A measurable reduction in TSS relative to storm intensity is noted for GS39 after the implementation of enhanced erosion controls (Figure 2-41). This is likely the result of sediment trapping and soil stabilization in the GS39 subdrainage coupled with a reduction in project activities associated with the 903 Pad remediation. However, data from both SW022 and GS10 show no reduction in TSS relative to flow rate (Figure 2-42 and Figure 2-40). This may be caused by the transport of residual solids in the flow pathways downstream of the new erosion controls. Additional data are needed to further assess the effects of erosion controls on water quality at GS10.

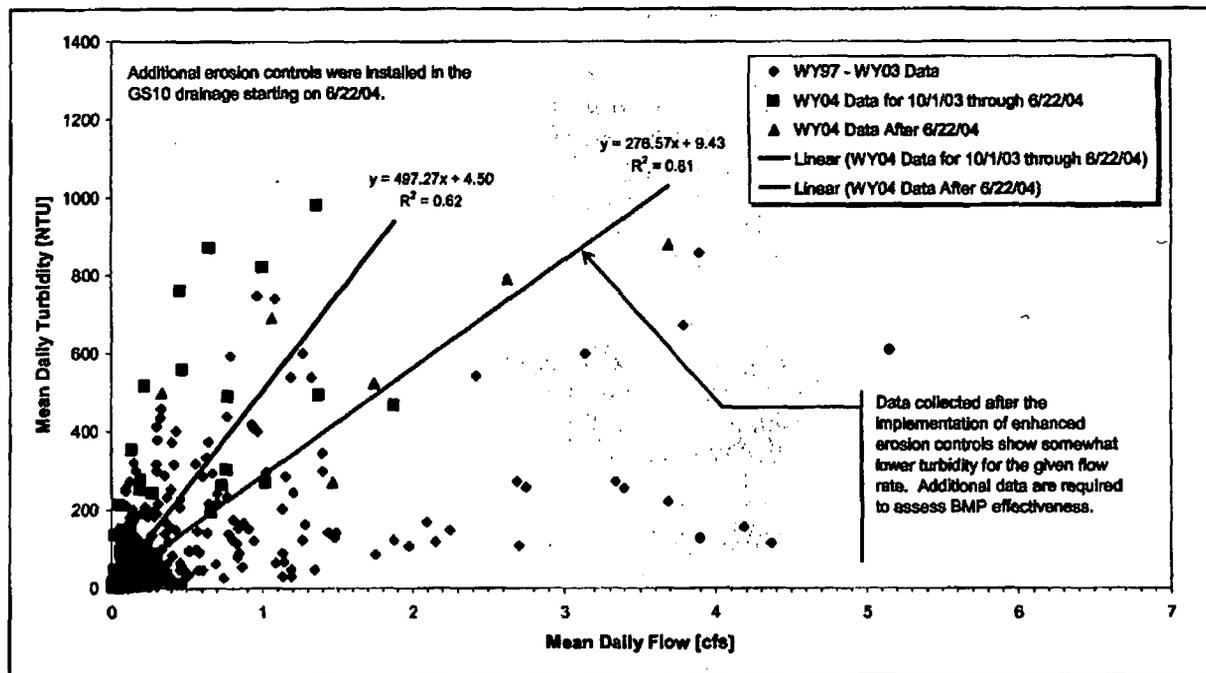


Figure 2-39. Variation of Mean Daily Turbidity with Flow Rate at GS10.

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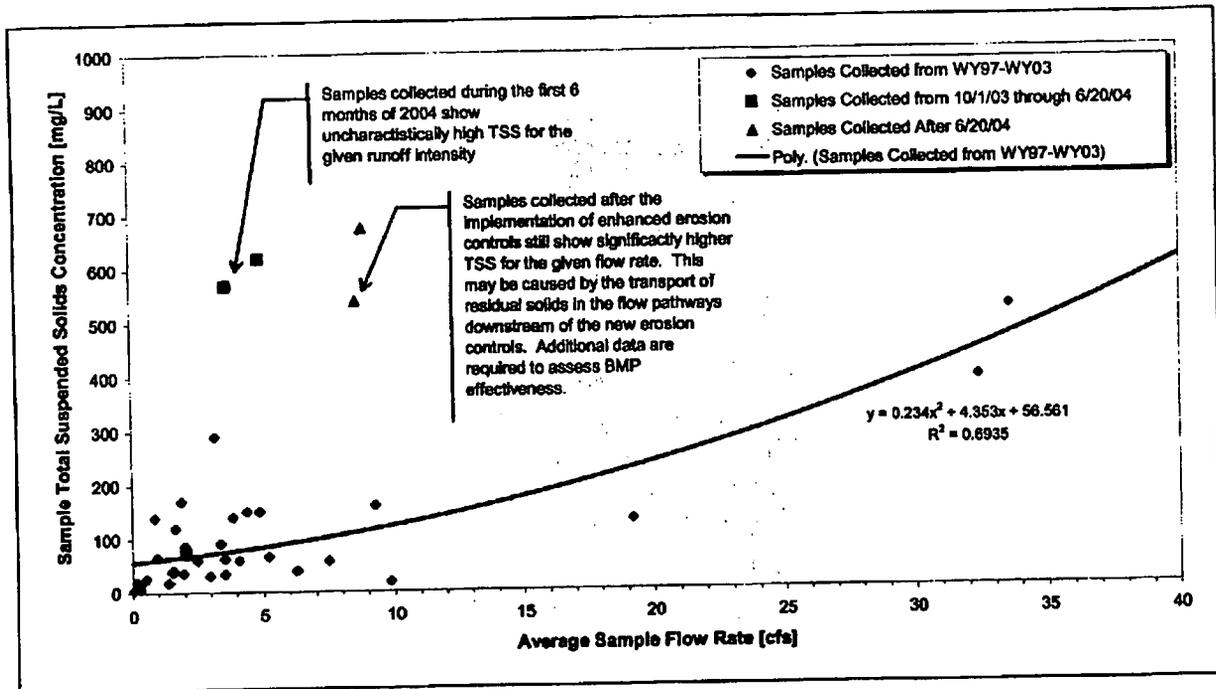


Figure 2-40. Variation of Sample TSS with Flow Rate at GS10.

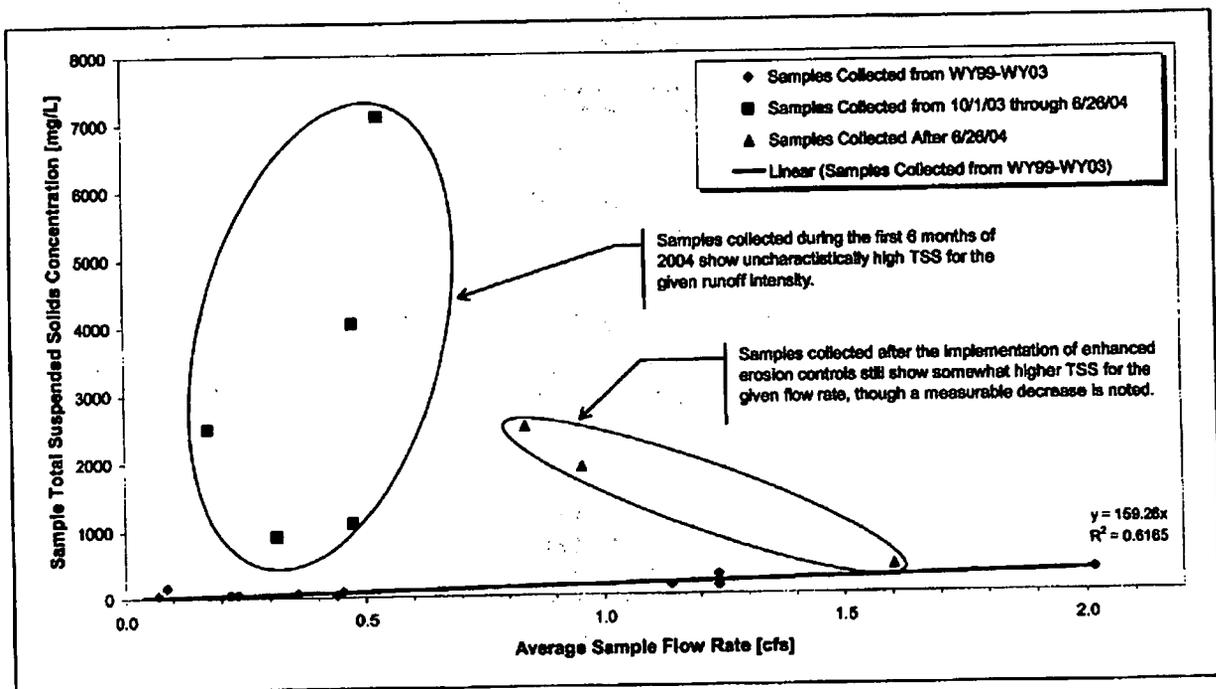
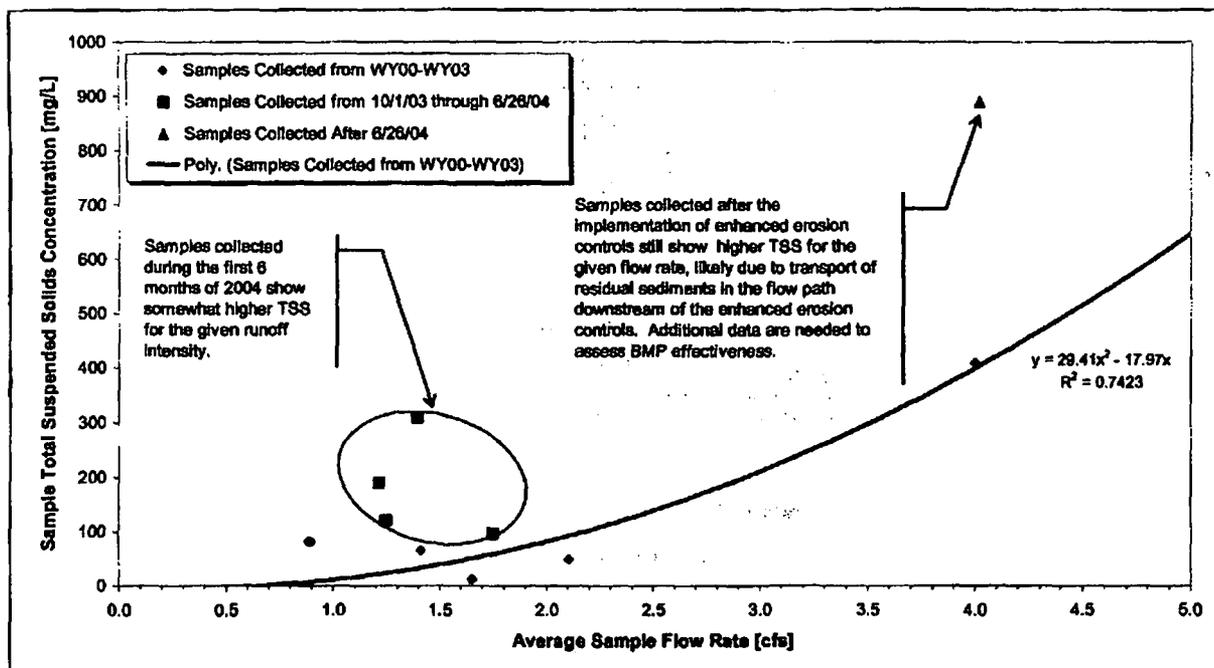


Figure 2-41. Variation of Sample TSS with Flow Rate at GS39.

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Note: Only continuous flow-paced samples shown

Figure 2-42. Variation of Sample TSS with Flow Rate at SW022.

2.7 SITE ACTIVITIES AND PROJECTS IN AREAS TRIBUTARY TO GS10

During the period of reportable values at GS10, multiple projects within the GS10 drainage were occurring. The loading analysis and water-quality correlations presented above indicate that project activities associated with the 903 Pad are likely to have had the most significant impact to water-quality at GS10.

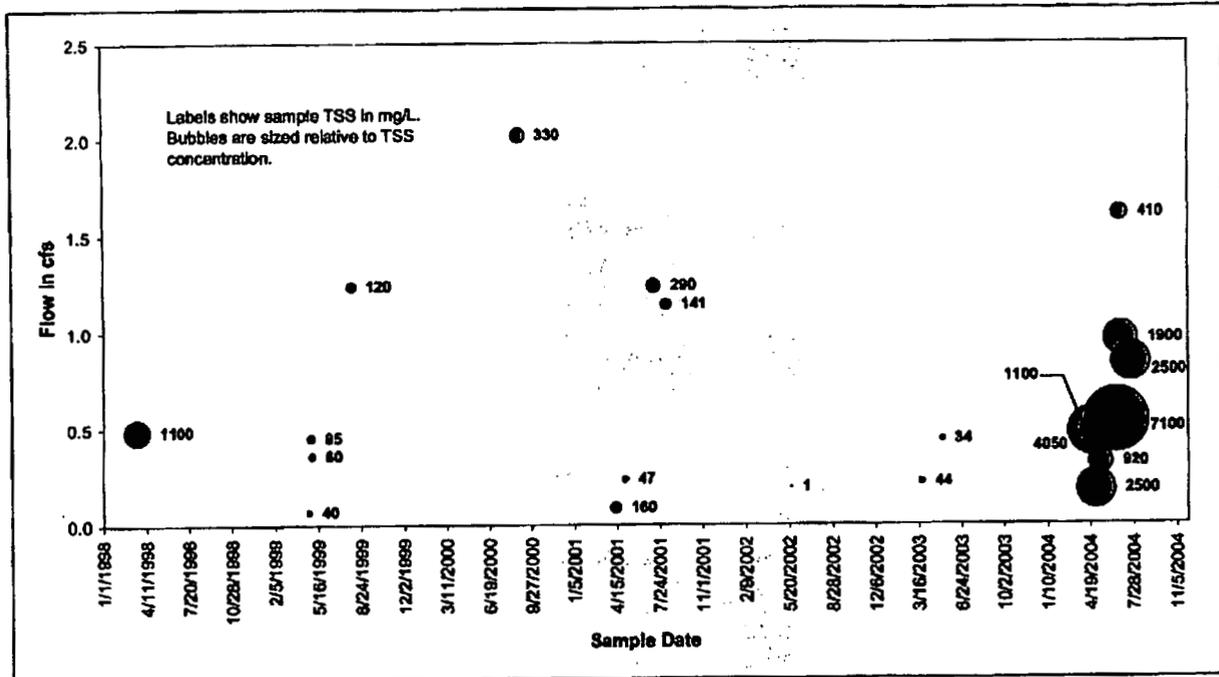
2.7.1 903 Pad/Lip Remediation

Remediation activities at the 903 Pad/Lip area began in mid-November 2002. The IMIRA for IHSS Group 900-11 (Kaiser-Hill, 2004b) provides background for this project. The 903 Pad/Lip area flows to both the SID (POE SW027) and South Walnut Creek (POE GS10). The portion of the 903 Pad tributary to GS10 is upstream of GS39 (Figure 2-43), and all runoff from the area shown on the map is sampled at GS39. The 903 Pad/Lip project also included remediation activities in the dirt area north of the East Access Road directly tributary to SW022. During WY04, disturbed soils associated with the remediation effort were available for transport in runoff. The loading analysis above showed that the loads from both GS39 and SW022 increased significantly in WY04. Figure 2-30 and Figure 2-31 both show that activities at GS39 and SW022 increased after the start of the 903 Pad/Lip project began, coinciding with the normal spring and summer increase in runoff.¹⁴ Based on field observations, runoff from the area contained unusually high levels of suspended solids. Figure 2-45 and Figure 2-46 show that TSS concentrations relative to flow rate increased significantly during the same period.

The existence of significant actinide soil contamination in association with the 903 Pad is well documented. The fact that the activity of the suspended solids did not increase at GS39 during WY04 (Figure 2-37) indicates that the 903 remediation was successful in preventing migration of the most contaminated soils subject to remediation. However, erosion controls appear to have been less effective in preventing increased transport of suspended solids with lower levels of contamination (average Pu 1.5 pCi/g, Am 0.3 pCi/g).

¹⁴ During WY04, 91% of the flow at GS39 and 87% of the flow at SW022 occurred during the April through August period.

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Note: Only continuous flow-paced samples shown

Figure 2-45. Bubble Chart Showing Temporal Variation of Sample TSS with Flow Rate and Date: GS39.

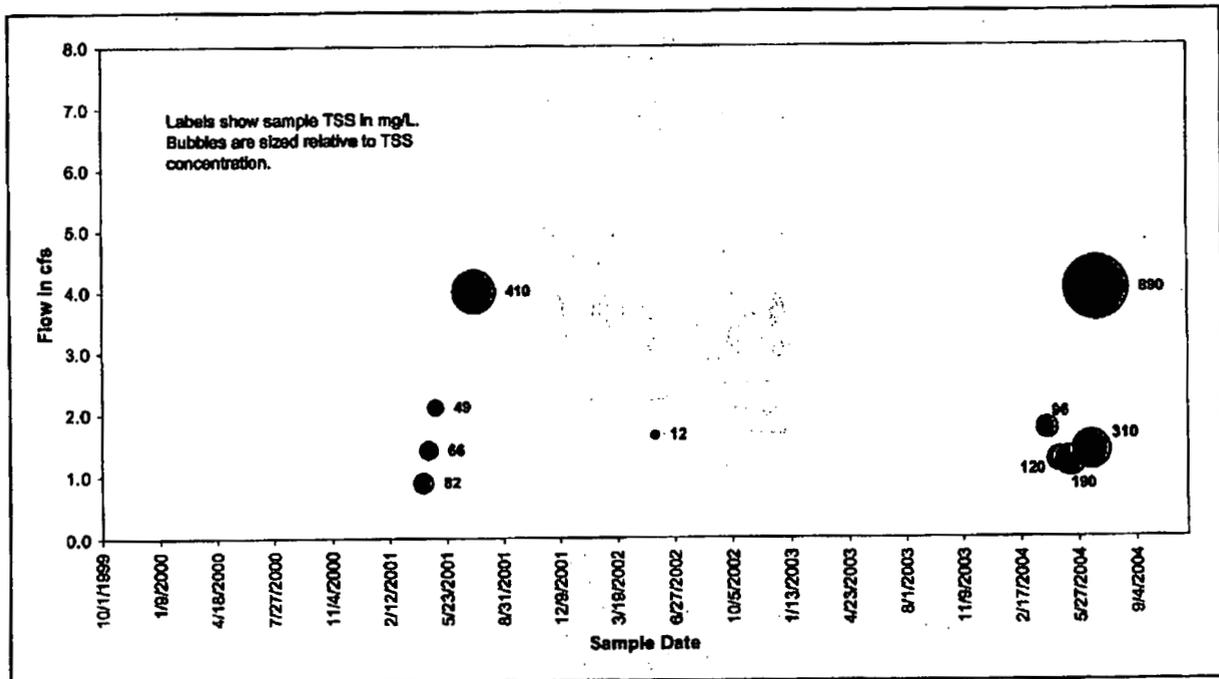


Figure 2-46. Bubble Chart Showing Temporal Variation of Sample TSS with Flow Rate and Date: SW022.

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2.8 SUMMARY AND CONCLUSIONS

The Site has completed the WY04 phase of the ongoing source evaluation for the potential cause(s) of reportable 30-day moving average values for Pu and Am at the POE monitoring location GS10. As for previous reports, the Site concludes that the likely source of the reportable 30-day moving average values at GS10 is diffuse actinide contamination associated with soils and sediments from past Site operations released to the environment through events and conditions over past years. This actinide contamination is transported with suspended solids in surface-water runoff during precipitation events.

Based on the above evaluation, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions and closure activities for the Site. The removal of source areas, the implementation of enhanced erosion controls, and the reduction of runoff as the Site moves toward closure all serve to improve water quality in the long-term. The surface-water monitoring conducted at the Site has provided valuable information regarding the near-term impacts to water quality to aid the Closure Projects in developing targeted methods for reducing the transport of low-level contamination. This source investigation has identified no previously unknown localized source(s) of contamination that warrant targeted remediation based on the available information. The current conclusions are summarized below:

- The Site retention ponds continue to effectively remove suspended solids and any associated contamination from the water column. Pu and Am activities at the terminal pond and fence-line POCs remain well below reporting thresholds.
- Based on the details regarding recent Site activities outlined above, it is concluded that various D&D, construction, ER, and excavation operations caused increased transport of low-level contamination associated with suspended solids in surface water that are likely to have resulted in the recent reportable values measured at GS10.
- A shift in Pu/Am ratios toward a higher relative abundance of Pu at GS10 in WY04 suggest increased actinide contribution from an area with higher Pu/Am ratios, such as the 903 Pad area.
- The loading analysis indicates that the GS39 subdrainage, the GS40 subdrainage, and the area directly tributary to SW022 are contributing the majority of the actinide load at GS10. Additionally, analysis shows that the Pu and Am loads from GS39 and SW022 have increased significantly in WY04. This suggests that recent projects impacting the GS39 and SW022 drainages, especially the 903 Pad remediation, have impacted water quality.
- Pu and Am suspended solids activities at GS10 show no change in WY04 (Figure 2-36). In conjunction with the increased activities at GS10, this suggests increased transport of suspended solids with contamination similar to past years, and not a significant new source term.
- Figure 2-39 shows that WY04 turbidities (as an indication of TSS) at GS10 relative to flow rate are generally higher than for WY03 and prior data. This suggests that soils in the GS10 drainage are more susceptible to transport for a given flow rate than for previous years. Similarly, WY04 TSS data at GS10 show higher values relative to flow rate than for previous years (Figure 2-40). A similar relationship is noted for samples collected at GS39 (Figure 2-41), and to a lesser extent at SW022 (Figure 2-42), prior to the implementation of enhanced erosion controls. These patterns suggest that the recent higher activities at GS10 may be the result, at least in part, of the increased transport of legacy contamination associated with soil and sediment, and not any new source contribution.
- Targeted erosion controls have proven to be effective in reducing sediment transport and associated

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contamination at selected locations. This is especially true for locations upstream of GS10 (nearer to the source terms) such as GS39 and SW022. No improvement is noted for GS10, most likely due to the continued transport of residual solids along the flow pathways downstream of the erosion controls. In the long-term, water quality is expected to improve at GS10 as these solids stabilize within the system, additional erosion controls are installed, source areas are removed, disturbed soils are stabilized, and runoff is reduced due to the removal of impervious areas.

The Site's proposed course of action includes: (1) continuing observation (routine monitoring), and (2) installation and maintenance of enhanced erosion controls in the drainage areas upstream of GS10 as part of the overall Closure process. Effective BMPs, such as the use of the existing terminal ponds to clarify stormwater of potentially-contaminated sediment and particulate matter, will also be continued. Specifically, DOE and the K-H Team propose the following actions as the path forward:

- Continued observation and ongoing data interpretation to provide better understanding of actinide transport directly related to the operation of the Site automated surface-water monitoring network and the effectiveness of erosion controls
- Implementation and maintenance of enhanced erosion controls as an integral part of Site Closure
- Continued use of the existing retention ponds as an effective BMP to clarify stormwater containing potentially contaminated sediment and particulate matter, and
- Continued reporting as appropriate

3. SOURCE EVALUATION FOR POE SW093

The following source evaluation is provided in accordance with the *Final Rocky Flats Cleanup Agreement* (RFCA) (CDPHE et al., 1996) (Attachment 5, §2.4(B)) under "Action Determinations". The RFCA requires reporting "when contaminant concentrations in Segment 5 exceed the Table 1 action levels" and that "source evaluation will be required". Further, RFCA states "if mitigating action is appropriate, the specific actions will be determined on a case-by-case basis, but must be designed such that surface water will meet applicable standards at the POCs.

Specifically, this source evaluation addresses the Site notification(s) of reportable 30-day moving average values for Pu and Am water-quality results at the POE monitoring location SW093, located 1300' above Pond A-1 in North Walnut Creek. Reportable values for Pu were measured for the period 4/11 through 7/23/04 inclusive, using validated data. Additional data recently received but not validated may extend the Pu event through 8/29/04. Reportable values for Am were also measured for the periods 4/23 through 5/22, 5/29 through 7/8, 7/13 through 7/20, and 7/22 through 7/23/04 inclusive, using validated data. Additional data recently received but not validated may extend the Am event through 8/29/04. The end of the reportable period(s) will be determined when the Site receives subsequent analytical results.

This evaluation for Walnut Creek monitoring station SW093 covers data received through 10/6/04. The following are included in this section:

- Evaluation of ongoing automated surface-water monitoring within the SW093 drainage
- Estimation of actinide loads within the SW093 drainage area
- Evaluation of water-quality trends and correlations within the SW093 drainage area
- A brief discussion of implemented erosion controls, and
- A brief assessment of D&D, ER, and Site Closure projects

3.1 HYDROLOGY

North Walnut Creek Flow Controls

All IA surface-water runoff that flows into North Walnut Creek, South Walnut Creek, or the SID is collected by a system of stormwater retention ponds. The ponds serve three main purposes for surface-water management: (1) storm water retention and settling of sediments, (2) water storage for sampling prior to release, and (3) emergency spill control in those instances where a spill cannot be adequately managed without use of the ponds.

SW093 is the POE for IA surface-water flows to North Walnut Creek. Surface water in North Walnut Creek is routed through the A-Series Ponds (Figure 3-1). Steps in the water collection and transfer process are briefly outlined as follows:

1. Runoff from the northern and western IA flows through various ditches and channels to a large cmp and directly to SW093 (Figure 3-1).
2. Runoff from SW093 then flows downstream through conveyance structures, to Pond A-3, and subsequently is batch discharged to Pond A-4 for detainment, and
3. Water detained in Pond A-4 is discharged periodically in batches to Walnut Creek.

As indicated above, all of the IA runoff that flows into North Walnut Creek is ultimately routed to Pond A-4, detained, and sampled prior to being released to lower Walnut Creek. There is no source of IA runoff to South

Walnut Creek that can enter lower Walnut Creek without first passing through the pond system for subsequent batch discharge from Pond B-5.¹⁵

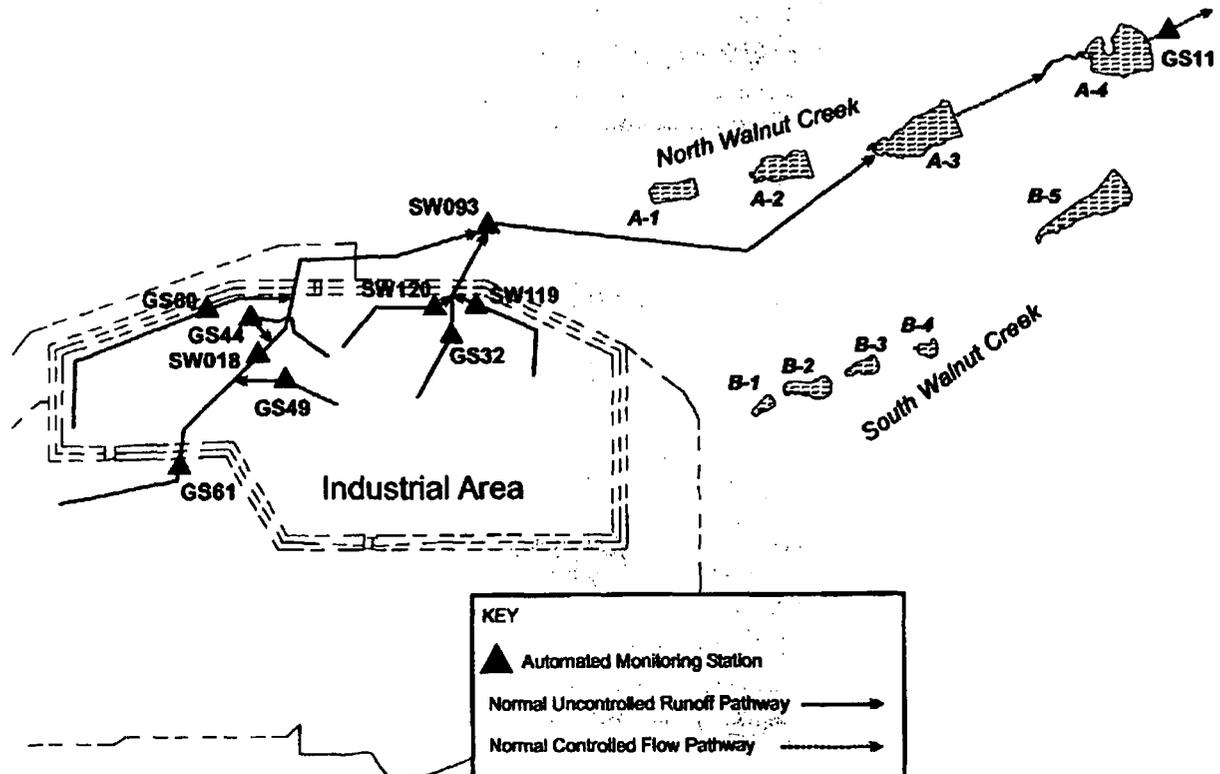


Figure 3-1. Hydrologic Routing Diagram for POE SW093 (WY2003-2004).

3.2 SW093 MONITORING RESULTS

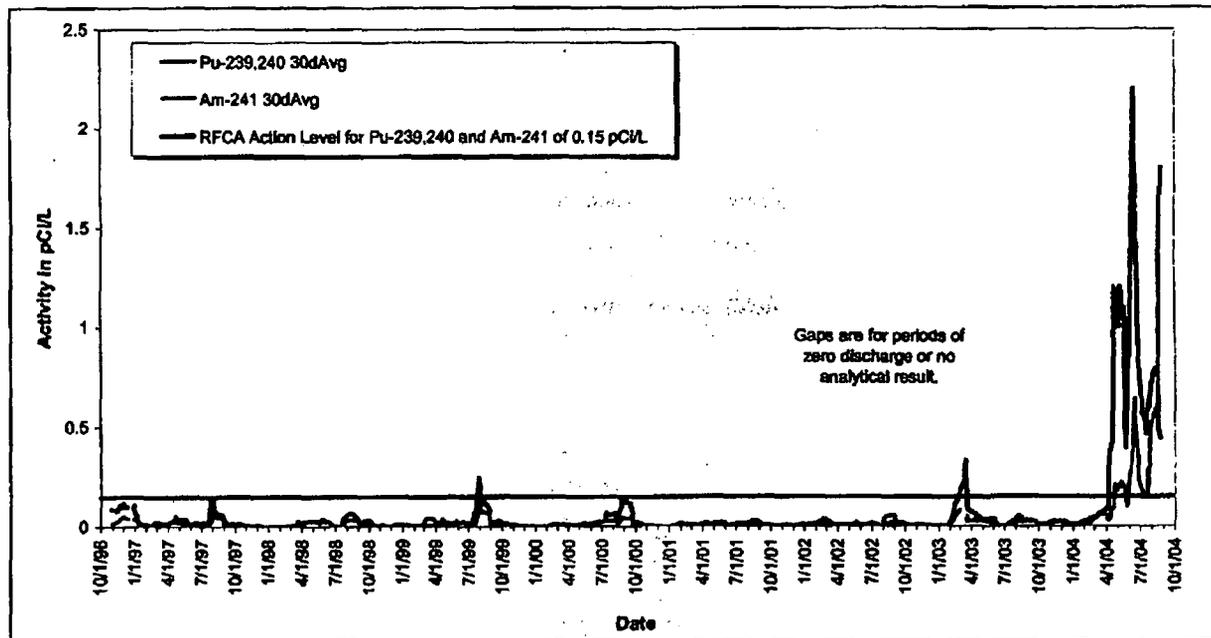
As specified in the IMP, Site personnel evaluate 30-day moving average values¹⁶ for selected radionuclides at POE surface-water monitoring location SW093. Recent evaluations of water-quality measurements at POE SW093 showed reportable values for Pu requiring notification and source evaluation under the RFCA ALF. Results for recent 30-day moving average values using available data at SW093 are summarized below in Table 3-1 and are shown on Figure 3-2.

¹⁵ A small area NE of the Solar Ponds flows directly to the A-Series Ponds and is not monitored at SW093. This water is monitored at SW091.

¹⁶ The method for calculating 30-day averages is given in Appendix B.1 - Analytical Data Evaluation Methods in the RFETS Automated Surface-Water Monitoring: WY03 Annual Report (URS, 2004).

Table 3-1. Recent Water-Quality Information from SW093 (Validated and Unvalidated Data).

| Location | Parameter | Date(s) of 30-Day Average Requiring Reporting | Date(s) of Maximum 30-Day Average | Maximum 30-Day Average (pCi/l) | Volume-Weighted Average for Water Year ¹⁷ (pCi/l) |
|----------|------------|---|-----------------------------------|--------------------------------|--|
| SW093 | Pu-239,240 | 4/11 – 8/29/04 | 6/16/04 | 2.2 | WY04 ¹⁸ : 0.715 |
| SW093 | Am-241 | 4/23 – 5/22/04; 5/29 – 7/8/04; 7/13 – 7/20/04; 7/22 – 8/29/04 | 8/29/04 | 1.8 | WY04 ¹⁸ : 0.287 |

**Figure 3-2. POE Monitoring Station SW093: 30-Day Volume-Weighted Average Values for Pu and Am Activities (10/1/96 – 8/29/04).**

The analytical results for the composite samples collected around the period of reportable values have been validated through 7/23/04. A review of historical SW093 monitoring data shows that these results are significantly higher than usual, and higher than results associated with previous reportable periods. During the period of continuous flow-paced monitoring under RFCA, there have been two other occurrences of reportable 30-day average values for Pu (Figure 3-2; no previous reportable Am periods). The reportable measurements generally occur during periods of increased stormwater runoff in the spring and summer months. Individual composite-sample results for SW093 are listed in Table 3-2 and plotted in Figure 3-3 for the recent period of interest.

¹⁷ A Water Year is defined as the period from October 1 through September 30. The term water year is abbreviated as WY; e.g. Water Year 2004 is WY04.

¹⁸ Through 8/29/04

Table 3-2. WY04 Composite Sample Analytical Results for SW093 Reportable Periods.

| Composite Sample Period | Pu-239,240 (pCi/l) | | Am-241 (pCi/l) | | Composite Sample Volume (Liters) | N. Walnut Cr. Discharge Volume During Sample Period (MG) |
|-------------------------|--------------------|-----------|----------------|-----------|----------------------------------|--|
| | Result | Error (±) | Result | Error (±) | | |
| 4/3 - 4/11/04 | 0.086 | 0.034 | 0.032 | 0.021 | 12.8 | 2.80 |
| 4/11 - 4/14/04 | 1.020 | 0.237 | 0.182 | 0.056 | 7.2 | 1.52 |
| 4/14 - 4/23/04 | 0.862 | 0.205 | 0.221 | 0.066 | 9.2 | 1.93 |
| 4/23 - 4/26/04 | 2.750 | 0.613 | 0.444 | 0.118 | 12.2 | 2.71 |
| 4/26 - 5/3/04 | 0.172 | 0.055 | 0.035 | 0.022 | 9.2 | 1.99 |
| 5/3 - 5/12/04 | 0.123 | 0.045 | 0.025 | 0.021 | 7.6 | 1.31 |
| 5/12 - 5/14/04 | 0.705 | 0.172 | 0.147 | 0.057 | 7.8 | 1.38 |
| 5/14 - 5/24/04 | 0.050 | 0.024 | 0.021 | 0.018 | 7.4 | 1.31 |
| 5/24 - 6/10/04 | 4.180 | 0.911 | 1.230 | 0.283 | 7 | 0.94 |
| 6/10 - 6/18/04 | 0.607 | 0.152 | 0.135 | 0.063 | 16.6 | 1.24 |
| 6/18 - 6/22/04 | 0.712 | 0.174 | 0.185 | 0.059 | 19.8 | 1.68 |
| 6/22 - 6/28/04 | 0.517 | 0.132 | 0.146 | 0.050 | 22 | 2.44 |
| 6/28 - 6/30/04 | 0.717 | 0.176 | 0.166 | 0.057 | 12 | 0.93 |
| 6/30 - 7/12/04 | 0.049 | 0.024 | 0.079 | 0.034 | 11 | 0.69 |
| 7/12 - 7/23/04 | 0.349 | 0.094 | 0.727 | 0.173 | 11 | 0.61 |
| 7/23 - 7/24/04 | 0.891 | 0.217 | 0.296 | 0.084 | 21.2 | 1.66 |
| 7/24 - 8/19/04 | 0.636 | 0.158 | 1.130 | 0.266 | 22 | 2.30 |
| 8/19 - 8/30/04 | 0.326 | 0.095 | 2.160 | 0.484 | 8.6 | 0.65 |

Notes: Activities greater than the Action Level are indicated in red. Action Levels apply only to 30-day averages and the selective formatting in this table is provided for reference only. Unvalidated data are *italicized*.

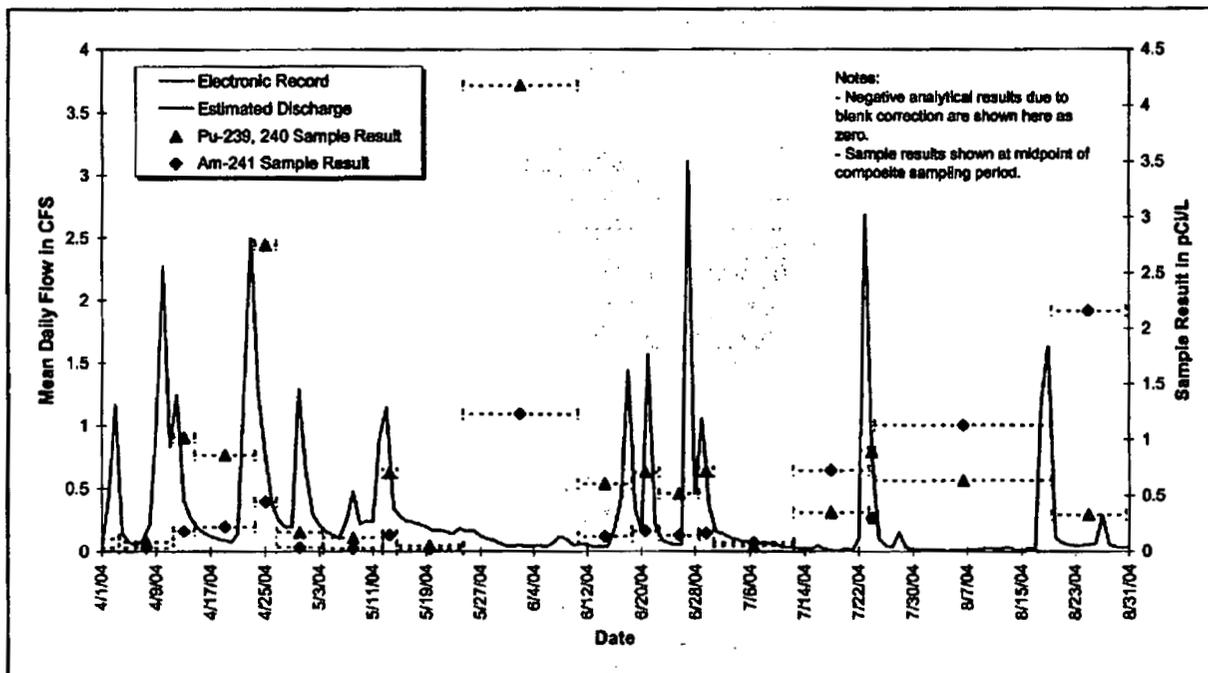


Figure 3-3. Monitoring Station SW093 Hydrograph with Individual Sample Results and Sample Period Bars: 4/3/04 – 8/30/04.

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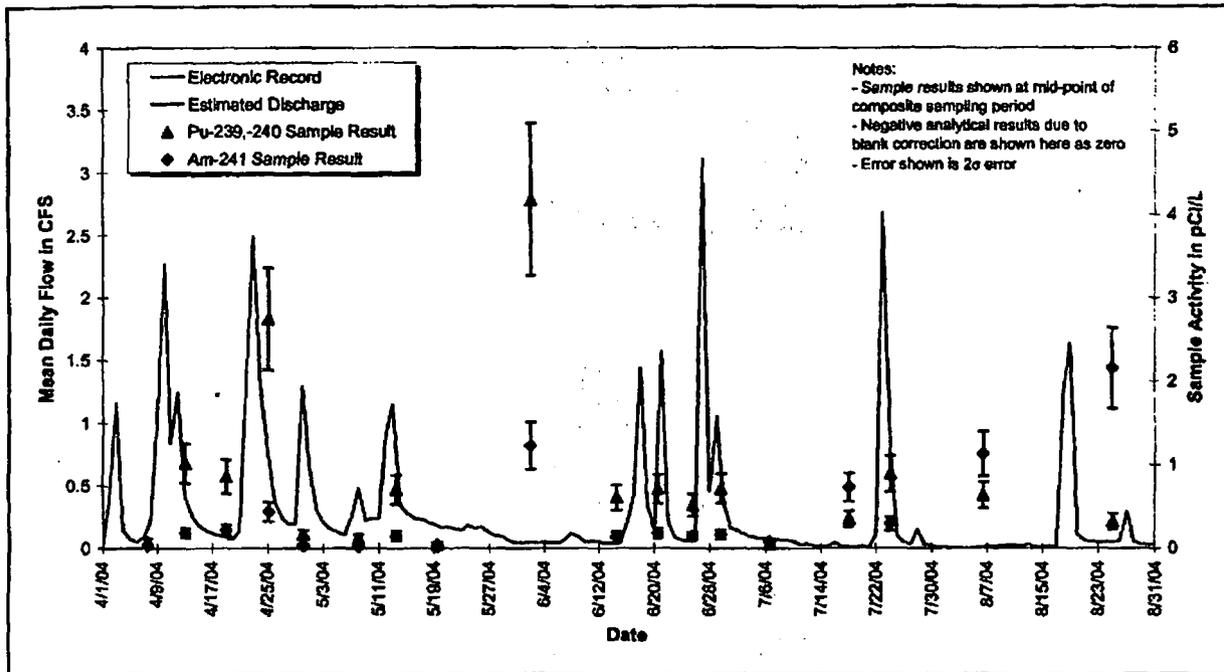


Figure 3-4. Monitoring Station SW093 Hydrograph with Individual Sample Results and Error Bars: 4/1/04 – 8/31/04.

All water monitored at SW093 flows to Pond A-3, is batch discharged Pond A-4, and eventually batch discharged to lower Walnut Creek. Pre-discharge samples of the water in Pond A-4 indicated acceptable water quality prior to all planned discharges during the reportable periods. Water monitored at SW093 after 8/14/04 is currently being detained in Pond A-4 awaiting discharge. All Pu and Am analytical results from composite samples collected at POC monitoring station GS11 (Pond A-4 outfall; Figure 3-1) during this period were well below 0.15 pCi/L (Figure 3-5), and there were no reportable 30-day average values.

All water discharged from Pond A-4 to Walnut Creek subsequently flows through RFCA POC GS03 at the eastern Site boundary. Pu and Am analytical results from composite samples collected at GS03 during the period of interest were all well below 0.15 pCi/L (Figure 3-6), and there were no reportable 30-day average values.

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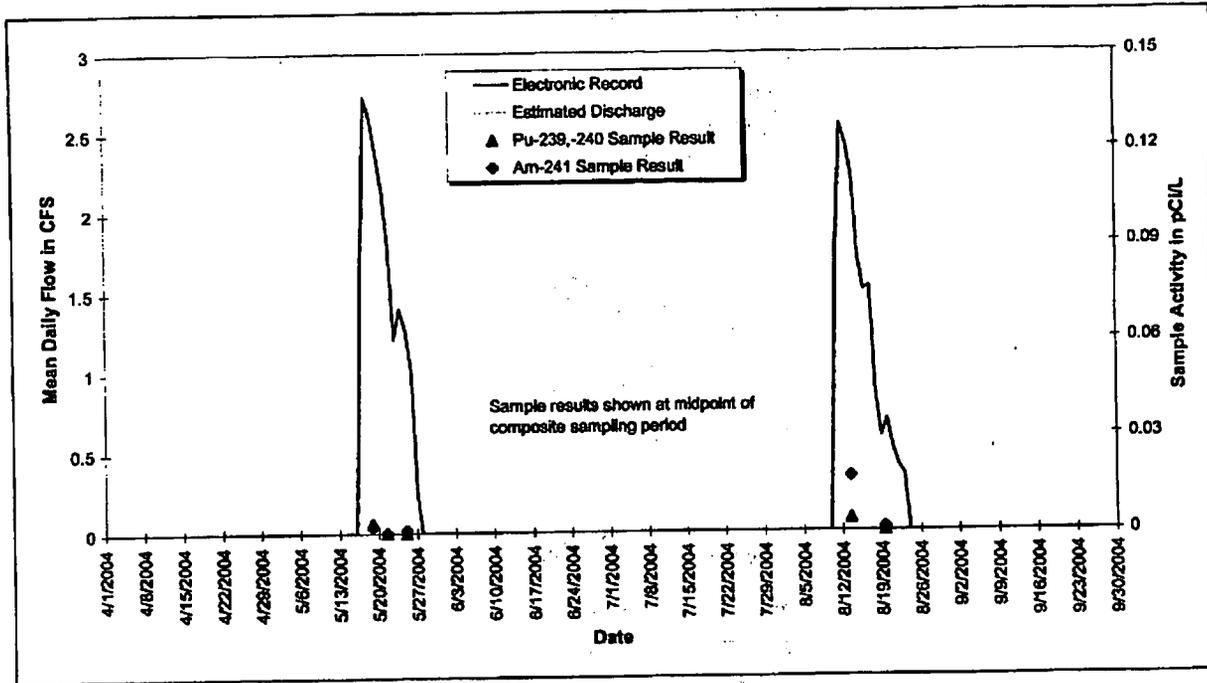


Figure 3-5. Monitoring Station GS11 Hydrograph with Individual Sample Results: 4/1/04 - 9/30/04.

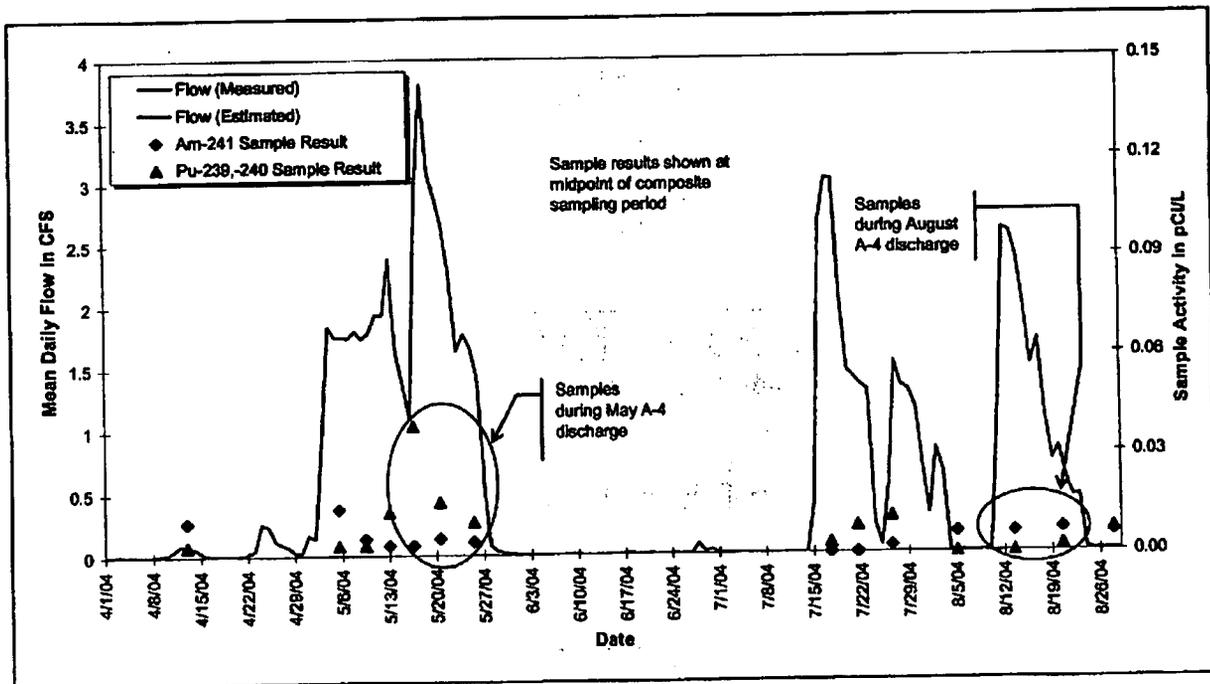


Figure 3-6. Monitoring Station GS03 Hydrograph with Individual Sample Results: 4/1/04 - 8/29/04.

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3.3 DATA SUMMARY AND ANALYSIS

The following data evaluation for SW093 includes all surface-water data available as of 10/6/04. Monitoring data were extracted from the SWD or taken from hardcopy analysis reports for the locations of interest and subsequently reconciled against SWD. The following list describes the environmental data compilation process:

- Individual sample result values are calculated as arithmetic averages of real and field duplicate results when both results are from the same sampling event.¹⁹
- When available, Site-requested laboratory reruns are averaged with initial runs for the same sampling event.¹⁹
- Laboratory duplicate and replicate QC results are not used.
- When negative values for actinide measurement are returned from the laboratories due to blank correction, 0.0 pCi/l is used in the calculations.
- Only total radionuclide measurements are used, and
- Data that did not pass validation (rejected data) are not used.

3.3.1 Verification and Validation of Surface-Water Analytical Results

All surface-water isotopic data are either verified or validated, based on criteria determined by ASD, or at the special request of the customer. Approximately 75% of all isotopic data are verified and the remaining 25% are validated. Validation is typically determined randomly for each subcontracted laboratory, based on the specific analytical suites. This random validation selection may or may not routinely include POE or POC locations. However, when reportable values are observed, all analytical results used in the calculations receive formal validation.

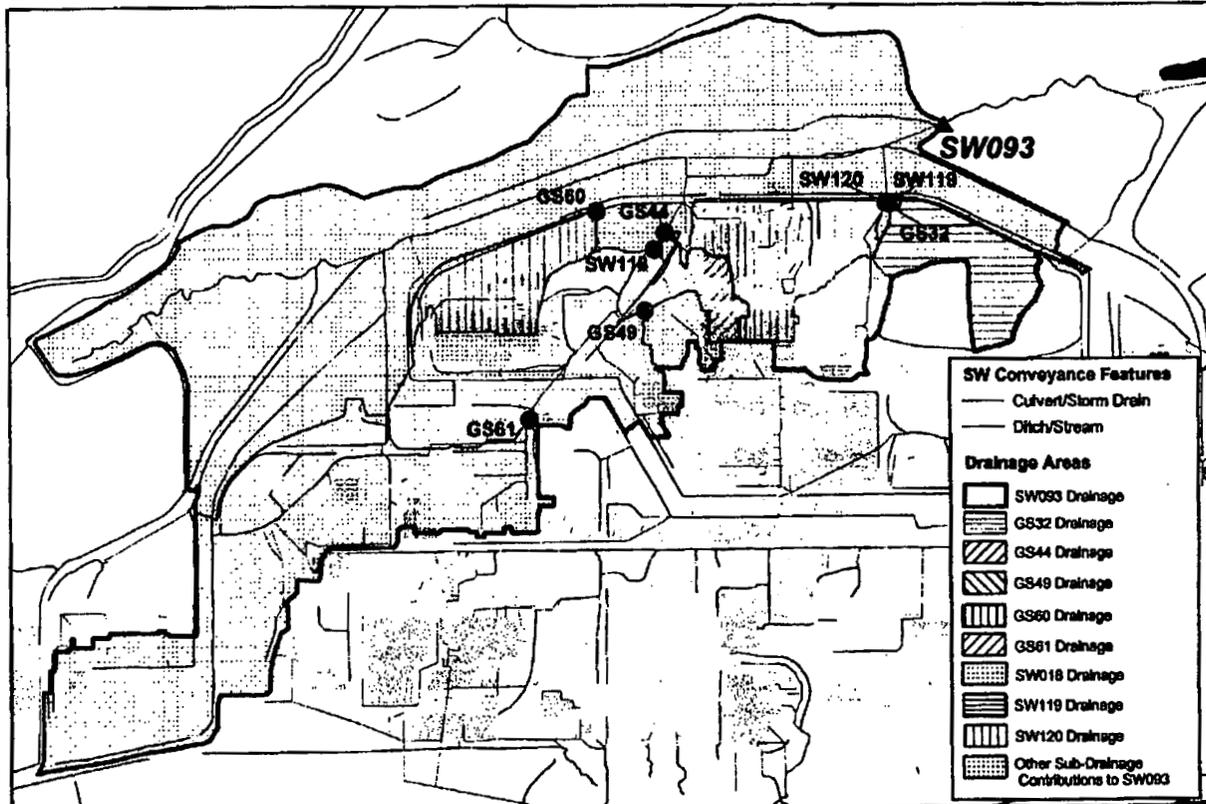
For samples collected at SW093 during the reportable periods, all isotopic data not randomly selected for validation were specifically submitted for validation at the request of Site personnel. All isotopic data package validation was performed by a subcontractor to ASD, and all packages during the reportable period through 7/23/04 were considered valid. Validation for subsequent data is pending.

3.3.2 Actinide Data Summary

Since 4/6/01, five upstream automated monitoring locations have been operating as Performance monitoring locations upstream of SW093. These locations are GS32, GS44²⁰, GS49, SW119, and SW120 (Figure 3-1). Additionally, GS60 was installed on 8/13/03, GS61 was installed on 10/29/03, and SW018 was installed on 10/9/03. These stations were installed or upgraded to monitor subdrainages that are tributary to SW093. These locations are operated as Source Location monitoring stations to characterize water quality and specifically measure Pu and Am loads from the respective subdrainages in an attempt to identify any discrete source areas. Summary statistics for sample results from these locations are shown in Table 3-3. The activities for GS32 are arithmetic averages since this location has historically sampled only selected storm events. Continuous flow-paced sampling is used for SW093, GS44, GS49, SW018, SW119, and SW120, and volume-weighted average activities are given in Table 3-3.

¹⁹ Radionuclide data pairs are averaged when the DER is less than 1.5 (see Appendix Section B.1 - Analytical Data Evaluation Methods in the RFETS Automated Surface-Water Monitoring: WY03 Annual Report).

²⁰ GS44 was removed on 8/25/04 to make way for D&D activities.



Note: Drainage areas have changed as the site moves toward closure and the land and drainage features are reconfigured. The drainage areas shown are current as of 10/6/04. The locations shown were all installed as of 10/29/03.

Figure 3-7. Automated Surface-Water Monitoring Locations and Corresponding Subdrainage Areas Tributary to SW093.

Table 3-3. Summary Statistics for Samples from SW093 and Monitoring Locations Tributary to SW093: 10/1/03 to Present.

| Sampling Location | Number of Samples | Pu-239,240 | | Am-241 | |
|-------------------|-------------------|--------------------------|-------------------------------|--------------------------|-------------------------------|
| | | Average Activity (pCi/l) | Maximum Sample Result (pCi/l) | Average Activity (pCi/l) | Maximum Sample Result (pCi/l) |
| SW093 | 25 | 0.715 | 4.18 | 0.287 | 2.16 |
| GS32 | 17 | 30.6 | 256 | 2.34 ^a | 13.1 |
| GS44 | 14 | 0.108 | 0.426 | 0.066 ^a | 0.201 |
| GS49 | 12 | 0.152 | 0.263 | 0.080 ^a | 0.454 |
| GS60 | 13 | 0.012 | 0.058 | 0.007 ^a | 0.014 |
| GS61 | 14 | 0.022 | 0.056 | 0.008 | 0.021 |
| SW018 | 12 | 0.025 | 0.067 | 0.012 | 0.032 |
| SW119 | 8 | 0.156 | 0.400 | 0.115 | 0.294 |
| SW120 | 13 | 0.896 | 3.63 | 0.921 | 4.49 |

Notes: ^aSome results rejected through validation.

GS44 was removed on 8/25/04 to make way for D&D activities.

Averages for GS61 and SW018 contain estimated data for the period from 10/1/03 to their respective installation dates.

Figure 3-8 shows the average annual activities at SW093 for WY97 – WY04²¹. Due to the continuous flow-paced sampling protocols currently in place under RFCA, volume-weighted average activities are shown. Although reportable 30-day average values occurred in recent years, the volume-weighted average for WY04 is significantly greater than the activities for previous years. This suggests the possibility of a new source term, a new source area not previously contributing contamination, and/or increased transport of previously contributing source terms.

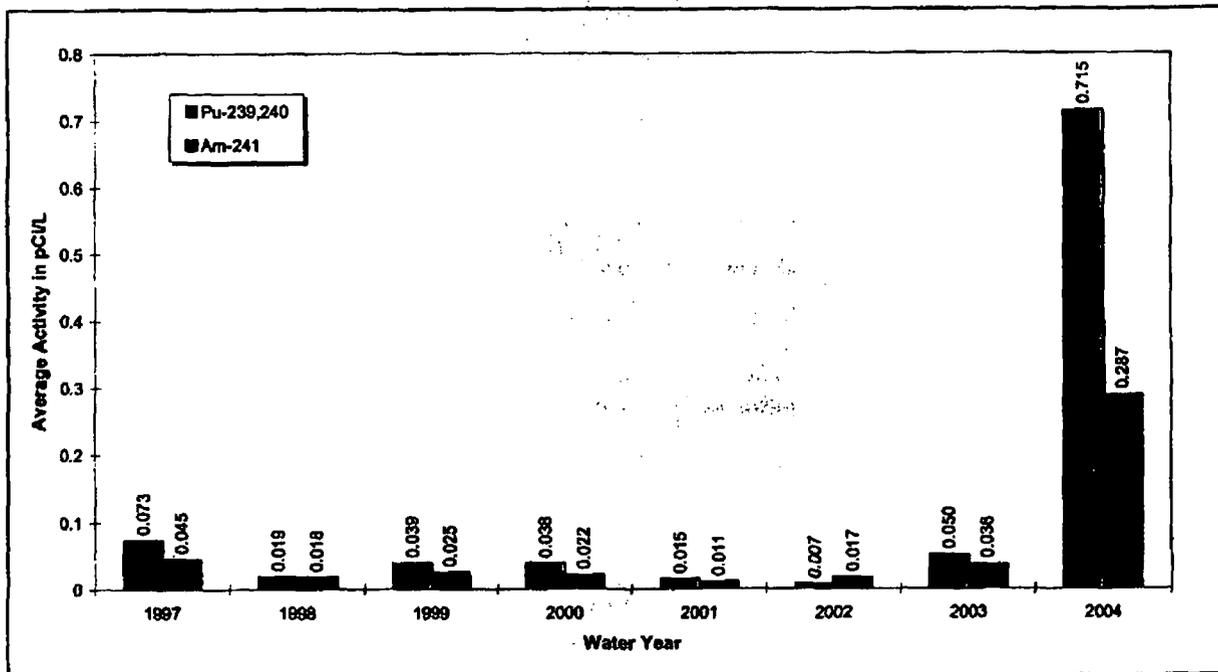
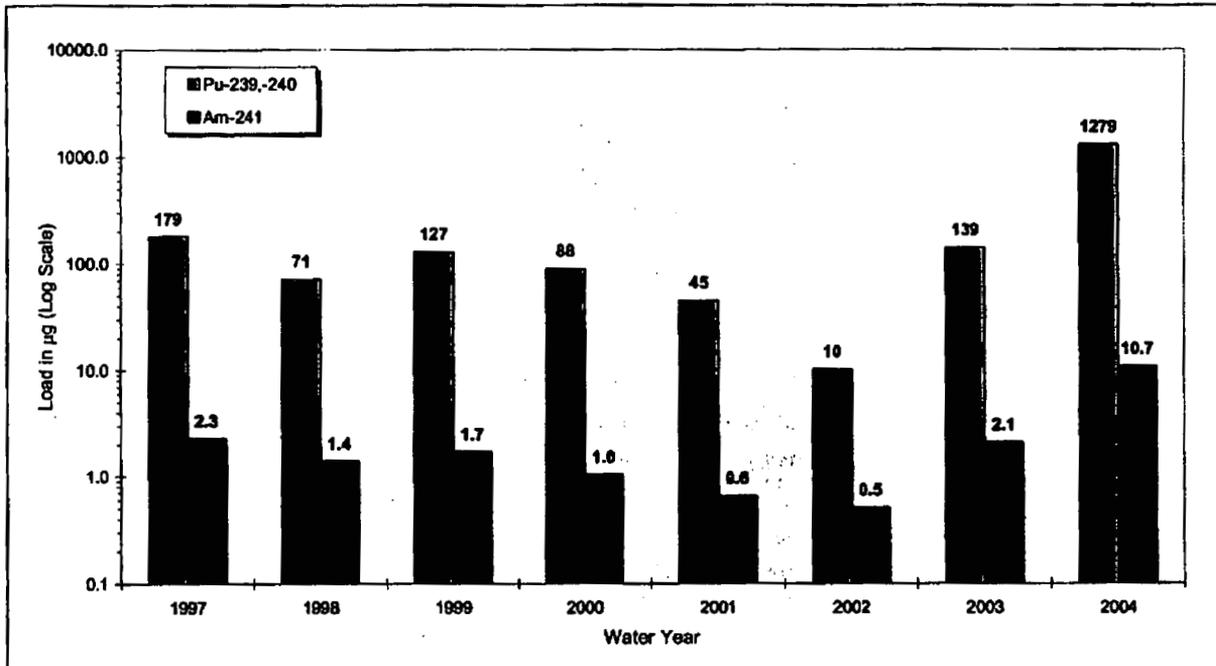


Figure 3-8. Average Annual Pu and Am Activities at SW093: WY97-04.

3.3.3 Annual SW093 Loads

Annual actinide loads for SW093 in micrograms (log-scale) are plotted in Figure 3-9 to show long term loading to SW093. For WY97-WY04, the activity for each flow-paced composite sample is multiplied by the associated discharge volume to get pCi, then converted to micrograms and totaled annually. Although reportable 30-day average values occurred in recent years, the loads for WY04 are significantly greater than the loads for previous years. As stated previously, this suggests the possibility of a new source term, a new source area not previously contributing contamination, and/or increased transport of previously contributing source terms.

²¹ For WY04 the average shown is through 8/29/04.



Load through 8/29/04 for WY04 is plotted.

Figure 3-9. Annual Pu and Am Loads at SW093: WY97-04.

3.4 RELATIVE LOADING ANALYSIS

This loading analysis uses data from all automated monitoring locations that are tributary to SW093 (Figure 3-10). These locations are GS32, GS44, GS49, GS60, GS61, SW018, SW119, and SW120. The analysis is performed for two overlapping time periods based on the operational periods for two groups of locations. For the first period, 4/6/01 through 8/19/04, monitoring locations GS32, GS44, GS49, SW119, and SW120 were all operational. For the second period, 10/1/03 through 8/19/04, monitoring locations GS32, GS44, GS49, GS60, GS61, SW018, SW119, and SW120 were all operational.²²

Table 3-4 gives location and drainage basin detail for the monitoring locations used in this loading analysis. The hydrologic connectivity of these locations is shown in Figure 3-1.

²² Locations GS61 and SW018 were installed on 10/29/03 and 10/9/03, respectively. As such, loads for 10/1/03 to the install date were estimated.

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Table 3-4. Location and Drainage Basin Detail.

| Location Code | Location Detail | Contributing Areas |
|---------------|--|--|
| SW093 | N. Walnut Creek 1300' upstream from the A-1 Bypass | 100, 300, 500, 700, 900; 233.6 acres |
| GS32 | Corrugated metal pipe (1.5') north of Solar Ponds in PA draining B779 area | Former B779 area; 6.9 acres |
| GS44 | Culvert between T771F and T771L | B771 area; 4.1 acres |
| GS49 | Ditch NW of B566 | B566 and west side of B776; 3.3 acres |
| GS60 | Ditch NE of B371 along former PA perimeter road | B371/374 area; 9.7 acres |
| GS61 | Confluence of ditches west of 231 tanks | 100, 300; 50.5 acres |
| SW018 | N. Walnut Creek tributary south of 771 trailers | 100, 300, B371/374 area; 80.2 acres |
| SW119 | Drainage ditch north of Solar Ponds along PA perimeter road | NE portion of Solar Ponds area; 9.5 acres |
| SW120 | Drainage ditch north of Solar Ponds along PA perimeter road | B771/774 area; 12.9 acres |

Loads for continuous flow-paced samples from the locations SW093, GS44, GS49, GS60, GS61, SW018, SW119, and SW120 were calculated as detailed in Appendix B.1 Analytical Data Evaluation Methods in the RFETS Automated Surface-Water Monitoring: WY03 Annual Report. The load for any period is then the sum of the individual sample loads during that period. In the following section, total loads and percentages do not necessarily balance due to rounding.

For GS32, loads for any period are calculated by multiplying an estimated overall activity²³ by the corresponding estimated discharge, and then converting to micrograms.²⁴ Since there is no direct flow measurement at GS32, the discharge for the loading period was estimated using seasonal runoff coefficients and measured Site precipitation. Seasonal and monthly runoff coefficients (total runoff depth divided by total depth of precipitation) were calculated using flow data from GS39 (the GS39 subdrainage has similar characteristics to the GS32 subdrainage²⁵) and arithmetic average precipitation from all Site precipitation gages. These seasonal and monthly runoff coefficients were then used to estimate the GS32 discharge volumes for the loading period based on measured precipitation and the GS32 drainage area size. The following methods were selected to estimate a range of loads for GS32:

- The seasonal arithmetic average activity is multiplied by the corresponding estimated seasonal discharge volume to estimate seasonal loads. The seasonal loads are then totaled for the analysis period.
- The monthly arithmetic average activity is multiplied by the corresponding estimated monthly discharge volume to estimate monthly loads. The monthly loads are then totaled for the analysis period.

²³ Various methods were evaluated to estimate an overall activity at GS27. These included averages (annual, seasonal, monthly), medians (annual, seasonal, monthly), geometric means, the minimum variance unbiased estimator (MVU), and the simple estimator (Gilbert, 1987).

²⁴ Storm-event sampling collects samples during the rising limb of a direct runoff hydrograph following a precipitation event. The highest TSS measurements, and corresponding Pu and Am activities, are typically measured during these hydrologic conditions. Therefore, simple arithmetic average activities using these sample results would be expected to be biased high relative to the 'true' mean activity for a given location. Additionally, actinide water-quality variation tends to be lognormal, and also varies with flow rate, season, storm size, and time. Therefore, various activity estimation techniques and periods are used to calculate a range of estimated loads.

²⁵ GS39 is located on near the 903 and 904 Pads. The subdrainage is of a similar grade and percent impervious area. The GS39 subdrainage includes portions of the 900 Area.

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- The annual arithmetic average activity is multiplied by the corresponding estimated annual discharge volume to estimate annual loads. The annual loads are then totaled for the analysis period.
- The seasonal median activity is multiplied by the corresponding estimated seasonal discharge volume to estimate seasonal loads. The seasonal loads are then totaled for the analysis period.

The loads estimated for GS32 are summarized in the following analysis by using the average of the estimated loads from the various methods.

3.4.1 Relative Subdrainage Loads: April 6, 2001 through August 19, 2004

The loading analysis in this section uses all available data for the period 4/6/01 through 8/19/04 from SW093 and the five upstream monitoring stations (GS32, GS44, GS49, SW119, and SW120). This loading analysis does not address the attenuation of actinides as they are transported from one monitoring location to the next. The analysis assumes that as the period of sampling is increased, the temporal effects of actinide transport will not significantly affect the relative loads from the various subdrainages. The hydrologic connectivity of these locations is shown in Figure 3-10.

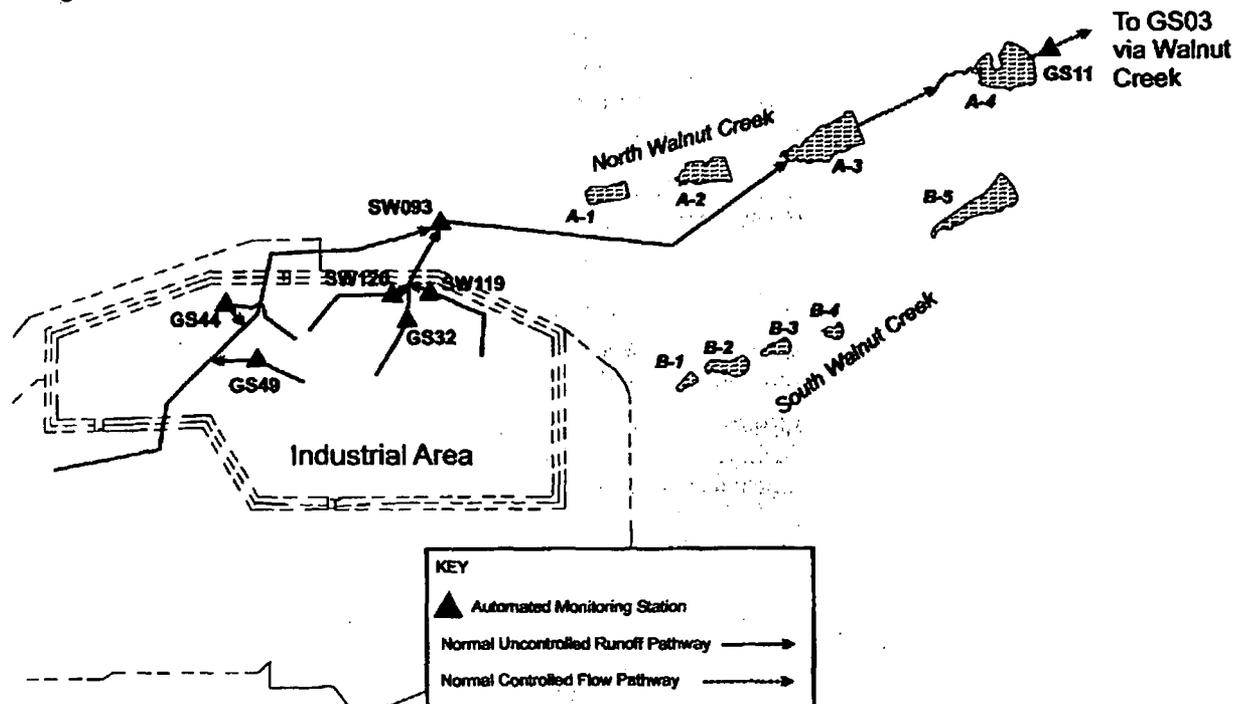


Figure 3-10. Hydrologic Connectivity of Monitoring Locations Tributary to SW093 (as of 4/6/01).

Table 3-5, Figure 3-12, and Figure 3-13 indicate that the GS32 subdrainage is contributing the majority of the Pu load estimated at SW093. Additionally, analysis shows that the Pu loads from GS32 have increased significantly in WY04 (Figure 3-16). This suggests that recent projects impacting the GS32 drainage, especially the B779 area projects (IHSS Group 700-7), may have negatively impacted water quality.

Table 3-5, Figure 3-14, and Figure 3-15 also indicate that the majority of the Am load reaching SW093 originates in the GS32 subdrainage. The area directly tributary to SW093 is also contributing significant Am load to SW093. Runoff from this area is not monitored prior to reaching SW093 (for the locations in the 4/06/01 loading group), and the origin of this Am is unknown.

Table 3-5. Comparison of Pu and Am Loads at Tributary Locations with SW093: 4/6/01 through 8/19/04.

| Location | Pu-239,240 Load in μg | Am-241 Load in μg |
|----------|----------------------------------|------------------------------|
| SW093 | 1456.5 | 12.22 |

| Location | Pu-239,240 | | Am-241 | |
|------------------------------------|-----------------------|---------------------------------|-----------------------|---------------------------------|
| | Load in μg | Load as a Percent of SW093 Load | Load in μg | Load as a Percent of SW093 Load |
| GS32 | 1500.2 | 103% | 6.82 | 55.8% |
| GS44 | 7.2 | 0.5% | 0.10 | 0.8% |
| GS49 | 4.0 | 0.3% | 0.05 | 0.4% |
| SW119 | 3.3 | 0.2% | 0.08 | 0.6% |
| SW120 | 60.7 | 4.2% | 1.05 | 8.6% |
| *Area Directly Tributary to SW093* | -118.9 (loss) | -8.2% (loss) | 4.12 | 33.7% |

Notes: The 'loss' for the Area Directly Tributary to SW093 is likely due to an overestimation of the GS32 loads.

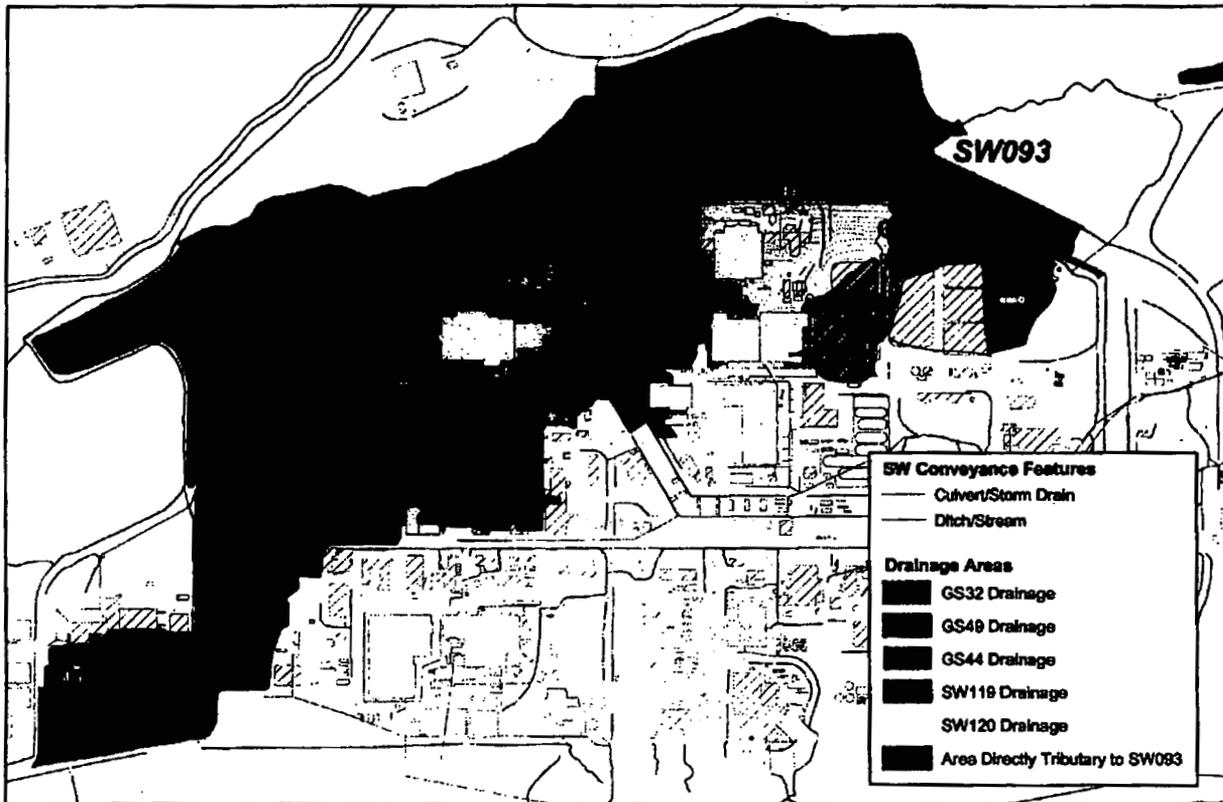


Figure 3-11. Subdrainage Map for Areas Tributary to SW093: As of 4/6/01.

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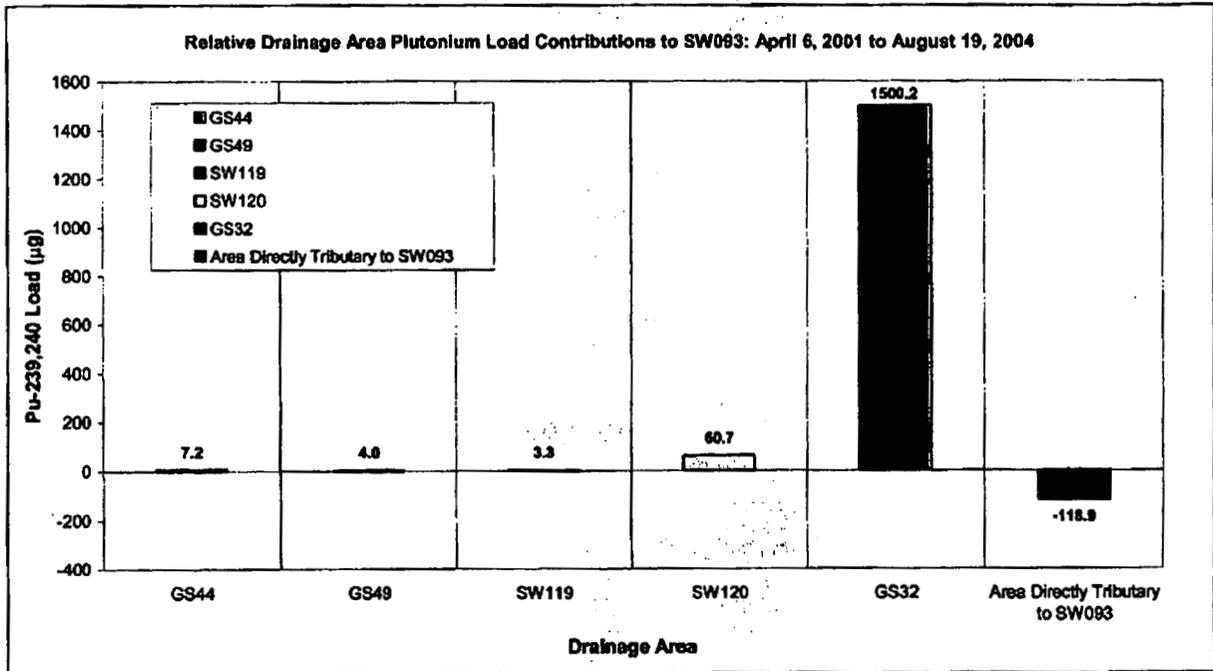


Figure 3-12. Relative Pu Load Contribution Chart for Locations Tributary to SW093: 4/6/01 through 8/19/04.

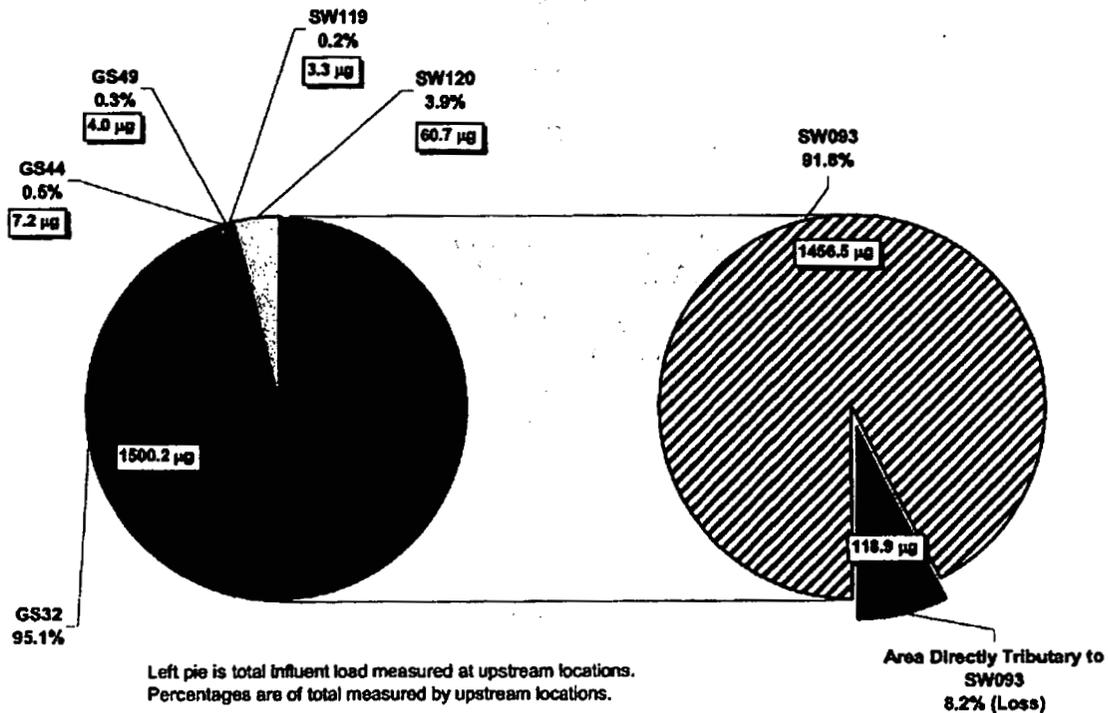


Figure 3-13. Relative Pu Load Contribution Pie for Locations Tributary to SW093: 4/6/01 through 8/19/04.

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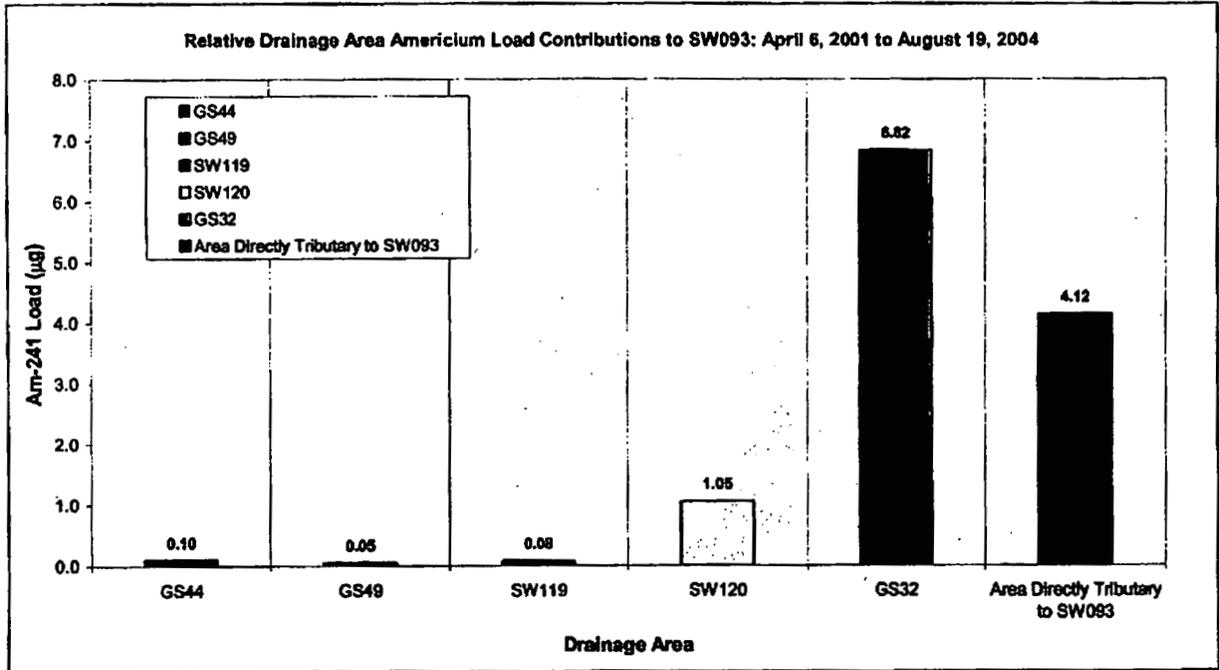


Figure 3-14. Relative Am Load Contribution Chart for Locations Tributary to SW093: 4/6/01 through 8/19/04.

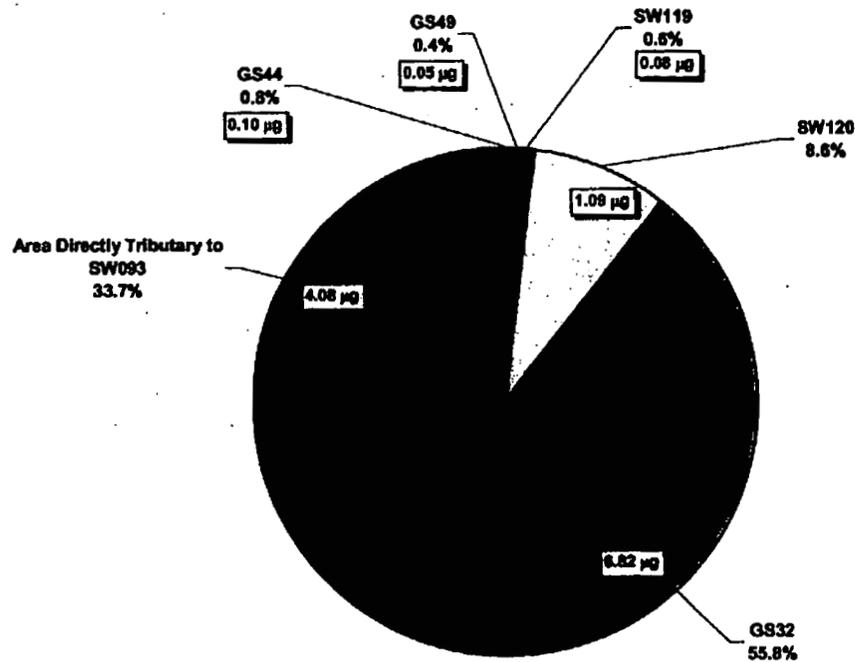


Figure 3-15. Relative Am Load Contribution Pie for Locations Tributary to SW093: 4/6/01 through 8/19/04.

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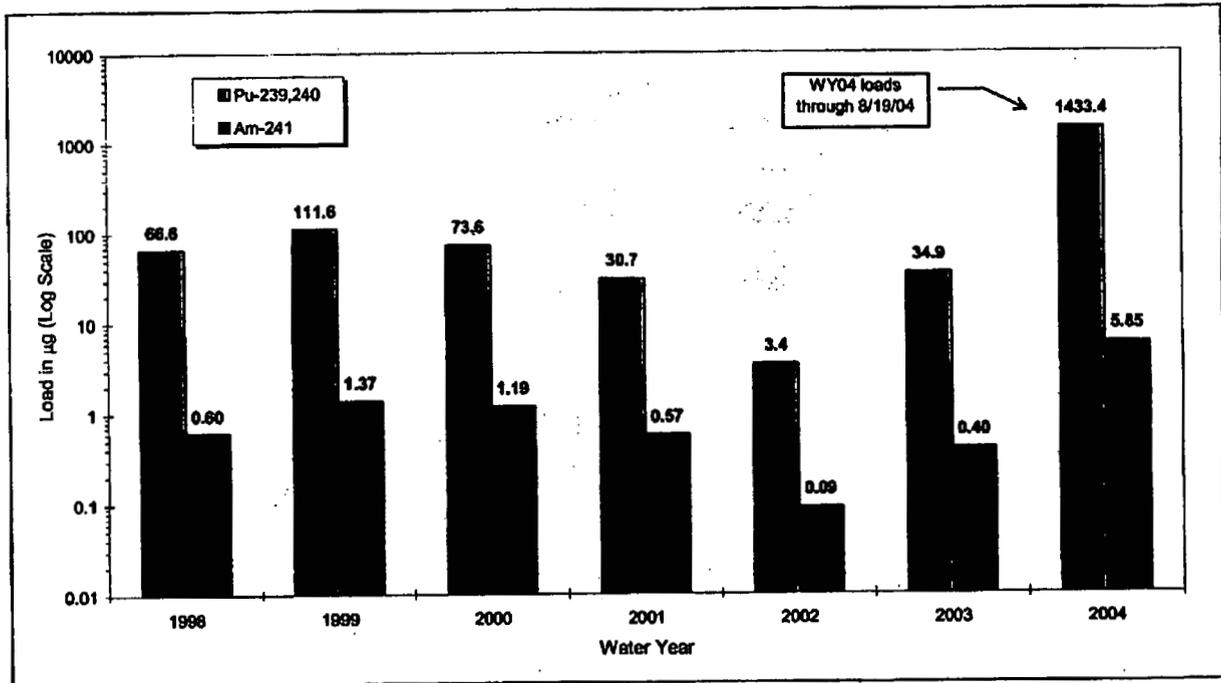


Figure 3-16. Annual Pu and Am Loads at GS32.

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3.4.2 Relative Subdrainage Loads: October 1, 2003 through August 19, 2004

The loading analysis in this section uses all available data for the period 10/1/03 through 8/19/04 from SW093 and the eight upstream monitoring stations (GS32, GS44, GS49, GS60, GS61, SW018, SW119, and SW120).²⁶ This loading analysis does not address the attenuation of actinides as they are transported from one monitoring location to the next. The analysis assumes that as the period of sampling is increased, the temporal effects of actinide transport will not significantly affect the relative loads from the various subdrainages. The hydrologic connectivity of these locations is shown in Figure 3-10.

Table 3-6, Figure 3-19, and Figure 3-20 indicate that the GS32 subdrainage is contributing the majority of the Pu load estimated at SW093. Additionally, analysis shows that the Pu loads from GS32 have increased significantly in WY04. This suggests that recent projects impacting the GS32 drainage, especially the B779 area projects (IHSS Group 700-7), may have negatively impacted water quality.

Table 3-6, Figure 3-21, and Figure 3-22 also indicate that the majority of the Am load reaching SW093 originates in the GS32 subdrainage. The area directly tributary to SW093 is also contributing significant Am load to SW093. Runoff from this area is not monitored prior to reaching SW093, and the origin of this Am is unknown.

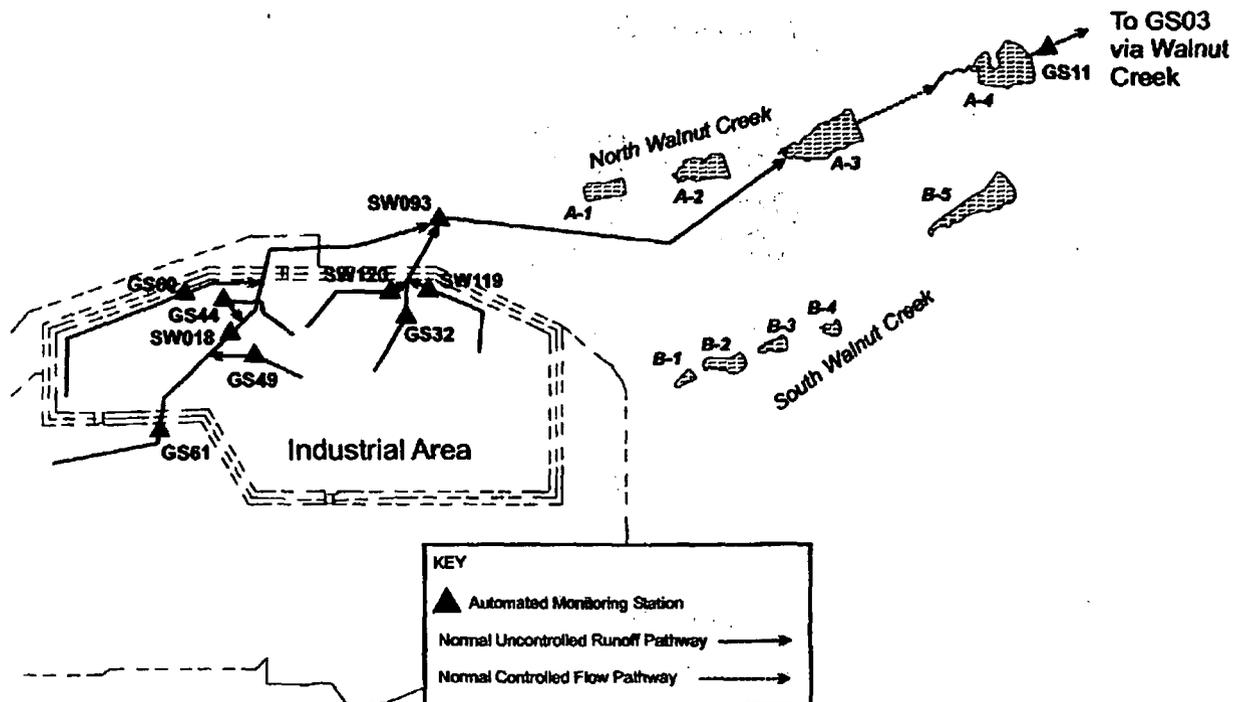


Figure 3-17. Hydrologic Connectivity of Monitoring Locations Tributary to SW093 (as of 10/1/03).

²⁶ Locations GS61 and SW018 were installed on 10/29/03 and 10/9/03, respectively. As such, loads for 10/1/03 to the install date were estimated.

Table 3-6. Comparison of Pu and Am Loads at Tributary Locations with SW093: 10/11/03 through 8/19/04.

| Location | Pu-239,240 Load in μg | Am-241 Load in μg |
|----------|----------------------------------|------------------------------|
| SW093 | 1268.0 | 9.11 |

| Location | Pu-239,240 | | Am-241 | |
|------------------------------------|-----------------------|---------------------------------|-----------------------|---------------------------------|
| | Load in μg | Load as a Percent of SW093 Load | Load in μg | Load as a Percent of SW093 Load |
| GS32 | 1433.4 | 113% | 5.85 | 64.3% |
| GS44 | 4.8 | 0.4% | 0.06 | 0.7% |
| GS49 | 3.1 | 0.2% | 0.03 | 0.4% |
| GS60 | 0.3 | <0.1% | <0.01 | <0.1% |
| GS61 | 10.2 | 0.8% | 0.07 | 0.8% |
| "Area Directly Tributary to SW018" | 12.1 | 1.0% | 0.14 | 1.5% |
| SW119 | 1.0 | 0.1% | 0.02 | 0.2% |
| SW120 | 34.2 | 2.7% | 0.73 | 8.0% |
| "Area Directly Tributary to SW093" | -231.1 (loss) | -18.2% (loss) | 2.20 | 24.1% (loss) |

Notes: The "loss" for the Area Directly Tributary to SW093 is likely due to an overestimation of the GS32 loads

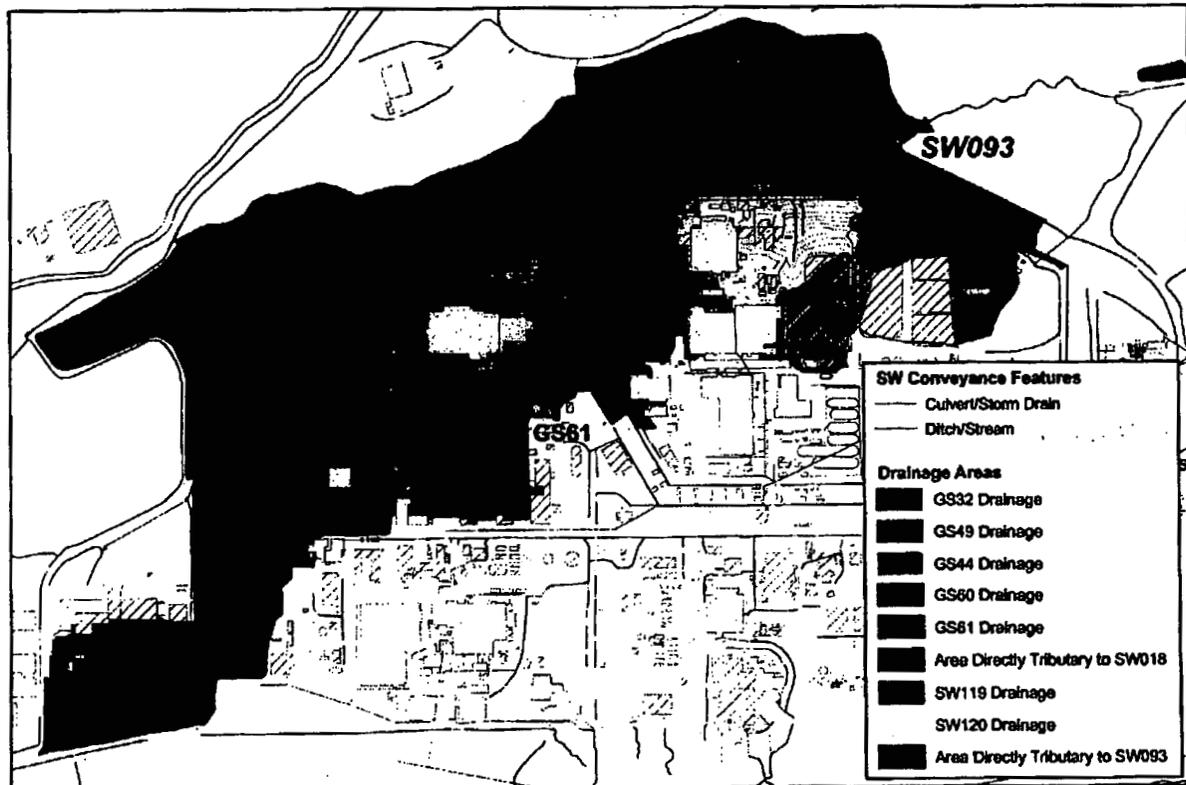


Figure 3-18. Subdrainage Map for Areas Tributary to SW093: As of 10/11/03.

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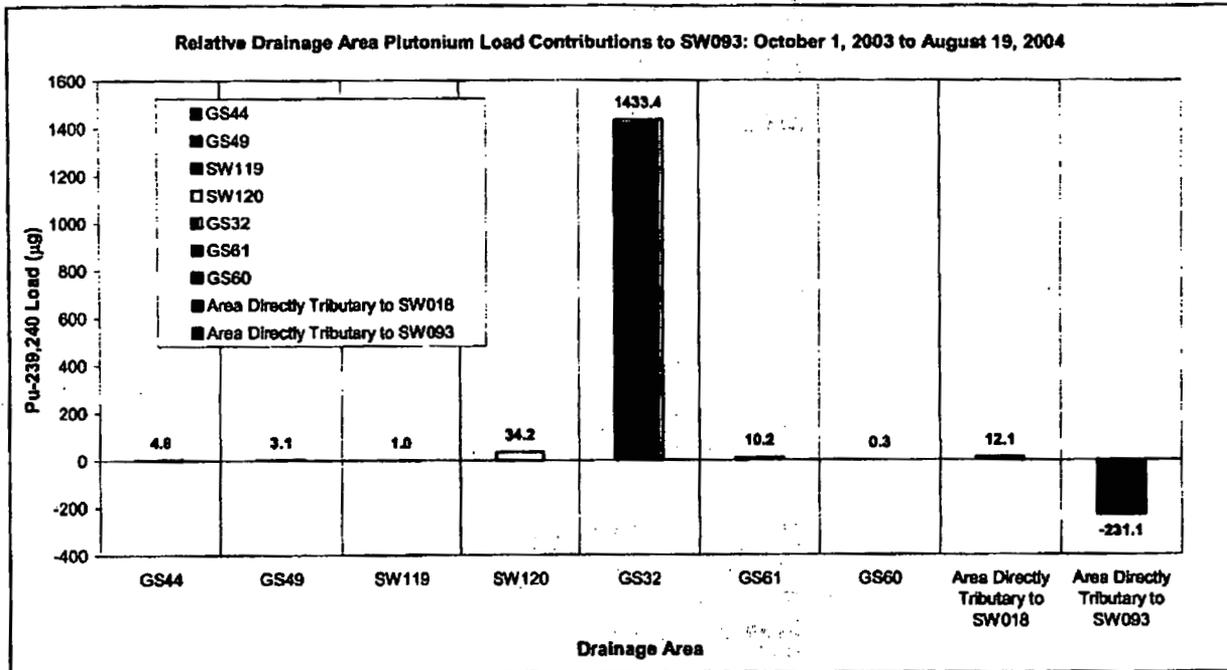


Figure 3-19. Relative Pu Load Contribution Chart for Locations Tributary to SW093: 10/1/03 through 8/19/04.

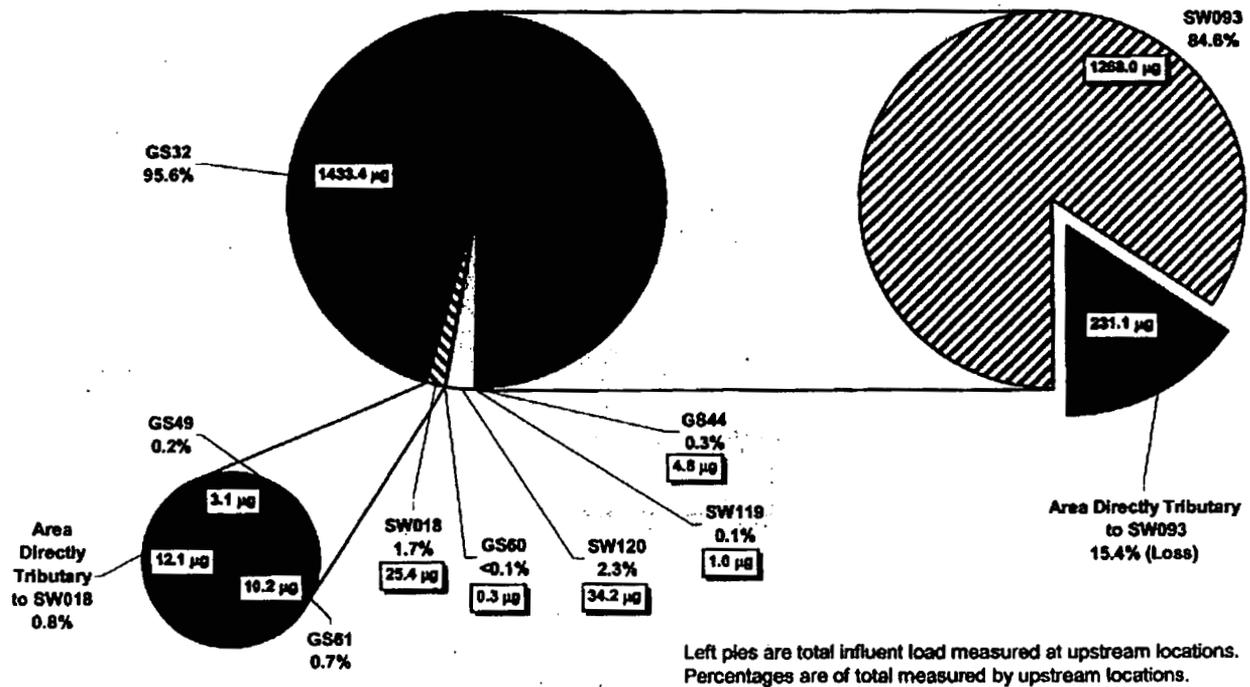


Figure 3-20. Relative Pu Load Contribution Pie for Locations Tributary to SW093: 10/1/03 through 8/19/04.

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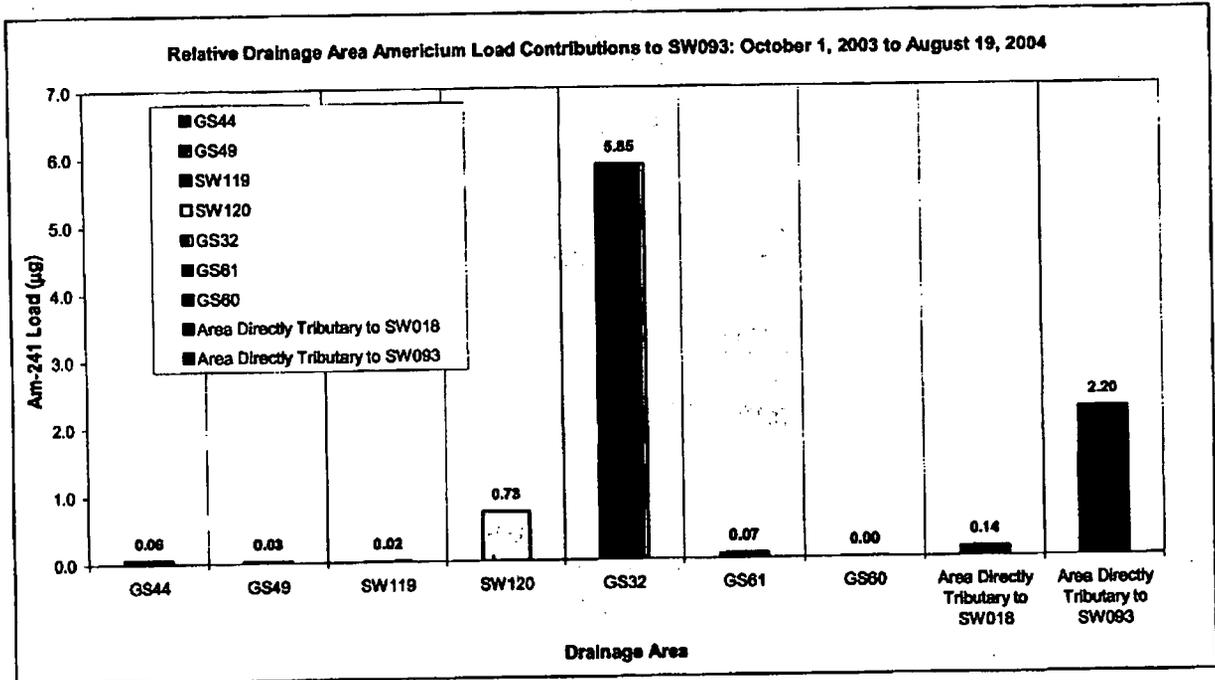


Figure 3-21. Relative Am Load Contribution Chart for Locations Tributary to SW093: 10/1/03 through 8/19/04.

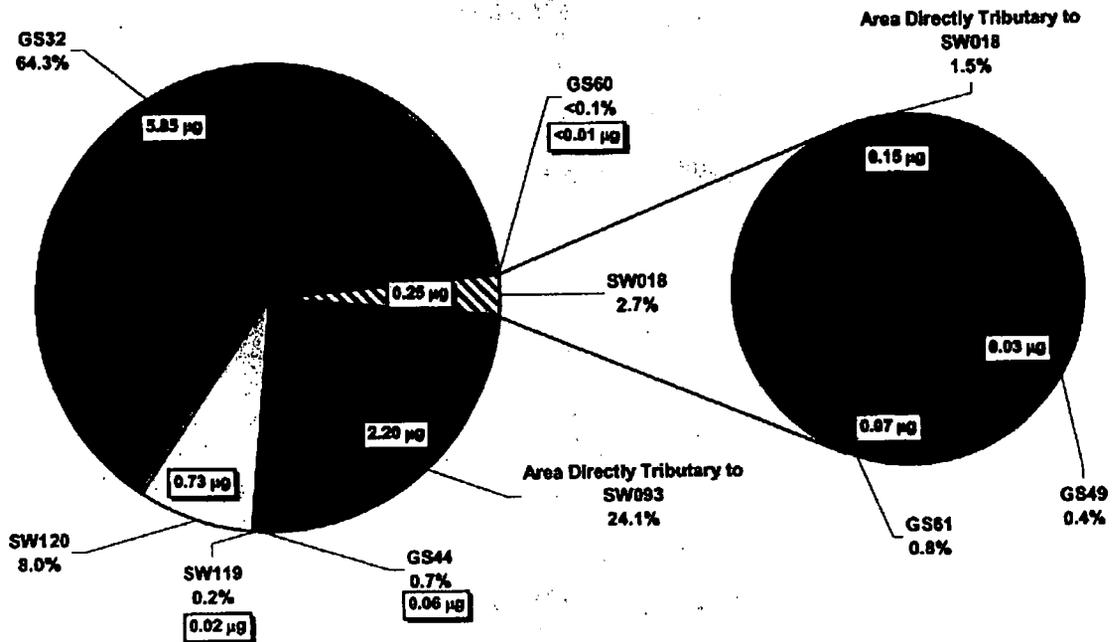


Figure 3-22. Relative Am Load Contribution Pie for Locations Tributary to SW093: 10/1/03 through 8/19/04.

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3.5 EROSION CONTROL MEASURES

The Site is implementing an aggressive program of erosion control to prevent the movement of soils and sediments and to protect storm water and surface-water quality. The increased activities of building removal and soil disturbance require rigorous erosion control methods. A number of control methods are currently being used, from straw bales and wattles to soil tackifiers and erosion blankets. Ultimately, disturbed sites are revegetated.

Immediately following confirmation of reportable values at SW093, a preliminary loading analysis was performed that also identified the GS32 subdrainage as a major contributor to SW093. The loading analysis above further confirms GS32 as a major Pu and Am load contributor to SW093. Since Pu and Am are characteristically transported in surface water attached to particulate matter (suspended solids), a number of erosion controls have been added to the Site drainages, and specifically the GS32 subdrainage. These more comprehensive controls were installed in the GS32 subdrainage starting on 7/1/04, augmenting the preexisting erosion methods the Site has been routinely using. Localized controls have been added in the form of straw wattles, straw bales, and erosion matting in the ditch that transports runoff to the culvert flowing to GS32 (Figure 3-23). Additional erosion controls have been installed throughout the SW093 drainage based on field walkdowns and monitoring data analysis identifying areas of sediment transport and specifically for projects likely to impact surface water.

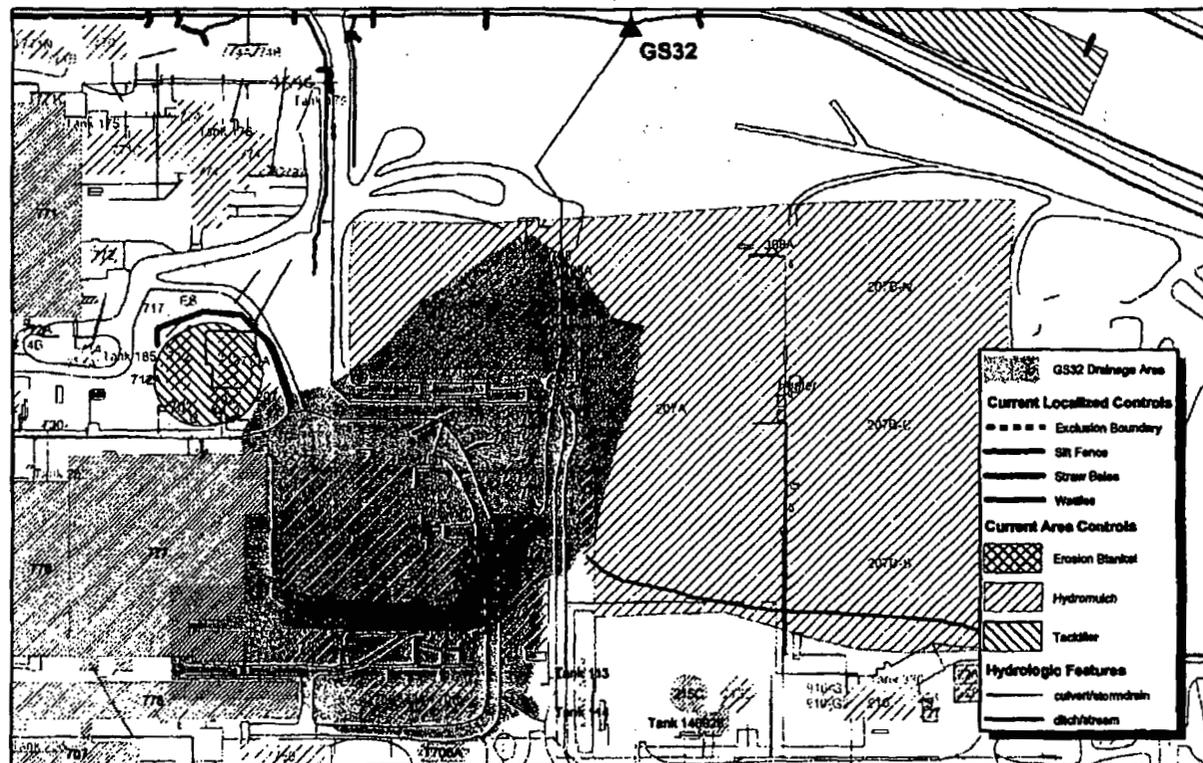


Figure 3-23. Erosion Controls in the GS32 Drainage as of 10/13/04.

Erosion control installations are monitored on a routine basis and any needed repairs or improvements are noted and implemented. Erosion controls are tracked in a database, and mapped on a weekly basis to provide an overall assessment of the system condition. As new projects commence, work planning includes the review of the project for erosion control needs and requires their installation prior to the start of work. At project completion, installed controls continued to be evaluated for performance and are either removed or left in place until revegetation is established.

3.6 WATER-QUALITY TRENDS AND CORRELATIONS: SW093

Higher than normal Pu and Am activities began to be measured at SW093 starting with the composite sample for the period 3/9 – 4/3/04 (Figure 3-24). For the period 10/1/02 – 3/8/04, average Pu/Am ratios at SW093 were 1.3. For the period 3/9 – 6/29/04, average Pu/Am ratios were 4.2, suggesting that recent higher activities were from different area or source term than the activities for previous samples. For roughly the same period, a similar pattern is noted for samples collected at GS32 (Figure 3-25). Figure 3-26 shows that the higher SW093 activities are generally associated with period of continuous runoff at GS32. This is particularly true for the period 5/24 – 6/9/04 when a domestic water leak was observed to be supporting sustained flows at GS32²⁷, a period of mostly baseflow at SW093. These patterns further support the conclusion that flow from the GS32 subdrainage was affecting water quality at SW093.

No significant water-quality improvement due to erosion controls has been observed to-date for SW093 (Figure 3-24). This may be caused by the continued transport of residual solids in the flow pathways downstream of the new erosion controls. However, data from GS32 (Figure 3-25) show a significant reduction in activities.

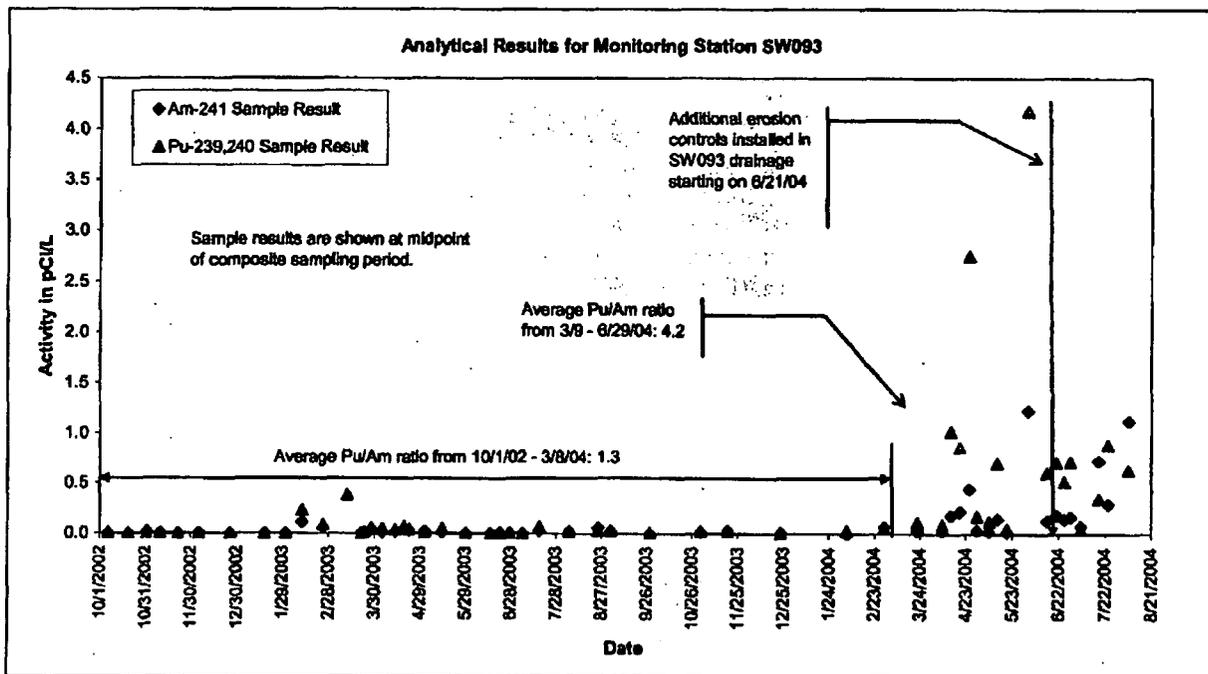
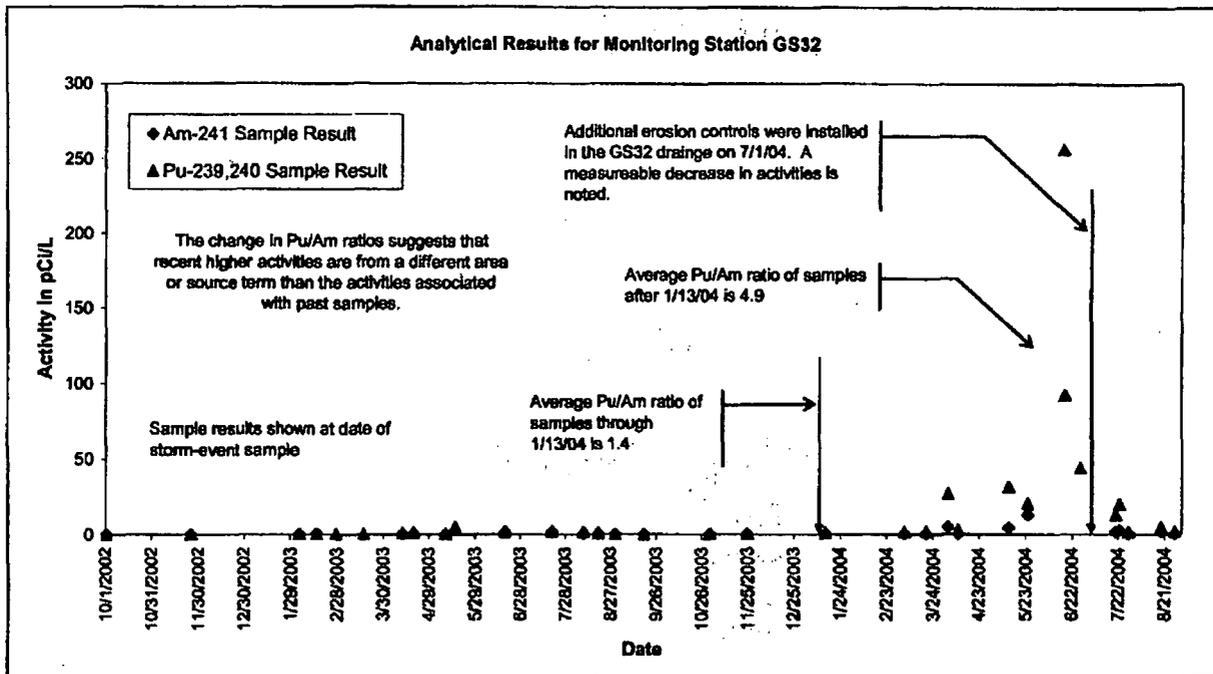


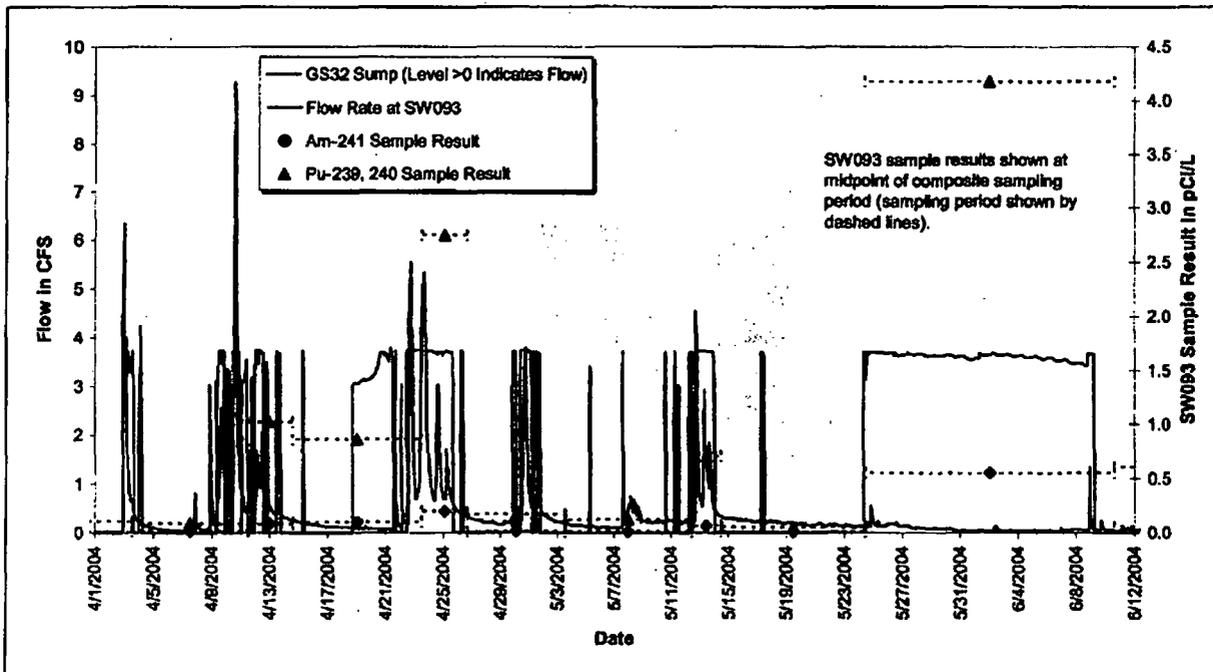
Figure 3-24. Individual Sample Results at SW093: 10/1/02- 8/18/04.

²⁷ The leak occurred at a water line in the northern portion of the project area. Water was observed flowing south across disturbed soils to the unlined ditch conveying flow to the storm drain feeding GS32.



Note: Several Am results rejected through data validation.

Figure 3-25. Individual Sample Results at GS32: 10/1/02- 8/27/04.



Note: Line shown for GS32 sump level is not a flow rate. Line represents a flow- or no-flow condition (values greater than 0 indicate flow at GS32).

Figure 3-26. Individual Sample Results at SW093 Shown with SW093 Hydrograph and GS32 Sump Levels.

Since Pu and Am are transported attached to suspended solids, an increase in suspended solids activity (sample activity divided by TSS concentration [pCi/g]) suggests the increased contribution of a relatively more contaminated area, and/or sediment transport from a previously non-contributing area or source term. Higher than normal Pu and Am suspended solids activities began to be measured at SW093 in WY04 (Figure 3-27). For roughly the same period, a similar pattern is noted for samples collected at GS32 (Figure 3-28). These patterns further support the conclusion that flow from the GS32 subdrainage was affecting water quality at SW093.

A measurable reduction in suspended solids activity is noted for GS32 after the implementation of enhanced erosion controls (Figure 3-28). This is likely the result of decreased contribution of relatively more contaminated areas of the GS32 subdrainage due to soil stabilization coupled with a reduction in vehicle traffic associated with 779 area Closure activities. Insufficient data are available at this time to draw conclusions for SW093 (Figure 3-27).

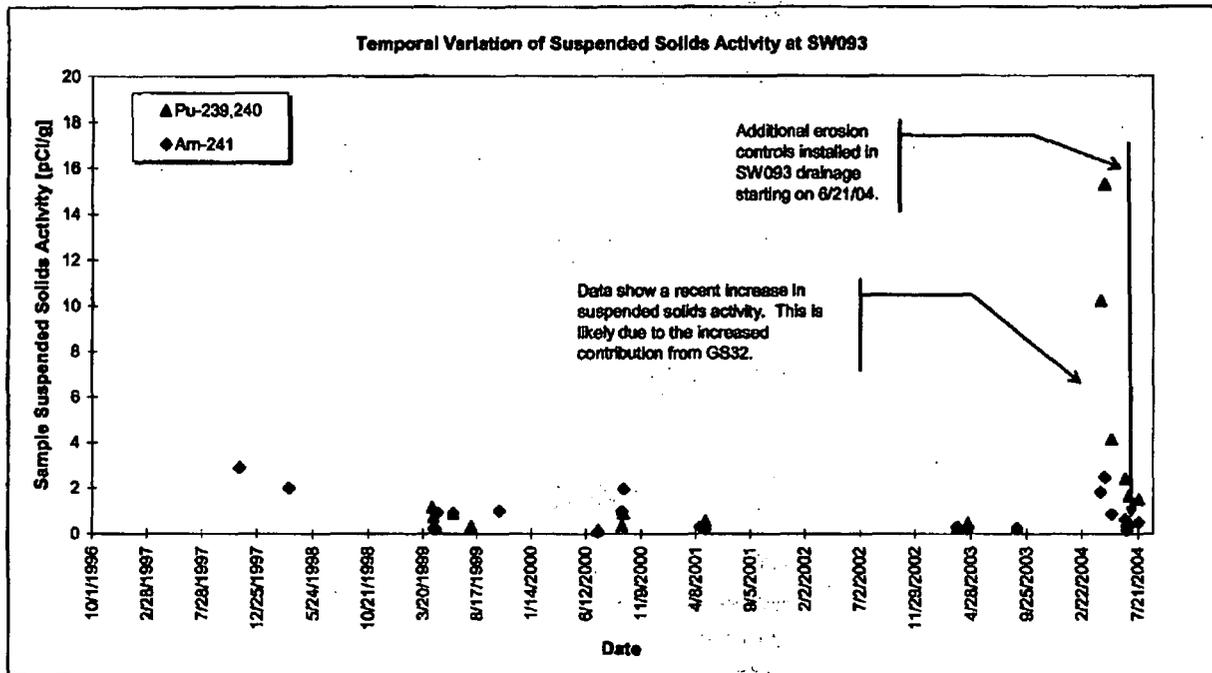


Figure 3-27. Temporal Variation of Suspended Solids Activity at SW093: All RFCA Data.

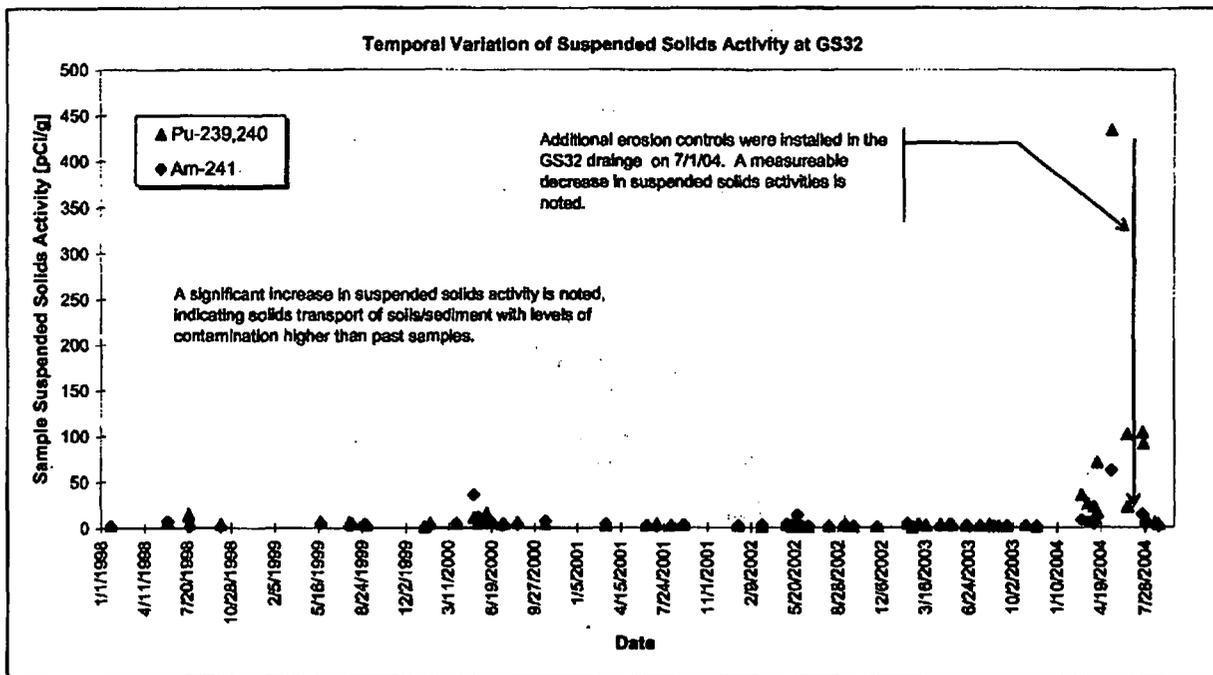


Figure 3-28. Temporal Variation of Suspended Solids Activity at GS32: All RFCA Data.

Since Pu and Am are transported attached to suspended solids, an increase in TSS can result in corresponding increases in activity. The amount of TSS in runoff depends on a number of factors including the availability of disturbed soils (e.g. unconsolidated and unvegetated soil), storm intensity (i.e. precipitation forces), and runoff intensity (flow rates). A deviation in the typical relationship between flow rate and TSS suggests increased availability of transportable soils. Figure 3-29 shows that WY04 turbidities (as an indication of TSS) relative to flow rate are generally higher than for WY03 and prior data. This suggests that soils in the SW093 drainage are more susceptible to transport for a given flow rate than for previous years. Similarly, WY04 TSS data show higher values relative to flow rate than for previous years (Figure 3-30). A similar relationship is noted for samples collected at GS32 prior to the implementation of enhanced erosion controls (Figure 3-31)²⁸. These patterns suggest that the recent higher activities at SW093 may be the result, at least in part, to the increased transport of legacy contamination associated with soil and sediment, and not new sources.

A measurable reduction in TSS relative to storm intensity is noted for GS32 after the implementation of enhanced erosion controls (Figure 3-31). This is likely the result of sediment trapping and soil stabilization in the GS32 subdrainage coupled with a reduction in vehicle traffic associated with 779 area Closure activities. Data from SW093 show no reduction in TSS relative to flow rate (Figure 3-30). This may be caused by the transport of residual solids in the flow pathways downstream of the new erosion controls. Additional data are needed to further assess the effects of erosion controls on water quality at SW093.

²⁸ Since flow is not measured at GS32, storm-event sample TSS is correlated with peak flow rate at GS40 (an adjacent drainage area) as an indicator of runoff intensity.

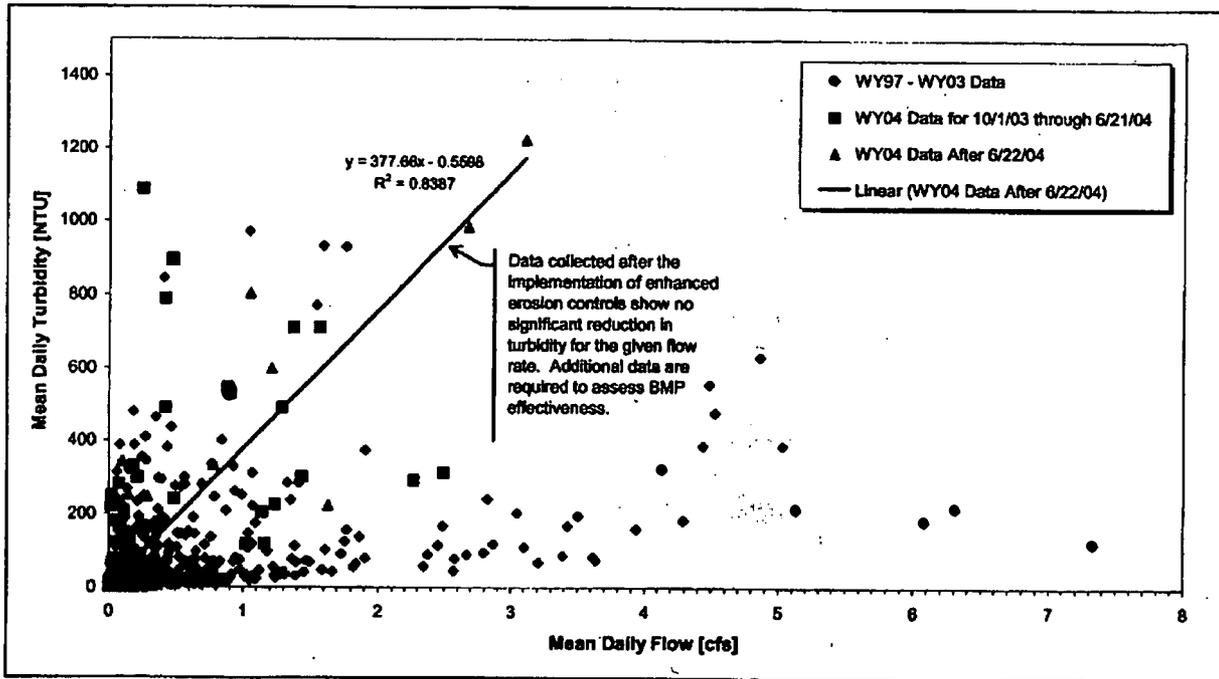


Figure 3-29. Variation of Mean Daily Turbidity with Flow Rate at SW093.

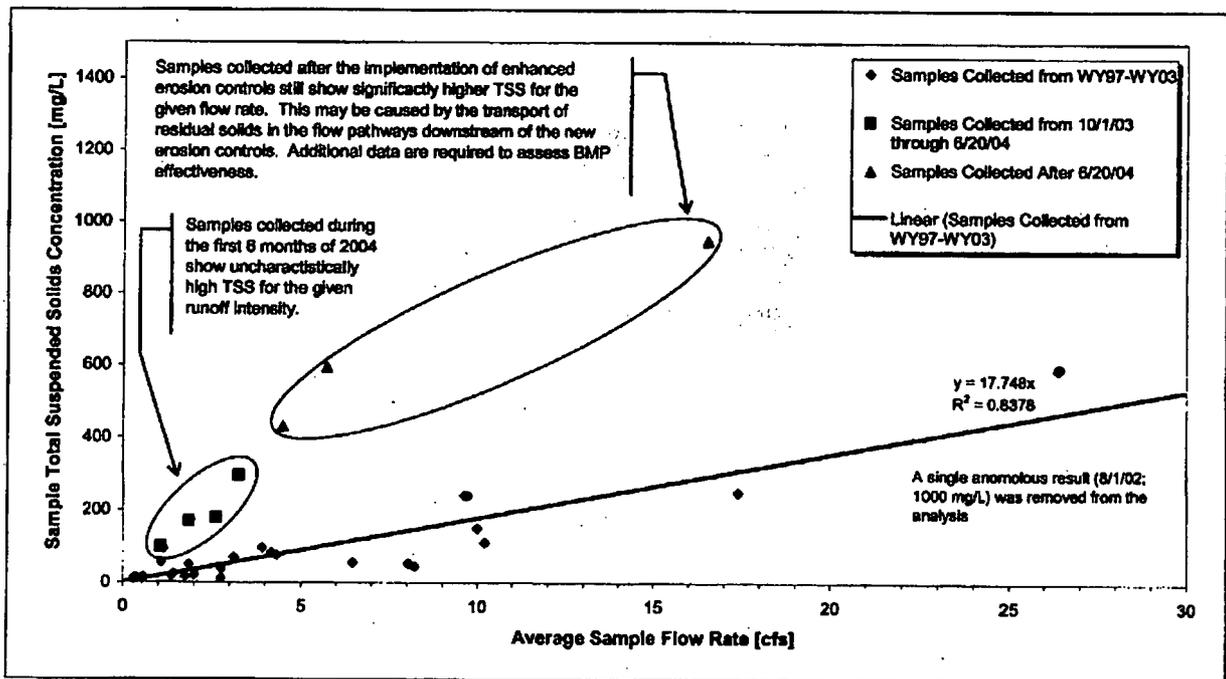


Figure 3-30. Variation of Sample TSS with Flow Rate at SW093.

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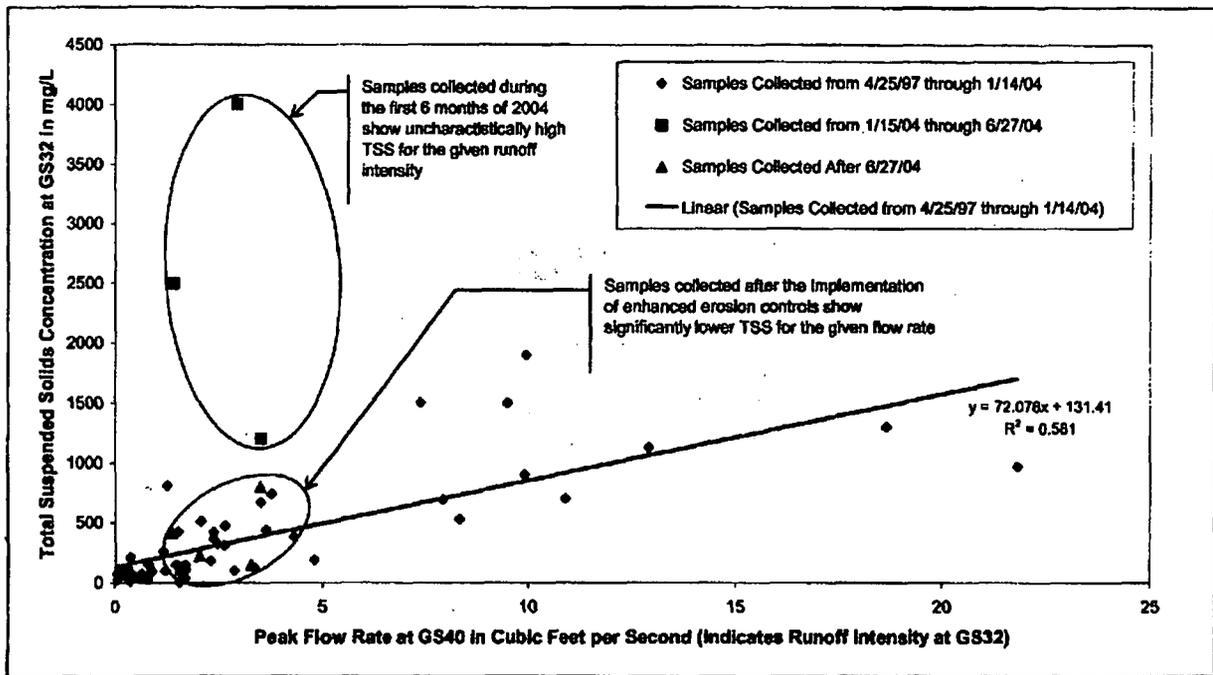


Figure 3-31. Variation of Sample TSS with Runoff Intensity at GS32.

3.7 SITE ACTIVITIES AND PROJECTS IN AREAS TRIBUTARY TO SW093

During the period of reportable values at SW093, multiple projects within the SW093 drainage were occurring. The loading analysis and water-quality correlations presented above indicate that Closure activities within the GS32 subdrainage are likely to have had the most significant impact to water-quality at SW093.

3.7.1 B779 Area Projects (IHSS Group 700-7)

Accelerated action activities (not including characterization sampling) for IHSS Group 700-7 began on 1/6/04. The Draft Closeout Report for IHSS Group 700-7 (Kaiser-Hill, 2004a) provides background for this project. The following list is a summary of the actions:

- Characterization of the 779 Under Building Contamination (UBC) Site, IHSSs within the Group, Potential Area of Concern 700-1105, including soil adjacent to and below the Original Process Waste Lines (OPWL)
- Removal of the B779 slab and other building structural features, including footer walls, the top 4 feet of the basement walls, waste trenches and pits, and other building slabs
- Removal of water and waste lines, including OPWL and sanitary lines under the B779 slab, the B782 plenum drain lines, and the B779 foundation drain line
- Removal of two diesel underground storage tanks
- Removal of three concrete pads, two of which held transformers containing oils with polychlorinated biphenyls (PCBs), and surrounding soil, and

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- Removal of other soil in conformance with RFCA requirements, including soil from under the B779 contamination area

The portion of the B779 area tributary to SW093 is upstream of GS32 (Figure 3-32), and runoff from the area shown on the map is sampled at GS32. During WY04, disturbed soils associated with the project were available for transport in runoff. Field observations during the Spring of 2004 noted areas of mud and standing water throughout the GS32 subdrainage. Runoff in the area flowed to a small, unlined ditch that conveys water through a drop structure to the storm drain flowing to GS32. During the project, the ditch was extended to the west to further facilitate the removal of runoff from the project area, with the project routinely routing runoff and pumped discharges (from sumps and basements) to this ditch.²⁹ Incidental waters from excavations at B702, B705, B706, B712, and PAC 700-1105 (B779) that were pumped to ground totaled approximately 21,000 gallons, potentially transporting disturbed soils. Additionally, the domestic leak noted in previous sections flowed across disturbed soils to this ditch for an extended period. Extensive vehicle traffic also resulted in the generation of suspended solids available for transport in runoff.

Several OPWL excavations were conducted in the NE corner of the B779 area; these excavations were within 20-30 feet of the buried storm drain conveying runoff to GS32. Field observations in the Spring of 2004 noted the accumulation of standing water in the pits covering the OPWL lines.³⁰ If the integrity of the GS32 storm drain was compromised by corrosion and/or subsidence, the possibility exists that the storm drain may have been in hydrologic connection with the water in the pits³¹, providing a pathway for potentially contaminated water to reach GS32.

The loading analysis above showed that the loads from GS32 increased significantly in WY04 (Figure 3-16). Figure 3-25 shows that activities at GS32 increased after the start of the IHSS Group 700-7 project began, and coinciding with the normal spring and summer increase in runoff. Based on field observations, runoff from the area contained unusually high levels of suspended solids. Figure 3-33 shows that TSS concentrations relative to runoff intensity increased significantly during the same period.

The existence of low-level actinide soil contamination in association with the B779 area is well documented (see Closeout Report for IHSS Group 700-7; Kaiser-Hill, 2004a). Above background levels for surface soil exist throughout the area, ranging up to approximately 20 pCi/g. With TSS concentrations up to 4,000 mg/L at GS32, activities significantly higher than 0.15 pCi/L are not unexpected. Figure 3-28 shows that the activity of the suspended solids at GS32 increased during WY04, with several results in excess of 50 pCi/g Pu.

Fractionation of both soils in surface-water runoff and radionuclides in soils is undoubtedly occurring in the area. Both mechanical and physiochemical suspension mechanisms suggest preferential suspension of certain fractions of the surface soil in stormwater runoff. Fractionation may occur as a function of particle size, density, and/or surface chemistry. Furthermore, Pu may associate preferentially with certain fractions of the soil based on surface area and/or surface chemistry. The net result may be a drastically different specific activity of suspended material in the surface water as compared to specific activity of the surface soils.

Regardless, the increase in suspended solids activity at GS32 is likely due to the increased contribution of relatively more contaminated suspended solids from areas not previously as susceptible to erosion. The removal of impervious surfaces (exposing the underlying soils) and the extensive disturbance of previously stable soil areas are the likely causes.

²⁹ The assumption is made that pumped discharges were dispositioned according to the Incidental Waters procedure. Most, if not all of these waters were pumped to tanks for subsequent disposal.

³⁰ The Draft Closeout Report for IHSS Group 700-7 states that approximately 10,000 gallons were pumped from the pits for treatment at B891.

³¹ The OPWL lines are assumed to be at a lower elevation than the storm drain. Therefore, this hypothesis assumes that the water levels in the pits rose to an elevation comparable to the storm drain, though actual pit water levels are unknown.

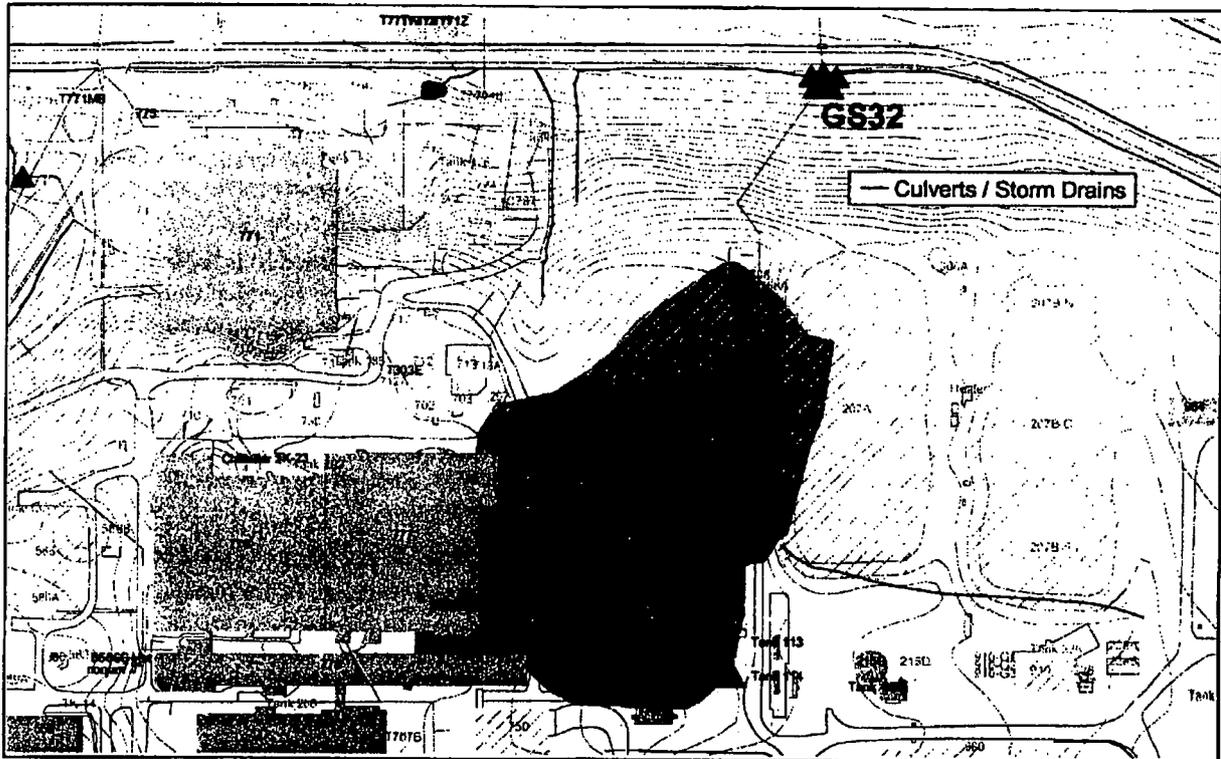


Figure 3-32. Drainage Area for GS32: B779 Area.

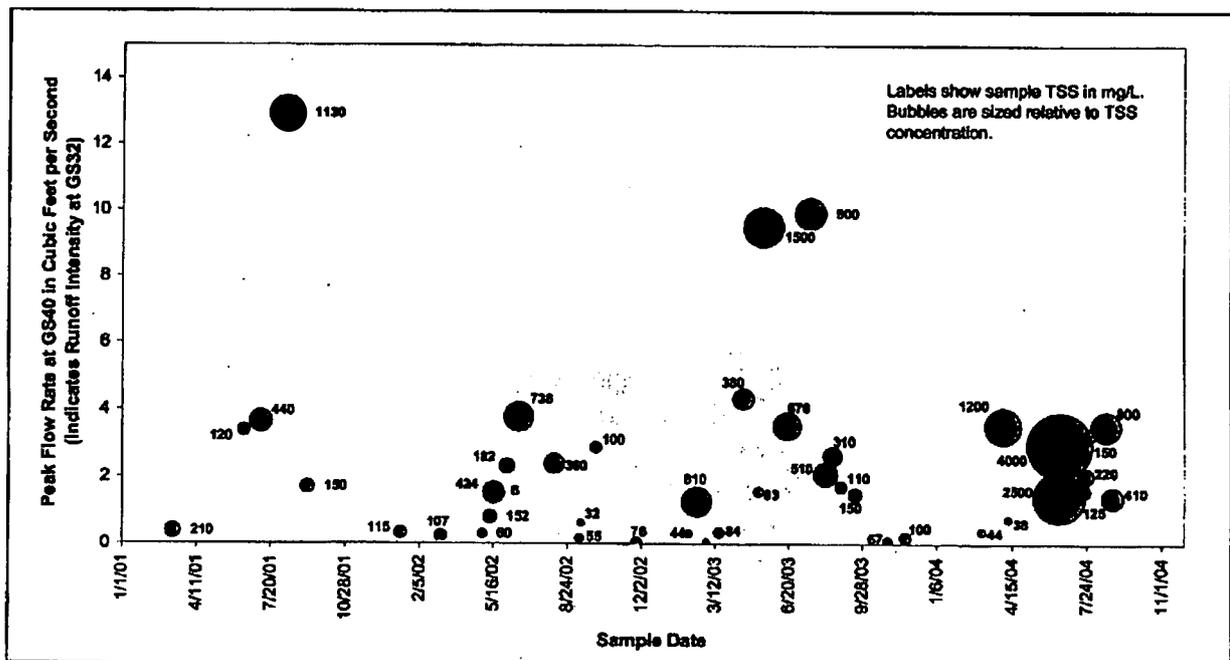


Figure 3-33. Bubble Chart Showing Temporal Variation of Sample TSS with Runoff Intensity and Date: GS32.

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3.8 SUMMARY AND CONCLUSIONS

The Site has completed the WY04 phase of the ongoing source evaluation for the potential cause(s) of reportable 30-day moving average values for Pu and Am at the POE monitoring location SW093. As for previous reports, the Site concludes that the likely source of the reportable 30-day moving average values at SW093 is diffuse actinide contamination associated with soils and sediments from past Site operations released to the environment through events and conditions over past years. This actinide contamination is transported with suspended solids in surface-water runoff during precipitation events.

Based on the above evaluation, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions and closure activities for the Site. The removal of source areas, the implementation of enhanced erosion controls, and the reduction of runoff as the Site moves toward Closure all serve to improve water quality in the long term. The surface-water monitoring conducted at the Site has provided valuable information regarding the near-term impacts to water quality to aid the Closure projects in developing targeted methods for reducing the transport of low-level contamination. This source investigation has identified no previously unknown localized source(s) of contamination that warrant targeted remediation based on the available information. The current conclusions are summarized below:

- The Site retention ponds continue to effectively remove suspended solids and any associated contamination from the water column. Pu and Am activities at the terminal pond and fenceline POCs remain well below reporting thresholds.
- Based on the details regarding recent Site activities outlined above, it is concluded that various D&D, construction, environmental remediation, and excavation operations caused increased transport of low-level contamination associated with suspended solids in surface water that are likely to have resulted in the recent reportable values measured at SW093. Evaluation suggests that project activities associated with IHSS Group 700-7 (GS32 subdrainage) resulted in the largest impacts to water quality at SW093.
- A shift in Pu/Am ratios toward a higher relative abundance of Pu at SW093 in WY04 suggest increased actinide contribution from an area with higher Pu/Am ratios. Data from GS32 show a similar pattern.
- The loading analysis indicates that the GS32 subdrainage is contributing the vast majority of the actinide load at SW093. Additionally, analysis shows that the Pu and Am loads from GS32 have increased significantly in WY04. This suggests that recent projects impacting the GS32 drainage, especially IHSS Group 700-7, may have negatively impacted water quality.
- Pu and Am suspended solids activities at SW093 show a significant increase in WY04 (Figure 2-36). In conjunction with the increased activities at SW093, this suggests the increased contribution of a relatively more contaminated area, and/or sediment transport from a previously non-contributing area or source term. For roughly the same period, a similar pattern is noted for samples collected at GS32.
- Figure 3-29 shows that WY04 turbidities (as an indication of TSS) at SW093 relative to flow rate are generally higher than for WY03 and prior data. This suggests that soils in the SW093 drainage are more susceptible to transport for a given flow rate than for previous years. Similarly, WY04 TSS data at SW093 show higher values relative to flow rate than for previous years (Figure 3-30). A similar relationship is noted for samples collected at GS32 (Figure 3-31), prior to the implementation of enhanced erosion controls. These patterns suggest that the recent higher activities at SW093 may be the result, at least in part, to the increased transport of legacy contamination associated with soil and sediment, and not solely a new source term.

- Targeted erosion controls have proven to be effective in reducing sediment transport and associated contamination at selected locations. This is especially true for locations upstream of SW093 (nearer to the source terms) such as GS32. No improvement is noted for SW093, most likely due to the continued transport of residual solids in the flow pathways downstream of the erosion controls. In the long-term, water quality is expected to improve at SW093 as these solids stabilize in the system, additional erosion controls are installed, source areas are removed, disturbed soils are stabilized, and runoff is reduced due to the removal of impervious areas.

The Site's proposed course of action includes: (1) continuing observation (routine monitoring), and (2) installation and maintenance of enhanced erosion controls in the drainage areas upstream of SW093 as part of the overall Closure process. Effective BMPs, such as the use of the existing terminal ponds to clarify stormwater of potentially-contaminated sediment and particulate matter, will also be continued. Specifically, DOE and the K-H Team propose the following actions as the path forward:

- Continued observation and ongoing data interpretation to provide better understanding of actinide transport directly related to the operation of the Site automated surface-water monitoring network and the effectiveness of erosion controls
- Implementation and maintenance of enhanced erosion controls as an integral part of Site Closure
- Continued use of the existing retention ponds as an effective BMP to clarify stormwater containing potentially contaminated sediment and particulate matter, and
- Continued reporting as appropriate

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4. SOURCE EVALUATION FOR POE SW027

The following source evaluation is provided in accordance with the *Final Rocky Flats Cleanup Agreement* (RFCA) (CDPHE et al., 1996) (Attachment 5, §2.4(B)) under "Action Determinations". The RFCA requires reporting "when contaminant concentrations in Segment 5 exceed the Table 1 action levels" and that "source evaluation will be required". Further, RFCA states "if mitigating action is appropriate, the specific actions will be determined on a case-by-case basis, but must be designed such that surface water will meet applicable standards at the POCs.

Specifically, this source evaluation addresses the Site notification(s) of reportable 30-day moving average values for Pu and Am water-quality results at the POE monitoring location SW027, located just above Pond C-2 in the SID. Reportable values for Pu were measured for the period 6/22 through 8/18/04 inclusive, using validated data. Additional data recently received but not validated may extend the Pu event through 8/23/04. Reportable values for Am were also measured for the periods 6/27 through 8/18/04 inclusive, using validated data. Additional data recently received but not validated may extend the Am event through 8/23/04. The end of the reportable period(s) will be determined when the Site receives subsequent analytical results.

This evaluation for SID monitoring station SW027 covers data received through 10/6/04. The following are included in this section:

- Evaluation of ongoing automated surface-water monitoring within the SW027 drainage
- Estimation of actinide loads within the SW027 drainage area
- Evaluation of water-quality trends and correlations within the SW027 drainage area
- A brief discussion of implemented erosion controls, and
- A brief assessment of D&D, ER, and Site Closure projects.

4.1 HYDROLOGY

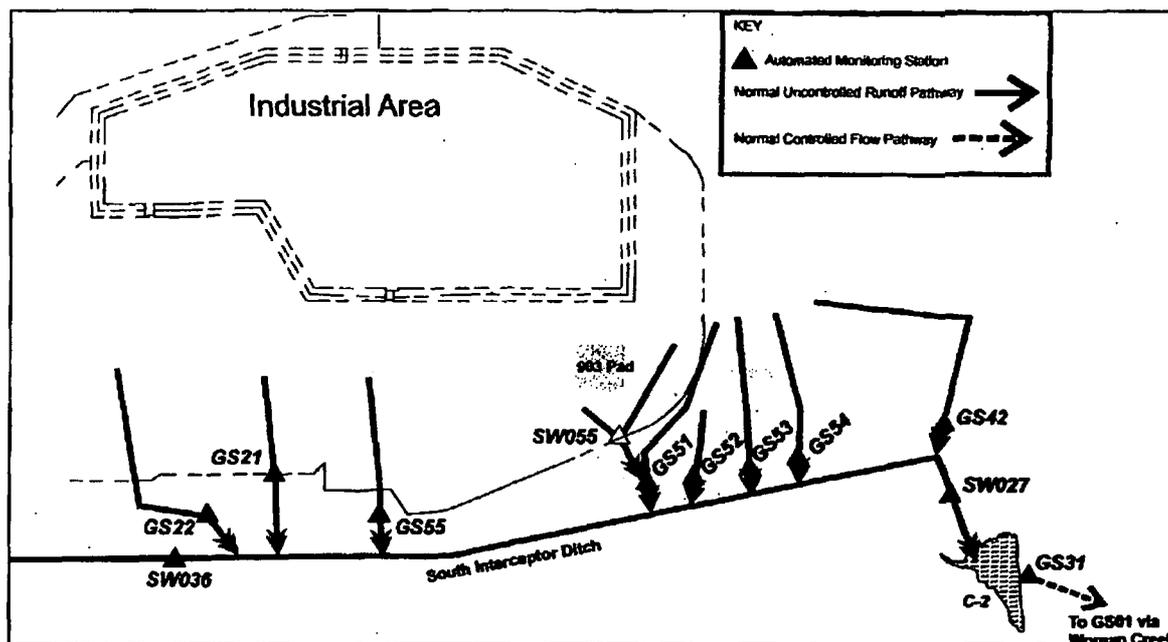
SID / Pond C-2 Flow Controls

All IA surface-water runoff that flows into North Walnut Creek, South Walnut Creek, or the SID is collected by a system of stormwater retention ponds. The ponds serve three main purposes for surface-water management: (1) storm water retention and settling of sediments, (2) water storage for sampling prior to release, and (3) emergency spill control in those instances where a spill cannot be adequately managed without use of the ponds.

SW027 is the POE for IA surface-water flows to Pond C-2. Surface water in the SID is routed through Pond C-2 to Woman Creek (Figure 4-1). Steps in the water collection and transfer process are briefly outlined as follows:

1. Runoff from the southern IA flows through the SID past monitoring location SW027.
2. Runoff from SW027 then flows downstream through conveyance structures to Pond C-2 where it is detained, and
3. Water detained in Pond C-2 is discharged periodically in batches to Woman Creek.

As indicated above, all of the IA runoff that flows into the SID is ultimately routed to Pond C-2, detained, and sampled prior to being released to lower Woman Creek. There is no source of IA runoff to the SID that can enter lower Woman Creek without first passing through the pond system for subsequent batch discharge from Pond C-2.



Notes: SW055 was removed on 4/28/04 to make way for soil removal activities. Runoff measured at SW055 used to flow directly to the SID. During remediation flows gradually began flowing to GS51. With the completion of the 903 Pad/Lip remediation, runoff from the area formerly monitored by SW055 is now monitored at GS51.

Figure 4-1. Hydrologic Routing Diagram for POE SW027 (WY03-04).

4.2 SW027 MONITORING RESULTS

As specified in the IMP, Site personnel evaluate 30-day moving average values³² for selected radionuclides at POE surface-water monitoring location SW027. Recent evaluations of water-quality measurements at POE SW027 showed reportable values for Pu and Am requiring notification and source evaluation under the RFCA Action Level Framework. Results for recent 30-day moving average values using available data at SW027 are summarized below in Table 4-1 and are shown on Figure 4-2.

Table 4-1. Recent Water-Quality Information from SW027 (Validated and Unvalidated Data).

| Location | Parameter | Date(s) of 30-Day Average Requiring Reporting | Date(s) of Maximum 30-Day Average | Maximum 30-Day Average (pCi/l) | Volume-Weighted Average for Water Year ³³ (pCi/l) |
|----------|------------|---|-----------------------------------|--------------------------------|--|
| SW027 | Pu-239,240 | 6/22 – 8/23/04 | 7/29/04 | 6.8 | WY04 ³⁴ : 2.72 |
| SW027 | Am-241 | 6/27 – 8/23/04 | 7/29/04 | 1.2 | WY04 ³⁴ : 0.486 |

³² The method for calculating 30-day averages is given in Appendix B.1 - Analytical Data Evaluation Methods in the RFETS Automated Surface-Water Monitoring: WY03 Annual Report (URS, 2004).

³³ A Water Year is defined as the period from October 1 through September 30. The term water year is abbreviated as WY; e.g. Water Year 2004 is WY04.

³⁴ Through 9/20/04

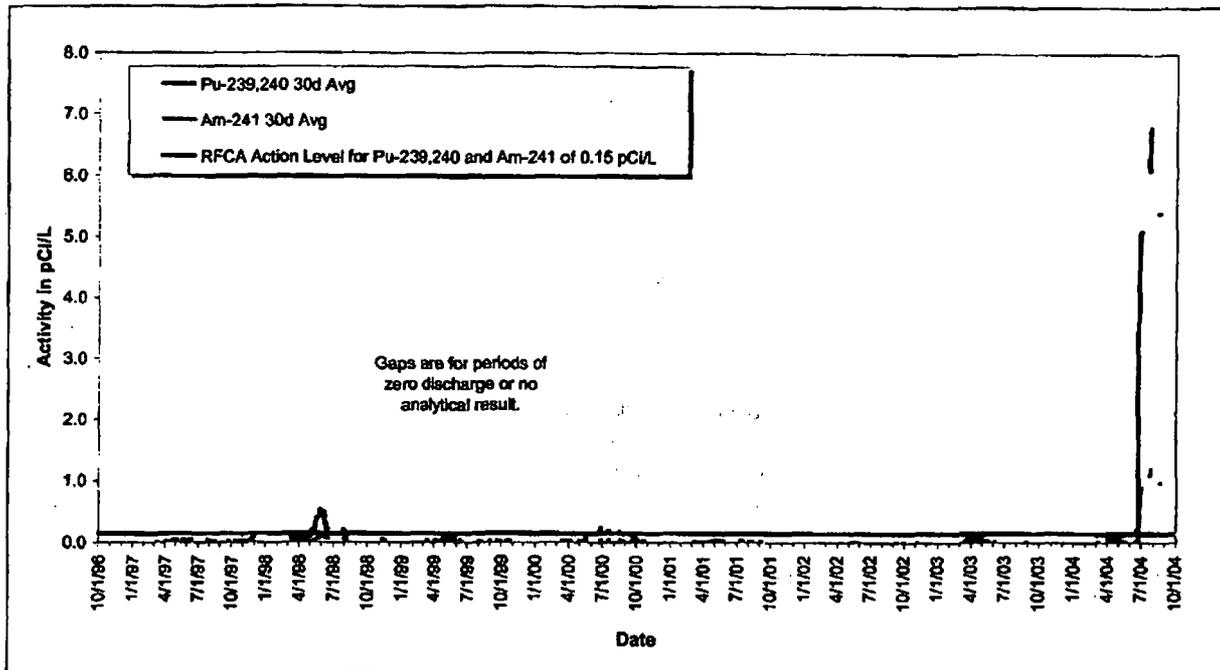


Figure 4-2. POE Monitoring Station SW027: 30-Day Volume-Weighted Average Values for Pu and Am Activities (10/1/96 - 9/20/04).

The analytical results for the composite samples collected around the period of reportable values have been validated through 8/18/04. A review of historical SW027 monitoring data shows that these results are significantly higher than usual, and higher than results associated with previous reportable periods. During the period of continuous flow-paced monitoring under RFCA, there have been two other occurrences of reportable 30-day average values for Pu (Figure 4-2; no previous reportable Am periods). The reportable measurements generally occur during periods of increased stormwater runoff in the spring and summer months. Individual composite-sample results for SW027 are listed in Table 4-2 and plotted in Figure 4-3 for the recent period of interest.

All water monitored at SW027 during this period flowed to Pond C-2 and remains in Pond C-2 as of 10/25/04.

Table 4-2. WY04 Composite Sample Analytical Results for SW027 Reportable Periods.

| Composite Sample Period | Pu-239,240 (pCi/l) | | Am-241 (pCi/l) | | Composite Sample Volume (Liters) | SID Discharge Volume During Sample Period (MG) |
|-------------------------|--------------------|-----------|----------------|-----------|----------------------------------|--|
| | Result | Error (±) | Result | Error (±) | | |
| 4/24 - 5/3/04 | 0.078 | 0.032 | 0.009 | 0.014 | 9.6 | 0.60 |
| 5/3 - 6/23/04 | 0.234 | 0.070 | 0.046 | 0.024 | 11.2 | 0.82 |
| 6/23 - 6/28/04 | 8.170 | 1.800 | 1.430 | 0.324 | 20.0 | 0.83 |
| 6/28 - 6/30/04 | 5.450 | 1.180 | 0.993 | 0.231 | 20.0 | 0.26 |
| 6/30 - 7/24/04 | 13.200 | 2.890 | 2.330 | 0.521 | 19.8 | 0.46 |
| 7/24 - 8/19/04 | 1.270 | 0.290 | 0.251 | 0.073 | 19.8 | 0.48 |
| 8/19 - 9/21/04 | 0.193 | 0.058 | 0.114 | 0.042 | 7.0 | 0.11 |

Notes: Activities greater than the Action Level are indicated in red. Action Levels apply only to 30-day averages and the selective formatting in this table is provided for reference only.

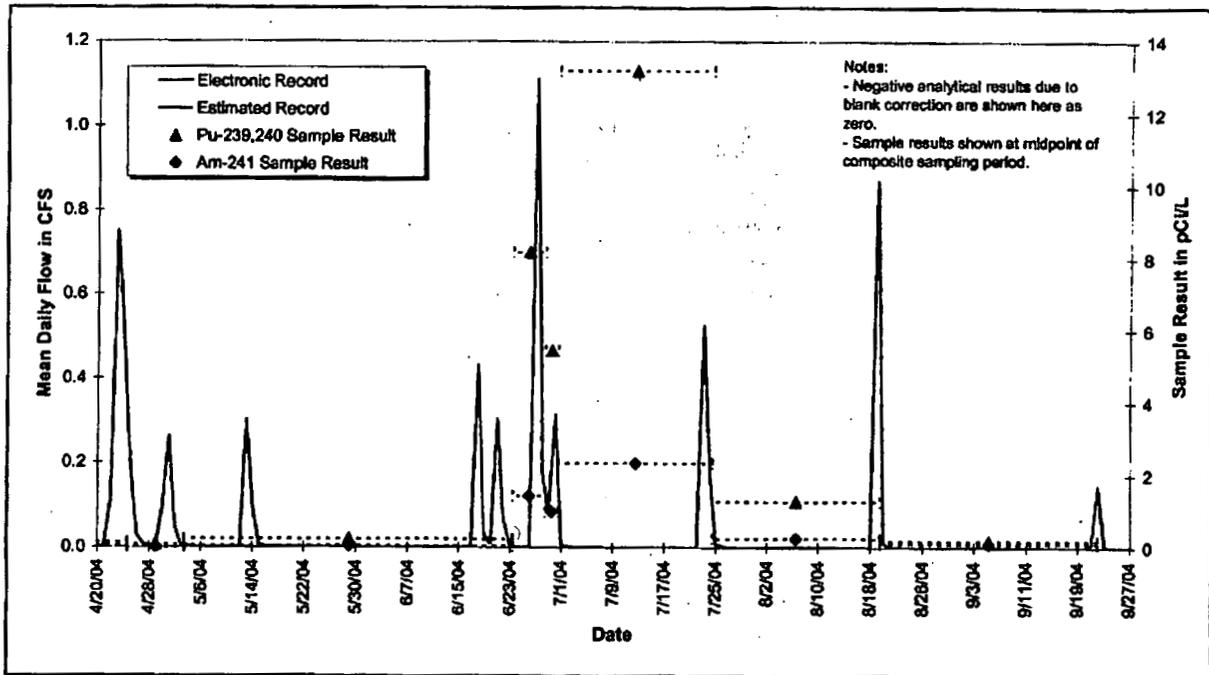


Figure 4-3. Monitoring Station SW027 Hydrograph with Individual Sample Results and Sample Period Bars: 4/24/04 – 9/21/04.

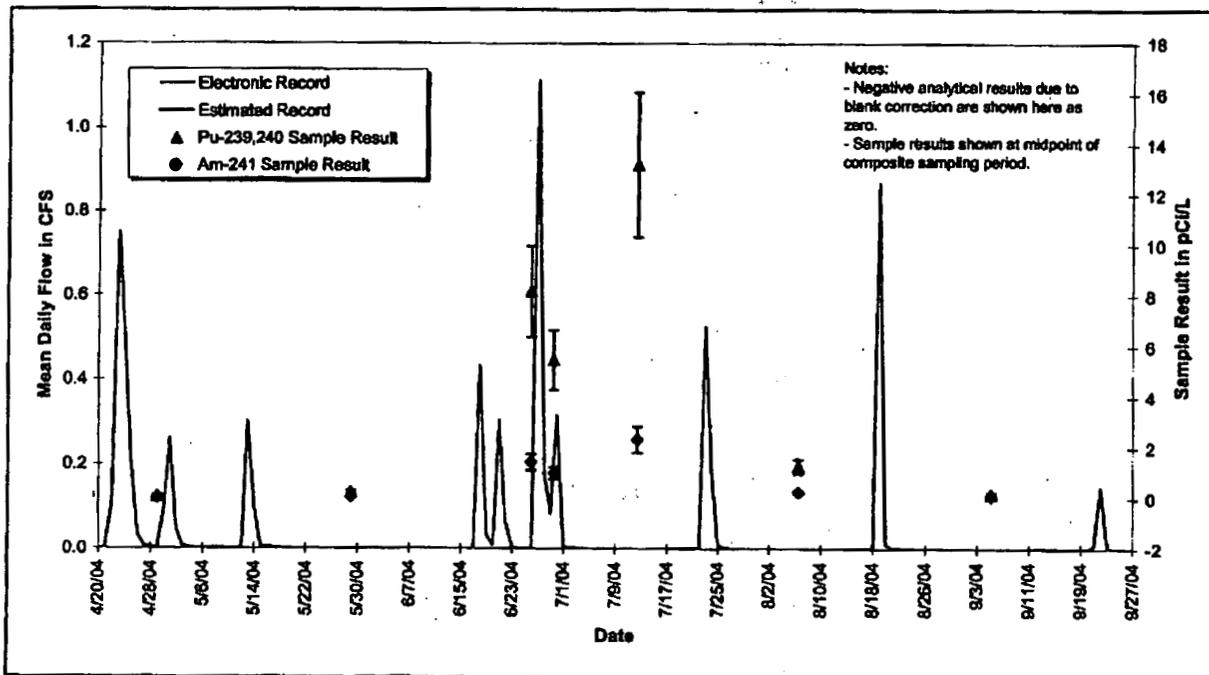


Figure 4-4. Monitoring Station SW027 Hydrograph with Individual Sample Results and Error Bars: 4/24/04 – 9/21/04.

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4.3 DATA SUMMARY AND ANALYSIS

The following data evaluation for SW027 includes all surface-water data available as of 10/6/04. Monitoring data were extracted from the SWD or taken from hardcopy analysis reports for the locations of interest and subsequently reconciled against SWD. The following list describes the environmental data compilation process:

- Individual sample result values are calculated as arithmetic averages of real and field duplicate results when both results are from the same sampling event.³⁵
- When available, Site-requested laboratory reruns are averaged with initial runs for the same sampling event.³⁵
- Laboratory duplicate and replicate QC results are not used.
- When negative values for actinide measurement are returned from the laboratories due to blank correction, 0.0 pCi/l is used in the calculations.
- Only total radionuclide measurements are used, and
- Data that did not pass validation (rejected data) are not used.

4.3.1 Verification and Validation of Surface-Water Analytical Results

All surface-water isotopic data are either verified or validated, based on criteria determined by ASD, or at the special request of the customer. Approximately 75% of all isotopic data are verified and the remaining 25% are validated. Validation is typically determined randomly for each subcontracted laboratory, based on the specific analytical suites. This random validation selection may or may not routinely include POE or POC locations. However, when reportable values are observed, all analytical results used in the calculations receive formal validation.

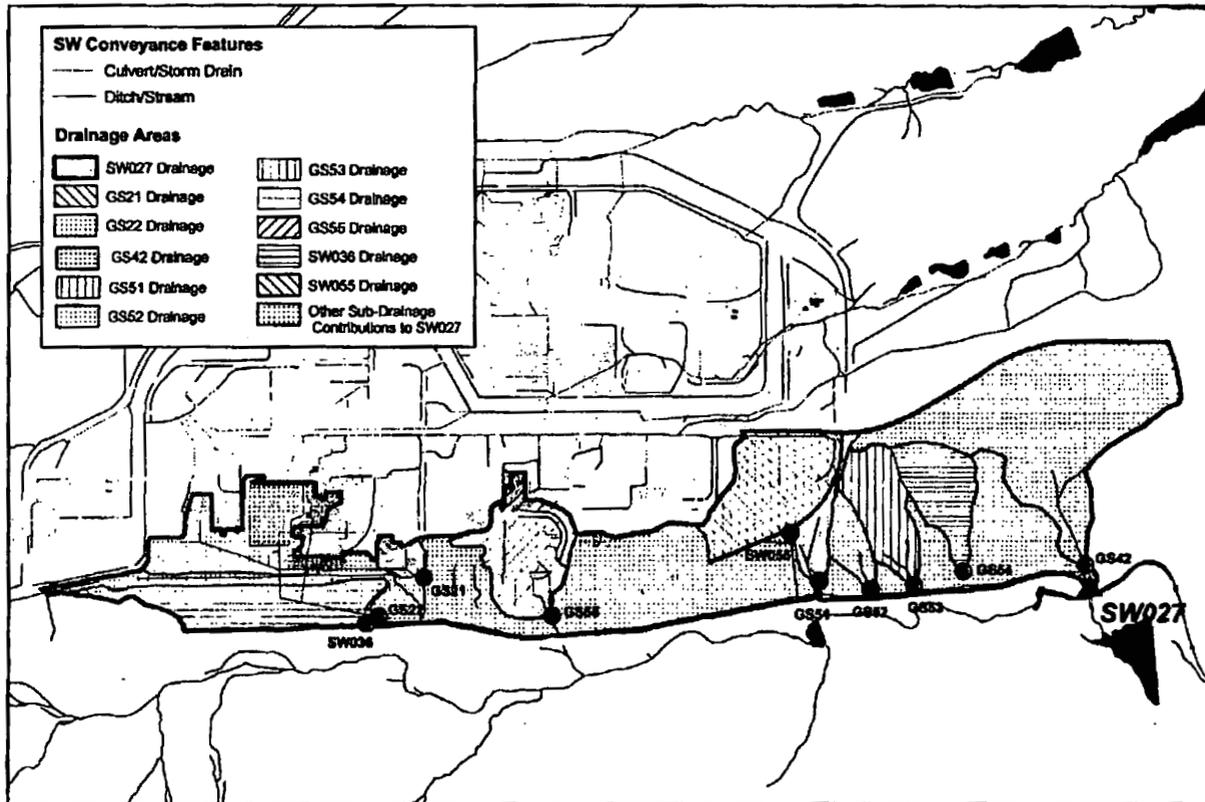
For samples collected at SW027 during the reportable periods, all isotopic data not randomly selected for validation were specifically submitted for validation at the request of Site personnel. All isotopic data package validation was performed by a subcontractor to ASD, and all packages during the reportable period through 8/18/04 were considered valid. Validation for subsequent data is pending.

4.3.2 Actinide Data Summary

Since 12/11/02, nine upstream automated monitoring locations have been operating as part of the continuing source evaluation for SW027 as a response action to past reportable Pu and Am measurements. These locations are GS21, GS22, GS42, GS51, GS52, GS53, GS54, GS55, and SW036 (Figure 4-5). These stations were installed or upgraded to monitor subdrainages that are tributary to SW027. These locations are operated Source Location monitoring stations to characterize water quality and specifically measure Pu and Am loads from the respective subdrainages in an attempt to identify any discrete source areas. Summary statistics for sample results from these locations are shown in Table 4-3. Continuous flow-paced sampling is used for the above locations and volume-weighted average activities are given in Table 4-3.

Monitoring location SW055 was also installed on 5/22/01 to support source evaluations for SW027. As the 903 Pad/Lip project progressed, it became necessary to remove SW055 on 4/28/04 to make way for soil removal actions. As the 903 Pad/Lip project reconfigured drainage areas as a direct result of soil removal actions, the area that had been tributary to SW055 became tributary to GS51. With the completion of the 903 Pad/Lip project, the remaining monitoring locations provide comprehensive surface-water monitoring. Due to the non-continuous period of data collection at SW055, data collected at SW055 are not included in the following analysis.

³⁵ Radionuclide data pairs are averaged when the DER is less than 1.5 (see Appendix Section B.1 - Analytical Data Evaluation Methods in the RFETS Automated Surface-Water Monitoring: WY03 Annual Report).



Note: Drainage areas have changed as the Site moves toward Closure and the land and drainage features are reconfigured. The drainage areas shown are current as of 9/10/04.
 SW055 was removed on 4/28/04 to make way for soil removal activities. Runoff measured at SW055 used to flow directly to the SID. During remediation, runoff gradually began flowing to GS51. With the completion of the 903 Pad/Lip remediation, runoff from the area formerly monitored by SW055 is now monitored at GS51. As such, SW055 is not included in the analysis.

Figure 4-5. Automated Surface-Water Monitoring Locations and Corresponding Subdrainage Areas Tributary to SW027.

Table 4-3. Summary Statistics for Samples from SW027 and Monitoring Locations Tributary to SW027: 12/11/02 to Present.

| Sampling Location | Number of Samples | Pu-239,240 | | Am-241 | |
|-------------------|-------------------|--------------------------|-------------------------------|--------------------------|-------------------------------|
| | | Average Activity (pCi/l) | Maximum Sample Result (pCi/l) | Average Activity (pCi/l) | Maximum Sample Result (pCi/l) |
| SW027 | 18 | 0.999 | 13.2 | 0.176 | 2.33 |
| GS21 | 19 | 0.019 | 0.048 | 0.006 | 0.022 |
| GS22 | 24 | 0.013 | 0.055 | 0.010 ^a | 0.029 |
| GS42 | 8 | 3.31 | 40.2 | 0.527 | 6.72 |
| GS51 | 17 | 8.76 | 99.7 | 2.01 ^b | 21.7 ^b |
| GS52 | 12 | 43.6 | 119 | 3.18 ^a | 17.3 ^b |
| GS53 | 5 | 44.9 | 49.0 | 10.9 | 11.9 |
| GS54 | 2 | 0.065 | 0.139 | 0.002 | 0.002 |
| GS55 | 25 | 0.058 | 0.568 | 0.016 ^a | 0.179 ^b |
| SW036 | 17 | 0.002 | 0.057 | 0.001 | 0.014 |

Notes: ^aSome results rejected through validation.

^bEstimated using Pu/Am ratio and available Pu result.

Figure 4-6 shows the average annual activities at SW027 for WY97 – WY04³⁶. Due to the continuous flow-paced sampling protocols currently in place under RFCA, volume-weighted average activities are shown. Although reportable 30-day average values occurred in recent years, the volume-weighted average for WY04 is significantly greater than the activities for previous years. This suggests the possibility of a new source term, a new source area not previously contributing contamination, and/or increased transport of previously contributing source terms.

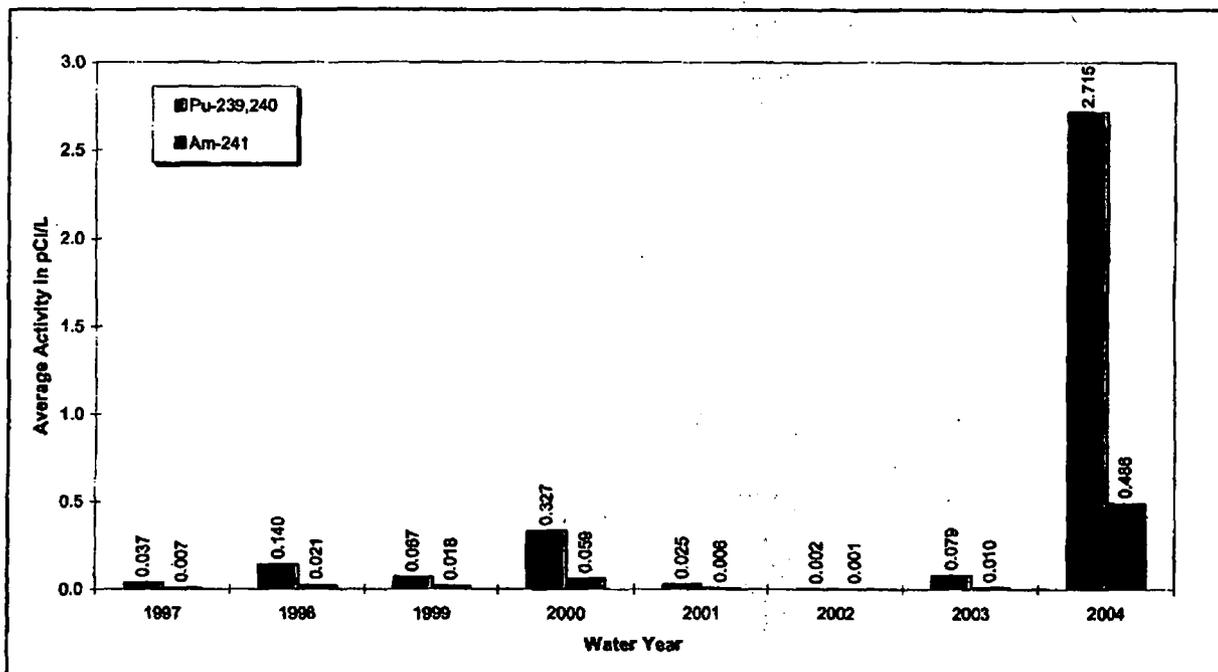
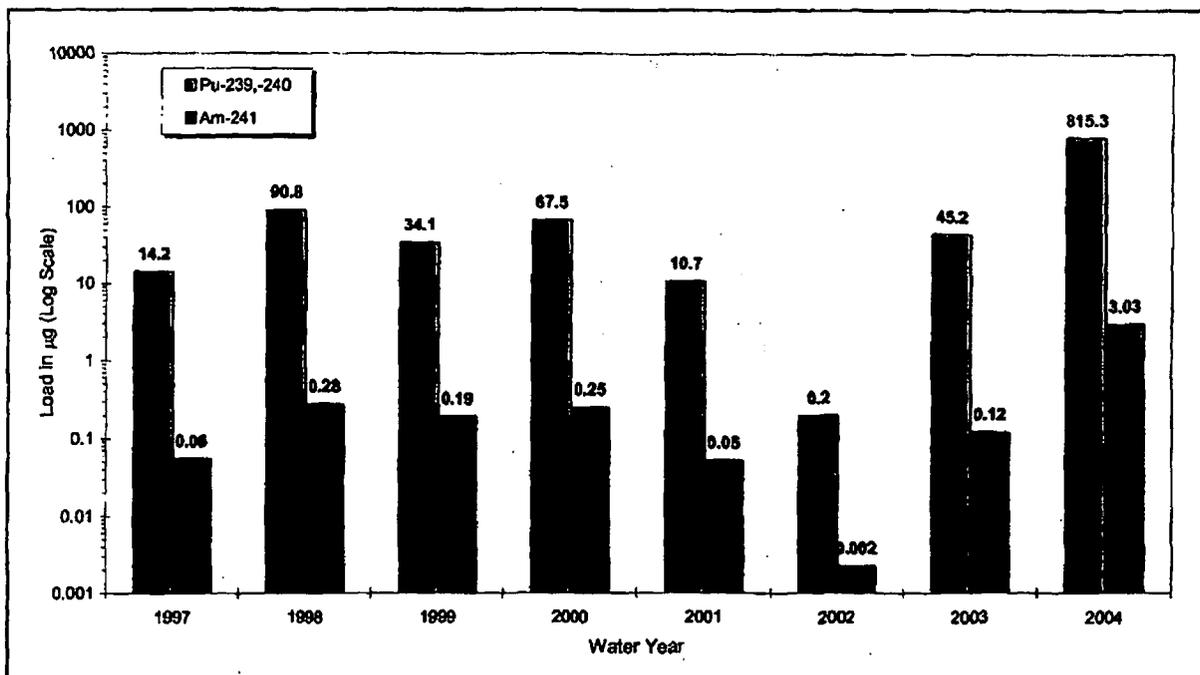


Figure 4-6. Average Annual Pu and Am Activities at SW027: WY97-04.

4.3.3 Annual SW027 Loads

Annual actinide loads for SW027 in micrograms (log-scale) are plotted in Figure 4-7 to show long-term loading to SW027. For WY97-WY04, the activity for each flow-paced composite sample is multiplied by the associated discharge volume to get pCi, then converted to micrograms and totaled annually. Although reportable 30-day average values occurred in recent years, the loads for WY04 are significantly greater than the loads for previous years. As stated previously, this suggests the possibility of a new source term, a new source area not previously contributing contamination, and/or increased transport of previously contributing source terms.

³⁶ For WY04 the average shown is through 9/20/04.



Load through 9/20/04 for WY04 is plotted.

Figure 4-7. Annual Pu and Am Loads at SW027: WY97-04.

4.4 RELATIVE LOADING ANALYSIS

This loading analysis uses data from all automated monitoring locations that are currently tributary to SW027 (Figure 4-5). These locations are GS21, GS22, GS42, GS51, GS52, GS53, GS54, GS55, and SW036. The analysis is performed for the time period 12/11/02 through 8/19/04.

Table 4-4 gives location and drainage basin detail for the monitoring locations used in this loading analysis. The hydrologic connectivity of these locations is shown in Figure 4-1

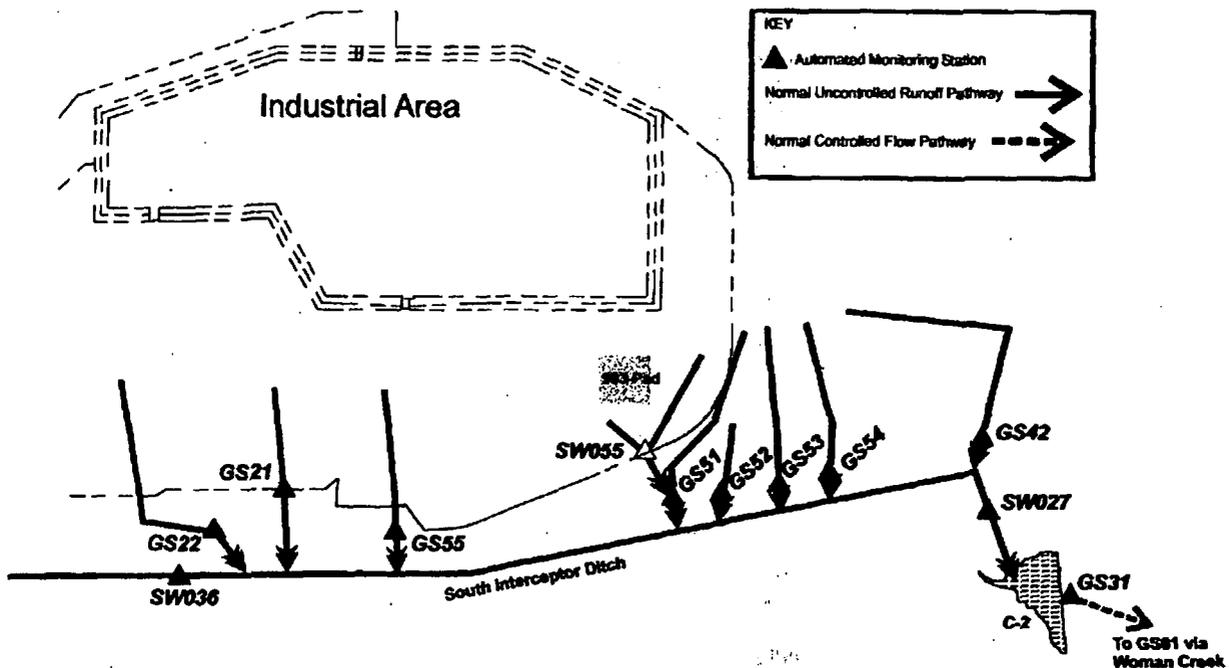
Table 4-4. Location and Drainage Basin Detail.

| Location Code | Location Detail | Contributing Areas |
|---------------|--|--|
| SW027 | SID just upstream of Pond C-2 | 100, 400, 600, 800, 900; 215.9 acres |
| GS21 | Culvert SE of B664 | B664 area; 2.4 acres |
| GS22 | Outfall to SID draining 400 Area | 400; 17.2 acres |
| GS42 | Gulch tributary to SID 150' above POE SW027 | Area east of 903 Pad/Lip; 45.2 acres |
| GS51 | Ditch along abandoned road south of 903 Pad just upstream of SID | 903 Pad/Lip area; 3.9 acres prior to rerouting of SW055 runoff, 21.6 acres including SW055 subdrainage |
| GS52 | Gully SSE of 903 Pad just upstream of SID | 903 Pad/Lip area; 4.3 acres |
| GS53 | Gully SE of 903 Pad just upstream of SID | 903 Pad/Lip area; 10.1 acres |
| GS54 | Gully ESE of 903 Pad just upstream of SID | 903 Pad/Lip area; 9.5 acres |
| GS55 | Outfall to SID draining B881 area | 800; 14.8 acres |
| SW036 | SID downstream of Original Landfill | Original Landfill area; 16.4 acres |

Loads for SW027, GS21, GS22, GS42, GS51, GS52, GS53, GS54, GS55, and SW036 continuous flow-paced samples were calculated as detailed in Appendix B.1 Analytical Data Evaluation Methods in the RFETS Automated Surface-Water Monitoring: WY03 Annual Report. The load for any period is then the sum of the individual sample loads during that period. In the following section, total loads and percentages do not necessarily balance due to rounding.

4.4.1 Relative Subdrainage Loads: December 11, 2002 through August 19, 2004

The loading analysis in this section uses all available data for the period 12/11/02 through 8/19/04 from SW027 and the nine upstream monitoring stations (GS21, GS22, GS42, GS51, GS52, GS53, GS54, GS55, and SW036). This loading analysis does not address the attenuation of actinides as they are transported from one monitoring location to the next. The analysis assumes that as the period of sampling is increased, the temporal effects of actinide transport will not significantly affect the relative loads from the various subdrainages. The hydrologic connectivity of these locations is shown in Figure 4-8.



Notes: SW055 was removed on 4/28/04 to make way for soil removal activities. Runoff measured at SW055 used to flow directly to the SID. During remediation flows gradually began flowing to GS51. With the completion of the 903 Pad/Lip remediation, runoff from the area formerly monitored by SW055 is now monitored at GS51.

Figure 4-8. Hydrologic Connectivity of Monitoring Locations Tributary to SW027 (as of 12/11/02).

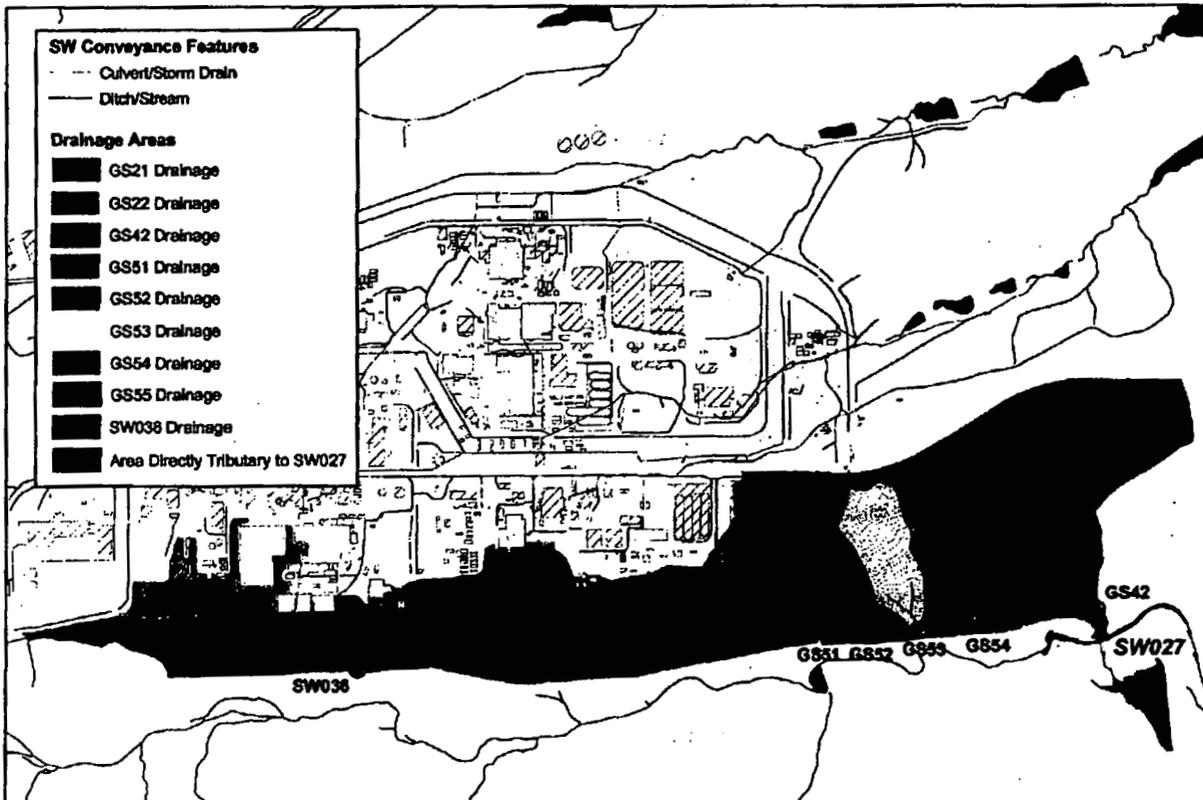
Figure 4-10 and Figure 4-11 indicate that the GS51 and GS52 subdrainages are contributing the majority of the Pu load estimated at SW027. Additionally, analysis shows that the Pu loads from GS51 and GS52 have increased significantly in WY04 (Figure 4-14 and Figure 4-15). This suggests that recent projects impacting these subdrainages, especially the 903 Pad/Lip remediation project, may have negatively impacted water quality.

Figure 4-12 and Figure 4-13 indicate that the GS51 and GS52 subdrainages are also contributing the majority of the Am load estimated at SW027.

Table 4-5. Comparison of Pu and Am Loads at Tributary Locations with SW027: 12/11/02 through 8/19/04.

| Location | Pu-239,240 Load in μg | Am-241 Load in μg |
|----------|----------------------------------|------------------------------|
| SW027 | 859.3 | 3.14 |

| Location | Pu-239,240 | | Am-241 | |
|------------------------------------|-----------------------|---------------------------------|-----------------------|---------------------------------|
| | Load In μg | Load as a Percent of SW027 Load | Load In μg | Load as a Percent of SW027 Load |
| GS21 | 0.9 | 0.1% | 0.01 | 0.2% |
| GS22 | 10.7 | 1.2% | 0.17 | 5.5% |
| GS42 | 16.2 | 1.9% | 0.05 | 1.7% |
| GS51 | 472.0 | 54.9% | 2.25 | 71.7% |
| GS52 | 722.8 | 84.1% | 1.09 | 34.8% |
| GS53 | 28.3 | 3.3% | 0.14 | 4.5% |
| GS54 | <0.1 | <0.1% | <0.01 | <0.1% |
| GS55 | 21.8 | 2.5% | 0.14 | 4.6% |
| SW036 | 0.2 | <0.1% | <0.01 | <0.1% |
| "Area Directly Tributary to SW027" | -413.6 (loss) | -48.1% (loss) | -0.73 (loss) | -23.2% (loss) |



Note: The former SW055 subdrainage is shown as magenta/green hatched; area is now tributary to GS51.

Figure 4-9. Subdrainage Map for Areas Tributary to SW027: As of 12/11/02.

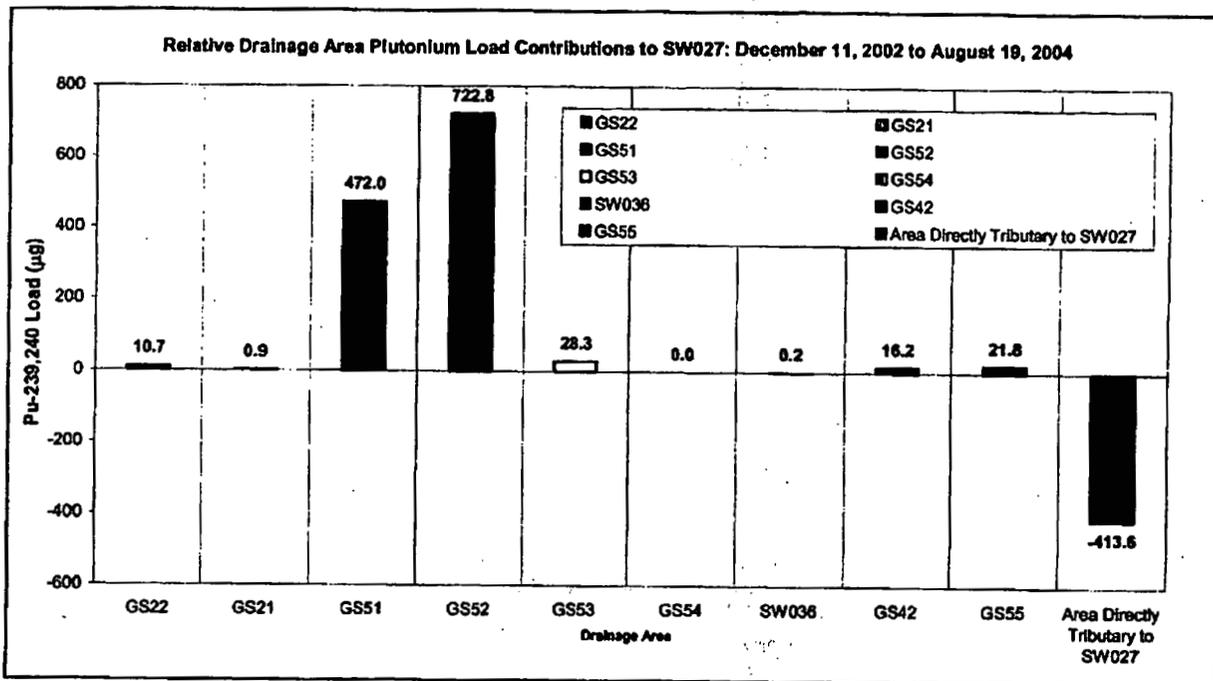


Figure 4-10. Relative Pu Load Contribution Chart for Locations Tributary to SW027: 12/11/02 through 8/19/04.

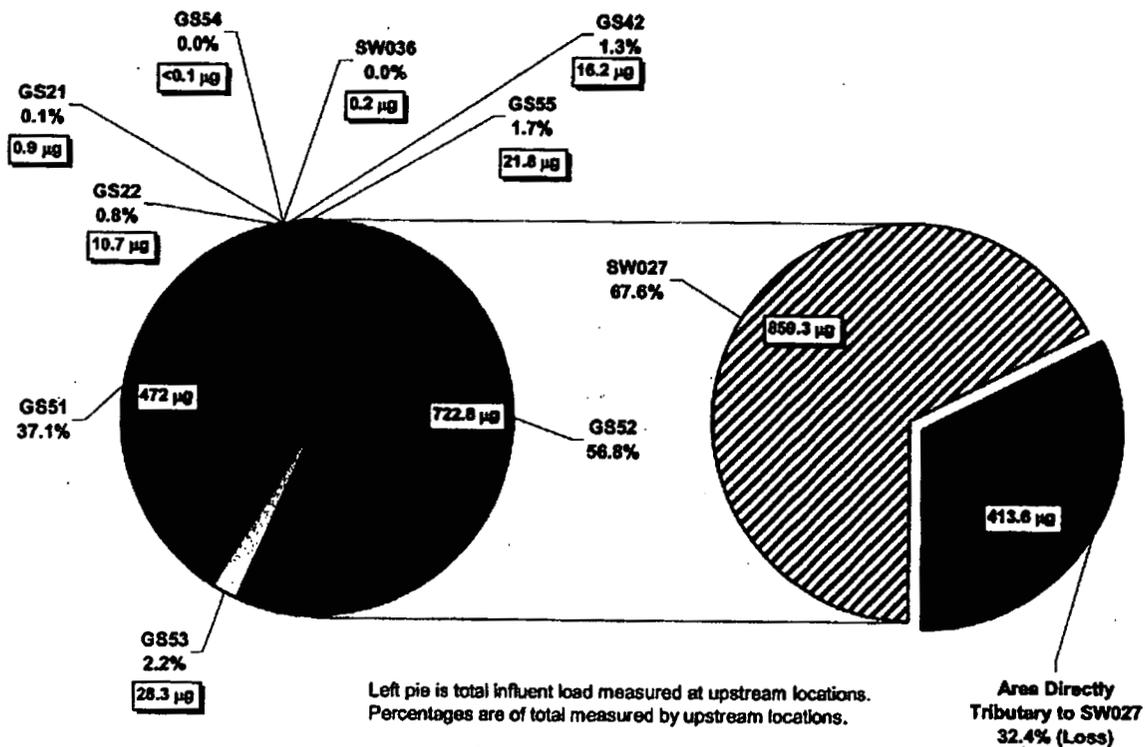


Figure 4-11. Relative Pu Load Contribution Pie for Locations Tributary to SW027: 12/11/02 through 8/19/04.

92

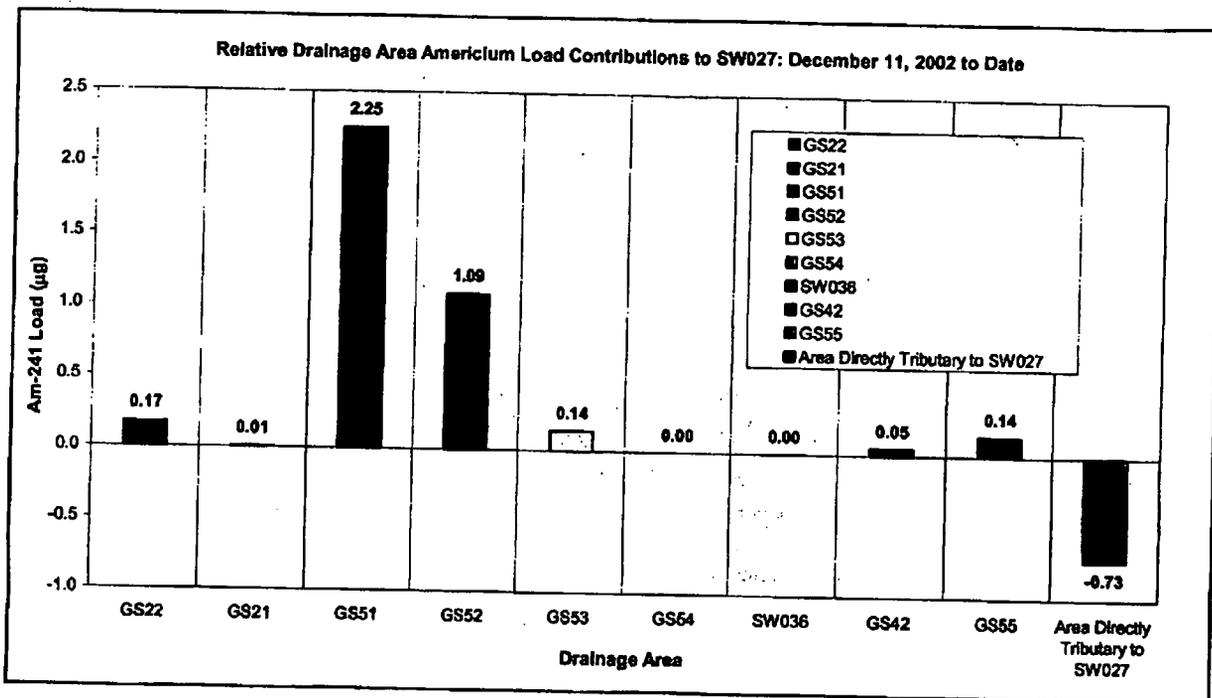


Figure 4-12. Relative Am Load Contribution Chart for Locations Tributary to SW027: 12/11/02 through 8/19/04.

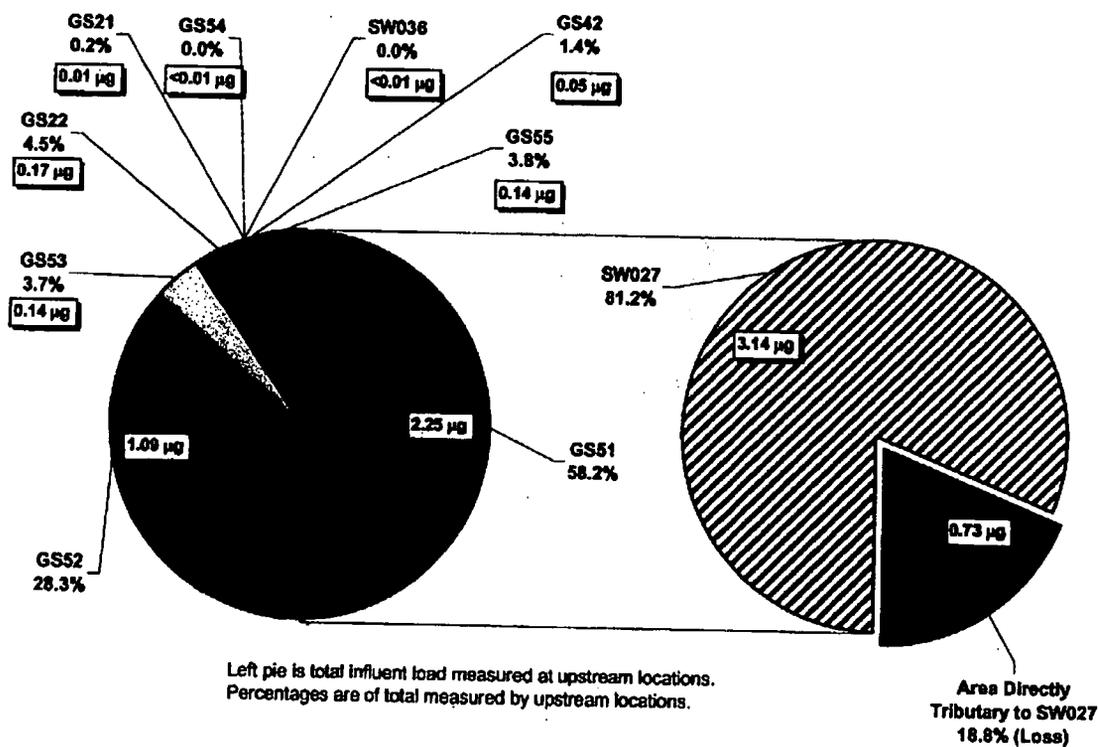


Figure 4-13. Relative Am Load Contribution Pie for Locations Tributary to SW027: 12/11/02 through 8/19/04.

91

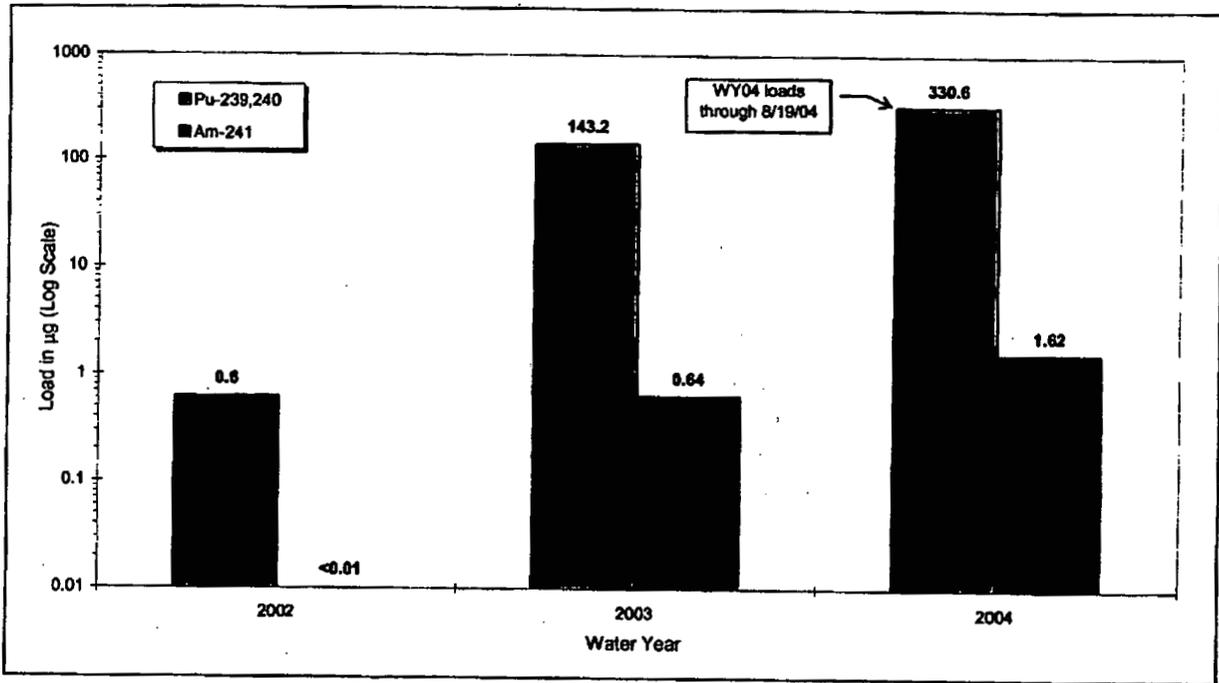


Figure 4-14. Annual Pu and Am Loads at GS51.

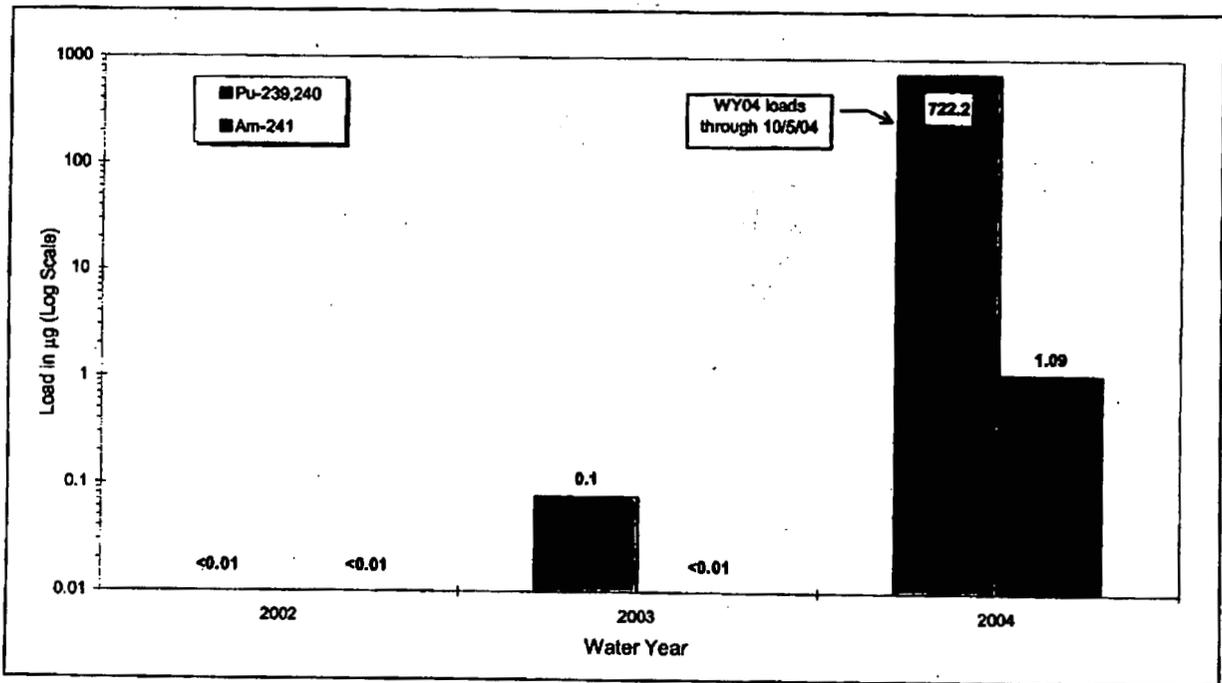


Figure 4-15. Annual Pu and Am Loads at GS52.

4.5 EROSION CONTROL MEASURES

The Site is implementing an aggressive program of erosion control to prevent the movement of soils and sediments and to protect storm water and surface-water quality. The increased activities of building removal and soil disturbance require rigorous erosion control methods. A number of control methods are currently being used, from straw bales and wattles to soil tackifiers and erosion blankets. Ultimately, disturbed sites are revegetated.

Immediately following confirmation of reportable values at SW027, a preliminary loading analysis was performed that also identified the GS51 and GS52 subdrainages as major contributor to SW027. The loading analysis above further confirms GS51 and GS52 as major Pu and Am load contributors to SW027. Since the majority of Pu and Am is transported in surface water attached to particulate matter (suspended solids), a number of erosion controls have been added to the Site drainages, and specifically the 903 Pad/Lip area. Although the 903 Pad/Lip project had been utilizing extensive erosion controls throughout the duration of the project, the reportable values at SW027 initiated the enhanced and more rigorous application of these controls. These additional controls were installed in the 903 Pad/Lip area starting on 6/23/04, augmenting the preexisting erosion methods the Site has been routinely using. Controls have been added in the form of straw wattles, straw bales, and erosion matting in the areas that contribute runoff to 903 Pad/Lip monitoring locations (Figure 4-16). Additional erosion controls have been installed throughout the SW027 drainage based on field walkdowns and monitoring data analysis identifying areas of sediment transport and specifically for projects likely to impact surface water.

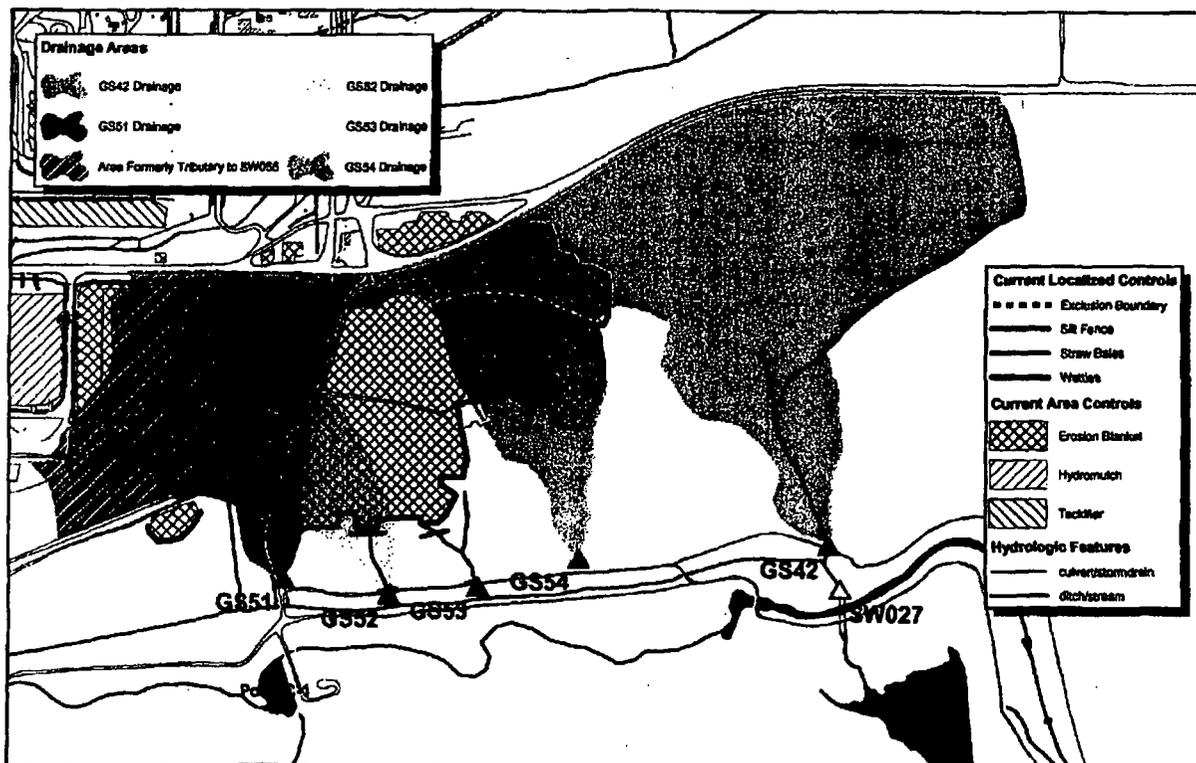


Figure 4-16. Erosion Controls in the 903 Pad/Lip Area as of 11/2/04.

4.6 WATER-QUALITY TRENDS AND CORRELATIONS: SW027

Higher than normal Pu and Am activities began to be measured at SW027 starting with the composite sample for the period 5/3 – 6/22/04 (Figure 4-17). For the period 10/1/02 – 9/20/04, the average Pu/Am ratio at SW027 was 5.5. No change in Pu/Am ratios is noted in WY04, suggesting that recent higher activities are from the same area or source term as the activities for previous samples. For roughly the same period, a similar pattern in activities is noted for samples collected at GS51 and GS52 (Figure 4-18 and Figure 4-19). These patterns further support the conclusion that flow from the 903 Pad/Lip area was affecting water quality at SW027.

No significant water-quality improvement due to erosion controls has been observed to-date for SW027 (Figure 4-17). This may be caused by the continued transport of residual solids in the flow pathways downstream of the new erosion controls. However, data from both GS51 and GS52 show a recent reduction in activities.

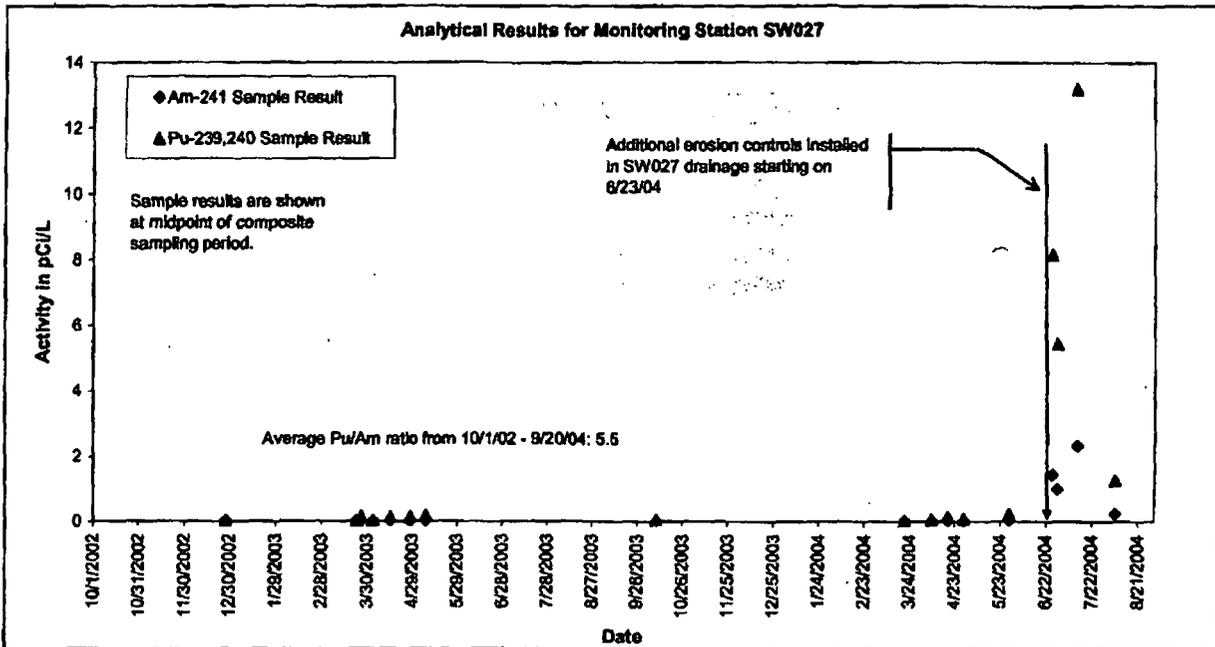
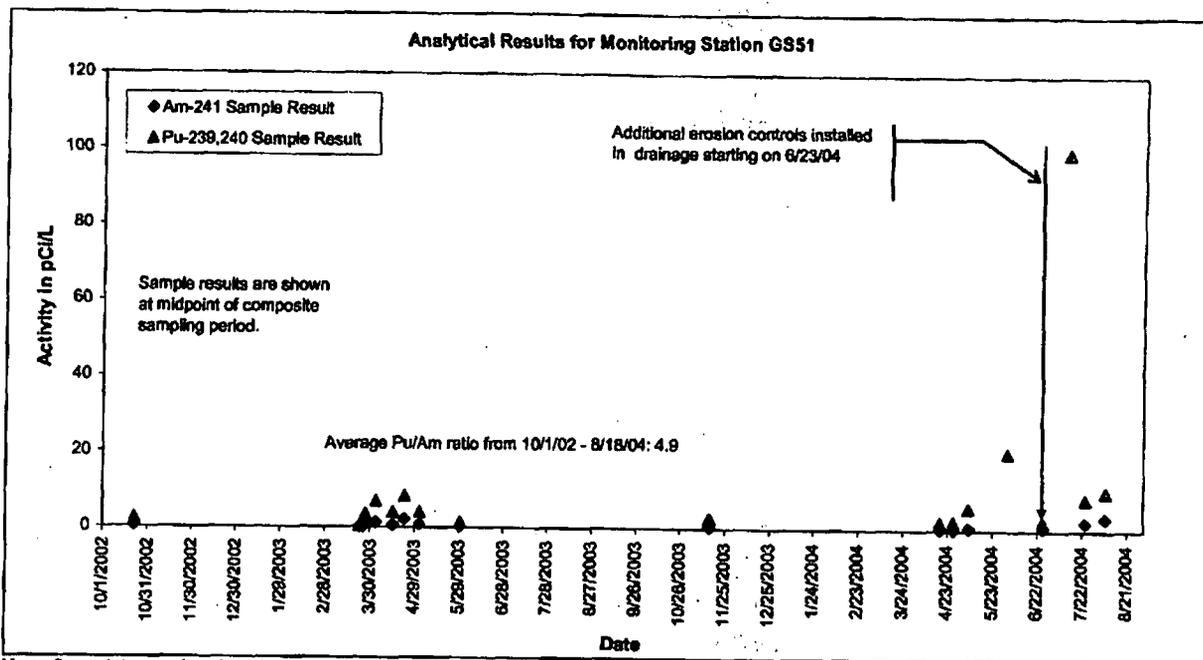


Figure 4-17. Individual Sample Results at SW027: 10/1/02- 9/20/04.

94



Note: Several Am results rejected through data validation.

Figure 4-18. Individual Sample Results at GS51: 10/1/02- 8/18/04.

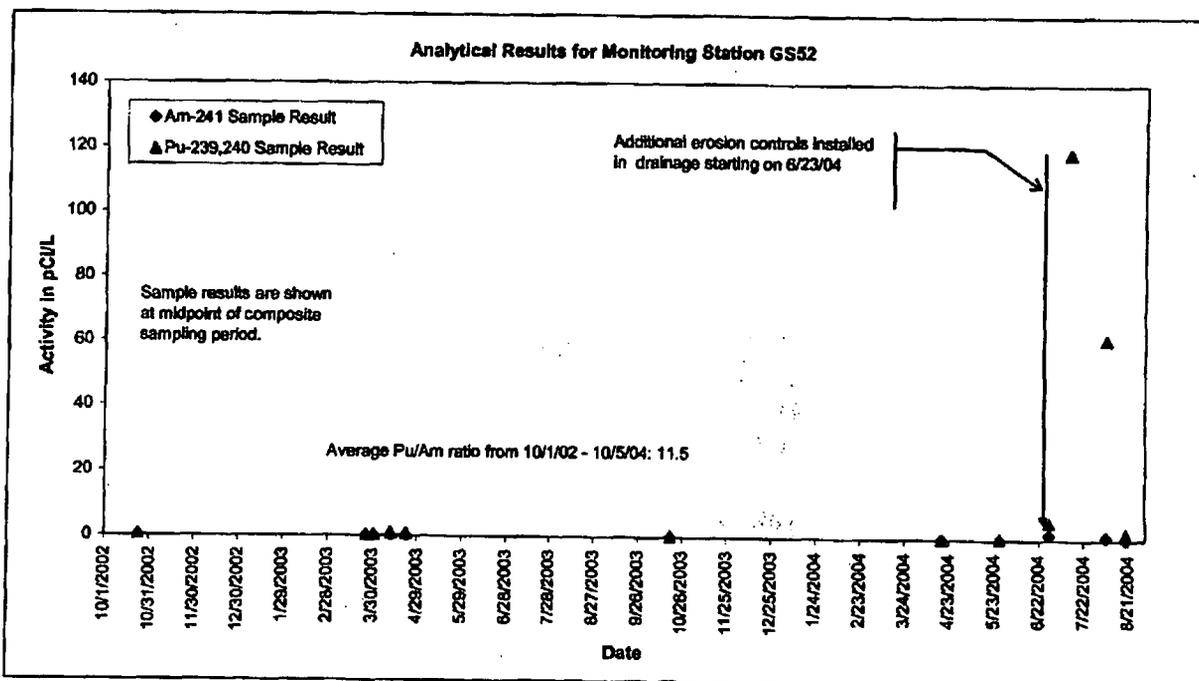


Figure 4-19. Individual Sample Results at GS52: 10/1/02- 10/5/04.

95

Since Pu and Am are transported attached to suspended solids, an increase in suspended solids activity (sample activity divided by TSS concentration [pCi/g]) suggests the increased contribution of a relatively more contaminated area, and/or sediment transport from a previously non-contributing area or source term. Higher than normal Pu and Am suspended solids activities began to be measured at SW027 in WY04 (Figure 4-20). The WY04 suspended solids activities at SW027 are of similar magnitude to those from GS51 and GS52 (Table 4-6).

Table 4-6. WY04 Suspended Solids Activities at SW027, GS51, and GS52.

| Location | Average Suspended Solids Am Activity [pCi/g] | Average Suspended Solids Pu Activity [pCi/g] |
|----------|--|--|
| SW027 | 8.9 | 49.5 |
| GS51 | 6.3 | 22.8 |
| GS52 | 5.3 | 80.8 |

Fractionation of both soils in surface-water runoff and radionuclides in soils is undoubtedly occurring in the area. Both mechanical and physiochemical suspension mechanisms suggest preferential suspension of certain fractions of the surface soil in stormwater runoff. Fractionation may occur as a function of particle size, density, and/or surface chemistry. Furthermore, Pu and Am may associate preferentially with certain fractions of the soil based on surface area and/or surface chemistry. The net result may be a drastically different specific activity of suspended material in the surface water as compared to specific activity of the surface soils.

Regardless, the increase in suspended solids activity at SW027 is likely due to the increased contribution of relatively more contaminated suspended solids from areas not previously susceptible to erosion. The removal of vegetation and the extensive disturbance of previously stable soil areas in the 903 Pad/Lip area are the likely causes.

Since Pu and Am are transported attached to suspended solids, an increase in TSS can result in corresponding increases in activity. The amount of TSS in runoff depends on a number of factors including the availability of disturbed soils (e.g. unconsolidated and unvegetated soil), storm intensity (i.e. precipitation forces), and runoff intensity (flow rates). A deviation in the typical relationship between flow rate and TSS suggests increased availability of transportable soils. Figure 4-21 shows that WY04 turbidities (as an indication of TSS) relative to flow rate are generally higher than for WY03 and prior data. This suggests that soils in the SW027 drainage are more susceptible to transport for a given flow rate than for previous years. Similarly, WY04 TSS data show higher values relative to flow rate than for previous years (Figure 4-22). These patterns suggest that the recent higher activities at SW027 may be the result, at least in part, to the increased transport of legacy contamination associated with soil and sediment, and not new sources.

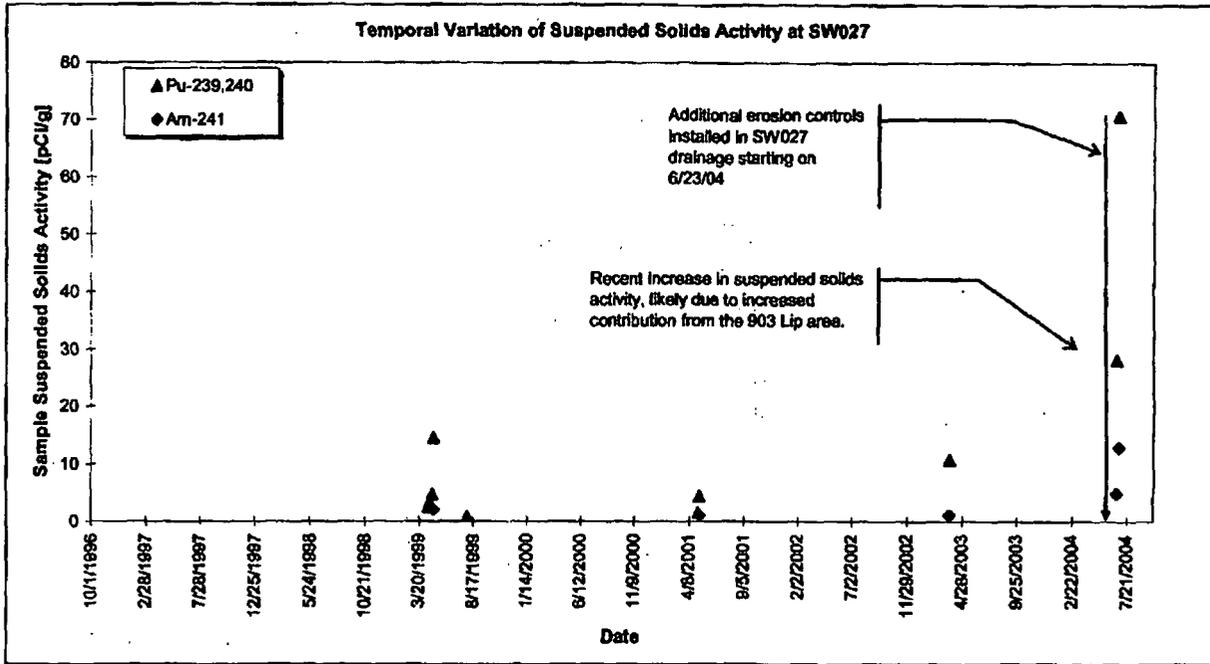


Figure 4-20. Temporal Variation of Suspended Solids Activity at SW027: All RFCA Data.

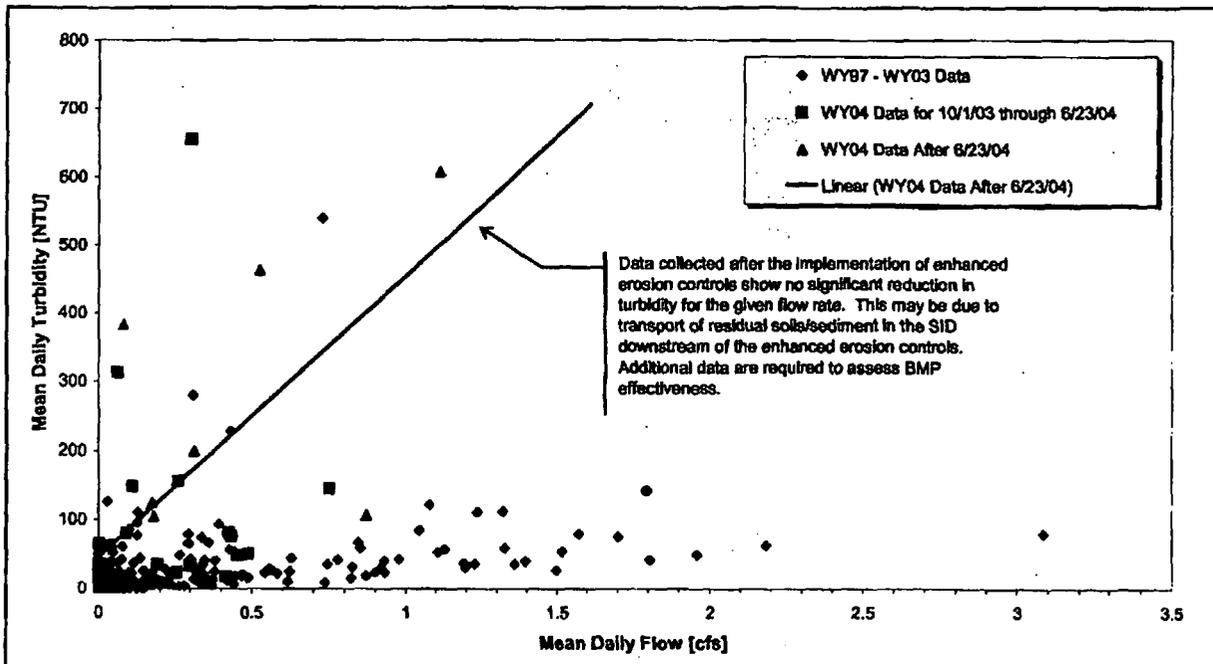


Figure 4-21. Variation of Mean Daily Turbidity with Flow Rate at SW027.

17

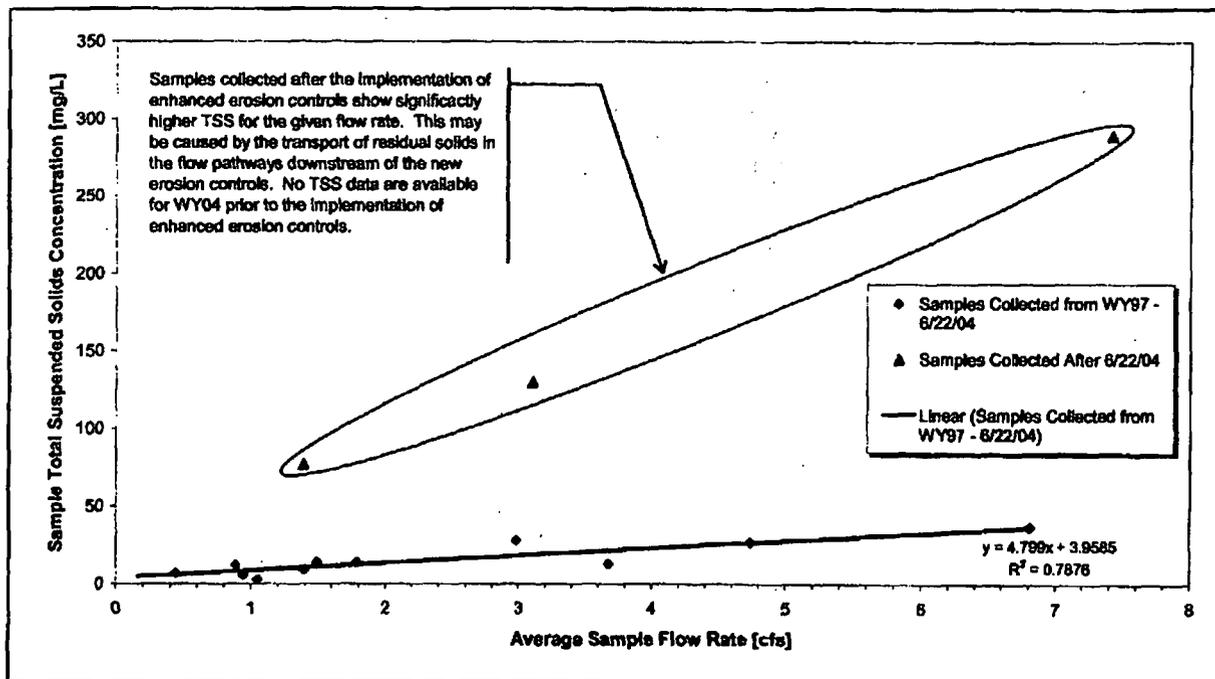


Figure 4-22. Variation of Sample TSS with Flow Rate at SW027.

4.7 SITE ACTIVITIES AND PROJECTS IN AREAS TRIBUTARY TO SW027

During the period of reportable values at SW027, several projects within the SW027 drainage were occurring. The loading analysis and water-quality correlations presented above indicate that remediation activities within the 903 Pad/Lip area are likely to have had the most significant impact to water-quality at SW027.

4.7.1 903 Pad Accelerated Actions

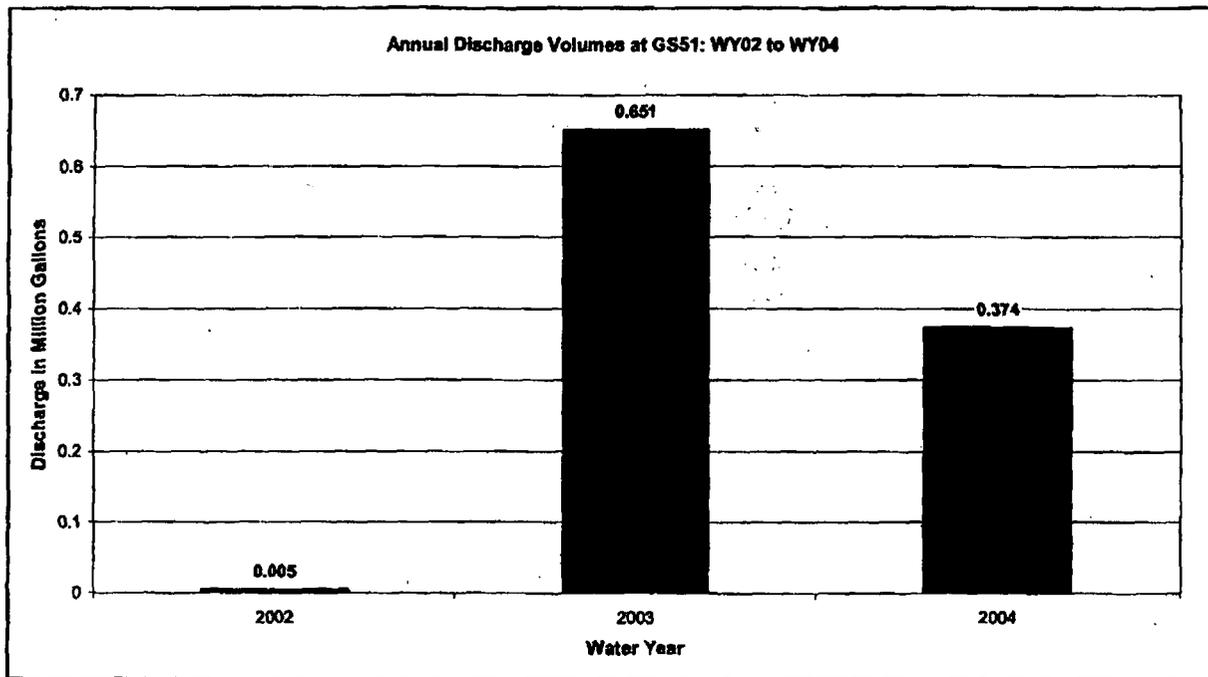
Remediation activities at the 903 Pad/Lip area began in mid-November 2002, with remediation activities in the Outer Lip beginning in the end of April 2004. The IMIRA for IHSS Group 900-11 (Kaiser-Hill, 2004b) provides background for this project. The 903 Pad/Lip area flows to both the SID (POE SW027) and South Walnut Creek (POE GS10). The portion of the 903 Pad tributary to SW027 is upstream of monitoring locations GS42, GS51, GS52, GS53, and GS54 (Figure 4-16).

During WY04, disturbed soils associated with the remediation effort were available for transport in runoff. The loading analysis above showed that the loads from both GS51 and GS52 increased significantly in WY04. In addition, the removal of vegetation and the likely compaction of soil due to vehicle traffic resulted in significantly increased runoff rates from the area. GS51, GS52, and GS53 began operation on 8/13/01, 7/25/01, and 8/1/01 respectively. Table 4-7 shows a comparison of peak flow rates for the periods before and after 5/18/04, when active remediation in the Outer Lip began in areas tributary to GS51, GS52, and GS53. These changes in peak runoff are not solely a function of storm size; WY04 precipitation event depths and frequency were not radically different than WY03.

Table 4-7. Peak Flow Rates at GS51, GS52, and GS53.

| Location | Peak Flow [cfs]; Date Through 5/18/04 | Peak Flow [cfs]; Date After 5/18/04 |
|----------|---------------------------------------|-------------------------------------|
| GS51 | 0.711; 5/10/03 | 1.41; 10/6/04 |
| GS52 | 0.004; 3/26/03 | 2.77; 7/23/04 |
| GS53 | 0.003; 3/26/03 | 0.209; 6/29/04 |

Figure 4-23 through Figure 4-25 show the WY02 – WY04 annual discharge volumes from GS51, GS52, and GS53. GS52 and GS53 show orders of magnitude more runoff volume.³⁷ GS51 does not show more runoff in WY04 compared to WY03. Prior to the 903 Pad/Lip activities, a significant portion of the GS51 drainage included relatively impervious dirt roads and 903 Pad/Lip activities had a lesser impact.

**Figure 4-23. Annual Discharge Volumes at GS51: WY02-04.**

³⁷ WY04 precipitation was 14.9"; WY03 precipitation was 11.3" (equivalent water of March 2003 snow underestimated by unheated gages); WY02 precipitation was 7.7".

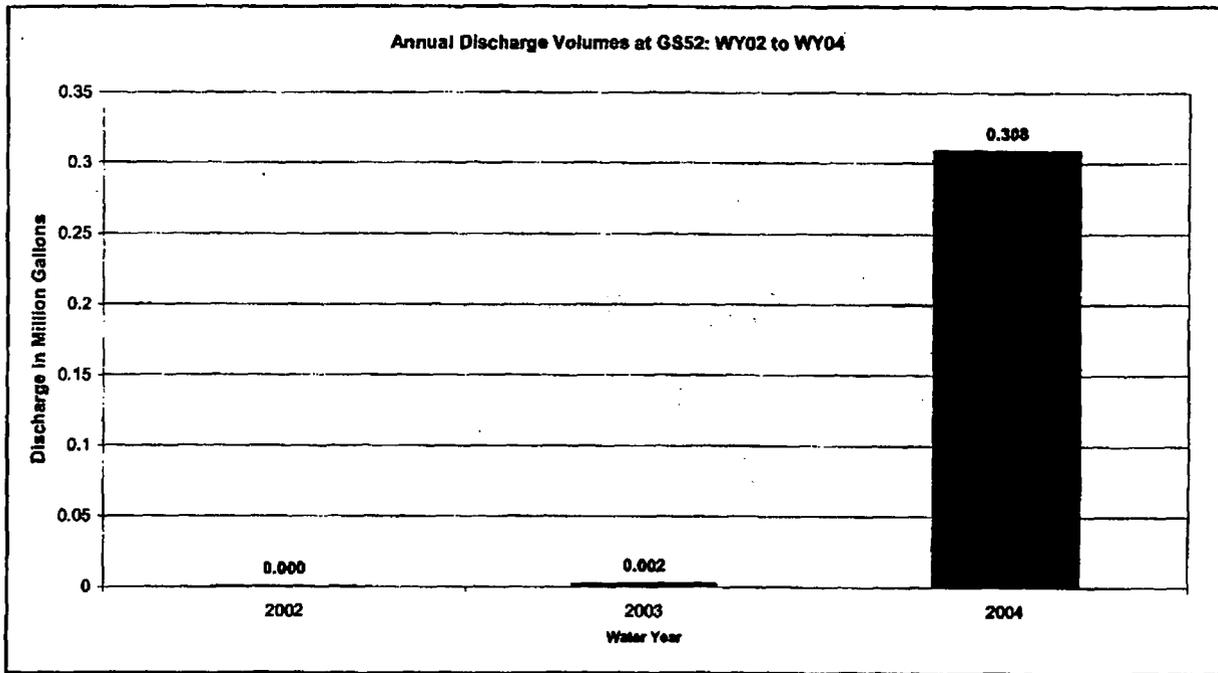


Figure 4-24. Annual Discharge Volumes at GS52: WY02-04.

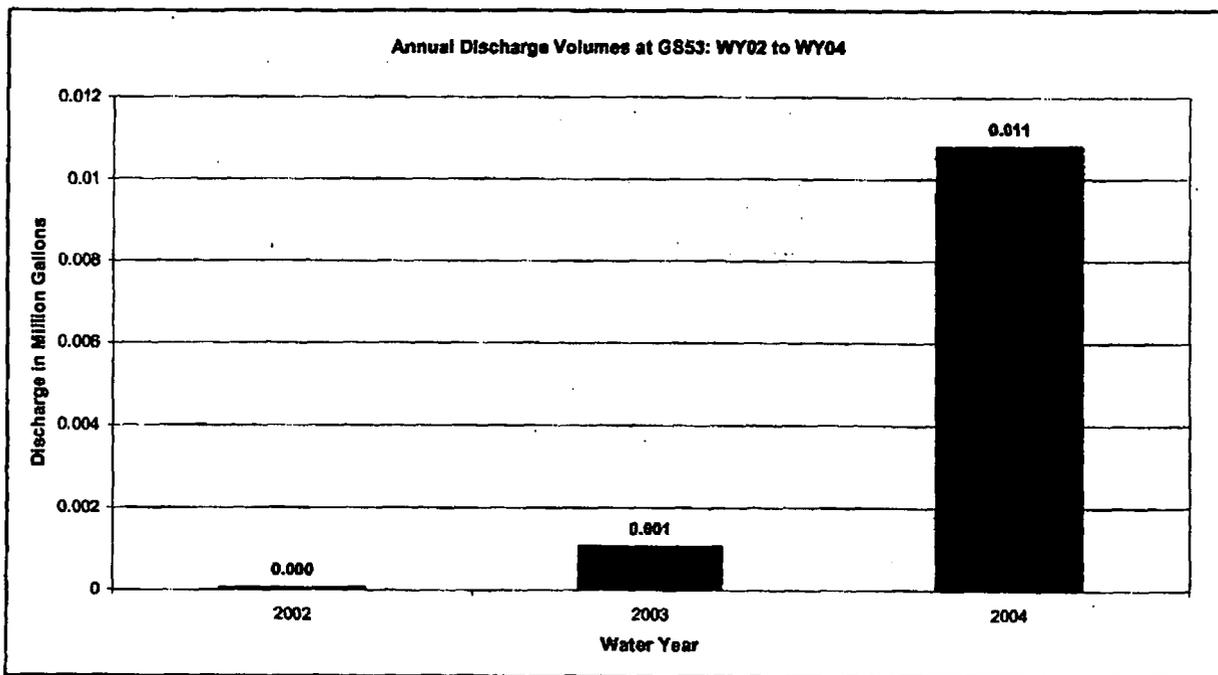
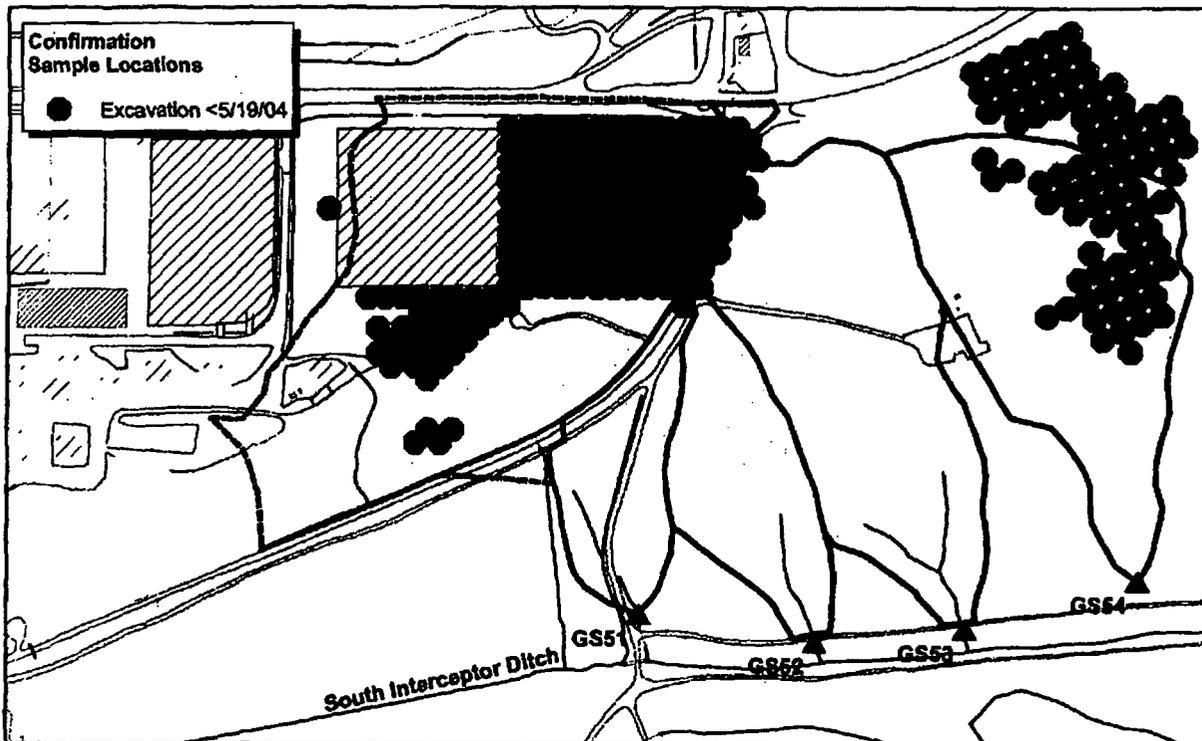


Figure 4-25. Annual Discharge Volumes at GS53: WY02-04.

100

As the 903 Pad/Lip project excavated soils from specific grid cells, confirmation samples were collected to establish that any remaining contamination was below acceptable levels. The date of these confirmation samples provides a method of tracking the remediation progress.

Figure 4-26 shows that as of 5/19/04, only soil areas tributary to GS54 had been excavated. Figure 4-27 shows the hydrographs for the period from the start of Outer Lip remediation (4/30/04) through 5/18/04. During this period, no appreciable flow was measured at GS54. This is likely due to the effective use of erosion matting³⁸, lower gradients in the subdrainage, and large vegetated areas between the excavated areas and GS54. The flow rates at GS54 during this period are comparable to flows in past years. No significant areas of soil had been excavated upstream of GS51, GS52, or GS53 as of 5/18/04. Flow rates at these locations during this period are comparable to flows in past years.

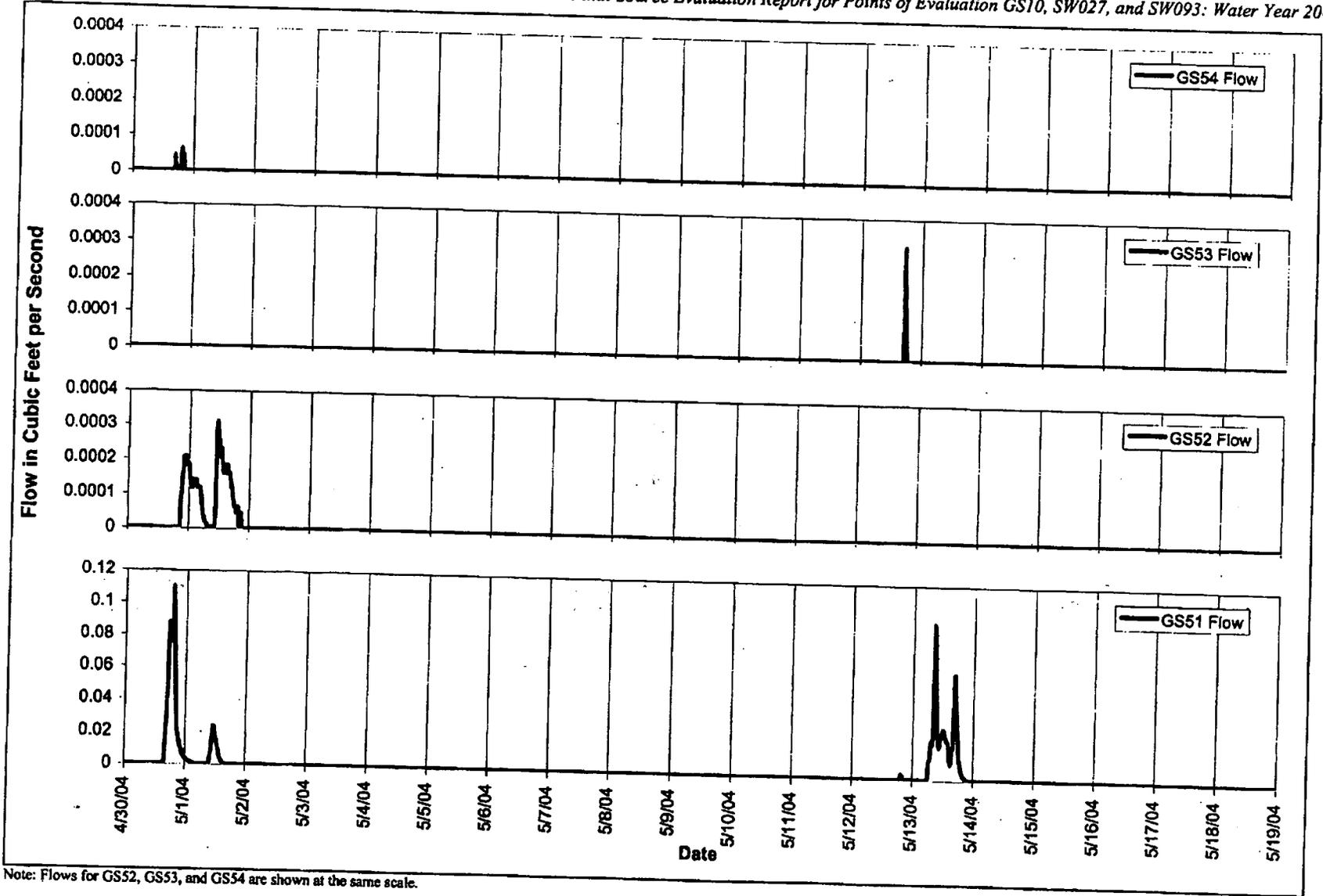


Note: Former SW055 drainage area delineated by dotted red line. Area gradually became tributary to GS51 through land configuration changes as project progressed.

Figure 4-26. 903 Pad/Lip Soil Excavation Areas as of 5/19/04.

³⁸ Aerial photos suggest that erosion matting was installed in the GS54 subdrainage soon after excavation.

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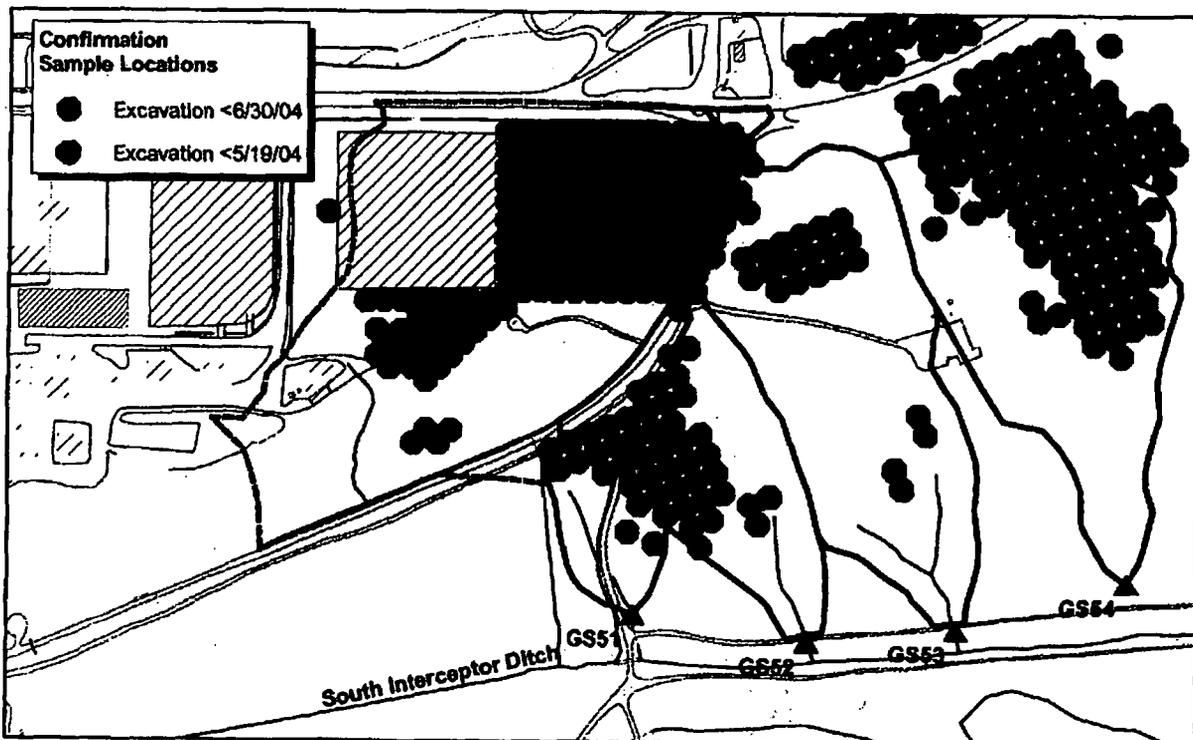


Note: Flows for GS52, GS53, and GS54 are shown at the same scale.

Figure 4-27. Hydrographs for 903 Pad/Lip: 4/30/04 – 5/18/04.

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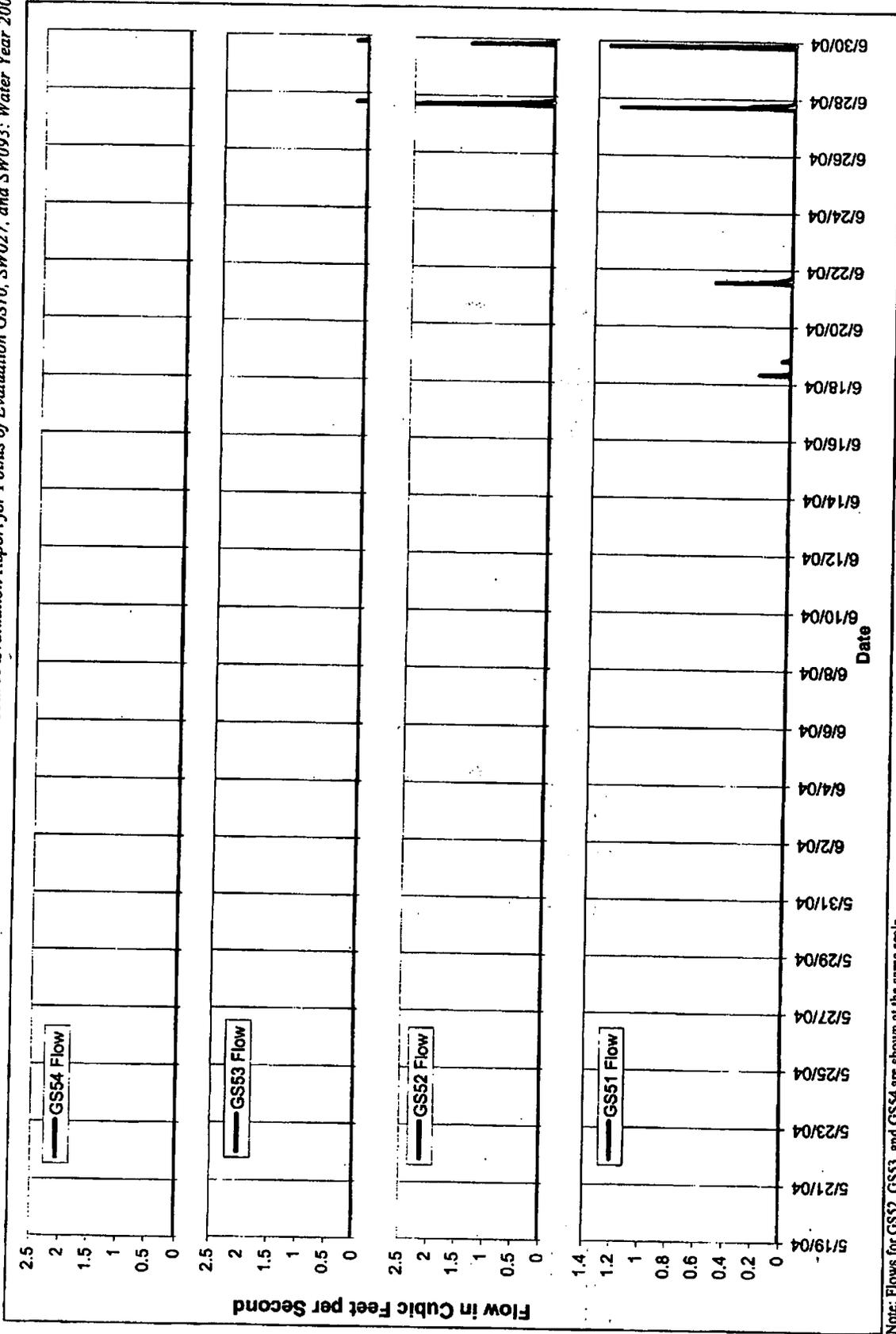
Figure 4-28 shows that as of 6/30/04, soil areas tributary to all locations had been excavated. Additionally, aerial photos suggest that vegetation in areas outside the excavations had been damaged due to vehicle traffic (soils are also assumed to have been compacted accordingly). This is especially significant upstream of GS52 and to a lesser extent GS53. Figure 4-29 shows the hydrographs for the period from 5/19/04 through 6/29/04. During this period, the highest flow rates measured to date were recorded at GS51, GS52, and GS53. The fact that GS53 flow rates were significantly lower than GS52 is likely due to the following: a lower percentage of the subdrainage had been excavated, runoff from the upper reaches of the subdrainage was routed to a small retention pond, larger areas of vegetation remained, a small 'bench' in the upper reaches of the subdrainage may have attenuated flows, and a ditch immediately upstream of GS53 detained a portion of the runoff. Sample TSS results at GS51 and GS52³⁹ also showed the highest values to date (6,700 mg/L at GS51; 5,000 mg/L at GS52).



Note: Former SW055 drainage area delineated by dotted red line. Area gradually became tributary to GS51 through land configuration changes as project progressed.

Figure 4-28. 903 Pad/Lip Soil Excavation Areas as of 6/30/04.

³⁹ TSS data was not available at GS53 since samples were not collected within the 7-day hold time criteria.



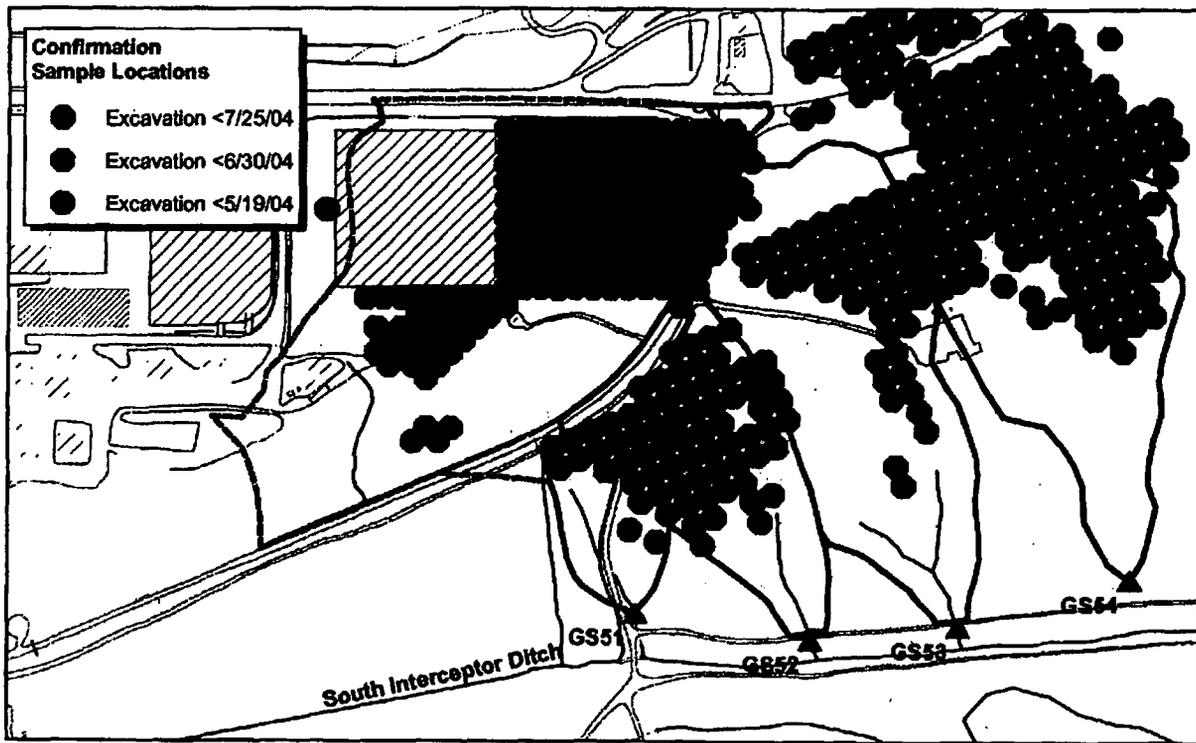
Note: Flows for GS52, GS53, and GS54 are shown at the same scale.

Figure 4-29. Hydrographs for 903 Pad/Lip: 5/19/04 – 6/29/04.

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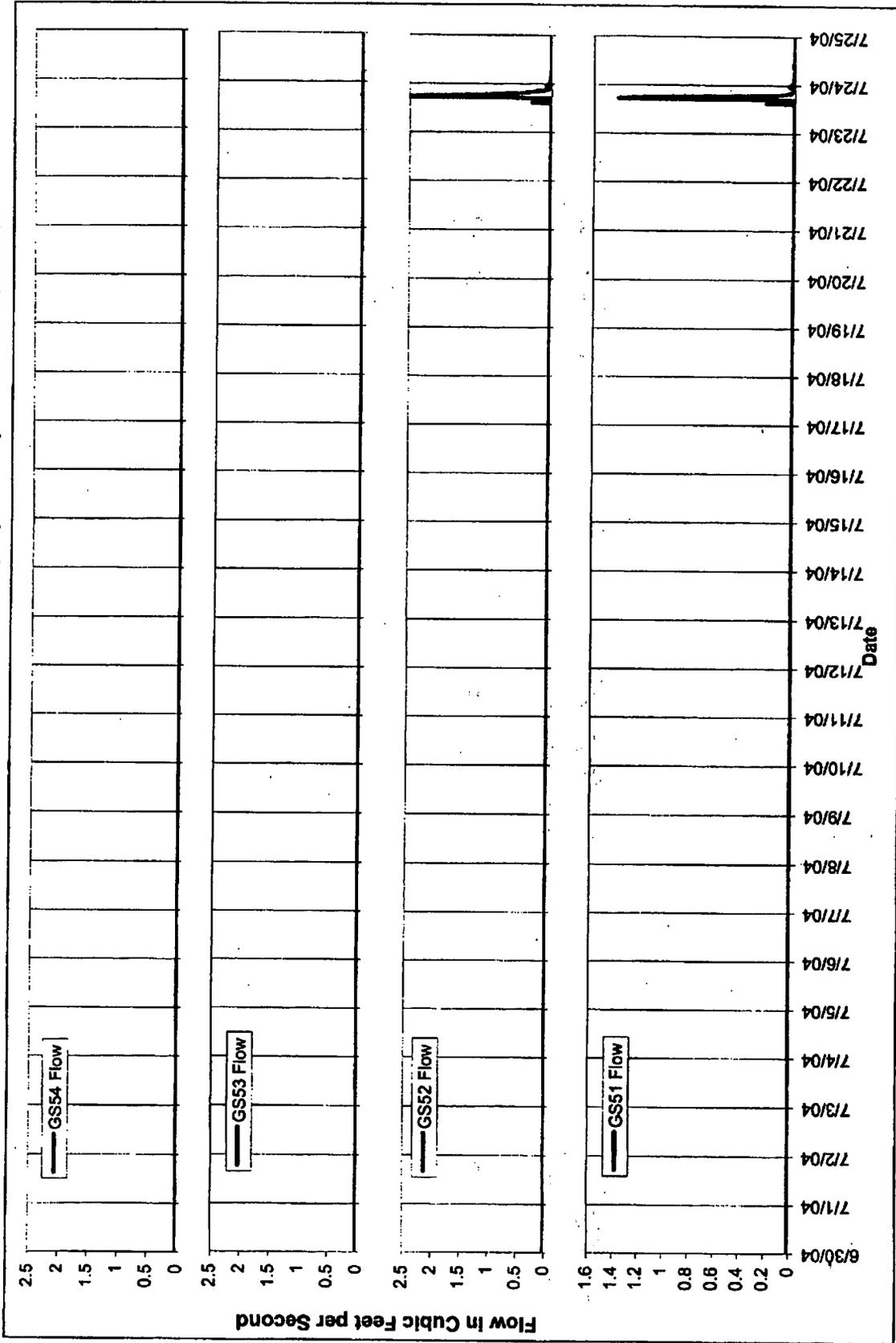
Figure 4-30 shows that as of 7/25/04, soil areas tributary to all locations had been excavated. As stated previously, aerial photos suggest that vegetation in areas outside the excavations had been damaged due to vehicle traffic (soils are also assumed to have been compacted accordingly). This is especially significant upstream of GS52 and to a lesser extent GS53. Figure 4-31 shows the hydrographs for the period from 6/30/04 through 7/24/04. During this period, the highest flow rates measured to date were recorded at GS51 and GS52; GS53 flow rates were significantly lower. The fact that GS53 flow rates were significantly lower than for previous events may be due to successful implementation of erosion controls. Sample TSS results at both GS51 and GS52⁴⁰ showed significantly reduced concentration, again likely due to enhanced erosion controls. While sediment loads were reduced by the reduction in precipitation forces (erosion matting) and runoff filtering (wattles and straw bales), runoff rates continued to be high due to compacted soils and lack of vegetation.



Note: Former SW055 drainage area delineated by dotted red line. Area gradually became tributary to GS51 through land configuration changes as project progressed.

Figure 4-30. 903 PadLip Soil Excavation Areas as of 7/25/04.

⁴⁰ TSS data was not available at GS53 since samples were not collected within the 7-day hold time criteria.

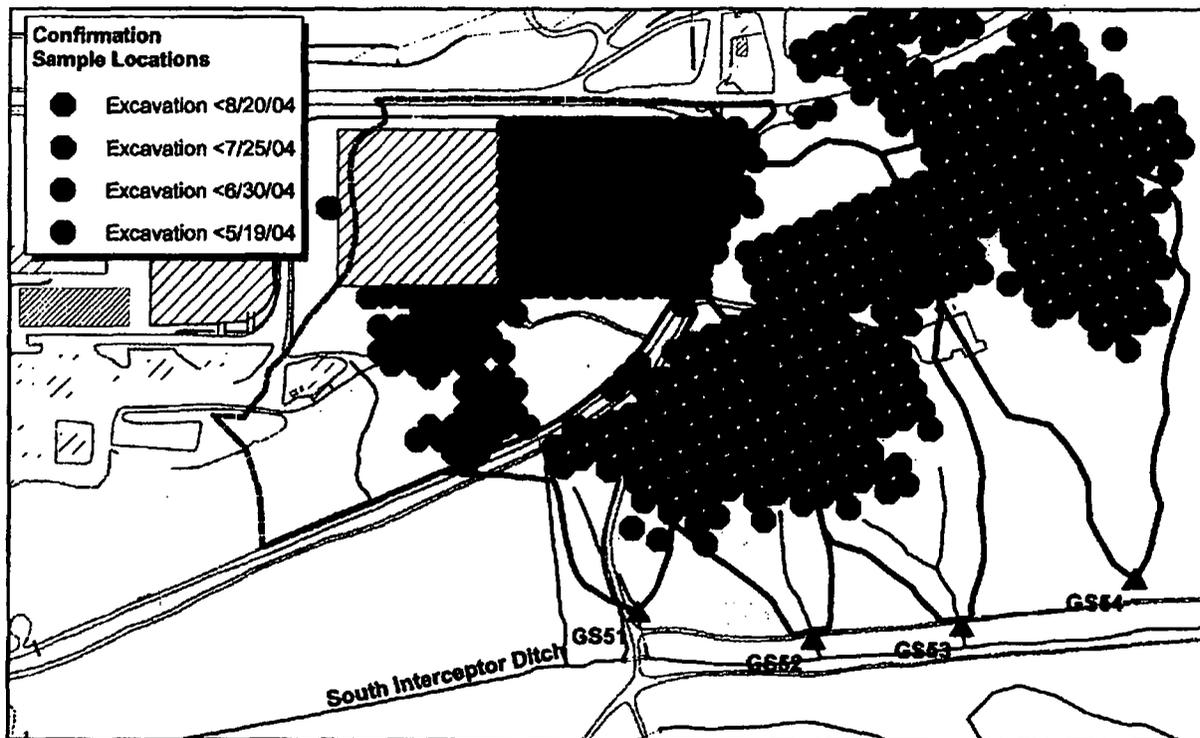


Note: Flows for GS52, GS53, and GS54 are shown at the same scale.

Figure 4-31. Hydrographs for 903 Pad/Lip: 6/30/04 - 7/24/04.

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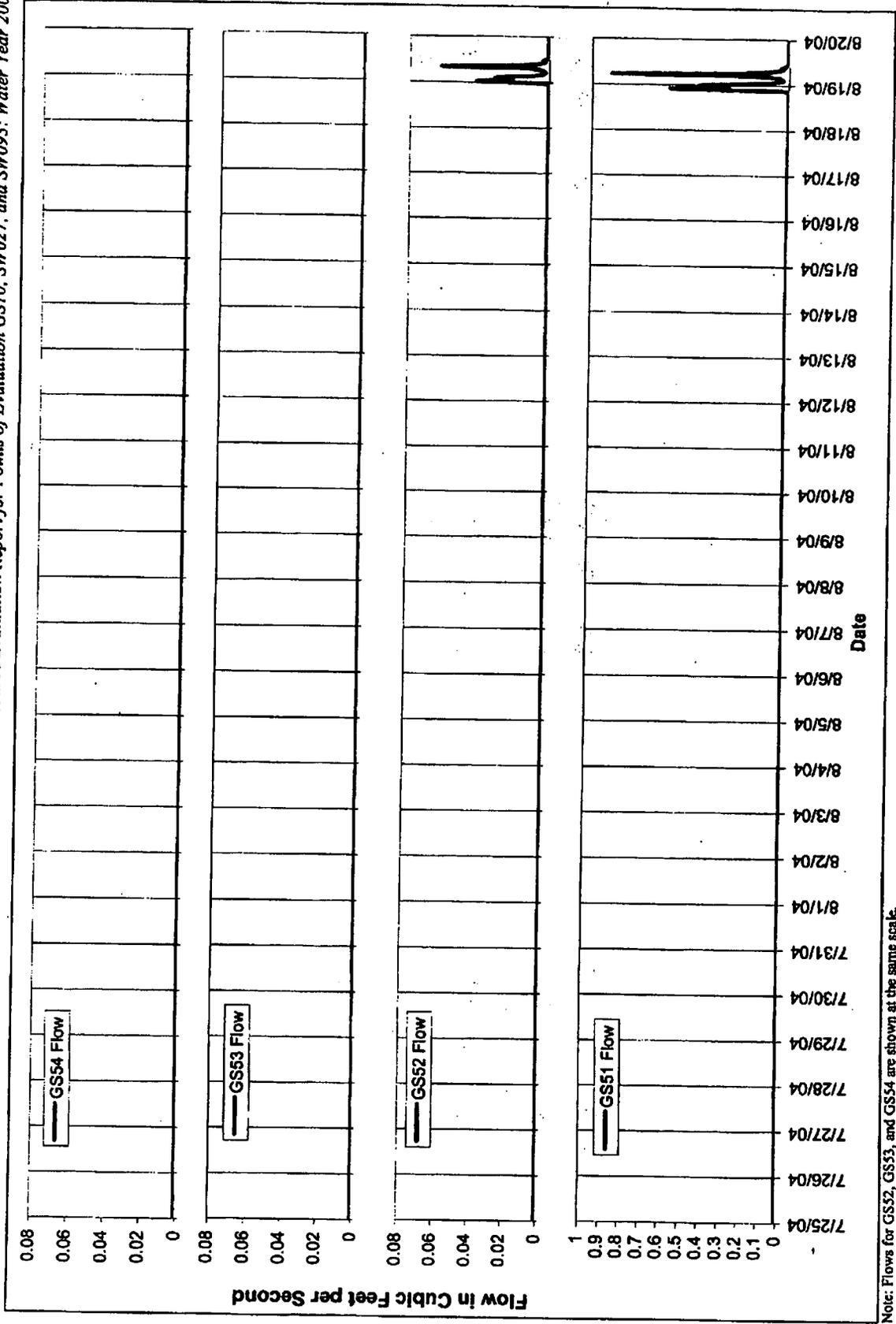
Figure 4-32 shows that as of 8/20/04, the majority of Outer Lip soil areas scheduled for remediation had been excavated. Figure 4-33 shows the hydrographs for the period from 7/25/04 through 8/19/04. During this period, flow rates were significantly lower at GS52, with virtually no flow measured at GS53. The fact that GS52 and GS53 flow rates were significantly lower than previous is likely due to successful implementation of erosion controls. Sample TSS results at GS52⁴¹ showed significantly reduced concentration (46 mg/L), again likely due to enhanced erosion controls.



Note: Former SW055 drainage area delineated by dotted red line. Area gradually became tributary to GS51 through land configuration changes as project progressed.

Figure 4-32. 903 Pad/Lip Soil Excavation Areas as of 8/20/04.

⁴¹ TSS data was not available at GS51 and GS53 since samples were not collected within the 7-day hold time criteria.

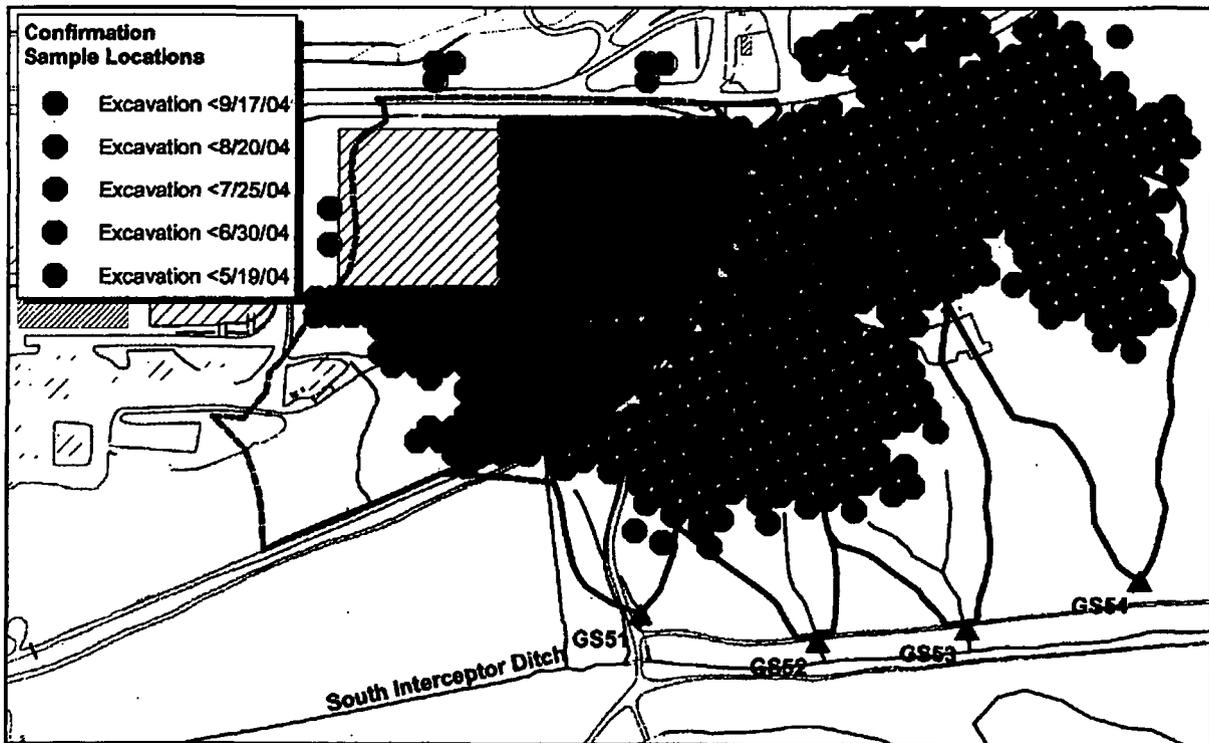


Note: Flows for GS52, GS53, and GS54 are shown at the same scale.

Figure 4-33. Hydrographs for 903 Pad/Lip: 7/25/04 - 8/19/04.

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Figure 4-34 shows that as of 9/17/04 (completion of 903 Pad/Lip project), all Outer Lip soil areas scheduled for remediation had been excavated. Figure 4-35 shows the hydrographs for the period from 8/20/04 through 10/13/04. During this period, low flow rates at GS52, GS53, and GS54 continued to be measured, likely due to successful implementation of erosion controls. The continued high flow rates at GS51 are likely due to the large areas of unvegetated areas and relatively impervious soils associated with former dirt roads. It should also be noted that sample TSS results at GS52⁴² continued to show significantly reduced concentration (58 mg/L; 26 mg/L), again likely due to enhanced erosion controls.



Note: Former SW055 drainage area delineated by dotted red line. Area gradually became tributary to GS51 through land configuration changes as project progressed.

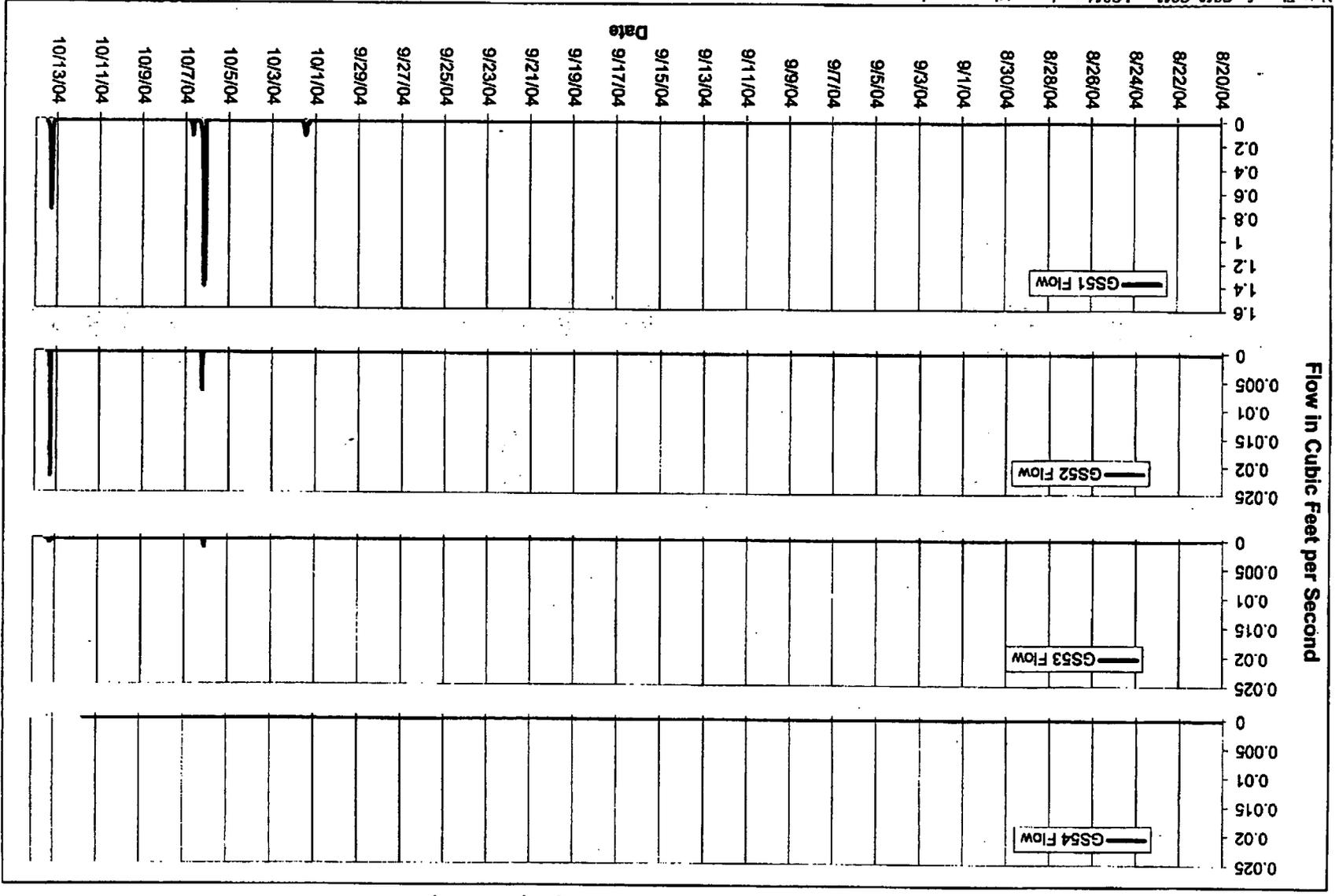
Figure 4-34. 903 Pad/Lip Soil Excavation Areas as of 9/17/04.

⁴² TSS data was not available at GS51 and GS53 since samples were not collected within the 7-day hold time criteria.

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Figure 4-35. Hydrographs for 903 Padlip: 8120104 - 10113104.

Note: Flows for GSS2, GSS3, and GSS4 are shown at the same scale.



4.8 SUMMARY AND CONCLUSIONS

The Site has completed the WY04 phase of the ongoing source evaluation for the potential cause(s) of reportable 30-day moving average values for Pu and Am at the POE monitoring location SW027. As for previous reports, the Site concludes that the likely source of the reportable 30-day moving average values at SW027 is diffuse actinide contamination associated with soils and sediments from past Site operations released to the environment through events and conditions over past years. This actinide contamination is transported with suspended solids in surface-water runoff during precipitation events.

Based on the above evaluation, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions and closure activities for the Site. The removal of source areas, the implementation of enhanced erosion controls, and the reduction of runoff as the Site moves toward Closure all serve to improve water-quality in the long-term. The surface-water monitoring conducted at the Site has provided valuable information regarding the near-term impacts to water quality to aid the Closure projects in developing targeted methods for reducing the transport of low-level contamination. This source investigation has identified no previously unknown localized source(s) of contamination that warrant targeted remediation based on the available information. The current conclusions are summarized below:

- Data collected from the upcoming Pond C-2 discharge are expected to show that the Site retention ponds continue to effectively remove suspended solids and any associated contamination from the water column. Pu and Am activities at the fence-line POCs remain well below reporting thresholds.
- Based on the details regarding recent Site activities outlined above, it is concluded that specific D&D, construction, environmental remediation, and excavation operations caused increased transport of low-level contamination associated with suspended solids in surface water that are likely to have resulted in the recent reportable values measured at SW027. Evaluation suggests that project activities associated with IHSS Group 900-11 (903 Pad/Lip) resulted in the largest impacts to water quality at SW027.
- The loading analysis indicates that the GS51 and GS52 subdrainages are contributing the vast majority of the actinide load at SW027. Additionally, analysis shows that the Pu and Am loads from both GS51 and GS52 have increased significantly in WY04. This suggests that recent projects impacting these subdrainages, especially the 903 Pad/Lip, may have negatively impacted water quality.
- Pu and Am suspended solids activities at SW027 show a significant increase in WY04 (Figure 4-20). In conjunction with the increased activities at SW027, this suggests the increased contribution of a relatively more contaminated area, and/or solids transport from a previously non-contributing area or source term. For roughly the same period, these suspended solids activities are comparable to those at GS51 and GS52.
- Figure 4-21 shows that WY04 turbidities (as an indication of TSS) at SW027 relative to flow rate are generally higher than for WY03 and prior data. This suggests that soils in the SW027 drainage are more susceptible to transport for a given flow rate than for previous years. Similarly, WY04 TSS data at SW027 show higher values relative to flow rate than for previous years (Figure 4-22). TSS results from both GS51 and GS52 also show unusually high values. These patterns suggest that the recent higher activities at SW027 may be the result, at least in part, to the increased transport of legacy contamination associated with soil and sediment, and not solely a new source term.
- Comparisons of hydrologic patterns at the 903 Pad/Lip monitoring stations with excavation progress support the conclusion that remediation activities resulted in both increased runoff and increased transport of

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suspended solids. The comparison also suggests that BMPs are effective at reducing both runoff and erosion. As soils stabilize and vegetation is reestablished, continued water-quality improvement is expected.

- Targeted erosion controls have proven to be effective in reducing runoff rates and sediment transport and associated contamination at selected locations. This is especially true for locations upstream of SW027 (nearer to the source terms) such as GS51, GS52, and GS53. No improvement is noted for SW027, most likely due to the continued transport of residual solids in the flow pathways downstream of the erosion controls. In the long-term, water quality is expected to improve at SW027 as these solids stabilize in the system, additional erosion controls are installed, source areas are removed, disturbed soils are stabilized, and runoff is reduced due to the establishment of vegetation.

The Site's proposed course of action includes: (1) continuing observation (routine monitoring), and (2) installation and maintenance of enhanced erosion controls in the drainage areas upstream of SW027 as part of the overall Closure process. Effective BMPs, such as the use of the existing terminal ponds to clarify stormwater of potentially-contaminated sediment and particulate matter, will also be continued. Specifically, DOE and the K-H Team propose the following actions as the path forward:

- Continued observation and ongoing data interpretation to provide better understanding of actinide transport directly related to the operation of the Site automated surface-water monitoring network and the effectiveness of erosion controls
- Implementation and maintenance of enhanced erosion controls as an integral part of Site Closure
- Continued use of the existing retention ponds as an effective BMP to clarify stormwater containing potentially contaminated sediment and particulate matter, and
- Continued reporting as appropriate

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