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Final

Rocky Flats Environmental Technology Site

Automated Surface-Water Monitoring Report

Water Years 1997-2000

Safe Sites
OF COLORADO, LLC
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

Volume 1 of 2 (Text)

Environmental Media Management
Rocky Flats Environmental Technology Site

ADMIN RECORD

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ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE AUTOMATED SURFACE-WATER MONITORING REPORT Water Years 1997-2000

U.S. DEPARTMENT OF ENERGY

Rocky Flats Environmental Technology Site

Golden, Colorado

FINAL

September 2002

ADMIN RECORD

REVIEWED FOR CLASSIFICATION/UCNI

By K. M. Hoffman

Date 9-9-02 U/NU

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1. EXECUTIVE SUMMARY

This Report presents the data from selected surface-water monitoring objectives implemented at the Rocky Flats Environmental Technology Site (Site) in accordance with the *Rocky Flats Cleanup Agreement* (RFCA; CDPHE, USDOE, USEPA, 1996) and the *Integrated Monitoring Plan(s)* (IMP; Kaiser-Hill, 1997, 1998, 1999). The IMP provides a framework for monitoring in support of transition activities at the Site. This framework includes implementation of a high-resolution surface-water monitoring program that supports data-driven decisions (monitoring objectives) determined by the IMP Data Quality Objectives (DQO) process. The automated surface-water monitoring program is intended to provide:

- Monitoring of multiple parameters for the safe and effective operation of the Site detention ponds;
- Monitoring of flows and contaminant levels in subdrainages to facilitate the identification of contaminant sources;
- Monitoring of various surface-water parameters at various locations on an Ad Hoc basis in support of special projects and/or building operations;
- Monitoring of indicator parameter values at various locations to determine a correlations between indicator parameters and analytical water-quality measurements;
- Detection of a release of contaminants from specific high-risk projects within the Industrial Area (IA);
- Detection of statistically significant increases of contaminants in runoff from within the IA in general;
- Detection of contaminants exceeding RFCA Action Levels in discharges entering Stream Segment 5 and the Site detention ponds;
- Detection of contaminants exceeding RFCA Standards in discharges entering Stream Segment 4 and at the Site boundary;
- Monitoring of indicator parameters in discharges leaving the Site boundary as a prudent management action; and
- Monitoring of flows and water-quality in the Buffer Zone (BZ) for ecological and water rights issues, closure planning and design, as well as supporting studies into the interaction between media.

The intent of this report is to provide a comprehensive and detailed summary of the automated surface-water monitoring conducted at RFETS fulfilling the applicable requirements of the Site IMP. As such, this report is organized to follow the framework of the IMP, with each report section providing the objective-specific data evaluations.

This report includes all data collected during Water Years 1997 through 2000. The term 'water year' (abbreviated as WY) is defined as the period from October 1st through September 30th. For example, WY99 refers to the period from 10/1/98 through 9/30/99. Future reports will be completed annually for each water year by the end of following water year (September 30th).

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2. INTRODUCTION

2.1 BACKGROUND

2.1.1 Environmental History

Processing and fabrication of weapons-related components began at the Site in 1952 and continued through 1989. Fabrication of stainless steel components continued in one building, however, through the early 1990's. During operation, environmental protection measures were established that seemed consistent with prudent environmental management. However, some activities resulted in the environmental contamination of portions of the Site. Efforts to document the extent of Site contamination became a major focus in the 1980s and continue today in accordance with the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the RFCA, a cooperative agreement between U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Colorado Department of Public Health and Environment (CDPHE). In addition, a historical release report (HRR) (DOE, 1992) has been developed that documents contamination arising from past practices. The HRR is updated on an annual basis with the knowledge gained from ongoing monitoring and investigative activities. The additional information is submitted on an annual basis to the EPA and CDPHE as addenda to the original document.

Documented areas of soil contamination have been designated as Individual Hazardous Substance Sites (IHSSs). Many of these IHSSs have been characterized as part of the Remedial Investigation/Feasibility Study (RI/FS) process that was conducted under the Interagency Agreement (1991) between DOE, CDPHE and EPA. Some IHSSs have already been remediated and the Environmental Restoration Department in accordance with a Site environmental remediation priority ranking system currently schedules others for remediation.

2.1.2 Rocky Flats Cleanup Agreement

The RFCA was officially adopted on July 19, 1996 (CDPHE et. al., 1996). The RFCA replaces the IAG as the environmental cleanup agreement for RFETS. The RFCA outlines the goals, objectives, and strategies that will lead to the RFETS cleanup and closure mission objectives. The Action Level Framework (ALF) attachment to the RFCA contains specific requirements for environmental monitoring and reporting, and it sets action levels for contaminant concentrations in surface water and in other media. The Integrated Monitoring Plan (IMP) is required under RFCA to further define the monitoring programs for the Site.

To align the surface-water monitoring program with the new RFETS mission and RFCA requirements, the monitoring network was evaluated in 1996. A data-quality objective (DQO) process was used to determine what decisions were necessary for surface water and the function of each location in the network in supporting those decisions. DOE, CDPHE, EPA, and stakeholders were directly involved in decisions involving the monitoring network. Results of this evaluation were integral to the development of the IMP, which is discussed below.

2.1.3 Integrated Monitoring Plan for Surface Water

The Site automated surface-water monitoring network is designed to meet the requirements documented in the Site IMP, which groups all Site surface-water monitoring objectives into five primary categories: Site-Wide, Industrial Area, Industrial Area Discharges to Ponds, Water Leaving the Site, and Off-Site. The ten IMP objectives that are accomplished through the automated monitoring as detailed in the annual Rocky Flats Environmental Technology Site Automated Surface-Water Monitoring Work Plans (RMRS, 1996, 1998b, 1999a, 2000a) are described briefly below.[1,2] During WY97-00, the Site monitoring network included 46 monitoring

[1] The IDLH decision rule (locations indicated in Table 2-1; included in the automated monitoring work plans) requires the collection of hydrologic data to support the management of the Site detention ponds. This objective does not require any detailed data analysis. Therefore, this decision rule is not included in this report, however, hydrologic data is presented here for completeness.

stations (Figure 2-2) to achieve these objectives.[3] In some situations, the same location may serve multiple objectives. Monitoring tasks and data collection, compilation, evaluation, and reporting for each objective included in this report are detailed in Sections 6 through 15.

The IMP used the Data-Quality Objective (DQO) process to determine necessary and sufficient monitoring requirements. The process yielded 19 individual, data-driven, surface-water monitoring objectives (a.k.a. decision rules under the DQO process), a subset (10) of which is implemented through automated monitoring. Some decisions need a higher priority than others, and some need greater confidence. The DQO process produced descriptions that expose the strengths and weaknesses of each data-driven decision and the value of the data (resources required) in making each decision. Management decisions often must be made based on incomplete information. The individual DQO sections of the IMP document guide management in establishing funding priorities for surface-water monitoring objectives.

Five of the IMP automated surface-water monitoring objectives are organized in a roughly upstream-to-downstream direction, beginning with Performance monitoring within the IA and ending downstream at the Points of Compliance at Indiana Street (Figure 2-1). These monitoring objectives are summarized in the following paragraphs and are discussed in detail in Sections 10 through 14.

For the first of the upstream-to-downstream monitoring categories (IA Objectives), the IMP and the IA IM/IRA Decision Document require the Site to characterize significant surface-water releases within the IA. Within the IA [usually], individual high-risk projects will sometimes warrant Performance monitoring (Section 10) to detect a spill or release of contaminants specifically associated with that project.

For the next upstream-to-downstream monitoring category (IA Discharges to Ponds / Segment 5 Objectives), the IMP and the IM/IRA require the Site to identify and correct significant accidental or undetected releases of contaminants from the IA to the Site Detention Ponds (surface water leaving the IA and entering Segment 5). The New Source Detection (NSD; Section 11) and Point of Evaluation (POE; Section 12) objectives deal with discharges from the IA to the ponds. In order to decide whether a significant release has occurred, the Site performs NSD monitoring of IA runoff for significant increases in contaminants. Additionally, RFCA specifies Stream Segment 5 / POE monitoring for the upstream reaches of Site drainages (above the ponds) and specifies action levels for contaminants (Action Level Framework).

The next, and perhaps most significant monitoring category, is Water Leaving the Site (Segment 4 Objectives). The Site is required to monitor at Points of Compliance (POCs) below the terminal ponds to protect state stream standards in Segment 4 (Section 13), as specified in RFCA. In addition, there are RFCA POCs that are located at the Site boundary at Indiana Street (Section 13) for both Walnut and Woman Creeks. The Non-POC decision rule (Section 14) also requires the Site to collect data for selected water-quality parameters at the Indiana Street POCs.

Monitoring objectives that do not fit into the upstream-to-downstream sequence are considered as Site-Wide Monitoring Objectives. Monitoring in support of these objectives can occur at any location within the Site boundary.

For example, Imminent Danger to Life and Health (IDLH) monitoring provides information necessary for safe operation of the Site detention pond dams. This monitoring objective is not discussed in this document, however the hydrologic data associated with this decision rule is presented in Section 3.

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[2] Data evaluation from the NPDES monitoring is also included here for the completeness. Additional details on the implementation of NPDES monitoring can be found in the applicable NPDES permit.

[3] The period of operation of these locations varies based on project needs and regulatory requirements.

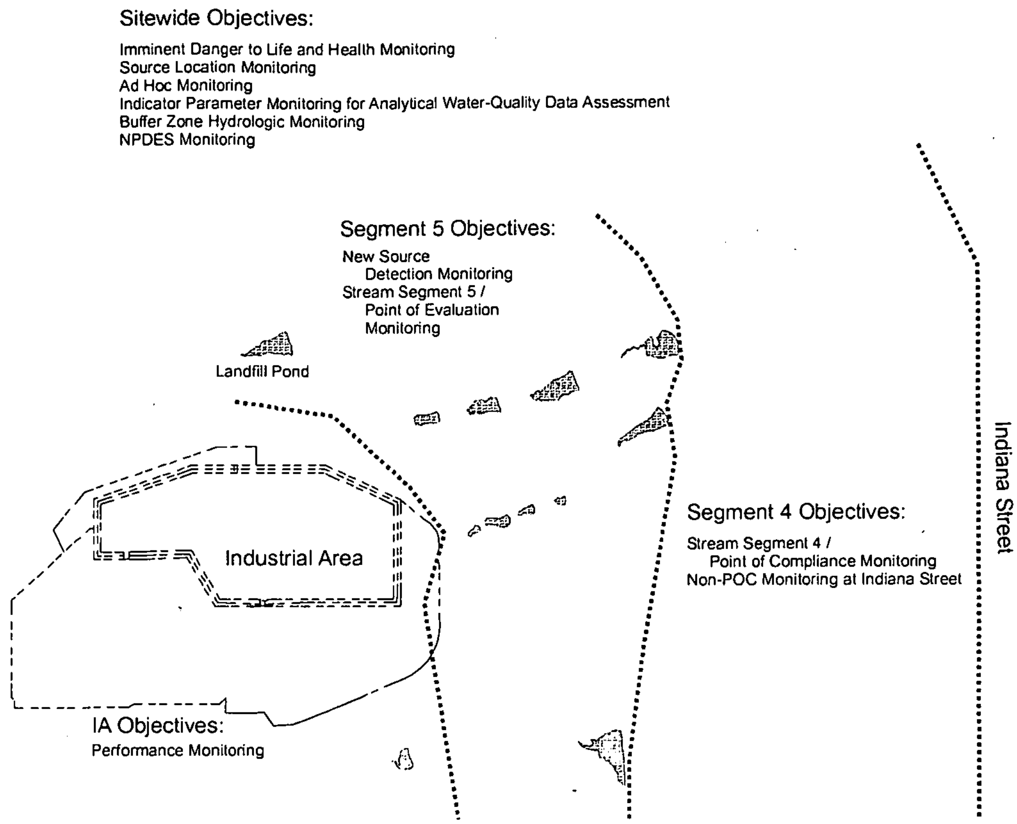

Figure 2-1. Conceptual Model of Site Automated Surface-Water Monitoring Objectives.

Another sitewide monitoring objective, Source Location monitoring (covered in Section 6), is designed to locate a source of contamination detected by other monitoring objectives, and can take place anywhere within the Site boundary. Unplanned, special-request monitoring activities are discussed as Ad Hoc monitoring in Section 7. For example, monitoring may be performed at various locations to evaluate alternatives for surface-water management, such as controlled-detention pond management or re-routing of wastewater treatment plant (WWTP) effluent. Similarly, monitoring may need to be performed to provide data to special projects such as Actinide Migration Evaluation and the Site-Wide Water Balance.

Indicator Parameter Monitoring for Analytical Water-Quality Data Assessment (Section 8) in also implemented sitewide. This objective provides the justification for the collection of general water-quality and quantity information to be used for various data assessments. Specifically, this objective outlines the current and expected uses of parameters such as TSS, turbidity, and flow rate.

The NPDES permit program controls the release of pollutants into the waters of the United States and requires routine monitoring of point source discharges and reporting of results (Section 9). The Site's first NPDES permit was issued by EPA in 1974. The permit was originally reissued by EPA in 1984, expired in 1989, and administratively extended through the reporting period of this report. All monitoring for NPDES compliance is prescriptively required by EPA and is not covered by the IMP process. For the period covered by this report, NPDES monitoring is performed at six locations.

Finally, Buffer Zone Hydrologic monitoring occurs at various locations across the Site and addresses the interfaces between surface water and other media: soil, groundwater, air, and ecology (Section 15).

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Figure 2-2. RFETS Automated Surface-Water Monitoring Locations and Precipitation Gages.

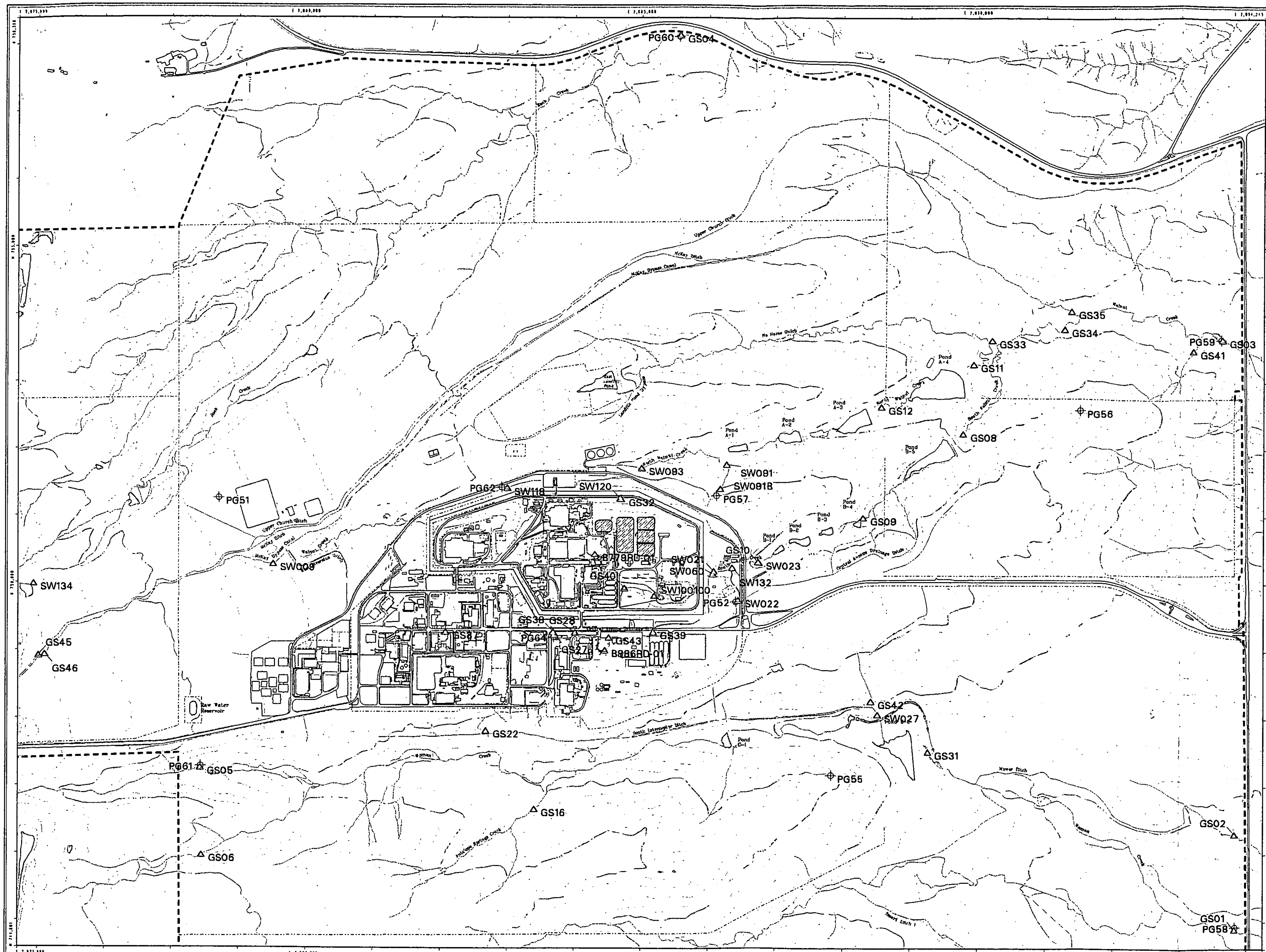

Figure 2-2
RFETS Automated Surface-Water Monitoring Locations and Precipitation Gages

EXPLANATION

- Precipitation Gage
- Automated Surface Water Monitoring Location

Standard Map Features

- Buildings and other structures
- Solar Evaporation Ponds (SEPs)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Topographic Contour (20-Foot)
- Rocky Flats boundary
- Paved roads

DATA SOURCE BASE FEATURES: Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95. Topographic contours were derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

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Scale = 1 : 17890
1 inch represents approximately 1491 feet

400 0 800 1600 Ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER-HILL COMPANY

September 05, 2002

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Table 2-1. Matrix of Monitoring Locations and Supported IMP Decision Rules: Water Years 1997 - 2000.

ID Code	Supported Decision Rule										
	IDLH	Source Location	Ad Hoc	Indicator Parameter	Performance	New Source Detection	POE	POC	Non-POC	BZ Hydro	Precip-itation
GS01				✓				✓	✓	✓	✓
GS02				✓						✓	
GS03				✓				✓	✓	✓	✓
GS04				✓						✓	✓
GS05				✓						✓	✓
GS06				✓						✓	
GS08	✓	✓		✓				✓			
GS09	✓										
GS10	✓	✓		✓		✓	✓				
GS11	✓	✓		✓				✓			
GS12	✓										
GS16										✓	
GS22			✓	✓							
GS27		✓		✓	✓						✓
GS28		✓		✓	✓						
GS31	✓			✓				✓			
GS32		✓		✓	✓						
GS33		✓		✓							
GS34		✓		✓							
GS35		✓		✓							
GS37		✓		✓	✓						
GS38		✓		✓							
GS39		✓		✓	✓						
GS40		✓		✓	✓						
GS41		✓	✓	✓							
GS42		✓	✓	✓							
GS43		✓		✓	✓						
GS45			✓								
GS46			✓								
SW009			✓								
SW021		✓		✓							
SW022		✓		✓	✓	✓					✓
SW023		✓		✓							
SW027	✓	✓		✓		✓	✓				
SW060		✓		✓							
SW091				✓		✓					✓
SW093	✓	✓		✓		✓	✓				
SW100100		✓		✓							
SW118		✓		✓						✓	✓
SW120		✓		✓	✓						
SW132		✓		✓							
SW134				✓						✓	
B371BAS			✓								
B371SUBBAS			✓								
B779RD-01			✓								
B886RD-01			✓								
RPTR											✓
RPTR2											✓
RPTR3											✓

Note: NPDES locations are not included in this table since all monitoring for NPDES compliance is prescriptively required by EPA and is not covered by the IMP process.
Many locations provide flow data to the Sitewide Water Balance as AdHoc locations. Only those locations specifically installed as AdHoc locations are noted above.

2.2 PURPOSE

This Report presents the data from the automated surface-water monitoring objectives implemented at the Rocky Flats Environmental Technology Site (Site) in accordance with the RFCA and the IMP. The IMP provides a framework for monitoring in support of transition activities at the Site. This framework includes implementation of a high-resolution surface-water monitoring program that supports data-driven decisions determined by the IMP Data-Quality Objectives (DQO) process. This automated monitoring program is intended to provide:

- Monitoring of multiple parameters for the safe and effective operation of the Site detention ponds;
- Monitoring of flows and contaminant levels in subdrainages to allow for the location of contaminant sources;
- Monitoring of various surface-water parameters at various locations on an Ad Hoc basis in support of special projects and/or building operations;
- Monitoring of indicator and field parameters at various locations to provide enhanced analytical data assessment;
- Routine monitoring of point source discharges and reporting of results in compliance with the NPDES permit program to control the release of pollutants into the waters of the United States.
- Detection of a release of contaminants from specific high-risk projects within the IA;
- Detection of statistically significant increases of contaminants in runoff from within the IA in general;
- Detection of contaminants exceeding RFCA Action Levels in discharges entering Stream Segment 5 and the Site detention ponds;
- Detection of contaminants exceeding RFCA Standards in discharges entering Stream Segment 4 and at the Site boundary;
- Monitoring of indicator parameters in discharges leaving the Site boundary as a prudent management action; and
- Monitoring of flows and water-quality in the Buffer Zone (BZ) for ecological and water rights issues, as well as supporting studies into the interaction between media.

2.3 SCOPE

This Report includes:

- A description of the site automated surface-water monitoring program and monitoring network;
- A summary of discharge and precipitation data;
- A general summary of selected analytical water-quality results;
- A loading analysis for selected radionuclides at POEs and POCs;
- An evaluation of analytical results as required by the Site IMP organized by monitoring objective;
- A PARCC data-quality assessment of analytical water-quality data; and,
- An appendix with hydrologic and water-quality data.

2.4 SETTING

2.4.1 Site Description

The Site is a government-owned, contractor-operated facility in the DOE nuclear weapons complex, located in Golden, Colorado. The Site is owned by the U.S. Department of Energy (DOE), managed by the DOE Rocky Flats Field Office (DOE, RFFO), and operated by Kaiser-Hill, L.L.C. (K-H). The RFCA surface-water monitoring program is managed and implemented by Safe Sites of Colorado, L.L.C. (SSOC), by the Water Programs Group, under contract to Kaiser-Hill.

This program is implemented at multiple locations throughout the Site. The Site land area can be divided into two portions: the IA (Industrial Area within the inner fence) and the Buffer Zone (the open space surrounding the IA but within the DOE property line). Figure 2-2 shows the locations of the automated surface-water monitoring locations operated during WY97-00 that are included in this report.

Each monitoring location is equipped with instrumentation capable of satisfying the location-specific data-acquisition requirements.

2.4.2 Hydrology

Streams and seeps at RFETS are largely ephemeral, with stream reaches gaining or losing flow, depending on the season and precipitation amounts. Surface water flow across RFETS is primarily from west to east, with three major drainages traversing the Site. Fourteen detention ponds (plus several small stock ponds) collect surface water runoff, although only ten ponds are actively managed. The Site drainages and detention ponds, including their respective interest to this report, are described below and shown in Figure 2-3.

Walnut Creek

Walnut Creek receives surface-water flow from the central third of RFETS, including the majority of the IA. It consists of several tributaries, North Walnut Creek, South Walnut Creek and No Name Gulch that join prior to Walnut Creek flowing off RFETS at the eastern boundary (Indiana Street). East of Indiana Street, Walnut Creek flows through a diversion structure normally configured to divert flow to the Broomfield Diversion Ditch around Great Western Reservoir and into Big Dry Creek. The Walnut Creek tributaries, from north to south, are described below:

McKay Ditch

The McKay Ditch was formerly a tributary to Walnut Creek within the RFETS boundaries but was diverted in July 1999 into a new pipeline to keep McKay Ditch water from co-mingling with RFETS water in Walnut Creek. Although no longer a contributor to Walnut Creek, the McKay Ditch drainage is described here to clarify water routing at the Site. The new configuration allows the City of Broomfield to transport water from the South Boulder Diversion Canal, across the northern Rocky Flats Buffer Zone and directly into Great Western Reservoir without entering Walnut Creek. This configuration prevents commingling of McKay water with discharged water from the Site detention ponds.

No-Name Gulch

This drainage is located downstream from the Present Landfill and Landfill Pond. Runoff from the IA does not flow into this basin.

North Walnut Creek

Runoff from the northern portion of the IA flows into this drainage, which has four detention ponds (Ponds A-1, A-2, A-3, and A-4). The combined capacity of the A-Series ponds is approximately 197,000 cubic meters (m^3) (52 million gallons [160 acre-feet]). In the normal operational configuration, Ponds A-1 and A-2 are bypassed and maintained for emergency spill control; evaporation or transfer controls water levels in these ponds. Pond A-1 also receives water pumped from the Landfill Pond roughly once per year. North Walnut Creek flow is diverted around Ponds A-1 and A-2 to Pond A-3 for detainment and settling of solids. Pond A-3 is discharged in batches to the A-Series "terminal pond", Pond A-4. After filling to a maximum safe level (typically approximately 50 percent of capacity), Pond A-4 water is isolated, sampled and released if downstream surface-water quality criteria are met. These off-site discharges, each averaging approximately 63,000 m^3 (16.6 million gallons [51 acre-feet]), typically occur 2 to 4 times per year.

South Walnut Creek

Runoff from the central portion of the IA flows into this drainage, which has five detention ponds (Ponds B-1, B-2, B-3, B-4, and B-5). The combined capacity of the South Walnut Creek detention ponds (B-series ponds) is approximately 102,000 m^3 (27 million gallons [83 acre-feet]). Ponds B-1 and B-2 are bypassed and maintained for emergency spill control; evaporation or transfer controls water levels in these ponds. Pond B-3 receives effluent from the Site's wastewater treatment plant (WWTP) and flows into Pond B-4. South Walnut Creek flow is diverted around Ponds B-1, B-2, and B-3, into Pond B-4, which flows continuously into "terminal pond" Pond B-5. After filling to a maximum safe level, Pond B-5 is released in batches of approximately 54,000 m^3 (14.3 million gallons [44 acre-feet]) to South Walnut Creek.[4] Pond B-5 discharges typically occur 6 to 8 times per year.

South Interceptor Ditch

South of the IA is the South Interceptor Ditch (SID)/Woman Creek drainage system. Although it is tributary to Woman Creek, the SID warrants more thorough discussion than other comparable tributaries at the Site because it captures runoff from the southern portion of the IA, a drainage basin that includes the Original Landfill and the 903 Pad.

Surface water runoff from the southern portion of the IA is captured by the SID, which flows from west to east into Pond C-2. After 1992 Pond C-2 was pump discharged to the Broomfield Diversion Ditch after reaching a pre-designated level. Water from Pond C-2 is sampled and, if downstream surface-water quality is met, pump discharged into Woman Creek, which flows to the Woman Creek Reservoir. (See the Woman Creek description below.) These off-site discharges from Pond C-2, each averaging approximately 46,900 m^3 (12.4 million gallons [38 acre-feet]), typically occur once per year.

Woman Creek

South of the SID is Woman Creek, which flows through Pond C-1 and off-site at Indiana Street. The Woman Creek drainage basin extends eastward from the base of the foothills, near Coal Creek Canyon, to Standley Lake. In the current configuration, Woman Creek flows into the Woman Creek Reservoir located upstream of Standley Lake, where Woman Creek water is held until it is pump transferred to Big Dry Creek.

Other Drainages

The third major drainage at the Site, other than Walnut and Woman Creeks, is Rock Creek. The Rock Creek drainage covers the northwestern portion of the Site's Buffer Zone. Flat areas to the west, several small stock ponds within the creek bed, and multiple steep gullies and stream channels to the east characterize the drainage channel. This basin receives no runoff from the IA.

Smart Ditch, located south of Woman Creek, is also hydrologically isolated from the IA. The D-series Ponds (D-1 and D-2) are located on Smart Ditch. This drainage and these ponds are not discussed in this report.

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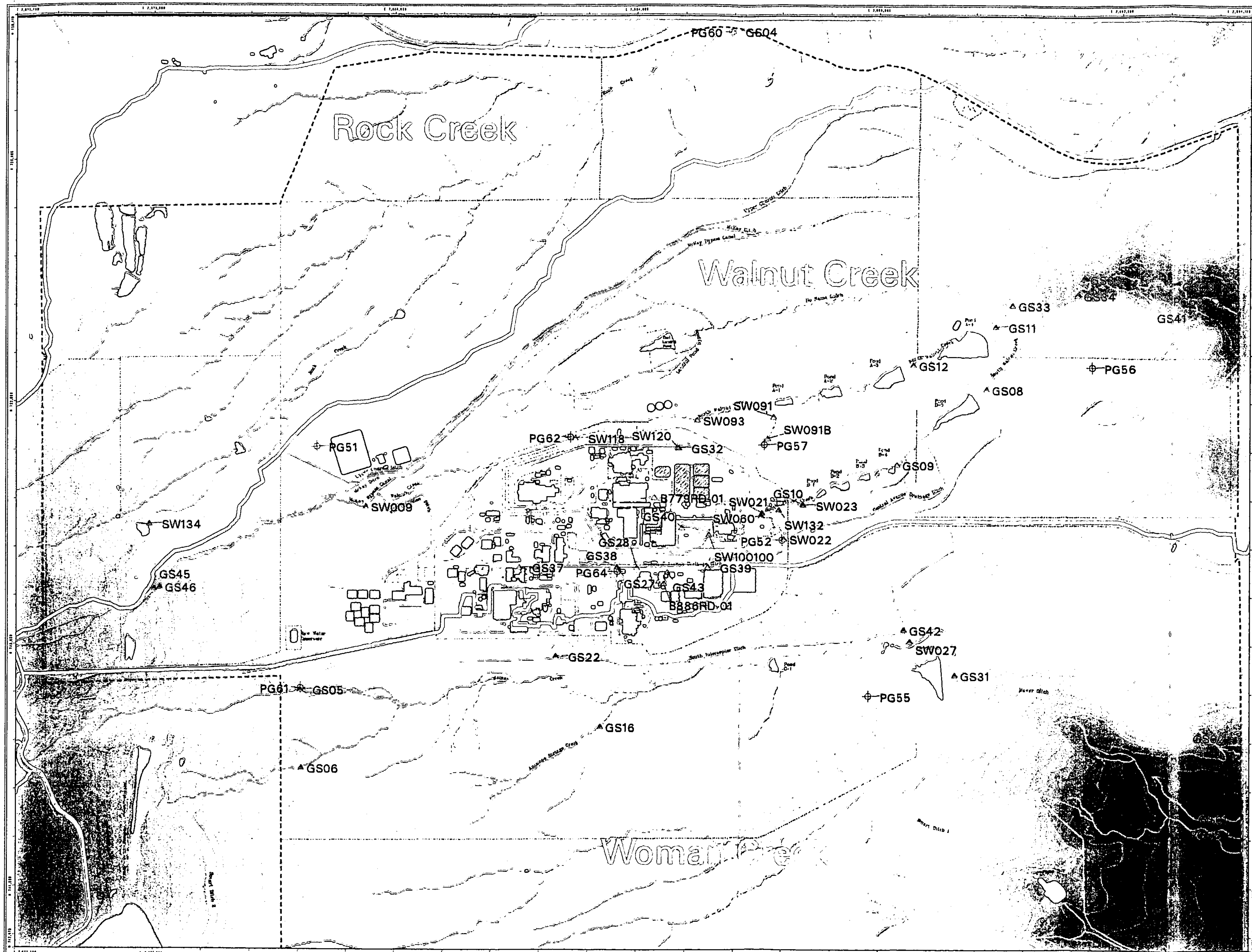
[4] During FY97, all routine North and South Walnut Creek water was discharged from Pond A-4 (B-5 was pump transferred to A-4, except during periods of high stormwater runoff). Flow measurement of these pump transfers was poor, and accurate volume measurements are not available. Therefore, in this report Ponds A-4 and B-5 are often combined and referred to as the A- and B-Series ponds. Starting in FY98, Pond B-5 began periodic direct discharge to Walnut Creek, effectively dividing discharges to Walnut Creek between Ponds A-4 and B-5.



Rocky Flats Environmental Technology Site

Figure 2-3
Major Site Drainage Areas: Walnut Creek, Woman Creek, and Rock Creek

EXPLANATION

- Precipitation Gage
- Automated Surface Water Monitoring Location
- Major Drainage Basins

Standard Map Features

- Buildings and other structures
- Solar Evaporation Ponds (SEPs)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Topographic Contour (20-Foot)
- Rocky Flats boundary
- Paved roads

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N

Scale = 1 : 19910
1 inch represents approximately 1659 feet

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER-HILL COMPANY

September 05, 2002

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3. HYDROLOGIC DATA

3.1 DATA PRESENTATION

3.1.1 Discharge Data Collection and Computation

The data obtained at a continuous surface-water gaging station on a stream or conveyance, such as an irrigation ditch, consist of a continuous record of stage[5], individual measurements of discharge throughout a range of stages, and notations regarding factors that might affect the relation of stage to discharge. These data, together with supplemental information such as climatological records, are used to compute daily mean discharges.

Continuous records of stage are obtained with electronic recorders that store stage values at selected time intervals or secondarily with radio-telemetry data-collection platforms that transmit near real-time data at selected time intervals to a central database for subsequent processing. Direct field measurements of discharge are made with current meters, using methods adapted by the USGS as a result of experience accumulated since 1880, or with flumes or weirs that are calibrated to provide a relation of observed stage to discharge. These methods are described by Carter and Davidian (1968) and by Rantz and others (1982).

In computing discharge records for non-standard flow-control devices, results of individual measurements are plotted against the corresponding stage, and stage-discharge relation curves are constructed. From these curves, rating tables indicating the computed discharge for any stage within the range of the measurements are prepared. For standard devices (e.g. flumes, weirs), rating tables indicating the discharge for any stage within the range of the device are prepared based on the geometry of the device. If it is necessary to define extremes of discharge outside the range of the device, the curves are extended using: (1) Logarithmic plotting; (2) velocity-area studies; (3) results of indirect measurements of peak discharge, such as slope-area or contracted-opening measurements, and computations of flow over dams or weirs; or (4) step-back-water techniques.

Daily mean discharges are computed by averaging the individual discharge measurements using the stage-discharge curves or tables. If the stage-discharge relation is subject to change because of frequent or continual change in the physical features that form the control, the daily mean discharge is determined by the shifting-control method, in which correction factors based on the individual discharge measurements and notes of the personnel making the measurements are applied to the gage heights before the discharges are determined from the curves or tables. This shifting-control method also is used if the stage-discharge relation is changed temporarily because of aquatic vegetation growth or debris on the control. For some gaging stations, formation of ice in the winter can obscure the stage-discharge relations so that daily mean discharges need to be estimated from other information, such as temperature and precipitation records, notes of observations, and records for other gaging stations in the same or nearby basins for comparable periods.

For most gaging stations, there might be periods when no gage-height record is obtained or the recorded gage height is so faulty that it cannot be used to compute daily mean discharge or contents. This record loss occurs when recording instruments malfunction or otherwise fail to operate properly, intakes are plugged, the stilling well is frozen, or various other reasons. For such periods, the daily discharges are estimated from the recorded range in stage, previous or following record, discharge measurements, climatological records, and comparison with other gaging-station records from the same or nearby basins. Information explaining how estimated daily discharge values are identified in gaging-station records is provided in the "Identifying Estimated Daily Discharge" section below.

3.1.2 Data Presentation

The information published for each continuous-record surface-water gaging station consist of six parts: the station description; a map showing the drainage area for the station; a plot of the daily mean discharge for the water year(s); a table of daily mean discharge values for the water year with summary data; a tabular statistical

[5] Stage is the water level (in units such as feet or meters) in a conveyance structure.

summary of monthly mean discharge data for the water year; and a summary statistics table that includes statistical data of annual discharge and runoff. The tables are included in Appendix A: Hydrologic Data, while the other information is presented below.

3.1.3 Station Description

The station description provides, under various headings, descriptive information included gaging-station location, drainage area, period of record, and gage information. The following information is provided:

LOCATION - This entry provides the gaging-station state plane coordinates and geographic location. Gaging station state plane coordinates were obtained by GPS or digitized from RFETS GIS coverages.

DRAINAGE AREA - This entry provides the drainage area (in acres) of the gaged basin. If, because of unusual natural conditions or artificial controls, some part of the basin does not contribute flow to the total flow measured at the gage, the noncontributing drainage area also is identified. Drainage area is usually measured using digital techniques and the most accurate maps available. Because the type of map available might vary from one drainage basin to another, the accuracy of digitized drainage areas also can vary. Drainage areas are updated as better maps become available. Some of the gaging stations included in this report measure stage and discharge in channels that convey water to or from reservoirs or other features; these channels might have little or no contributing drainage area. Drainage areas in this report were provided by RFETS GIS coverages.

PERIOD OF RECORD - This entry provides the period for which the Site has been collecting records at the gage. This entry includes the month and year of the start of collection of hydrologic records by the Site and the words "to current year" if the records are to be continued into the following year.

GAGE - This entry provides the type of gage currently in use; and a condensed history of the types and locations of previous gages.

3.1.4 Daily Mean Discharge Values

The daily mean discharge values computed for each gaging station during a water year are listed in the body of the data tables in Appendix A. In the monthly "FLOW RATE" summary part of the table, the line headed "AVERAGE" lists the average discharge, in cubic feet per second, during the month; and the lines headed "MAXIMUM" and "MINIMUM" list the maximum and minimum daily mean discharges for each month. Total discharge for the month also is expressed in cubic feet ("CUBIC FEET"), gallons ("GALLONS"), and acre-feet ("ACRE-FEET"). The term "PARTIAL DATA" denotes a month with incomplete data.

3.1.5 Summary Statistics

A section of the table titled ANNUAL SUMMARIES FOR WY## follows the monthly mean data section. This section provides a statistical summary of annual discharge flow rates and volumes for the labeled water year. The applicable units are left of the table value. The term "PARTIAL DATA" denotes a year with incomplete data.

3.1.6 Identifying Estimated Daily Discharge

Estimated daily discharges published in water-discharge tables and figures of this annual report are identified by *italicizing* individual daily values or through color-coding in hydrographs.

3.1.7 Other Records Available

Information used in the preparation of the records in this report, such as discharge-measurement notes, gage-height records, and rating tables, are on file at the Site. Information on the availability of the unpublished information or on the published statistical analyses is available from RFETS personnel involved with data collection at the Site.

Figure 3-1
RFETS Buffer Zone Water Routing Schematic

EXPLANATION

- Automated Monitoring Station
- Normal Uncontrolled Runoff Pathway
- Normal Controlled Flow Pathway

Standard Map Features

- Buildings and other structures
- Paved roads fill
- Solar Evaporation Ponds (SEPs)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

NOTES:
The monitoring locations, flow and runnoff pathways on this map are approximate and, as such, are not intended to accurately portray the true locations of these features. This schematic has been modified to clearly identify the relationships between the surface water map features.

DISCLAIMER:
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N

Scale = 1 : 17870
1 inch represents approximately 1489 feet

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER•HILL COMPANY

September 05, 2002

NT_Svr w:/projects/fy2001/01-0420/shade_base-arcs.aml

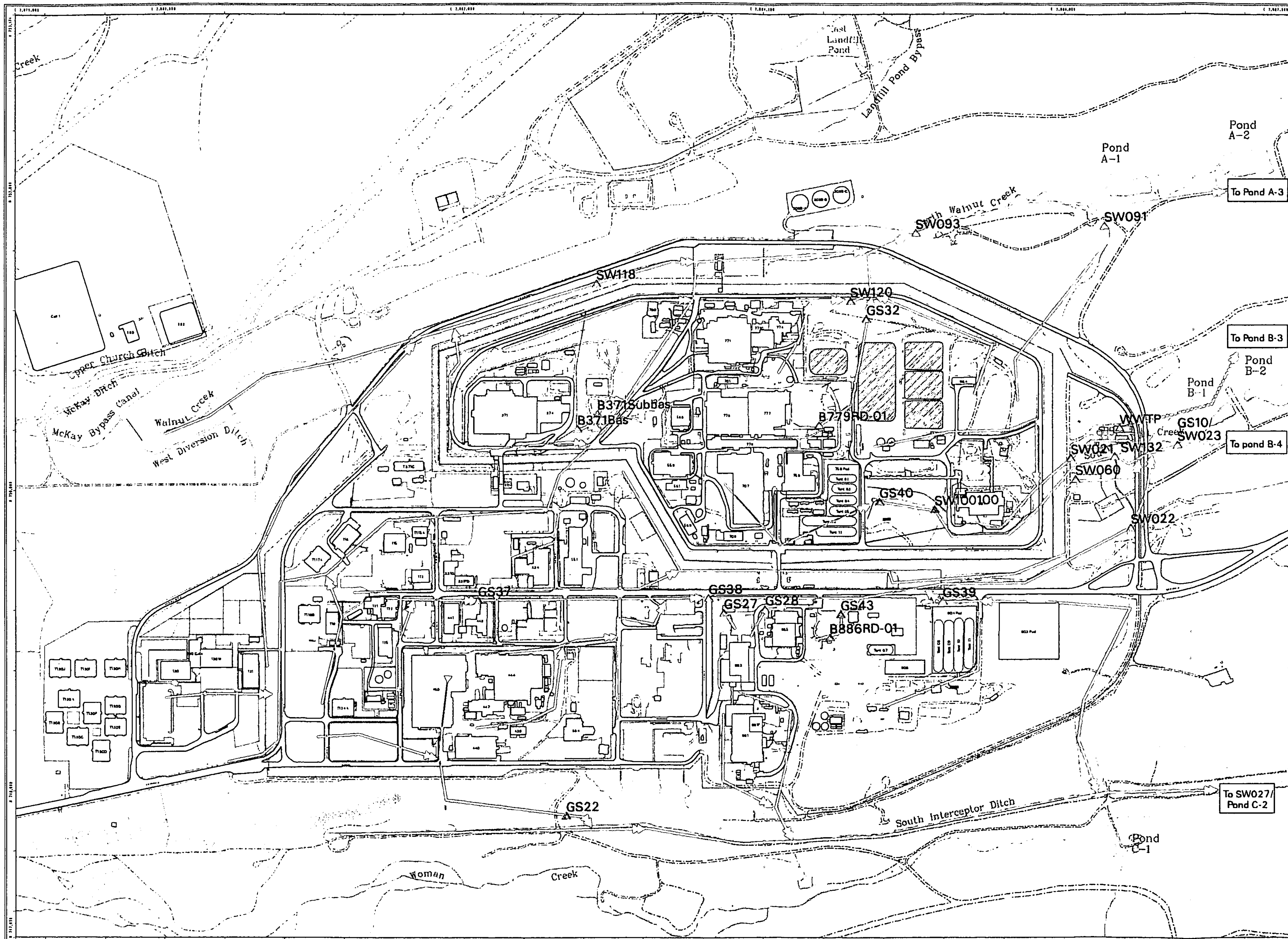

Figure 3-2
RFETS Industrial Area Water Routing Schematic

EXPLANATION

- Automated Monitoring Station
- Normal Uncontrolled Runoff Pathway
- Normal Controlled Flow Pathway

Standard Map Features

- Buildings and other structures
- Paved roads fill
- Solar Evaporation Ponds (SEPs)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

NOTES:
The monitoring locations, flow and runnoff pathways on this map are approximate and, as such, are not intended to accurately portray the true locations of these features. This schematic has been modified to clearly identify the relationships between the surface water map features.

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Scale = 1 : 7930
1 inch represents approximately 661 feet

200 0 400 800 Ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

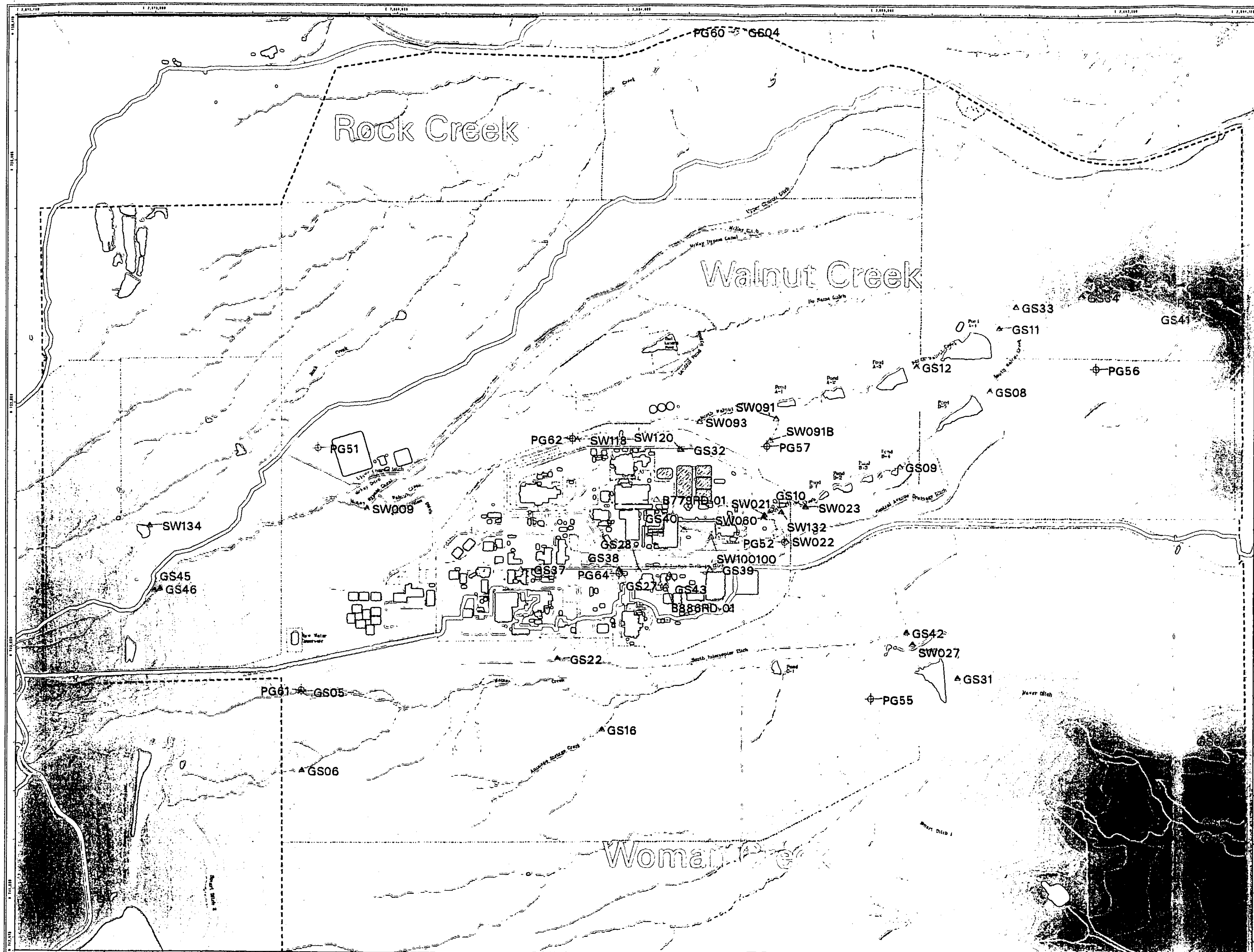
Prepared for: KAISER-HILL COMPANY

September 05, 2002

NT_Svr w:/projects/fy2001/01-0420/shade_base-ia_zoom-arcs.aml

Rocky Flats Environmental Technology Site

Figure 2-3
Major Site Drainage Areas: Walnut Creek, Woman Creek, and Rock Creek



EXPLANATION

- Precipitation Gage
- Automated Surface Water Monitoring Location
- Major Drainage Basins

Standard Map Features

- Buildings and other structures
- Solar Evaporation Ponds (SEPs)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Topographic Contour (20-Foot)
- Rocky Flats boundary
- Paved roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95
Topographic contours were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

Scale = 1 : 19910
1 inch represents approximately 1659 feet

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER•HILL COMPANY

September 05, 2002

NT_Svr w:/projects/fy2002/02-0061/auto-sw-loc-wom_wal-hillshade-b.aml

3.2 DISCHARGE DATA SUMMARIES

The following section provides information on all automated surface-water monitoring locations at RFETS operating during Water Years 1997 through 2000. Some locations do not have continuous flow record; they were operated only to collect automated surface-water samples for laboratory analysis. For locations with continuous flow measurement, graphical discharge summaries are given below. Numerical discharge values are included in the tables in Appendix A. The hydrologic routing diagrams for the locations included in this report are given in Figure 3-1 and Figure 3-2.

3.2.1 Sitewide Discharge Summary

Discharge summaries for the three major Site drainage areas (Walnut, Woman, and Rock Creeks) are given in Figure 3-3 and Figure 3-4. Walnut Cr. flows are measured at GS03 and Rock Cr. flows are measured at GS04. For WY98-00, Woman Cr. flows were measured exclusively at GS01. For WY97, the Woman Cr. volumes include those measured at GS02 (Mower Ditch at Indiana St.).[6] Figure 3-5 shows the relative total WY97-00 discharge volumes from the major Site drainages as measured at GS01, GS03, and GS04.

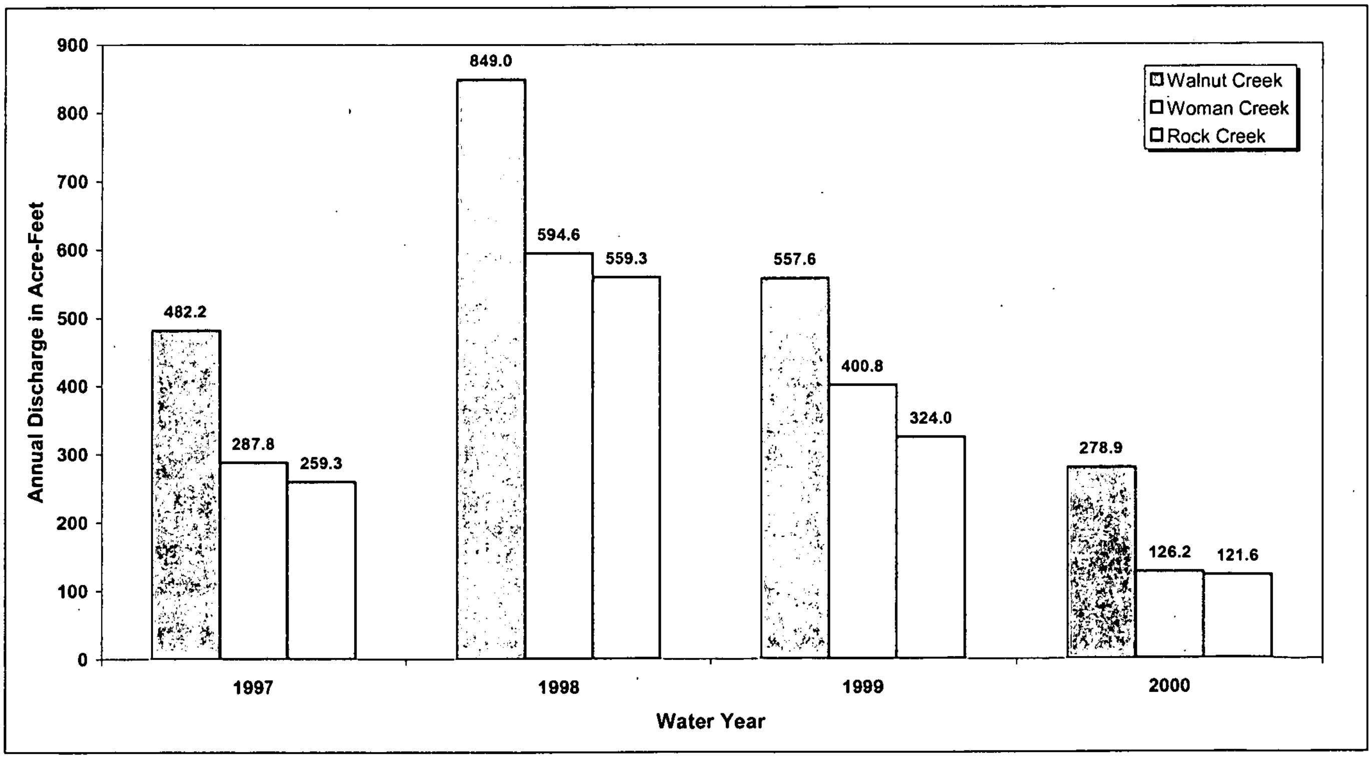


Figure 3-3. Annual Discharge Summary from Major Site Drainages: WY97-00.

[6] Prior to WY98, Woman Cr. flows were normally diverted to Mower Ditch. During high Woman Cr. flows, this diversion structure was bypassed with flows going to both GS01 and GS02. Therefore, the WY97 Woman Cr. volume given here is the total of GS01 and GS02.

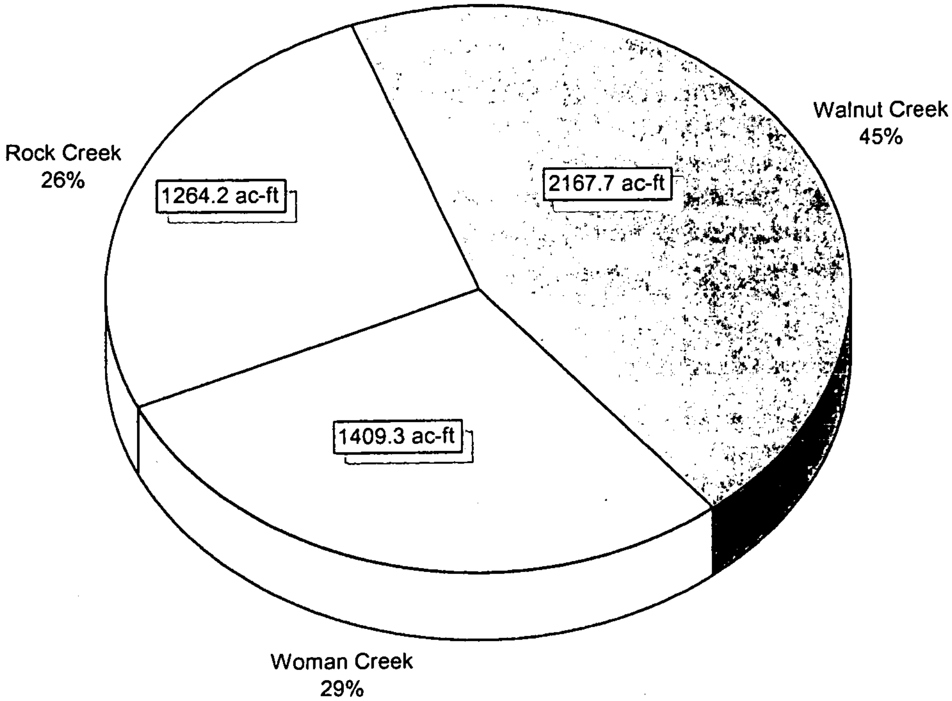


Figure 3-4. Relative Total Discharge Summary from Major Site Drainages: WY97-00.

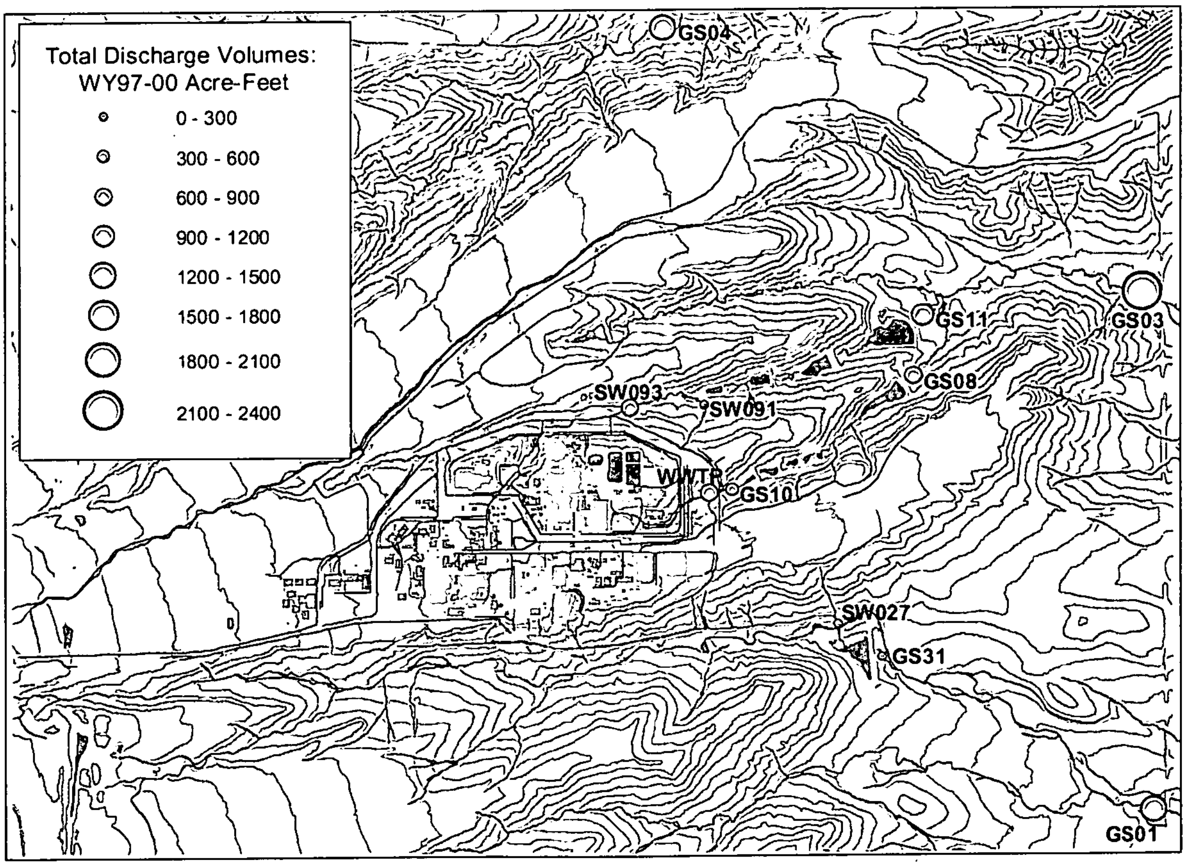
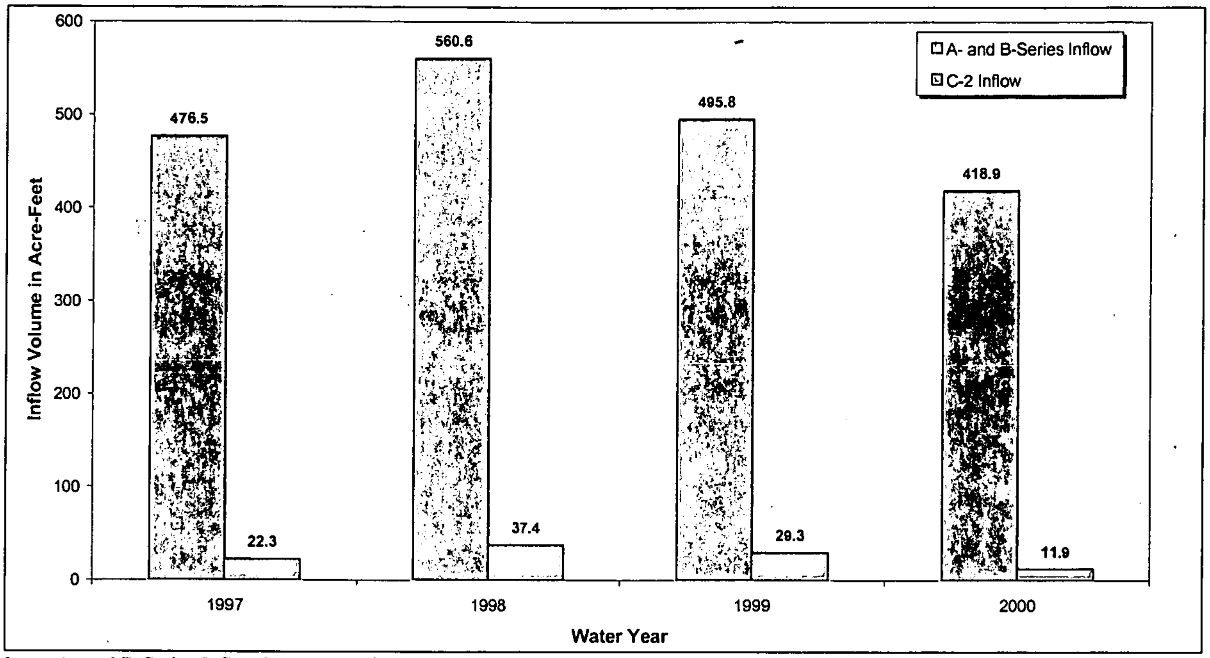


Figure 3-5. Map Showing Relative WY97-00 Discharge Volumes for Selected Gaging Stations.

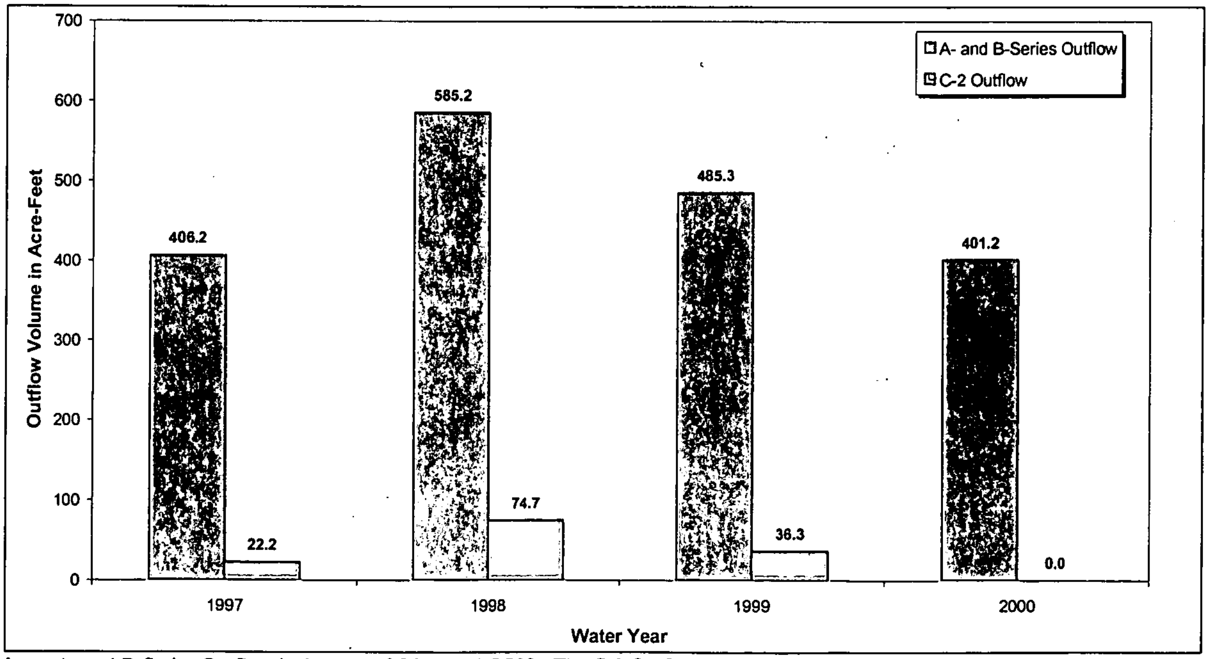
3.2.2 Detention Ponds Discharge Summary

Figure 3-6 and Figure 3-7 show the relative annual detention ponds inflows and outflows, respectively. Due to the routine FY97 pump transfers of Pond B-5 water to Pond A-4 (see Section **2.4.2**), the volumes for the A- and B-Series ponds are combined. Figure 3-5 shows the relative total WY97-00 discharge volumes from the detention ponds (as measured at GS08, GS11, and GS31) and from the major IA drainages to the ponds (as measured at GS10, SW027, SW093, and the WWTP). Pond inflows do not necessarily equal outflows for any given year, due to the storage of water in the ponds across water years.



Notes: A- and B-Series Inflow is the sum of GS10, the WWTP, SW091 and SW093. The C-2 Inflow is the volume measured at SW027.

Figure 3-6. Detention Pond Inflows: WY97-00.



Notes: A- and B-Series Outflow is the sum of GS11 and GS08. The C-2 Outflow is the volume measured at GS31.

Figure 3-7. Detention Pond Outflows: WY97-00.

3.2.3 GS01: Woman Creek at Indiana Street

Location

Woman Creek 200' upstream of Indiana Street; State Plane: 2093820; 744894

Drainage Area

- The basin includes the Woman Cr. drainage and southern portions of the IA; areas west of SH93 also contribute runoff (total drainage acreage unknown)
- IA Areas tributary to GS01: 900, 800, 600, and 400

Period of Record

September 16, 1991 to current year

Gage

Water-stage recorder and 18" Parshall flume (flume is located just east of Indiana St., sampling conducted on Site property); prior to 3/24/98 flow measurement was at sampling location on 9" Parshall flume

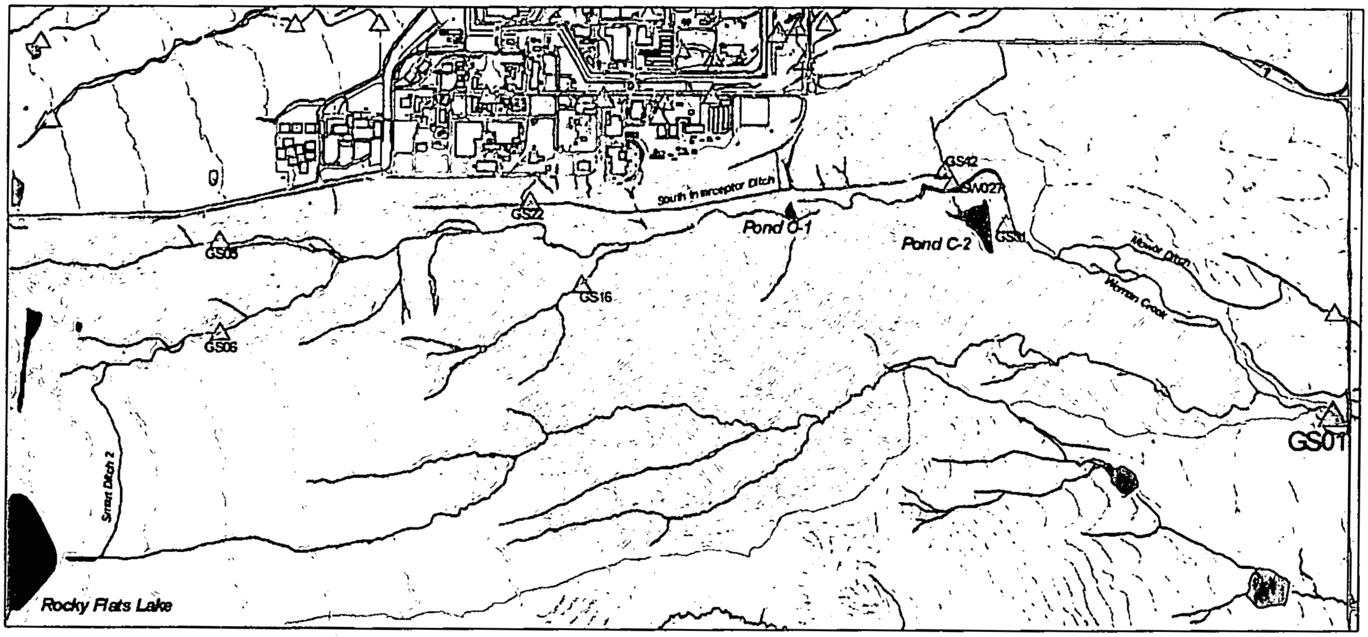


Figure 3-8. Map Showing GS01 Drainage Area.

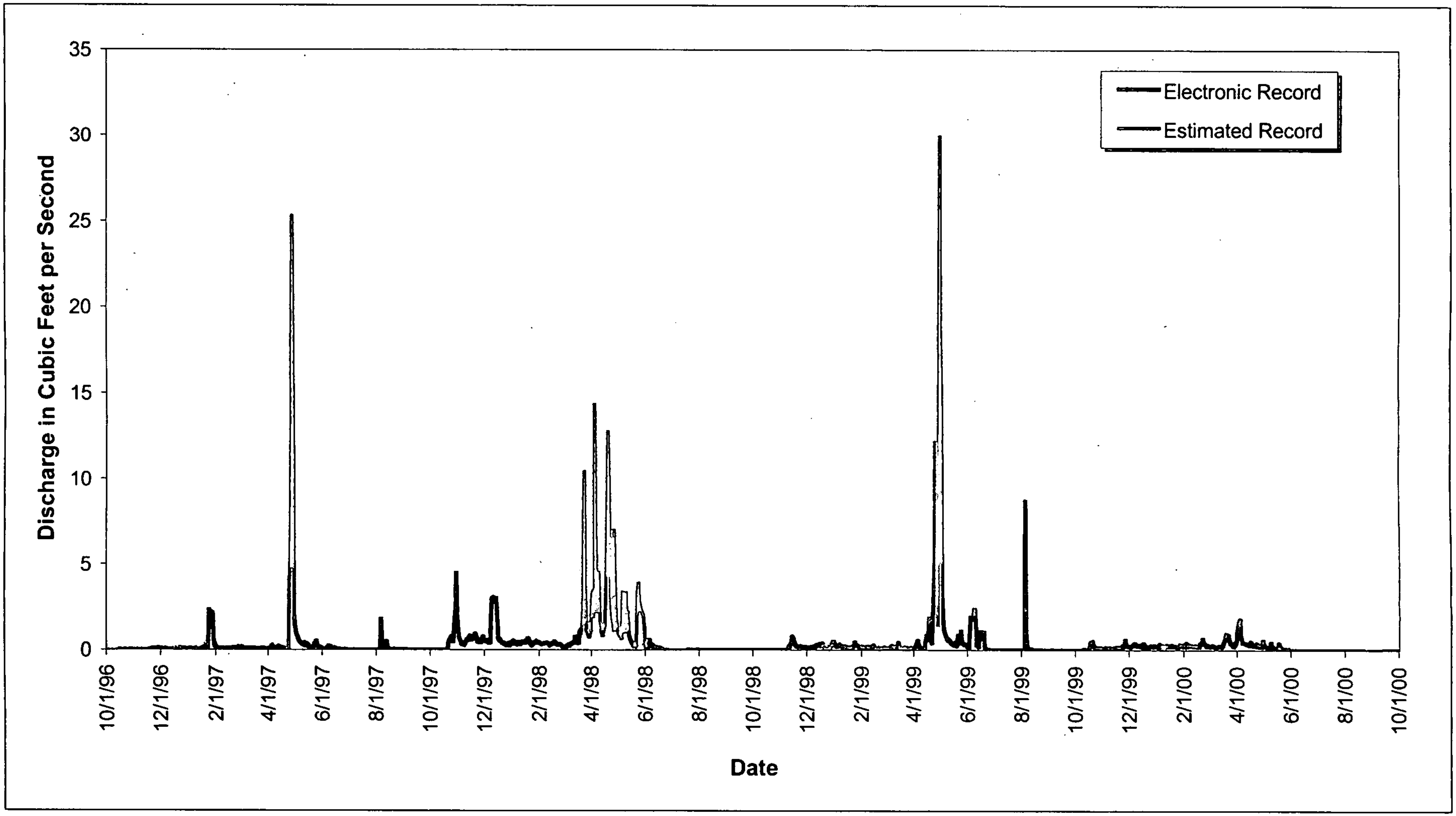


Figure 3-9. WY97-00 Mean Daily Hydrograph at GS01: Woman Creek at Indiana Street.

3.2.4 GS02: Mower Ditch at Indiana Street

Location

Mower Ditch 200' upstream of Indiana Street; State Plane: 2093817; 746302

Drainage Area

- The basin includes areas upgradient of Mower Ditch (total of 157.7 acres)
- IA Areas draining to GS02: none

Period of Record

9/16/91 to current year

Gage

Water-stage recorder and 9" Parshall flume; weir insert installed 3/8/99

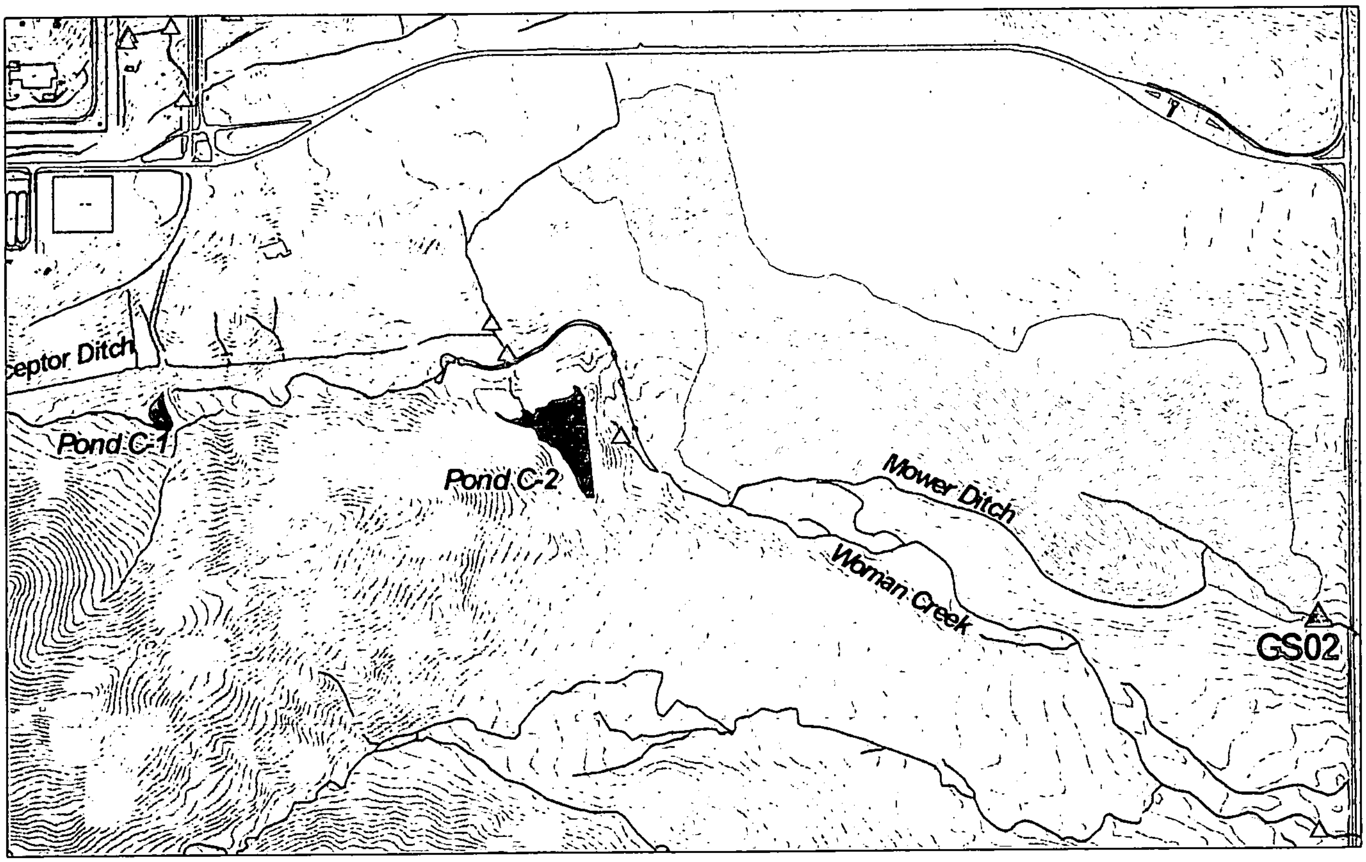


Figure 3-10. Map Showing GS02 Drainage Area.

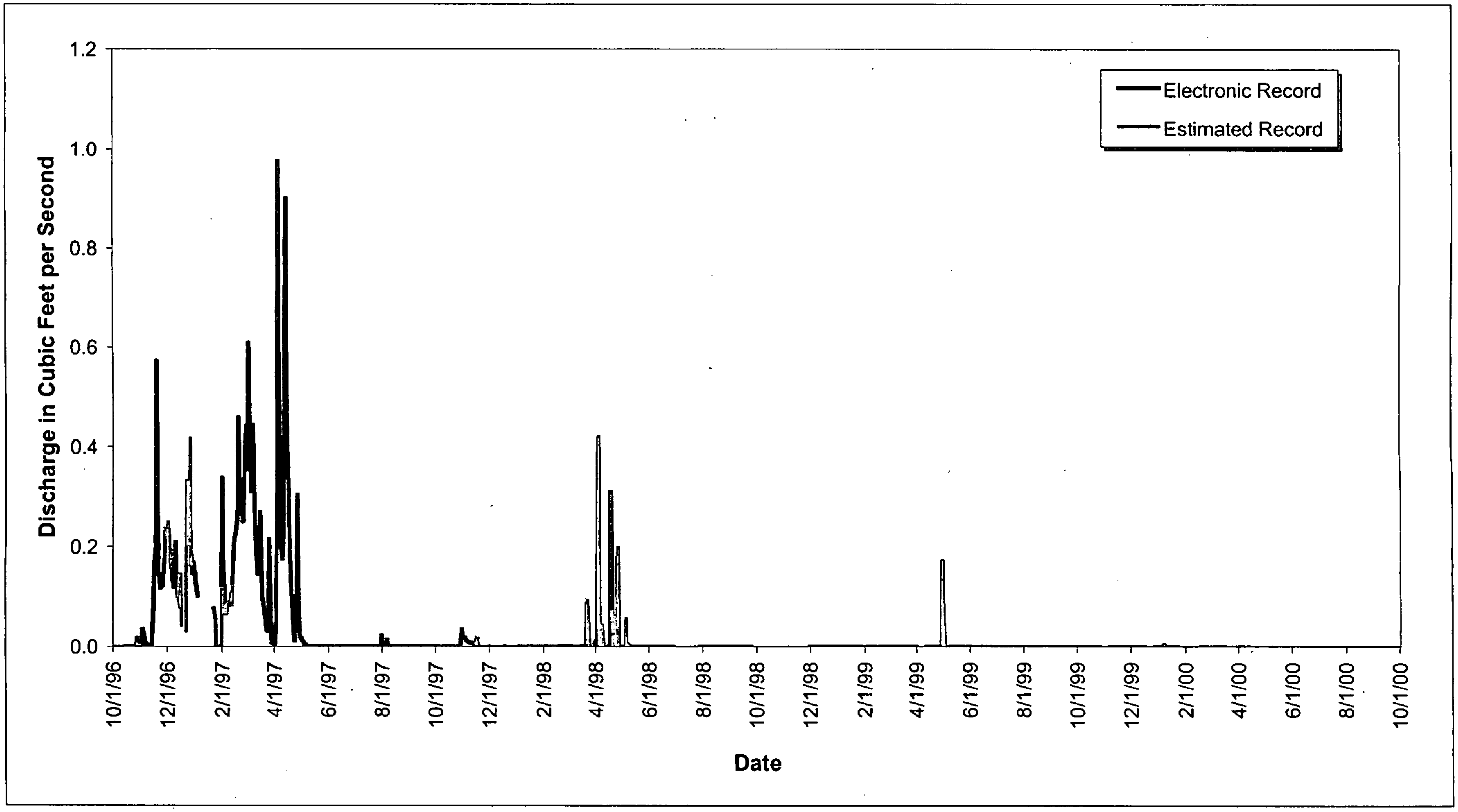


Figure 3-11. WY97-00 Mean Daily Hydrograph at GS02: Mower Ditch at Indiana Street.

3.2.5 GS03: Walnut Creek at Indiana Street

Location

Walnut Creek at Flume Pond outlet upstream of Indiana Street; State Plane: 2093606; 753652

Drainage Area

- The basin includes the Walnut Cr. drainage and the majority of the IA; areas west of SH93 also contribute runoff (total drainage acreage unknown)
- IA Areas draining to GS03: all Areas

Period of Record

9/2/91 to current year

Gage

Water-stage recorder and parallel 6" and 36" Parshall flumes

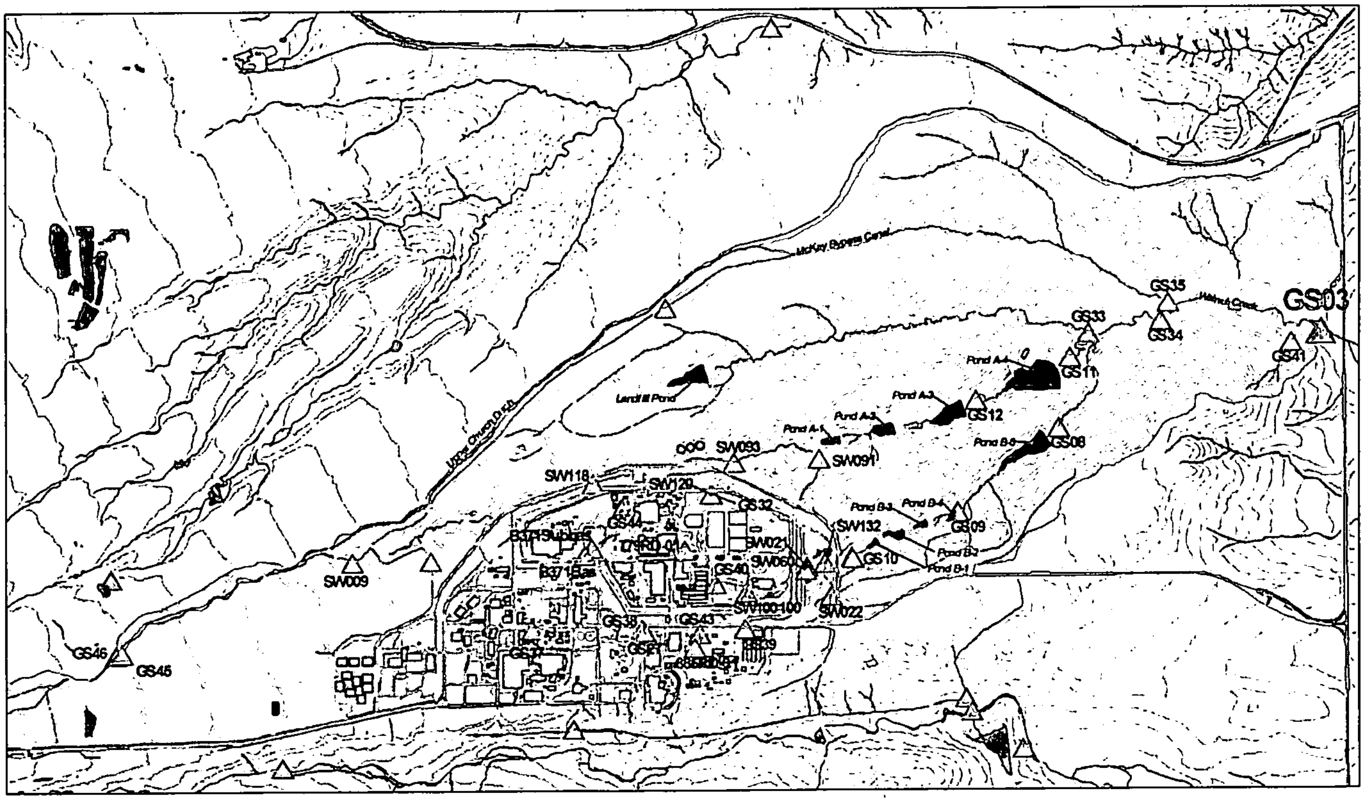


Figure 3-12. Map Showing GS03 Drainage Area.

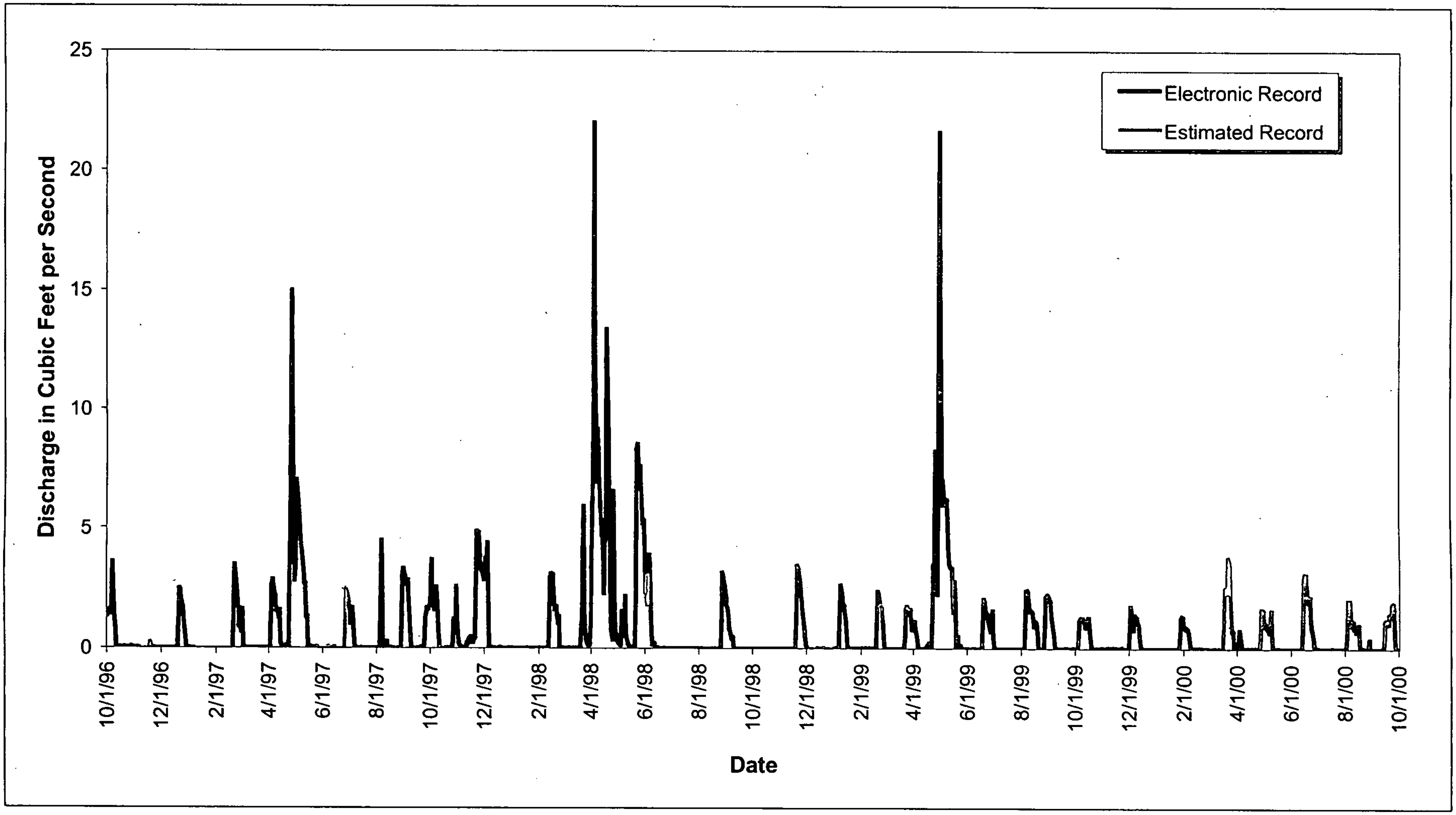


Figure 3-13. WY97-00 Mean Daily Hydrograph at GS03: Walnut Creek at Indiana Street.

3.2.6 GS04: Rock Creek at Highway 128

Location

Rock Creek 200' upstream of box culvert under Route 128; State Plane: 2085568; 758145

Drainage Area

- The basin includes the Rock Cr. basin; total drainage acreage unknown
- IA Areas draining to GS04: none

Period of Record

9/27/91 to current year

Gage

Water-stage recorder and 9" Parshall flume; weir insert installed 3/4/99

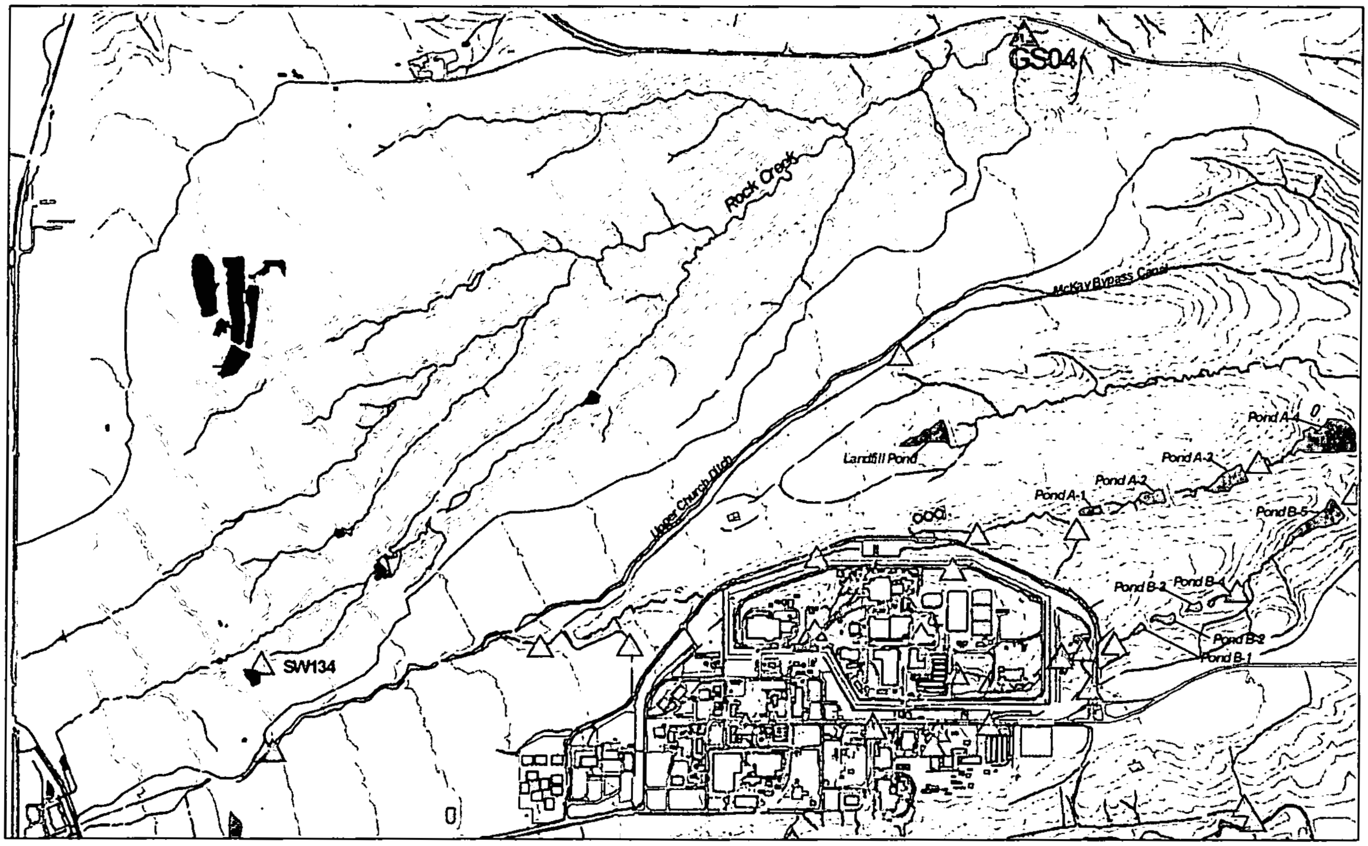


Figure 3-14. Map Showing GS04 Drainage Area.

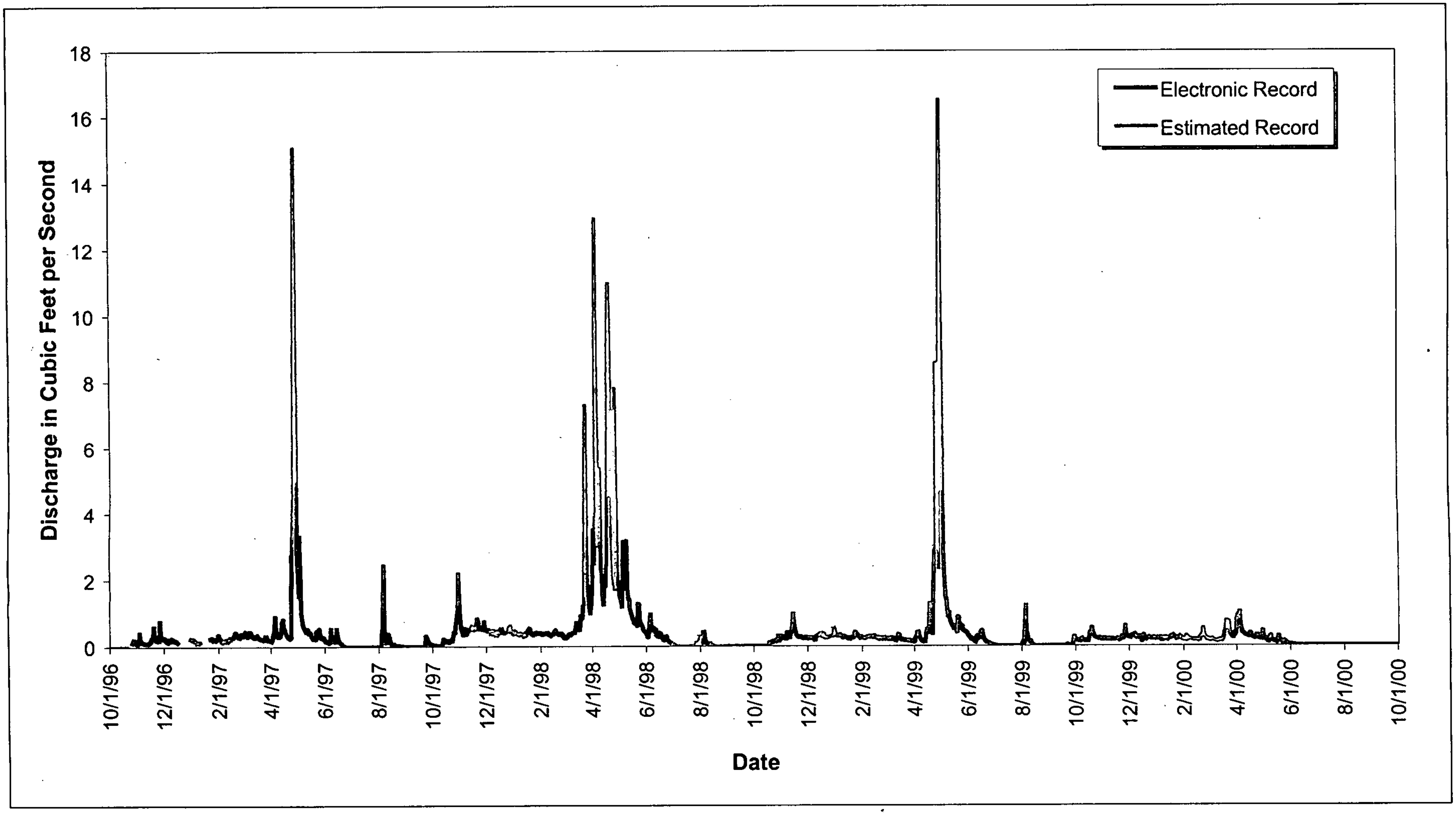


Figure 3-15. WY97-00 Mean Daily Hydrograph at GS04: Rock Creek at Highway 128.

3.2.7 GS05: Woman Creek at West Fenceline

Location

Woman Cr. east of west Site boundary; State Plane: 2078428; 747260

Drainage Area

- The basin includes a portion of the Woman Cr. drainage; areas west of SH93 also contribute runoff (total drainage acreage unknown)
- IA Areas draining to GS05: none

Period of Record

9/23/91 to current year

Gage

Water-stage recorder and 9" Parshall flume

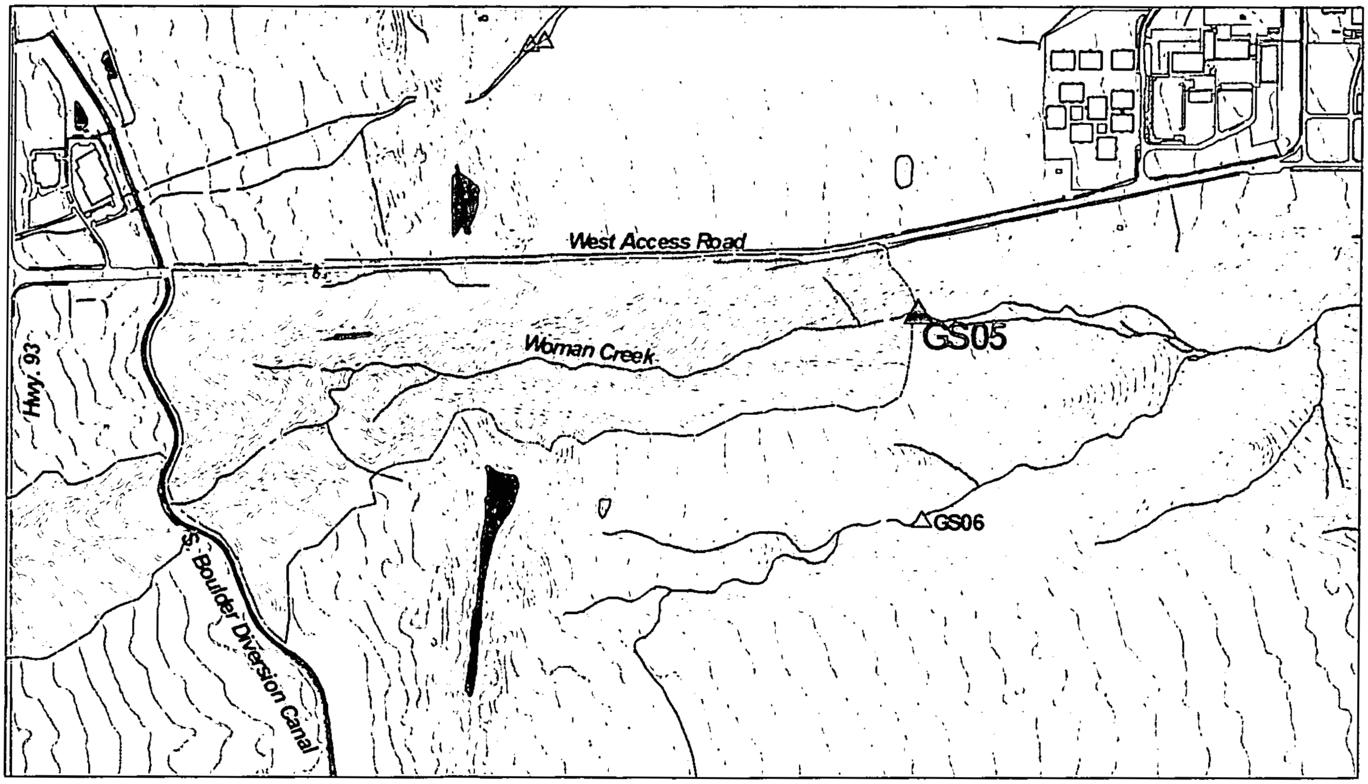


Figure 3-16. Map Showing GS05 Drainage Area.

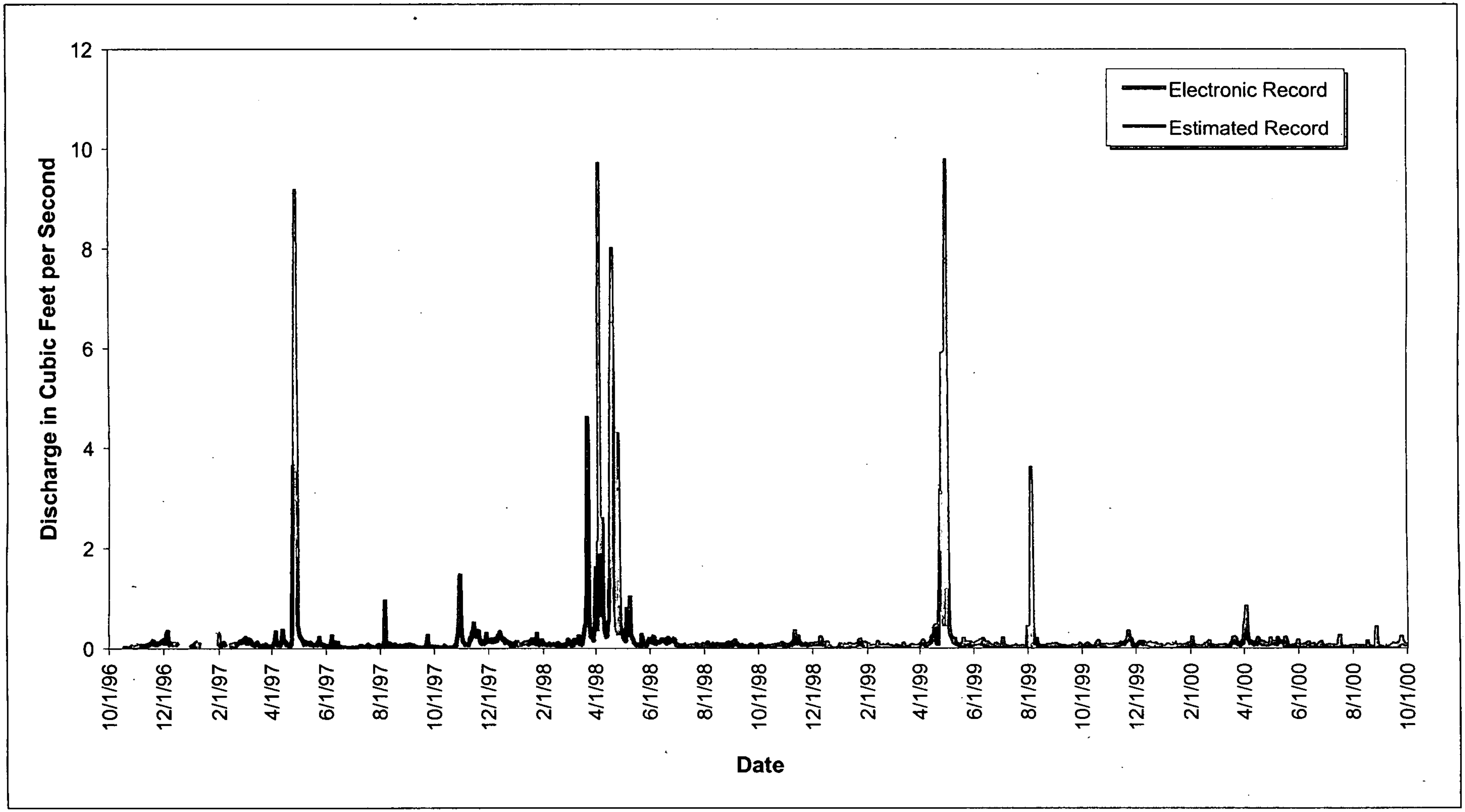


Figure 3-17. WY97-00 Mean Daily Hydrograph at GS05: North Woman Creek at West Fenceline.

3.2.8 GS06: Owl Branch at West Fenceline

Location

Owl Branch east of west Site boundary; State Plane: 2078449; 745968

Drainage Area

- The basin includes the Owl Branch of Woman Cr. (total drainage acreage unknown)
- IA Areas draining to GS06: none

Period of Record

9/23/91 to current year

Gage

Water-stage recorder and 6" Parshall flume; weir insert installed 11/13/96

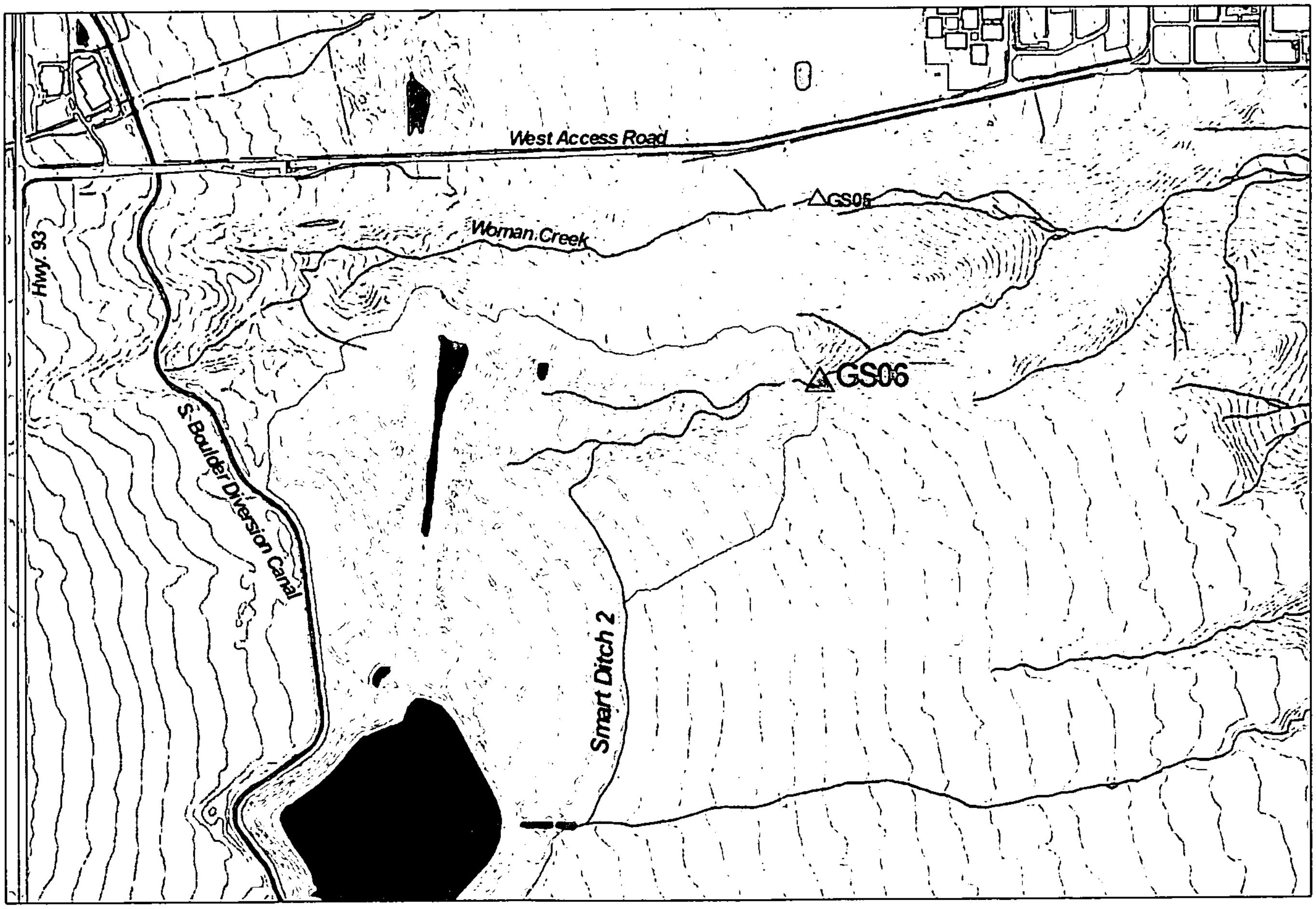


Figure 3-18. Map Showing GS06 Drainage Area.

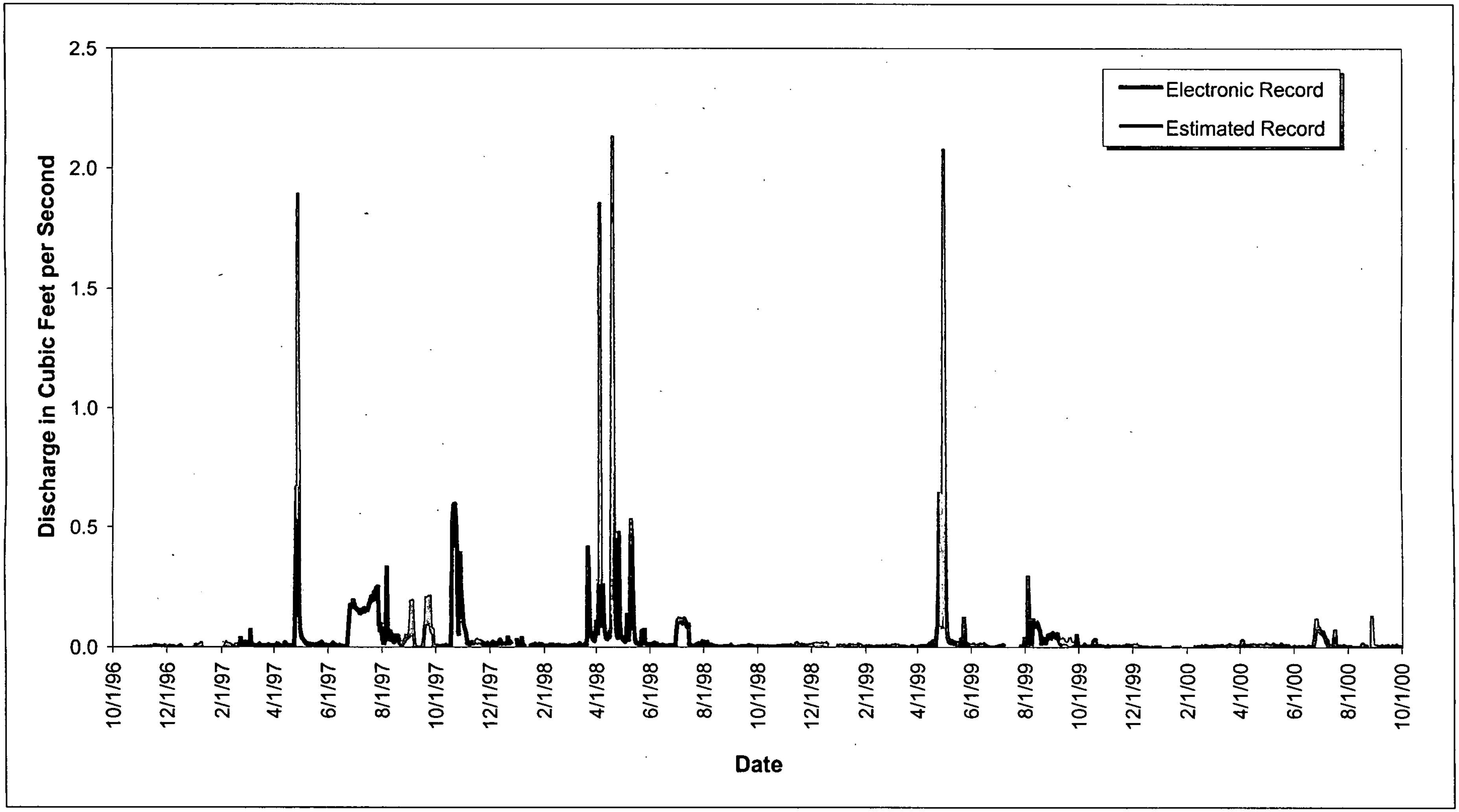


Figure 3-19. WY97-00 Mean Daily Hydrograph at GS06: South Woman Creek at West Fenceline.

3.2.9 GS08: South Walnut Creek at Pond B-5 Outlet

Location

South Walnut Cr. At Pond B-5 outlet; State Plane: 2089779; 752234

Drainage Area

- The basin includes the S. Walnut Cr. drainage and southern portions of the IA (total of 263.3 acres); Pond B-1 is normally pump transferred to Pond B-2, with Pond B-2 normally pump transferred to Pond A-2
- IA Areas draining to GS08: 900, 800, 700, 500, 600, 400, 300 and 100

Period of Record

3/23/94 to current year

Gage

Water-stage recorder and 24" Parshall flume

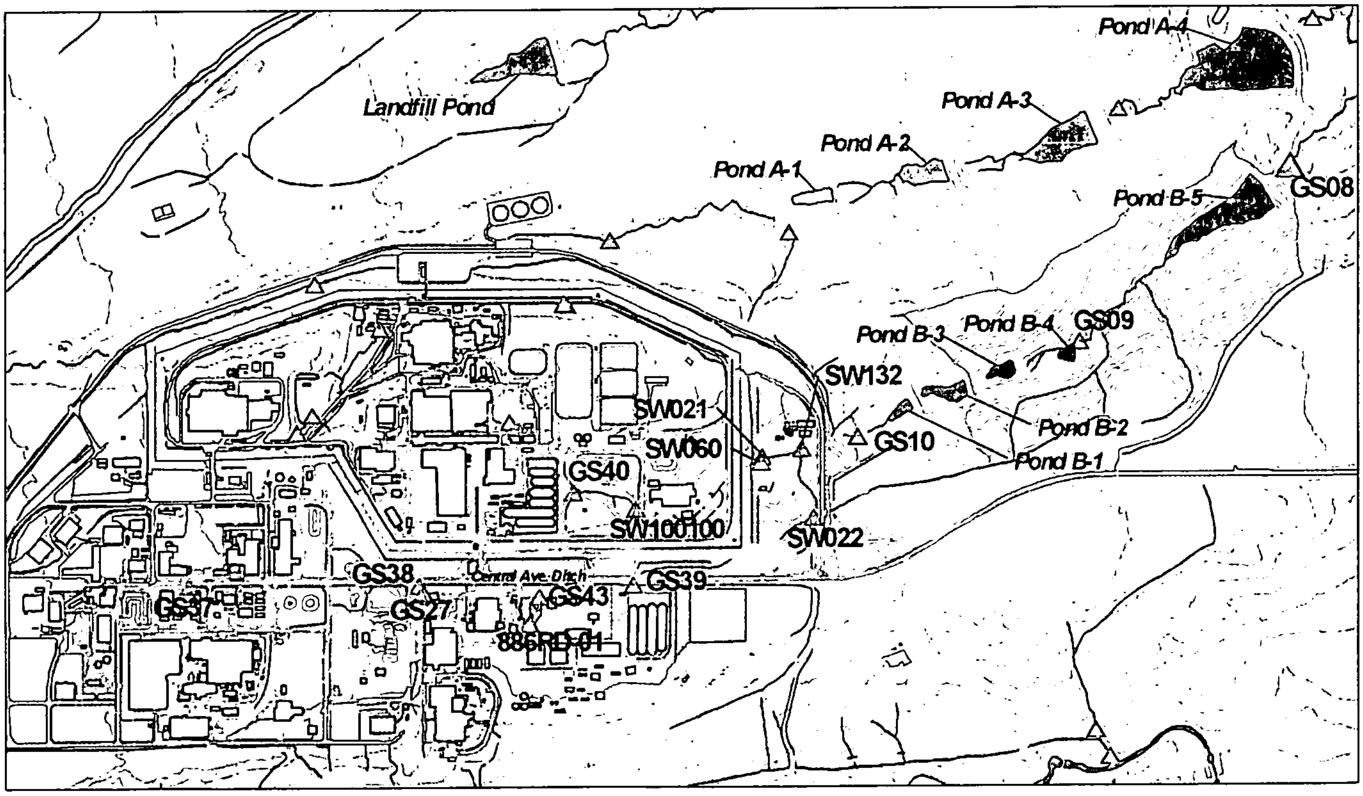


Figure 3-20. Map Showing GS08 Drainage Area.

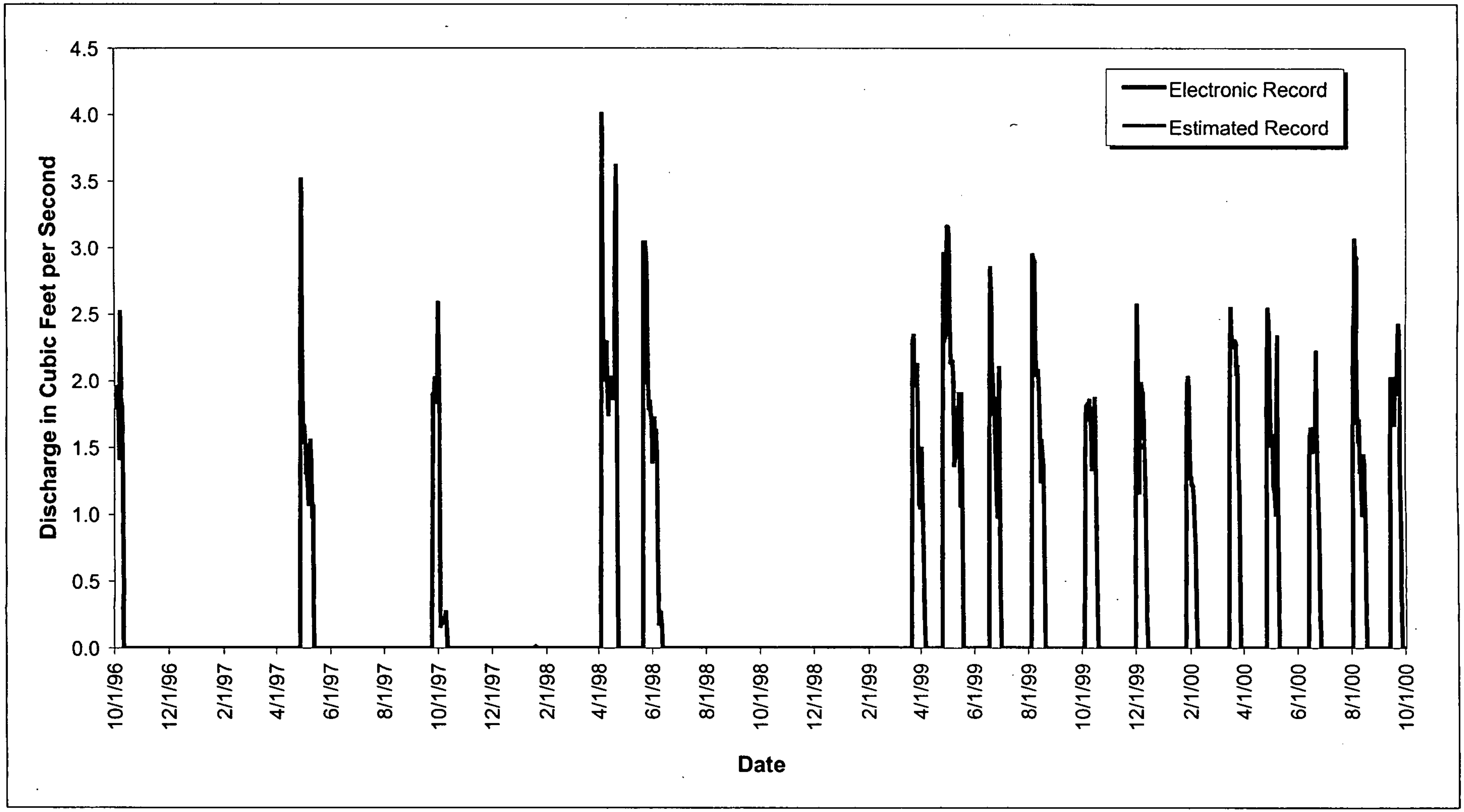


Figure 3-21. WY97-00 Mean Daily Hydrograph at GS08: South Walnut Creek at Pond B-5 Outlet.

3.2.10 GS09: South Walnut Creek at Pond B-4 Outlet

Location

South Walnut Cr. at Pond B-4 outlet; State Plane: 2088301; 750987

Drainage Area

- The basin includes the S. Walnut Cr. drainage and southern portions of the IA (total of 182.9 acres); Pond B-1 is normally pump transferred to Pond B-2, with Pond B-2 normally pump transferred to Pond A-2
- IA Areas draining to GS09: 900, 800, 700, 600, 500, 400, 300, and 100

Period of Record

5/12/92 to 1/2/01

Gage

Water-stage recorder and 30" sharp-crested rectangular weir with end contractions

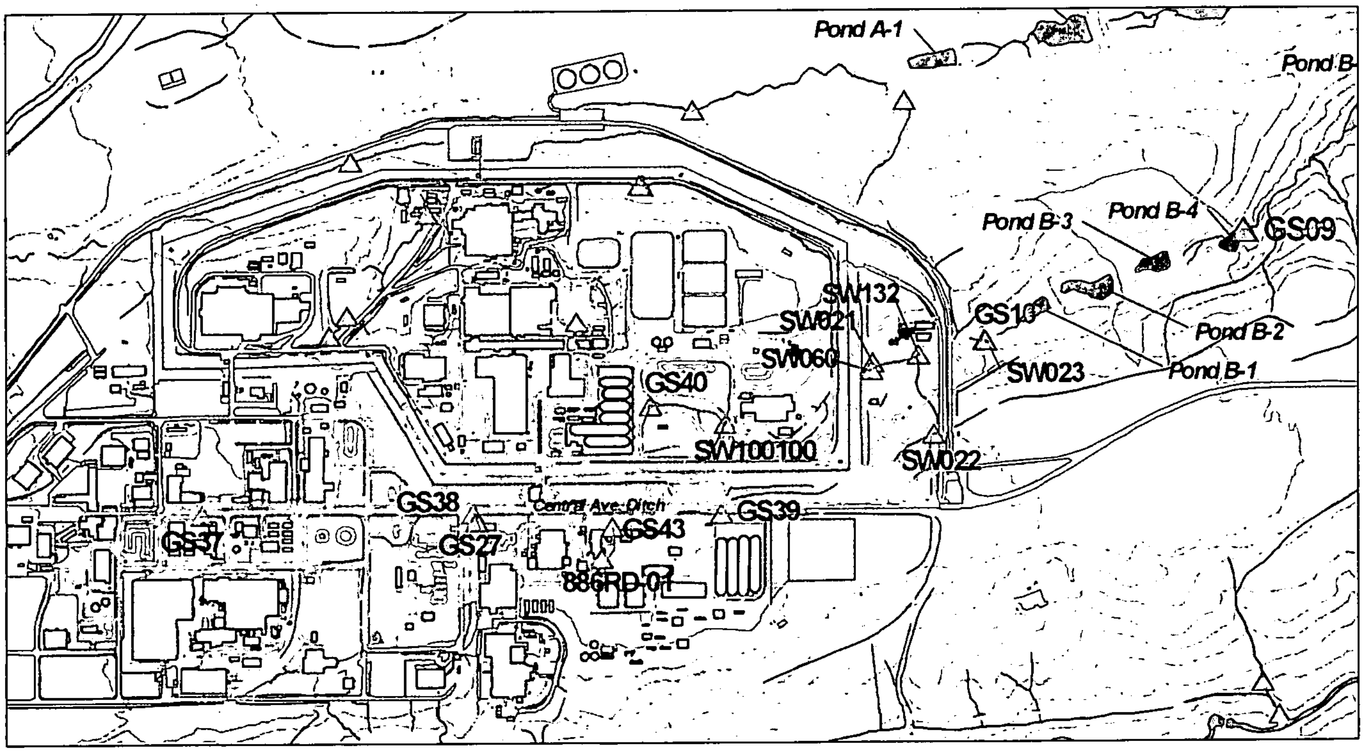


Figure 3-22. Map Showing GS09 Drainage Area.

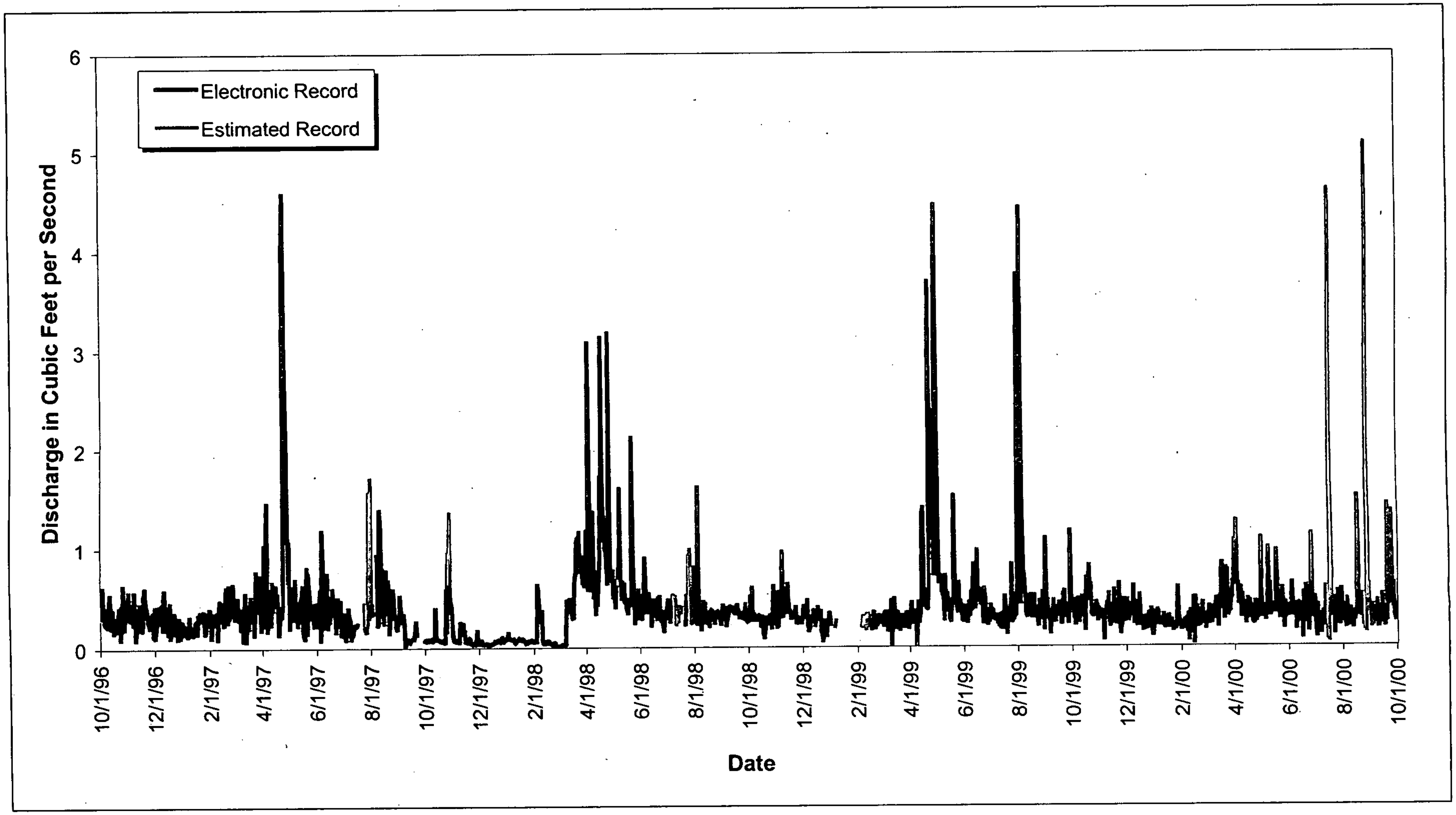


Figure 3-23. WY97-00 Mean Daily Hydrograph at GS09: South Walnut Creek at Pond B-4 Outlet.

3.2.11 GS10: South Walnut Creek at B-1 Bypass

Location

South Walnut Cr. above B-1 Bypass; State Plane: 2086741, 750326

Drainage Area

- The basin includes the central and southern portions of the IA (total of 167.2 acres)
- IA Areas draining to GS10: 900, 800, 700, 600, 500, 400, 300, and 100

Period of Record

4/1/93 to current year

Gage

Water-stage recorder and 9" Parshall flume

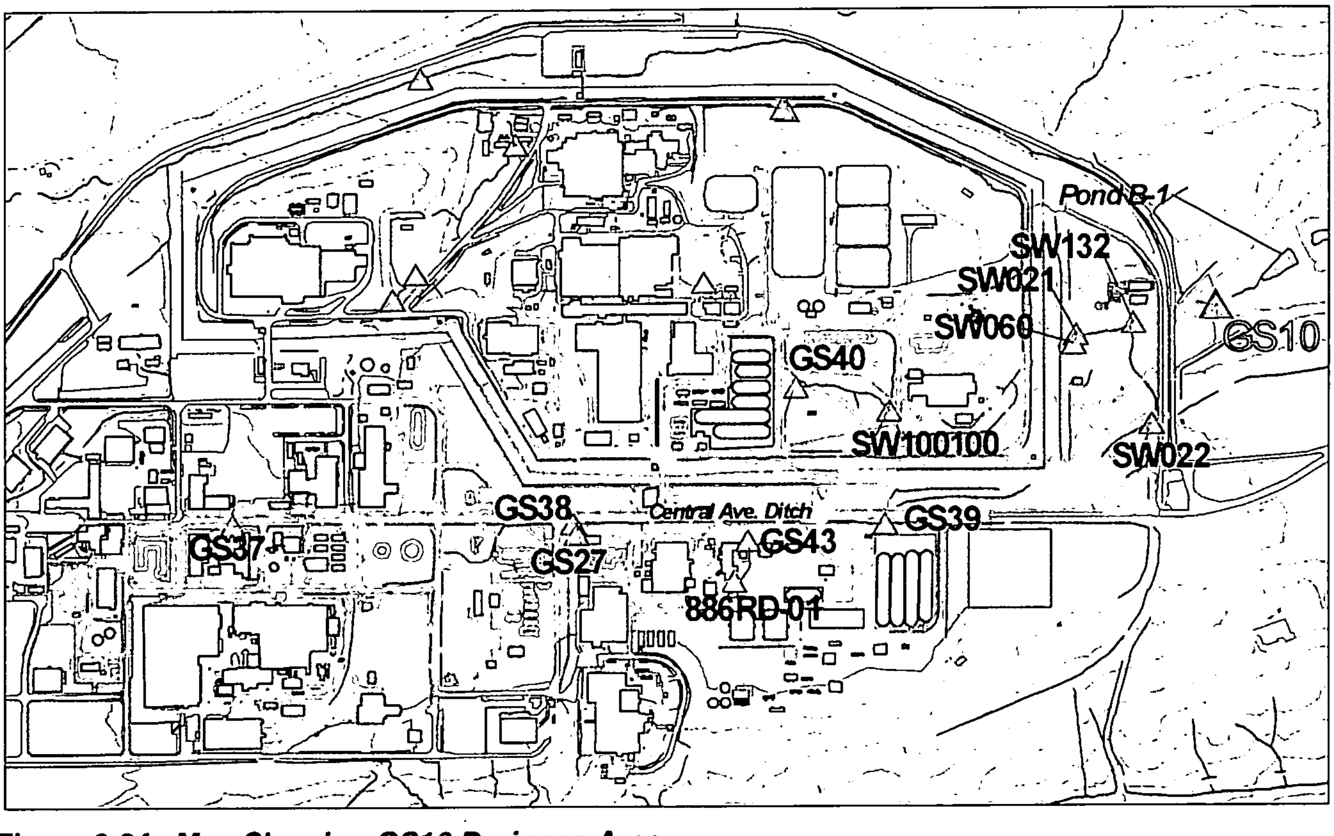


Figure 3-24. Map Showing GS10 Drainage Area.

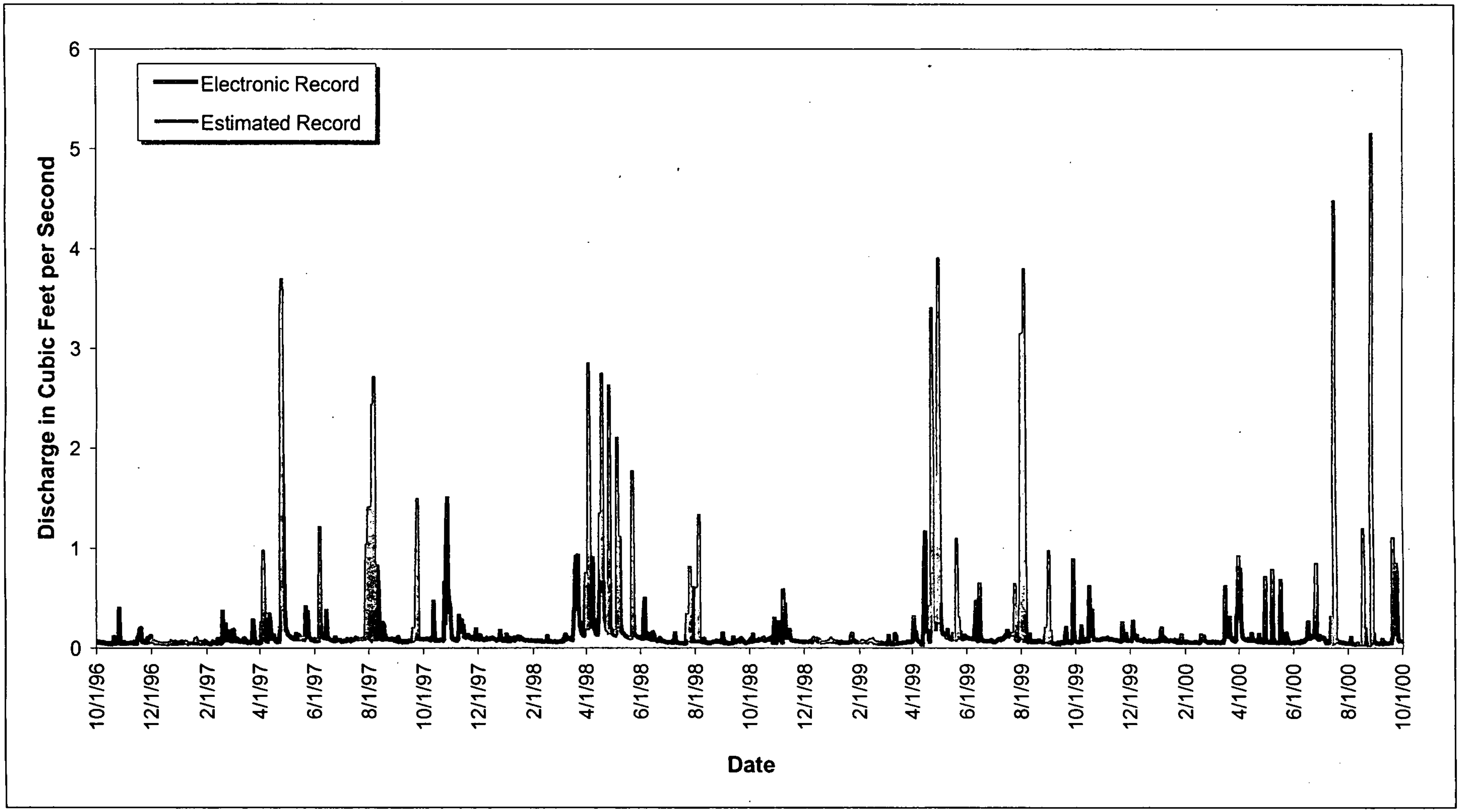


Figure 3-25. WY97-00 Mean Daily Hydrograph at GS10: South Walnut Creek at B-1 Bypass.

3.2.12 GS11: North Walnut Creek at Pond A-4 Outlet

Location

N. Walnut Cr. at Pond A-4 outlet; State Plane: 2089934, 753267

Drainage Area

- The basin includes the N. Walnut Cr. drainage, the Landfill Pond (pump transferred to A-Series ponds), Ponds B-1 and B-2 (normally pump transferred to Pond A-2), and northern portions of the IA (total of 467.6 acres)
- IA Areas draining to GS11: 900, 700, 300, and 100

Period of Record

5/12/92 to current year

Gage

Water-stage recorder and 24" Parshall flume

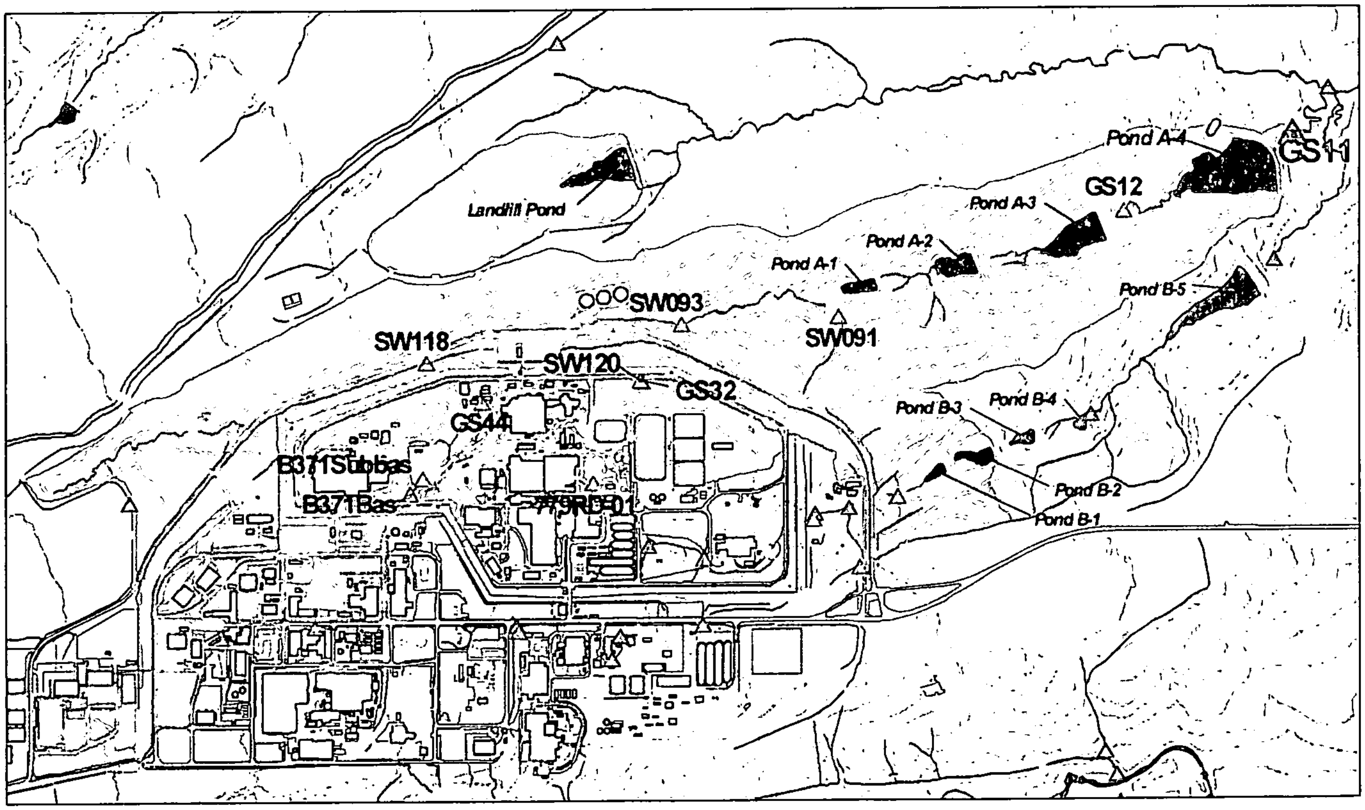


Figure 3-26. Map Showing GS11 Drainage Area.

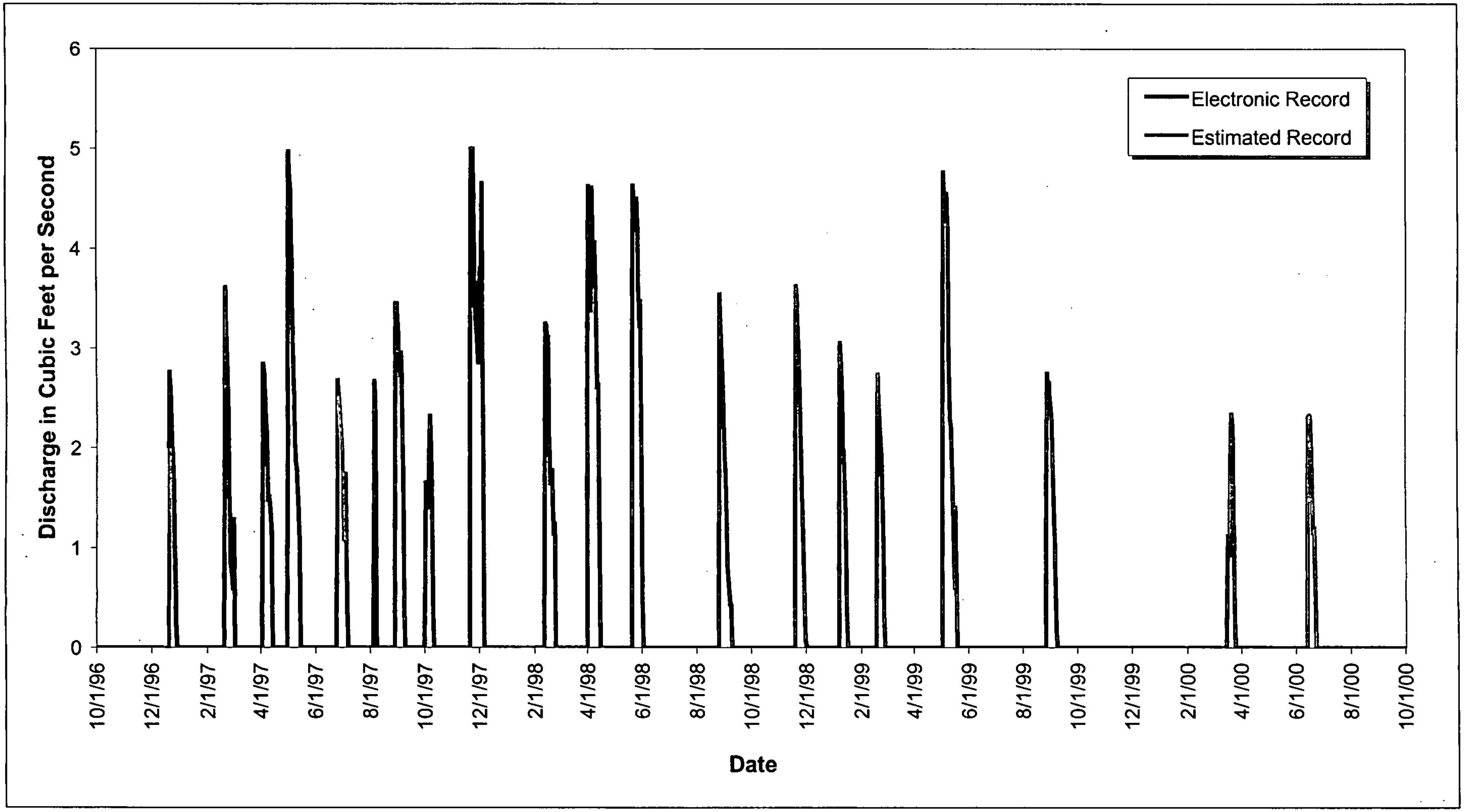


Figure 3-27. WY97-00 Mean Daily Hydrograph at GS11: North Walnut Creek at Pond A-4 Outlet.

3.2.13 GS12: North Walnut Creek at Pond A-3 Outlet

Location

N. Walnut Cr. at Pond A-3 outlet; State Plane: 2088569, 752633

Drainage Area

- The basin includes the N. Walnut Cr. drainage, the Landfill Pond (pump transferred to A-Series ponds), Ponds B-1 and B-2 (normally pump transferred to Pond A-2), and northern portions of the IA (total of 433.3 acres)
- IA Areas draining to GS12: 900, 700, 300, and 100

Period of Record

5/13/92 to current year

Gage

Water-stage recorder and 30" Parshall flume

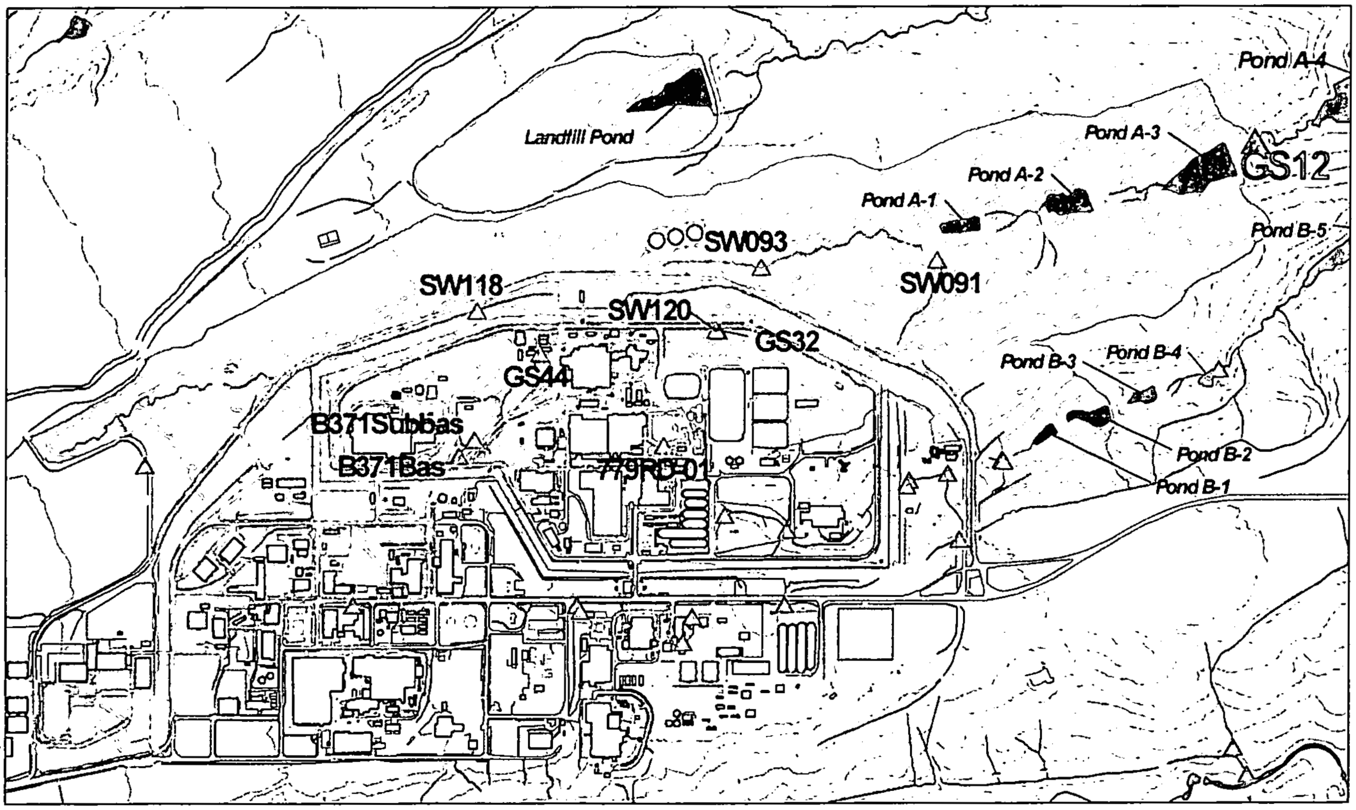


Figure 3-28. Map Showing GS12 Drainage Area.

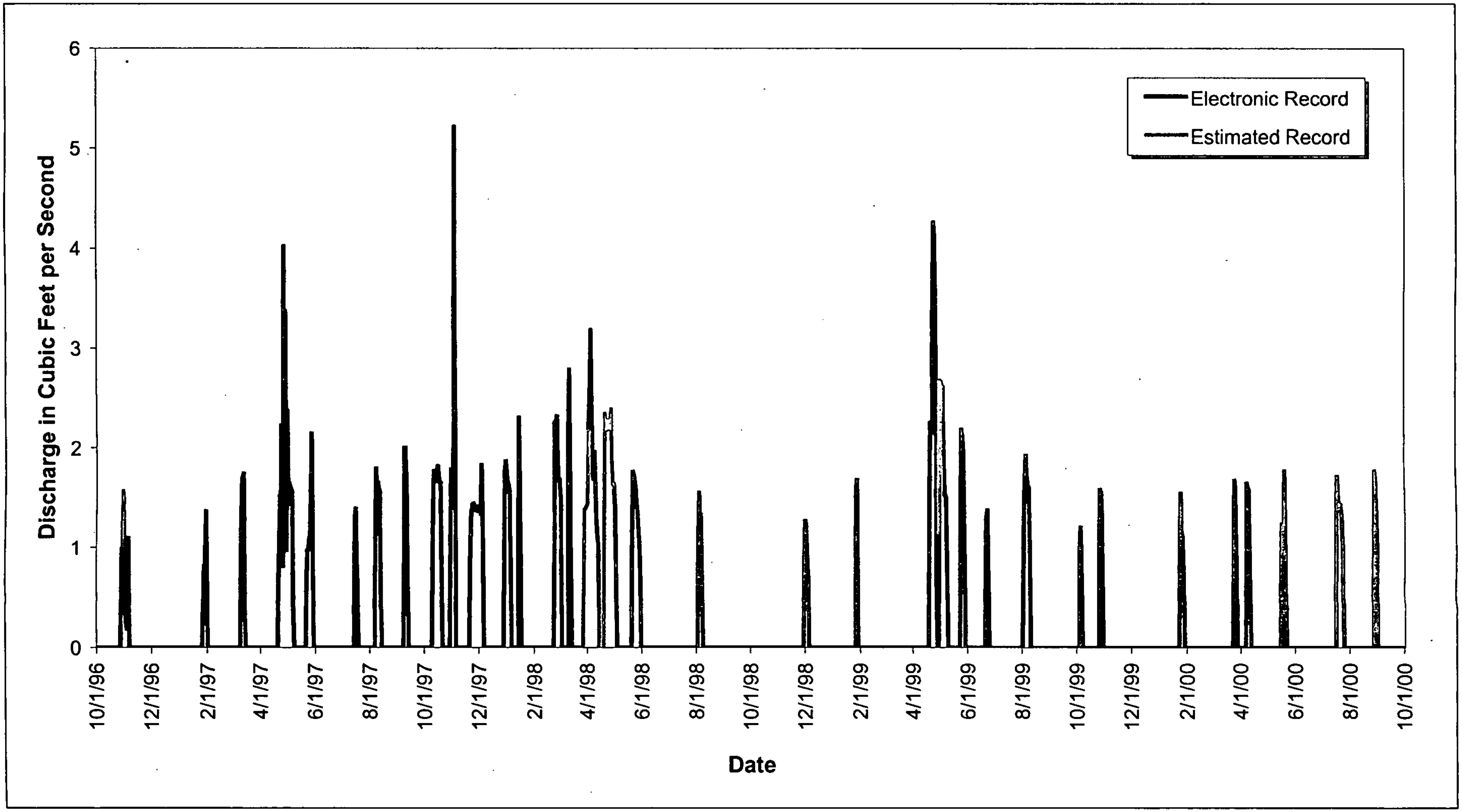


Figure 3-29. WY97-00 Mean Daily Hydrograph at GS12: North Walnut Creek at Pond A-3 Outlet.

3.2.14 GS16: Antelope Springs

Location

Antelope Springs Cr. in S. Buffer Zone; State Plane: 2083406, 746659

Drainage Area

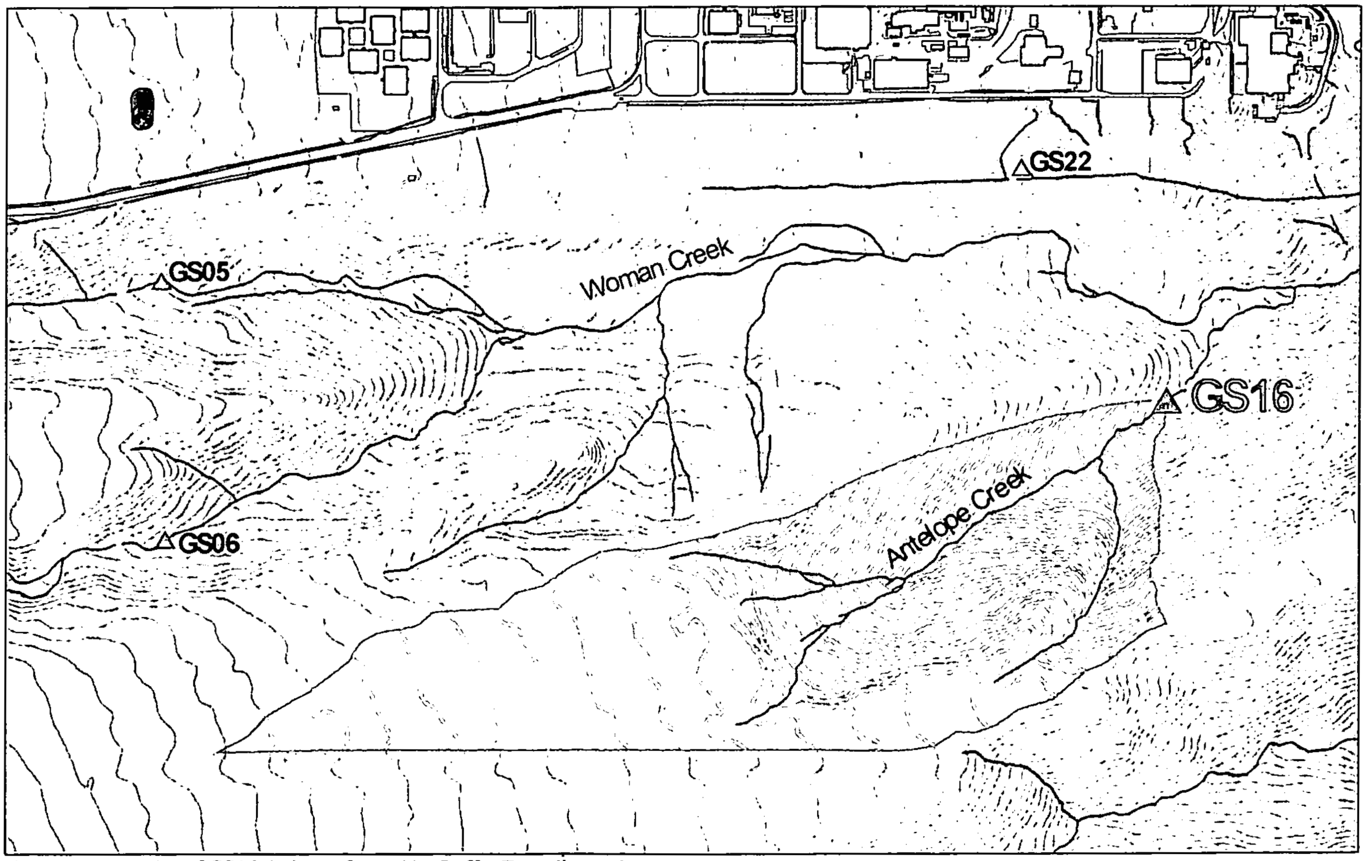
- The basin includes the Antelope Springs Cr. drainage (total of 104.7 acres)
- IA Areas draining to GS16: none

Period of Record

4/8/93 to current year

Gage

Water-stage recorder and 6" Parshall flume; 6" Parshall flume 150' downstream prior to 11/30/98



Note: Southern edge of GS16 drainage formed by Buffer Zone dirt road.

Figure 3-30. Map Showing GS16 Drainage Area.

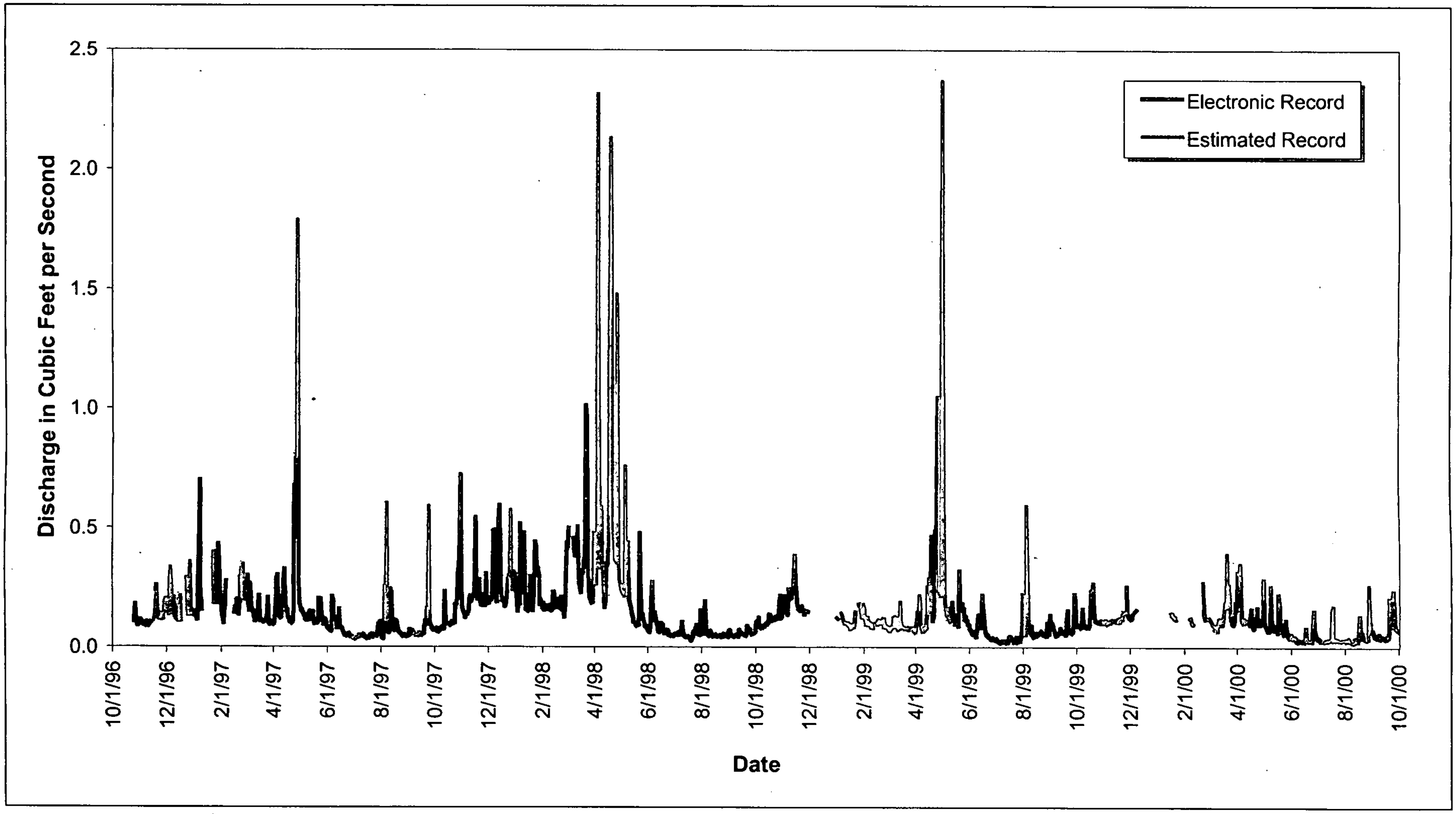


Figure 3-31. WY97-00 Mean Daily Hydrograph at GS16: Antelope Springs.

3.2.15 GS22: 400 Area Outfall to SID

Location

400 Area outfall to SID; State Plane: 2082678, 747820

Drainage Area

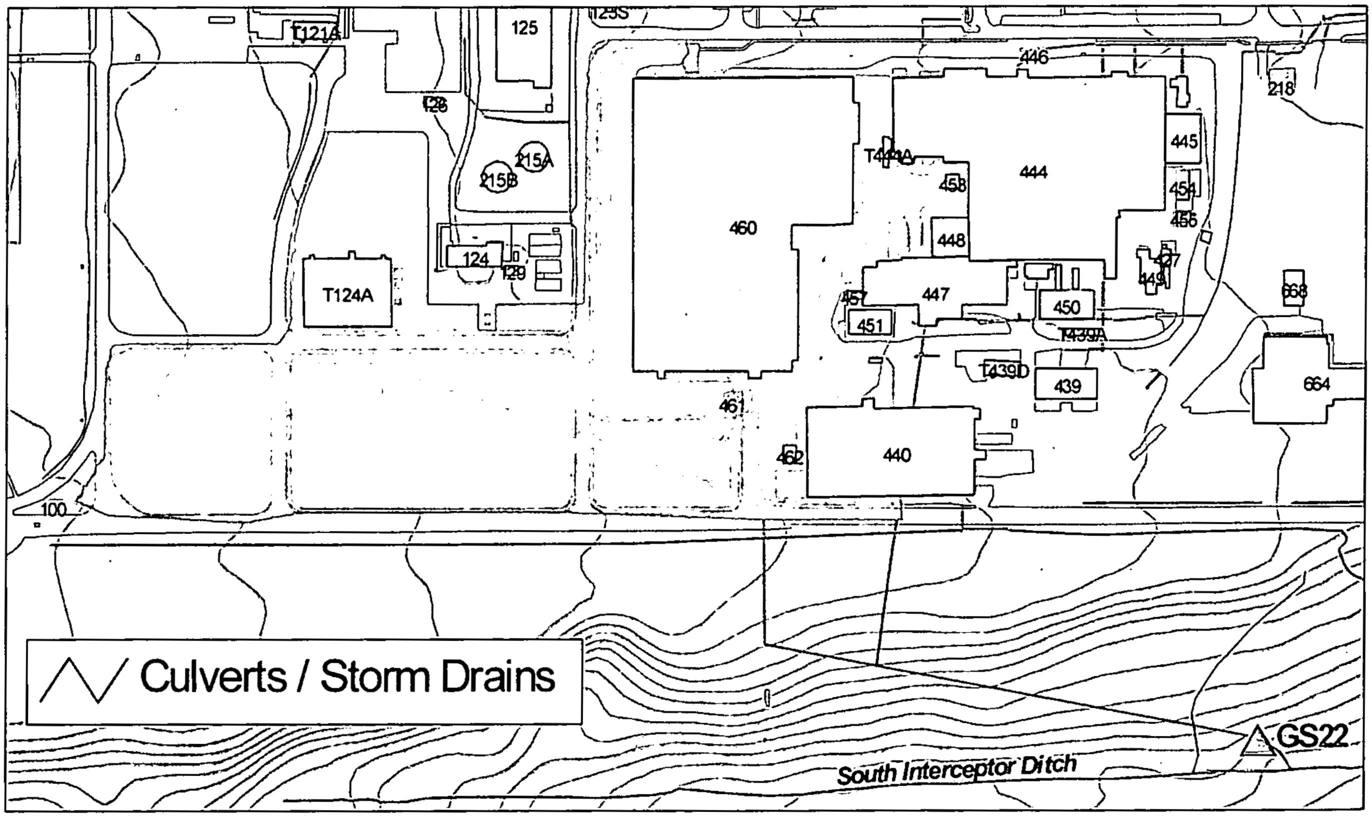
- The basin includes a portion of the southern IA (total of 17.2 acres)
- IA Areas draining to GS22: 400 and 100

Period of Record

4/18/95 – 10/1/96; 1/7/00 to current year

Gage

Water-stage recorder and 1.5' H-flume



Note: Water reaches GS22 via underground stormdrains.

Figure 3-32. Map Showing GS22 Drainage Area.

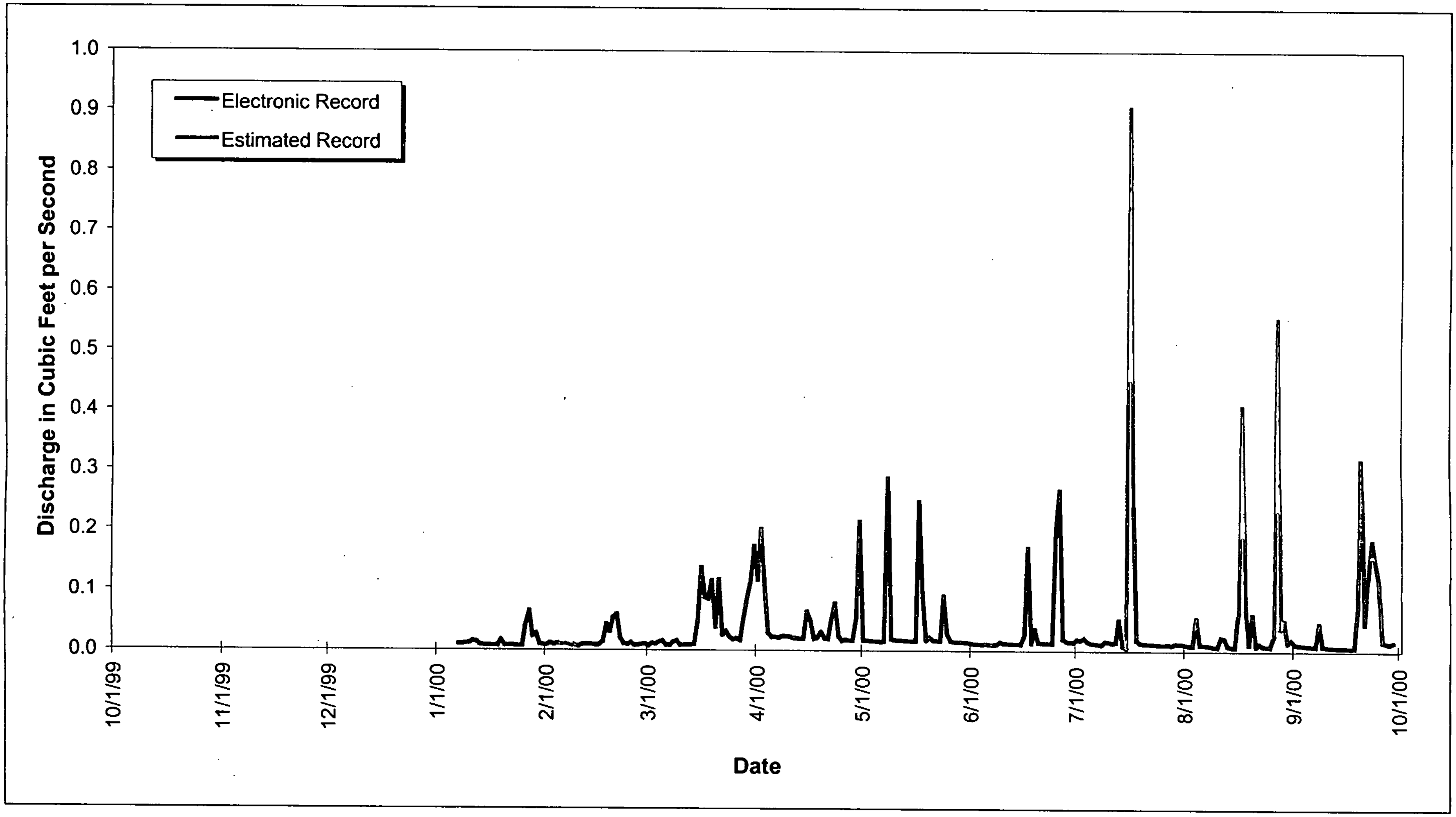


Figure 3-33. WY00 Mean Daily Hydrograph at GS22: 400 Area Outfall to SID.

3.2.16 GS27: Building 889/884 Subdrainage Area

Location

Building 889/884 subdrainage area; State Plane: 2083703, 749242

Drainage Area

- The basin includes the 889/884 area (total of 0.4 acres)
- IA Areas draining to GS27: 800

Period of Record

3/9/95 to current year

Gage

Water-stage recorder and 2" cutthroat flume

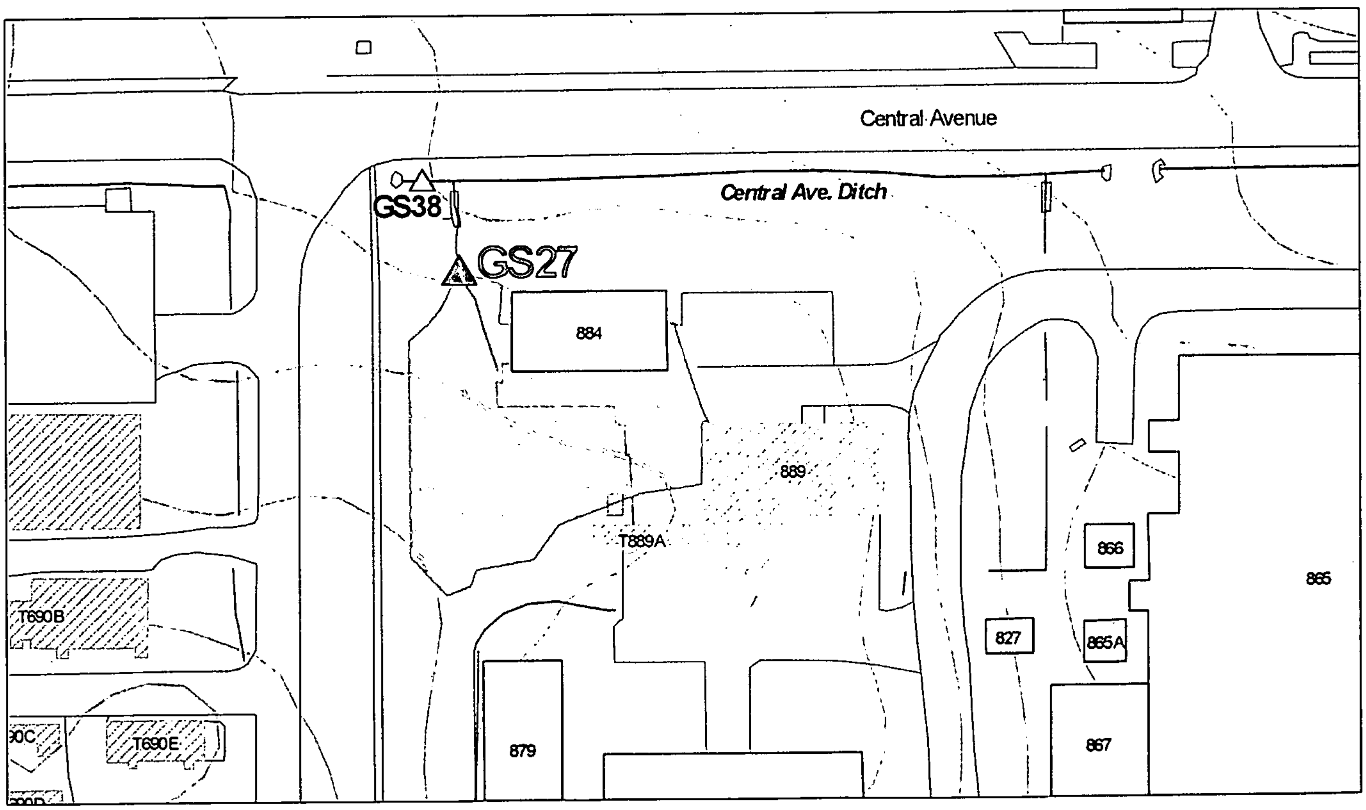


Figure 3-34. Map Showing GS27 Drainage Area.

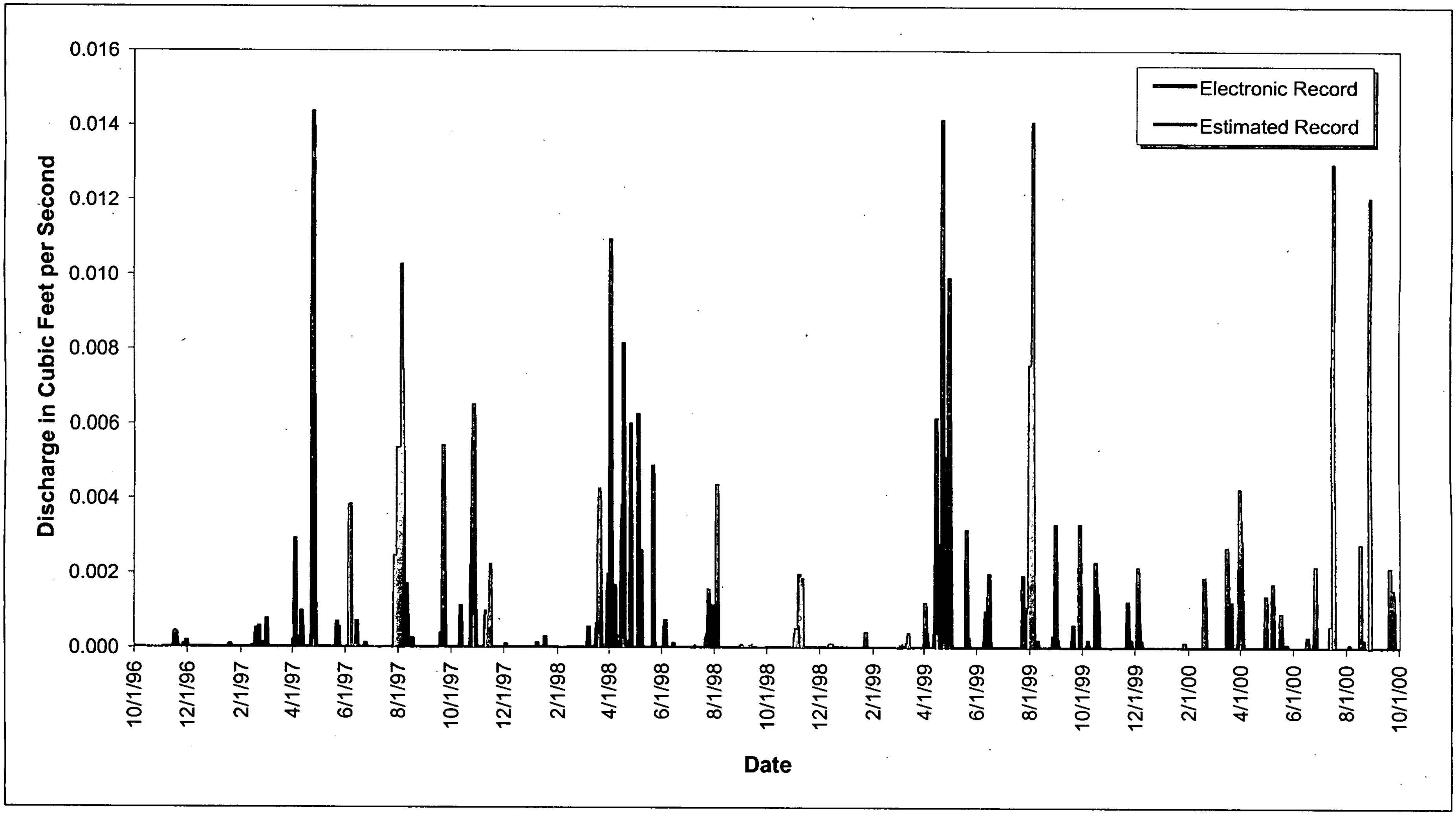


Figure 3-35. WY97-00 Mean Daily Hydrograph at GS27: Building 889/884 Subdrainage Area.

3.2.17 GS28: Building 889/865 Subdrainage Area

Location

Building 889/865 subdrainage area; State Plane: 2084008, 749279

Drainage Area

- The basin includes area near B883 and B865 (total of 3.0 acres)
- IA Areas draining to GS28: 800

Period of Record

5/9/95 – 8/26/97; to be re-installed in WY02

Gage

Water-stage recorder and 4" cutthroat flume

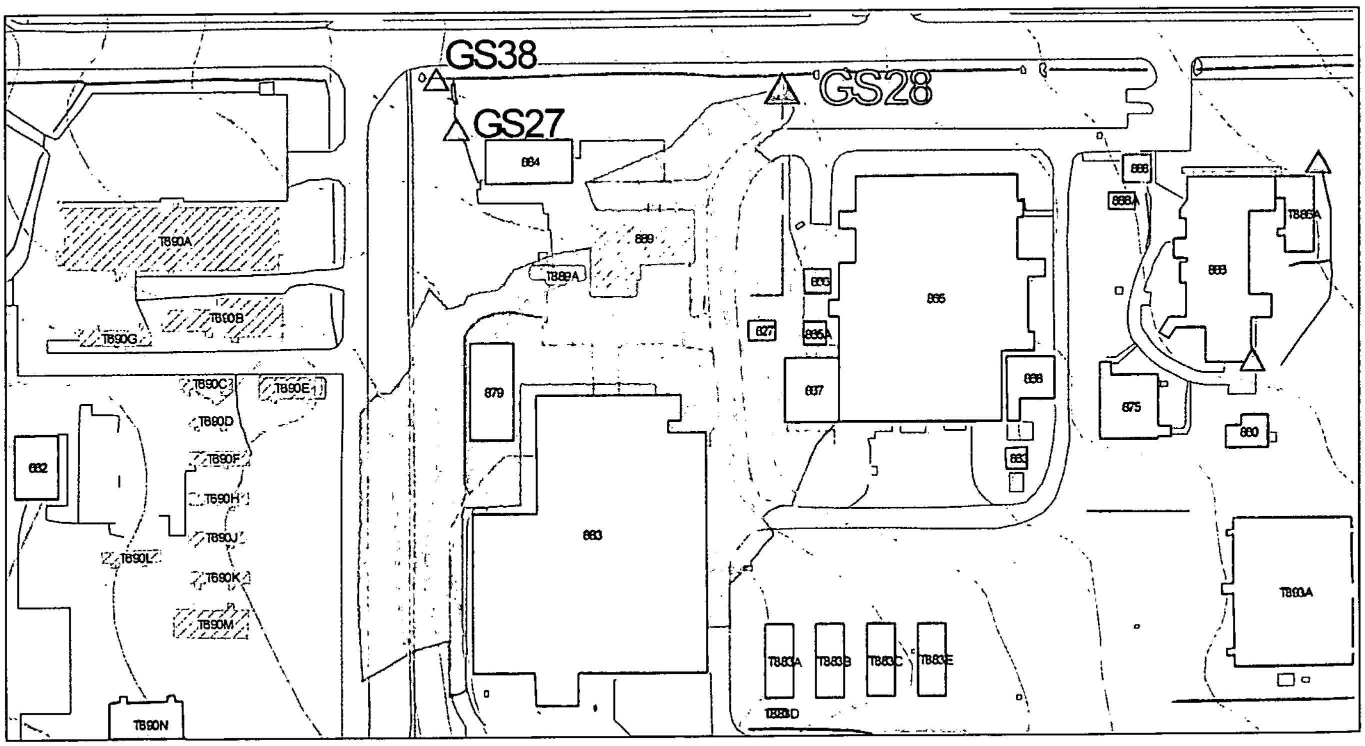


Figure 3-36. Map Showing GS28 Drainage Area.

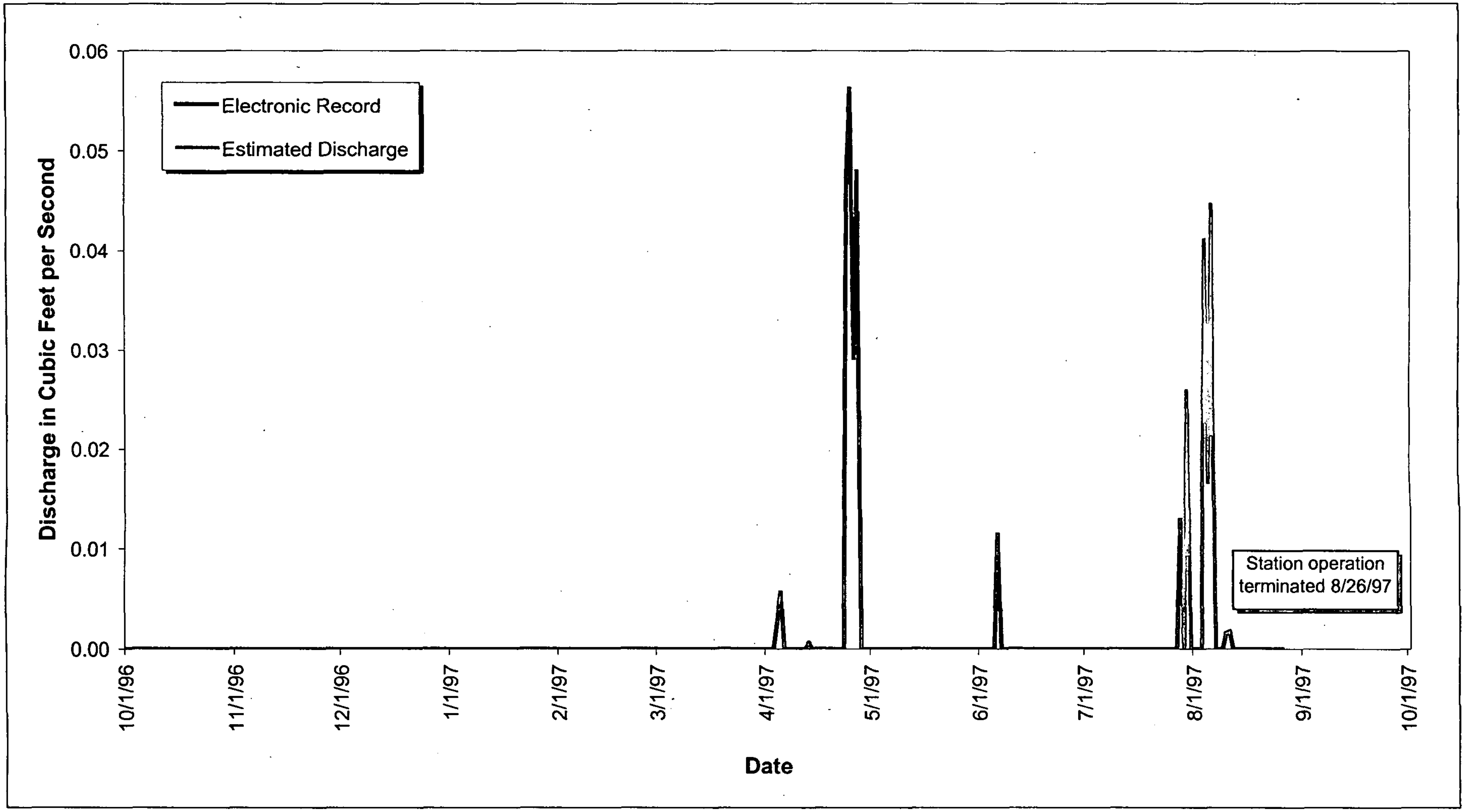


Figure 3-37. WY97 Mean Daily Hydrograph at GS28: Building 889/865 Subdrainage Area.

3.2.18 GS31: Woman Creek at Pond C-2 Outlet

Location

Pond C-2 outlet; State Plane: 2089262, 747515

Drainage Area

- The basin includes a portion of the southern IA draining to the SID and the area surrounding Pond C-2 (total of 240.2 acres)
- IA Areas draining to GS31: 900, 800, 600, 400, and 100

Period of Record

10/1/96 to current year

Gage

Water-stage recorder and 24" Parshall flume

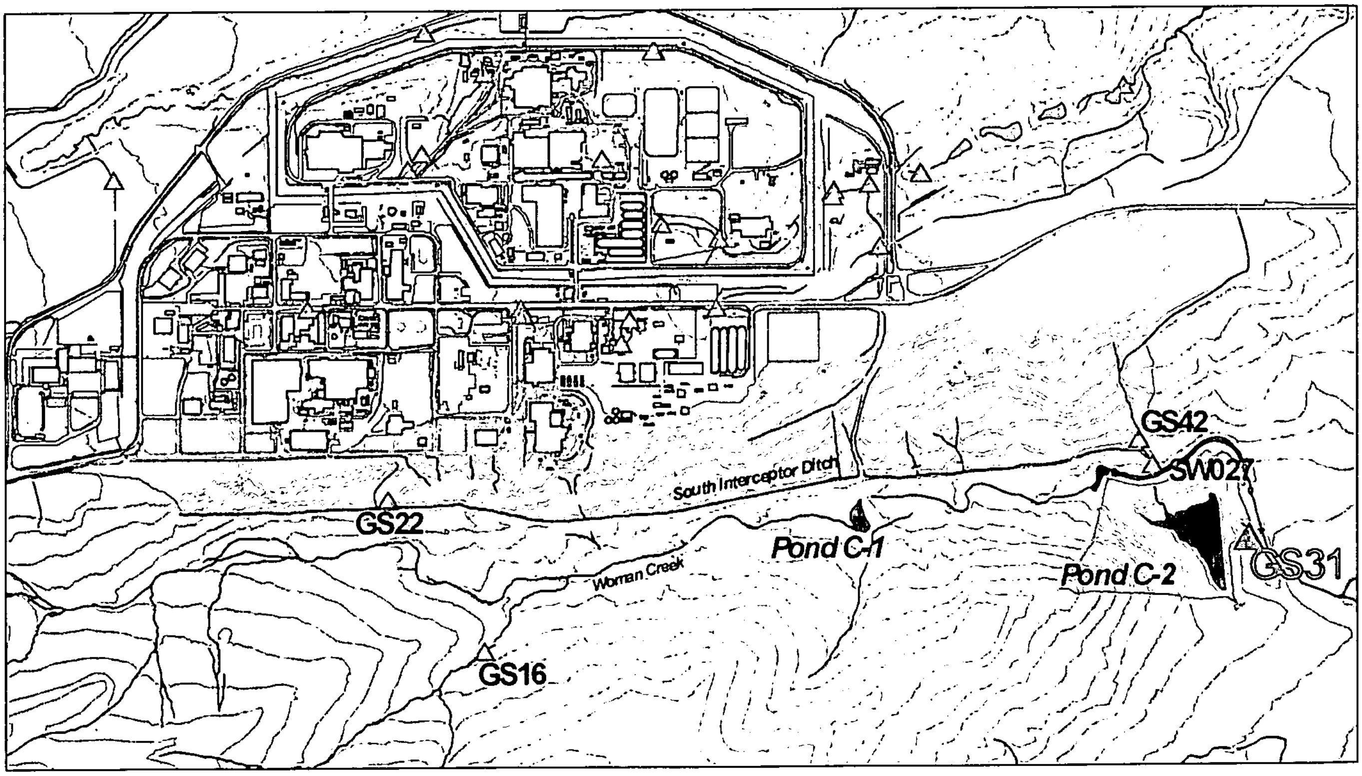


Figure 3-38. Map Showing GS31 Drainage Area.

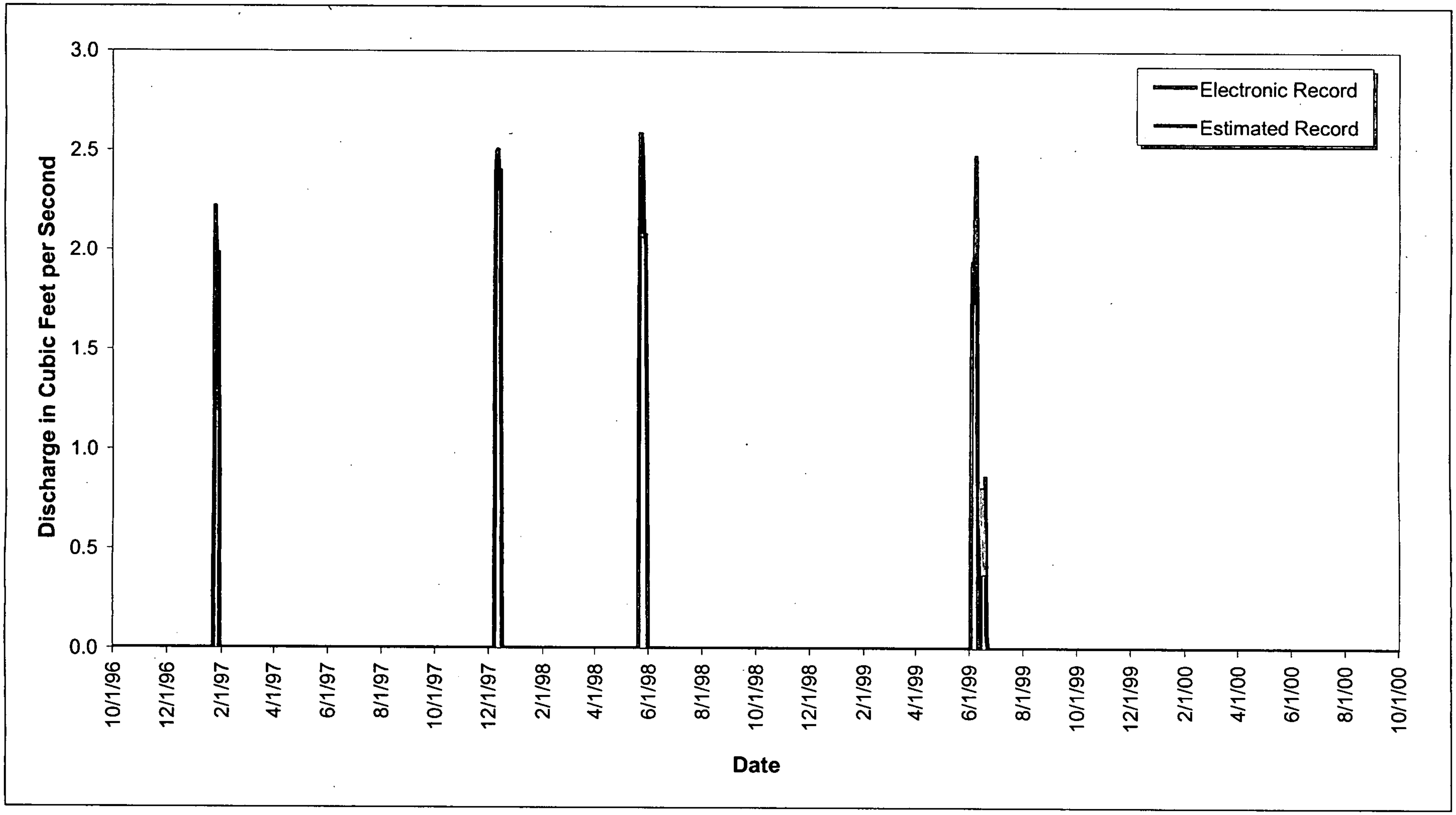


Figure 3-39. WY97-00 Mean Daily Hydrograph at GS31: Woman Creek at Pond C-2 Outlet.

3.2.19 GS32: Building 779 Subdrainage Area

Location

B779 Area outfall; State Plane: 2084700, 751262

Drainage Area

- The basin includes the B779 subdrainage (total of 5.6 acres)
- IA Areas draining to GS32: 700

Period of Record

1/31/97 to current year

Gage

No flow measurement at GS32

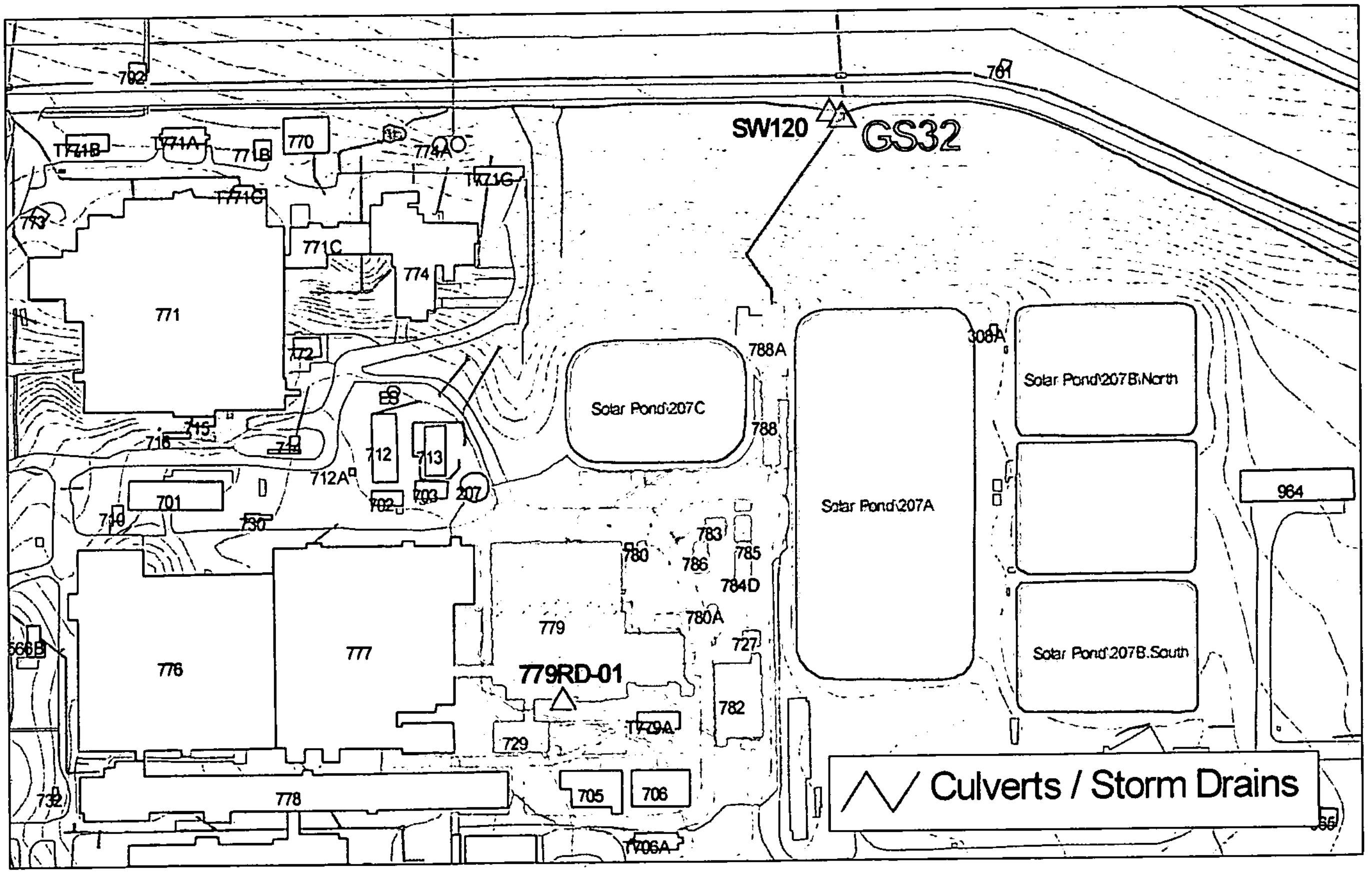


Figure 3-40. Map Showing GS32 Drainage Area.

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3.2.20 GS33: No Name Gulch at Walnut Creek

Location

No Name Gulch at Walnut Cr.; State Plane: 2090209, 753621

Drainage Area

- The basin is the No Name Gulch drainage not including the Landfill Pond which is pump transferred to the A-Series Ponds (total of 245.8 acres)
- IA Areas draining to GS33: none

Period of Record

9/16/97 to current year

Gage

Water-stage recorder and 9.5" Parshall flume

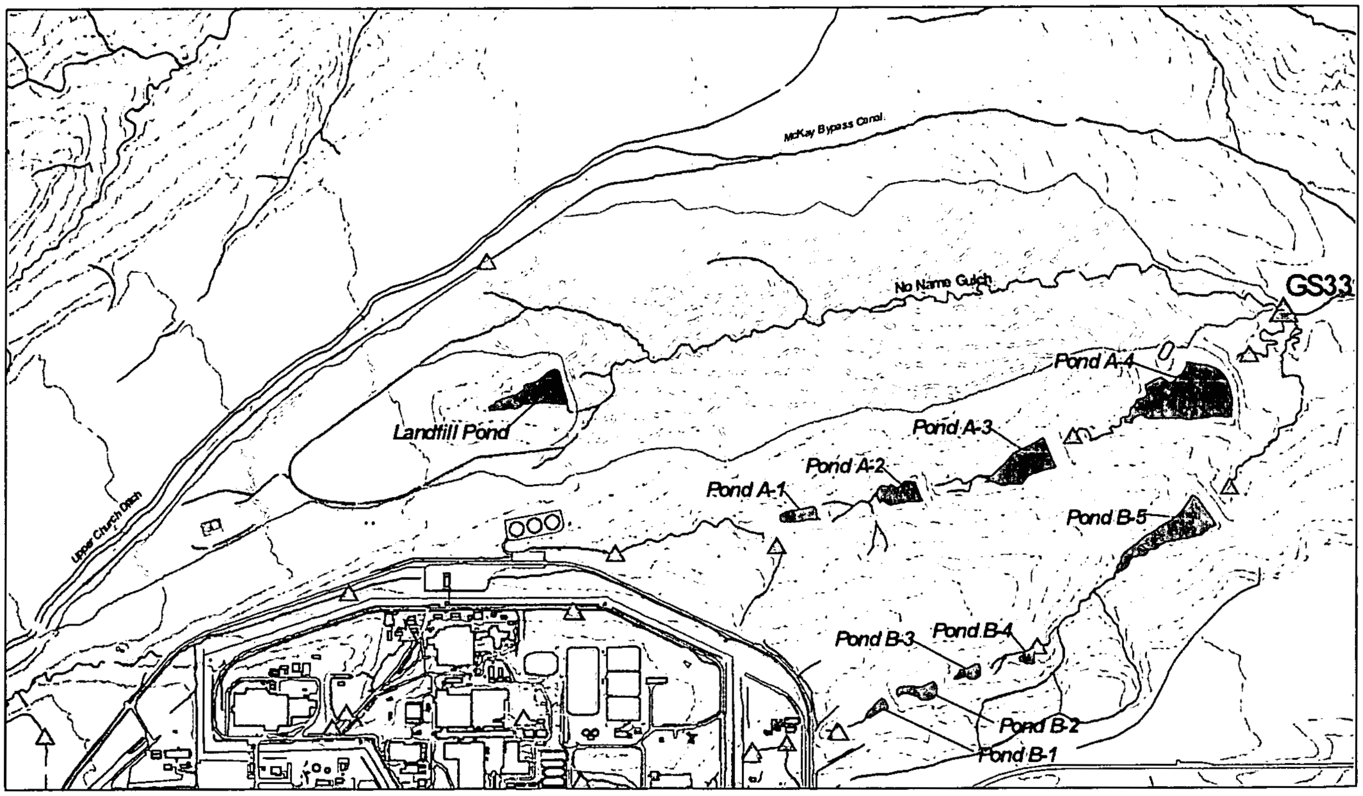

Figure 3-41. Map Showing GS33 Drainage Area.

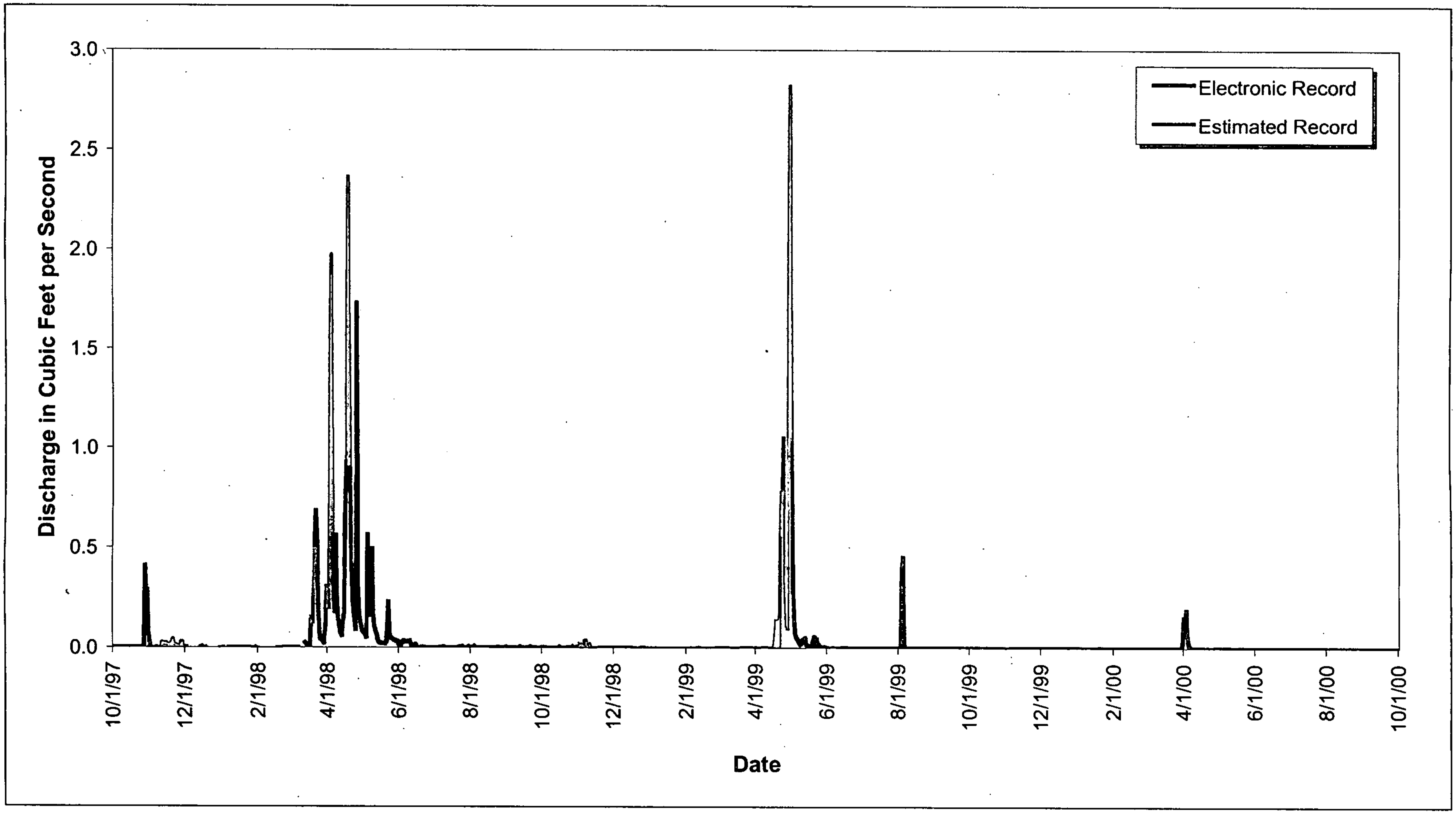

Figure 3-42. WY98-00 Mean Daily Hydrograph at GS33: No Name Gulch at Walnut Creek.

3.2.21 GS34: Walnut Creek Above Confluence with McKay Ditch

Location

Walnut Creek above confluence with McKay Ditch; State Plane: 2091278, 753793

Drainage Area

- The basin includes a majority of the IA, No Name Gulch, and the areas below Ponds A-4 and B-5 (total of 1093.2 acres)
- IA Areas draining to GS34: All

Period of Record

2/5/98 to current year

Gage

Water-stage recorder and 18" Parshall flume

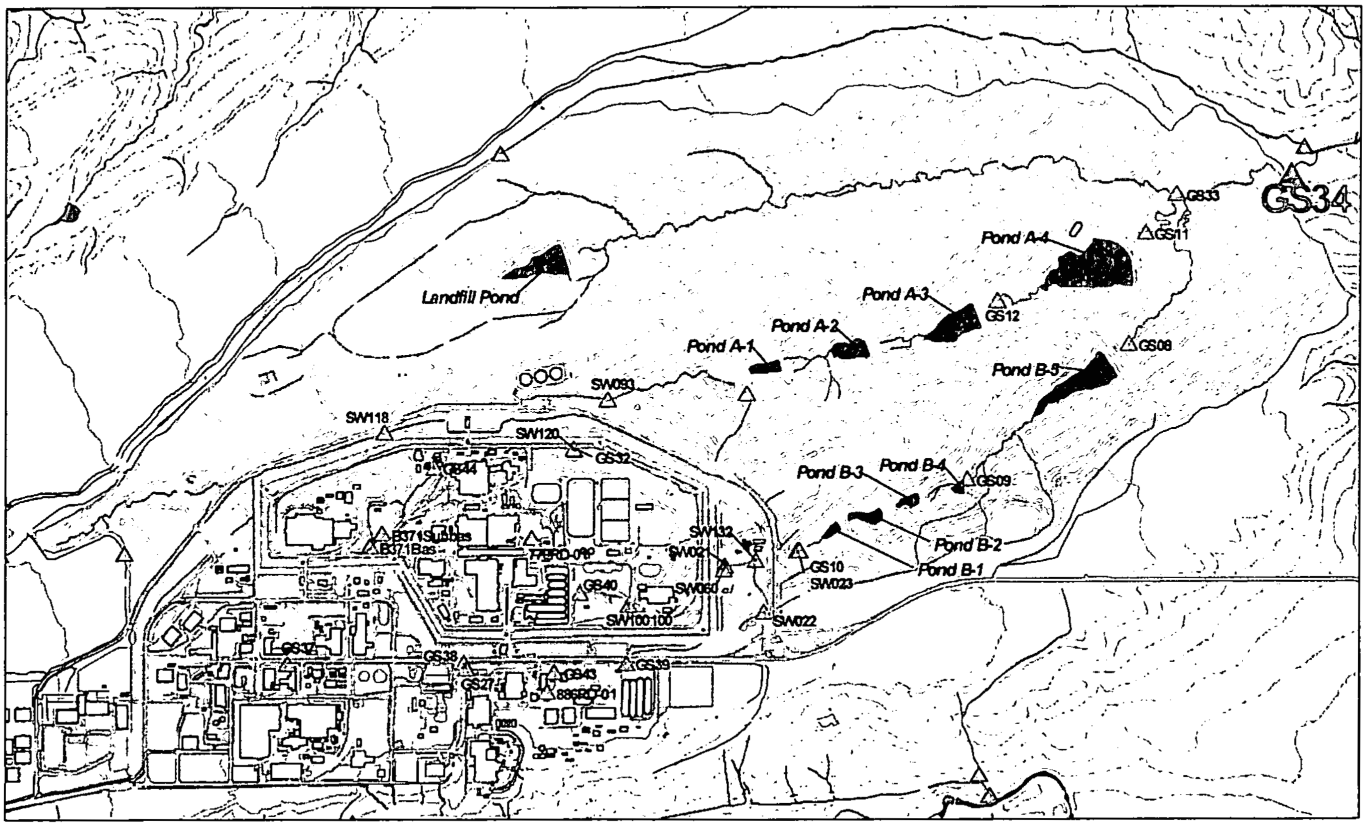

Figure 3-43. Map Showing GS34 Drainage Area.

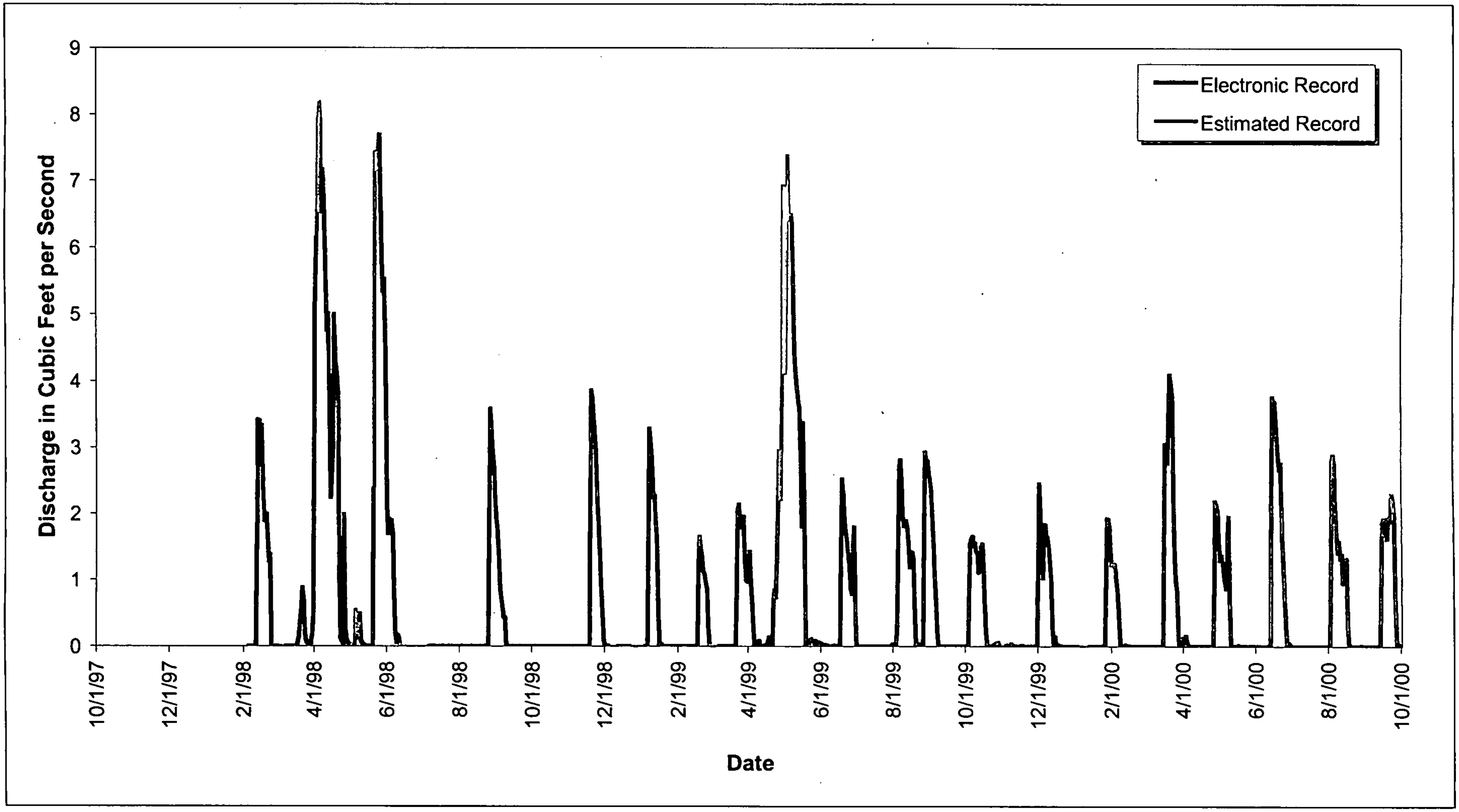

Figure 3-44. WY98-00 Mean Daily Hydrograph at GS34: Walnut Creek above Confluence with McKay Ditch.

3.2.22 GS35: McKay Ditch at Walnut Creek

Location

McKay Ditch at Walnut Cr.; State Plane: 2091379, 754062

Drainage Area

- The basin includes the McKay Ditch and areas west of the Site up to Coal Creek (total drainage acreage unknown). Completed in the summer of 1999, the McKay Bypass pipeline diverts water from McKay Ditch upstream of GS35 (Figure 3-1). The diverted water flows around Lower Walnut Creek to Great Western Reservoir. Small flows are still allowed to reach GS35 as habitat enhancement, and all flow can be diverted to GS35 at any time.
- IA Areas draining to GS35: 100

Period of Record

9/18/97 to current year

Gage

Water-stage recorder and 36" contracted rectangular weir

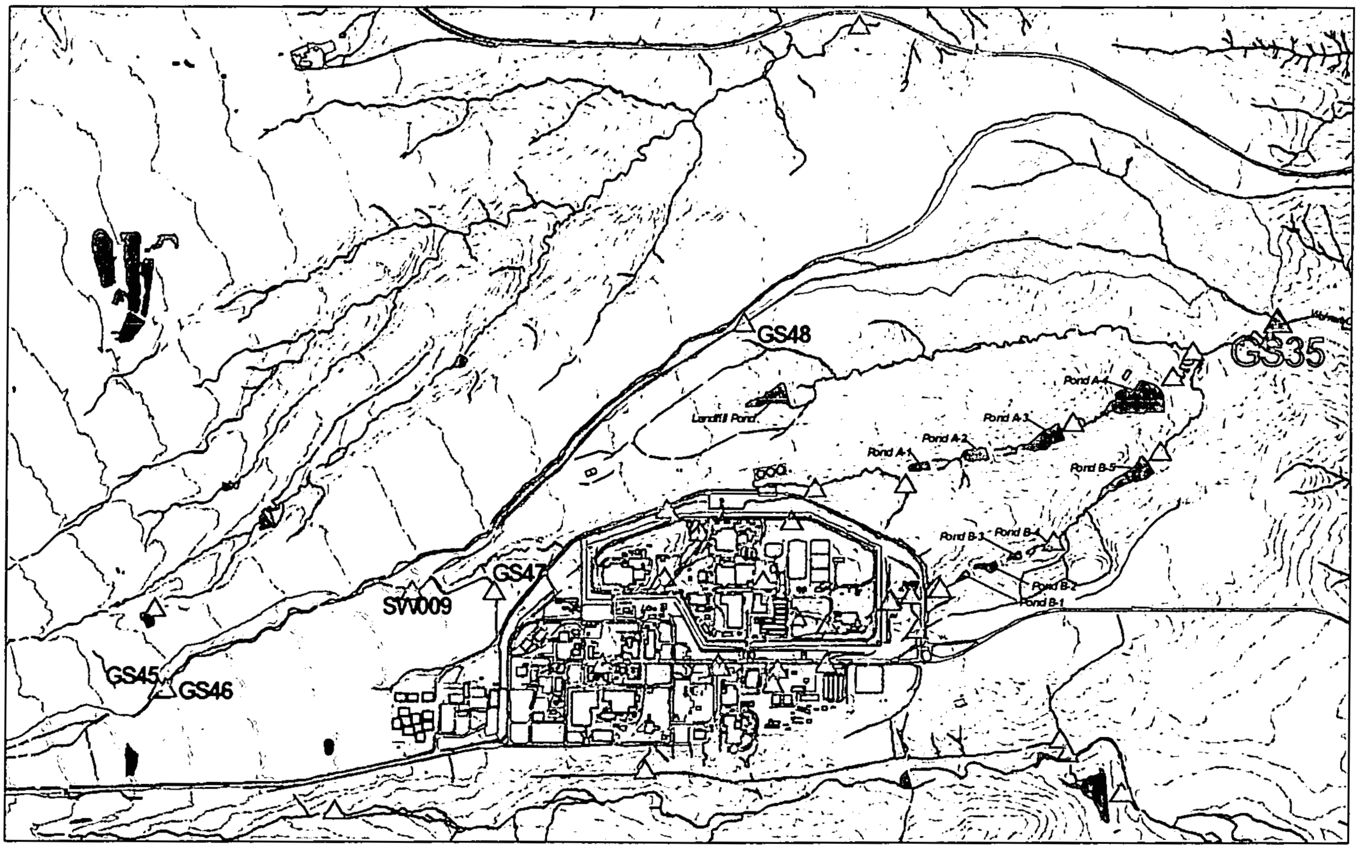

Figure 3-45. Map Showing GS35 Drainage Area.

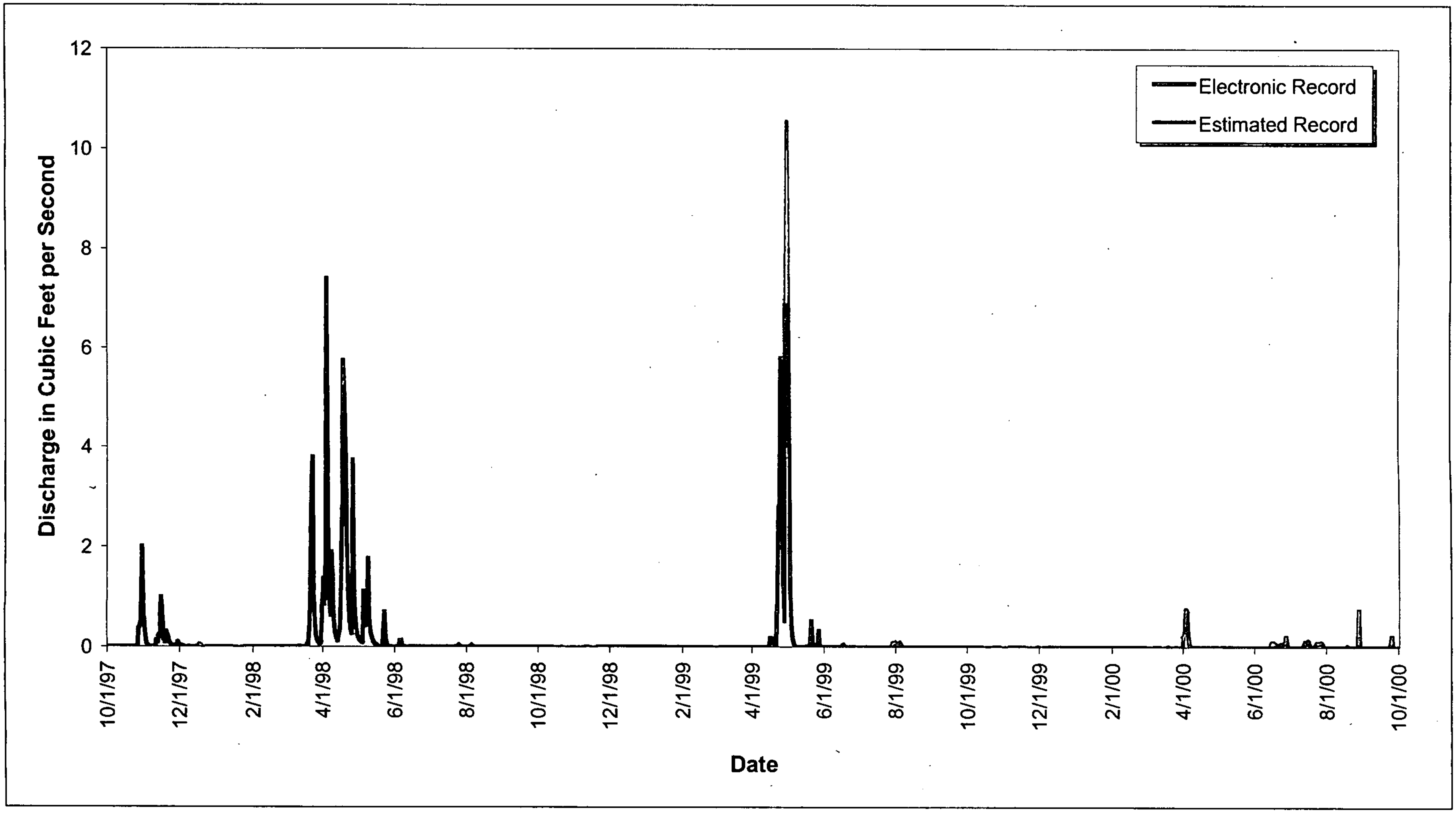

Figure 3-46. WY98-00 Mean Daily Hydrograph at GS35: McKay Ditch at Walnut Creek.

3.2.23 GS37: Building 123 Subdrainage Area

Location

B123 subdrainage; State Plane: 2082077, 749284

Drainage Area

- The basin includes B123 and surrounding areas (total of 8.5 acres)
- IA Areas draining to GS37: 100

Period of Record

10/28/97 – 11/10/98

Gage

Water-stage recorder and 9.5" Parshall flume

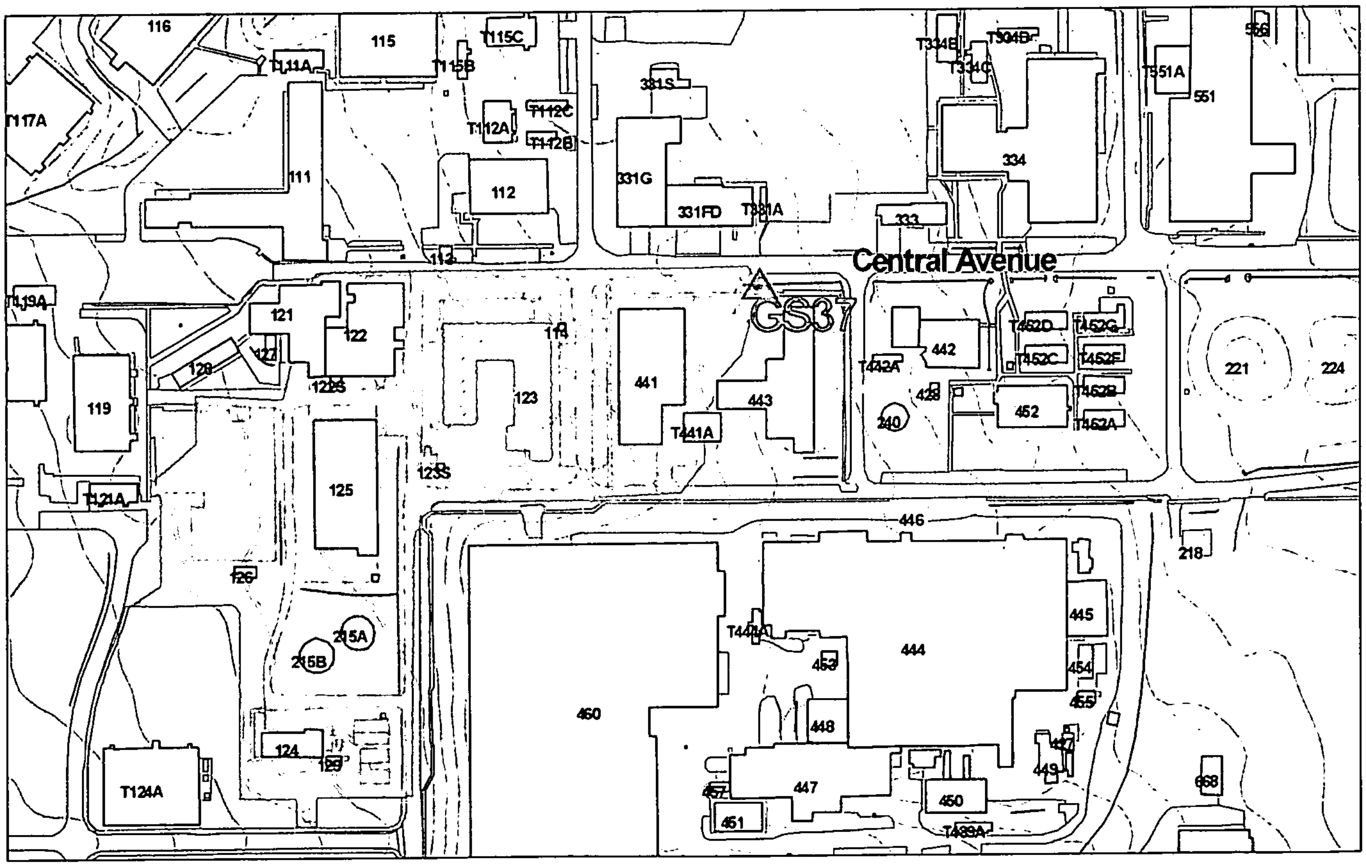

Figure 3-47. Map Showing GS37 Drainage Area.

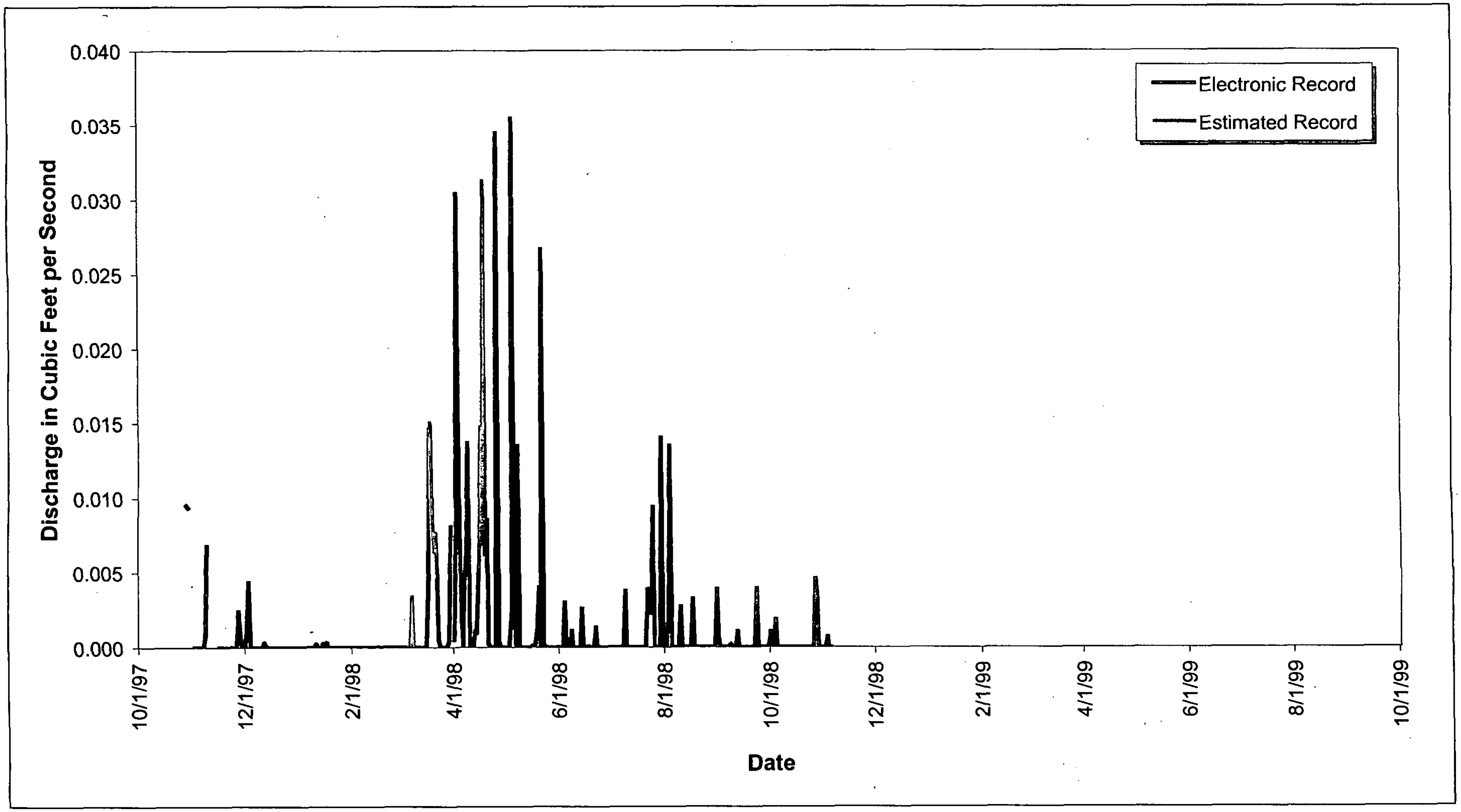

Figure 3-48. WY98-99 Mean Daily Hydrograph at GS37: Building 123 Subdrainage Area.

3.2.24 GS38: Central Avenue Ditch at Eighth Street

Location

Central Avenue Ditch at Eighth Street; State Plane: 2083684, 749289

Drainage Area

- The basin includes a portion of the southwestern IA (total of 41.3 acres)
- IA Areas draining to GS38: 600, 400, and 100

Period of Record

1/28/98 to current year

Gage

Water-stage recorder and 9.5" Parshall flume

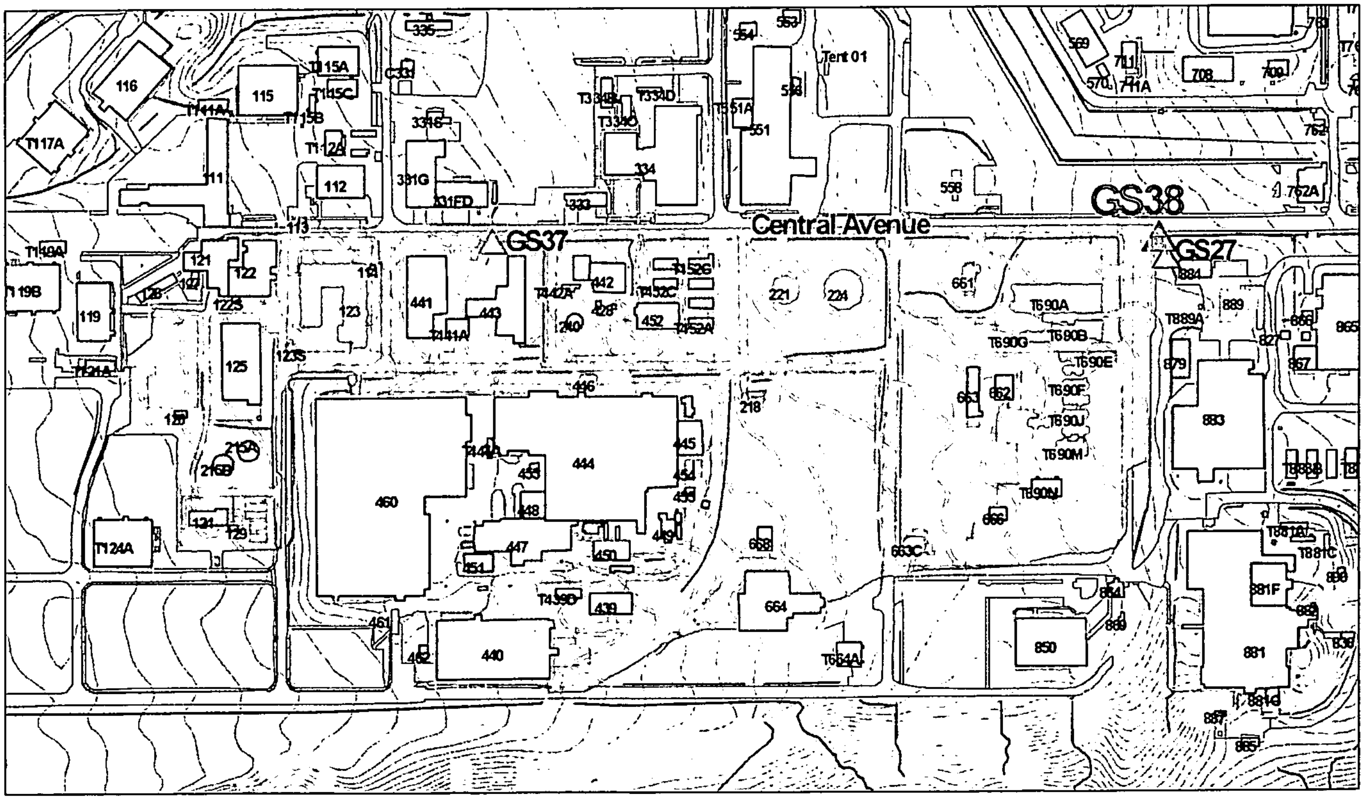

Figure 3-49. Map Showing GS38 Drainage Area.

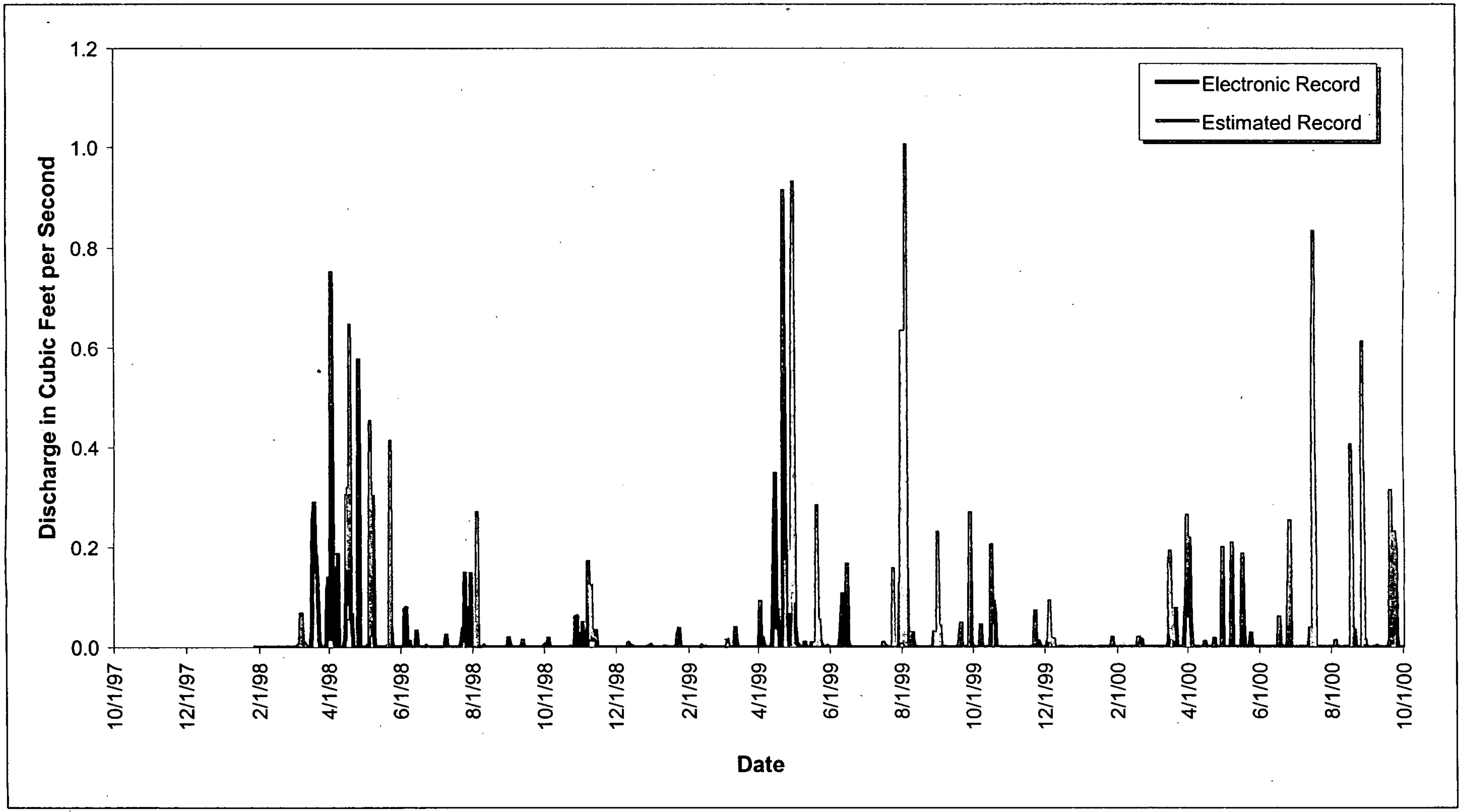

Figure 3-50. WY98-00 Mean Daily Hydrograph at GS38: Central Avenue Ditch at Eighth Street.

3.2.25 GS39: 903/904 Pad Subdrainage Area

Location

Ditch NW of 903 Pad; State Plane: 2085175, 749286

Drainage Area

- The basin includes a portion of the Contractor Yard, the 904 Pad, and the west side of the 903 Pad (total of 8.1 acres)
- IA Areas draining to GS39: 900

Period of Record

1/15/98 to current year

Gage

Water-stage recorder and 1' H-flume

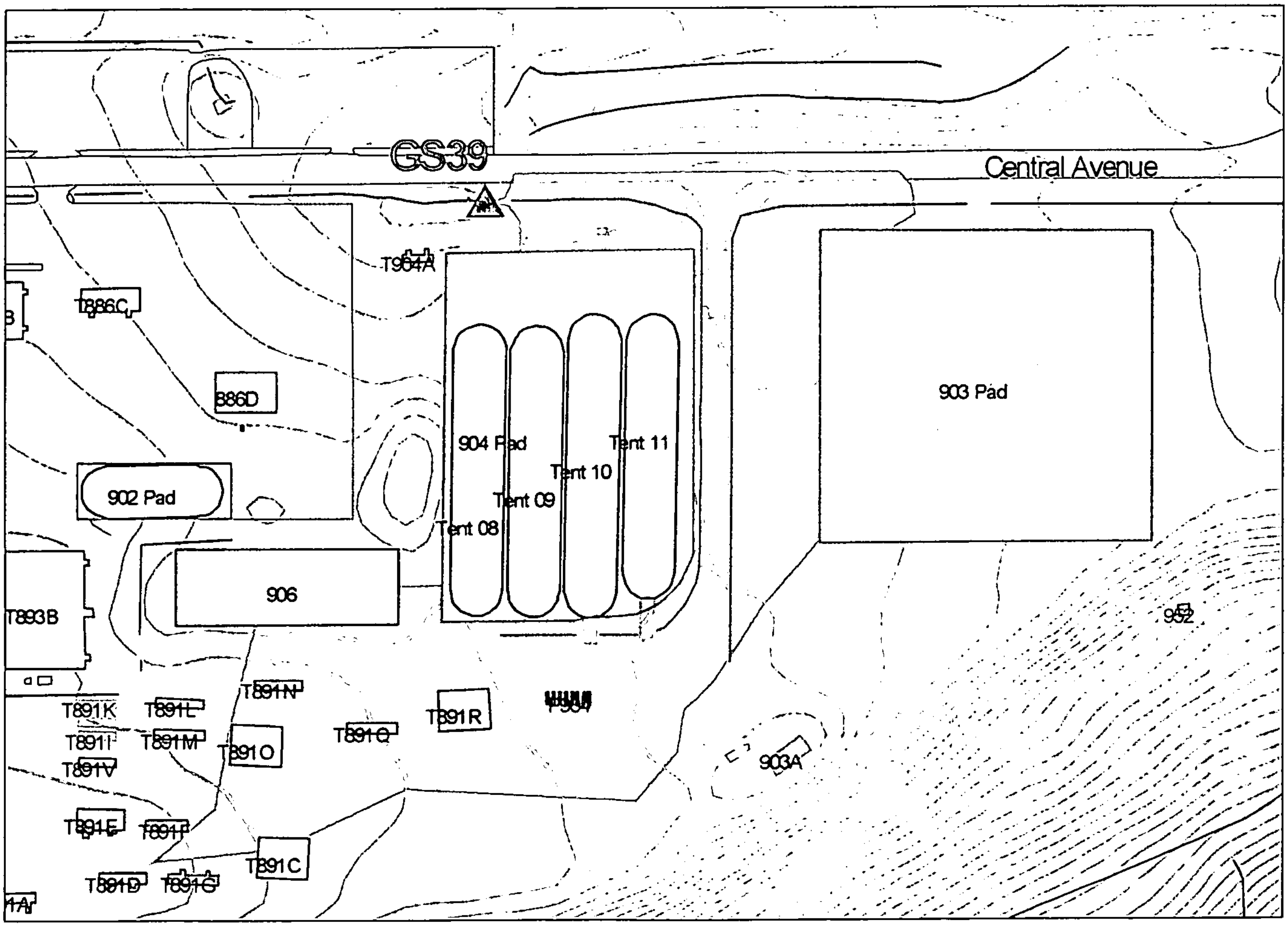

Figure 3-51. Map Showing GS39 Drainage Area.

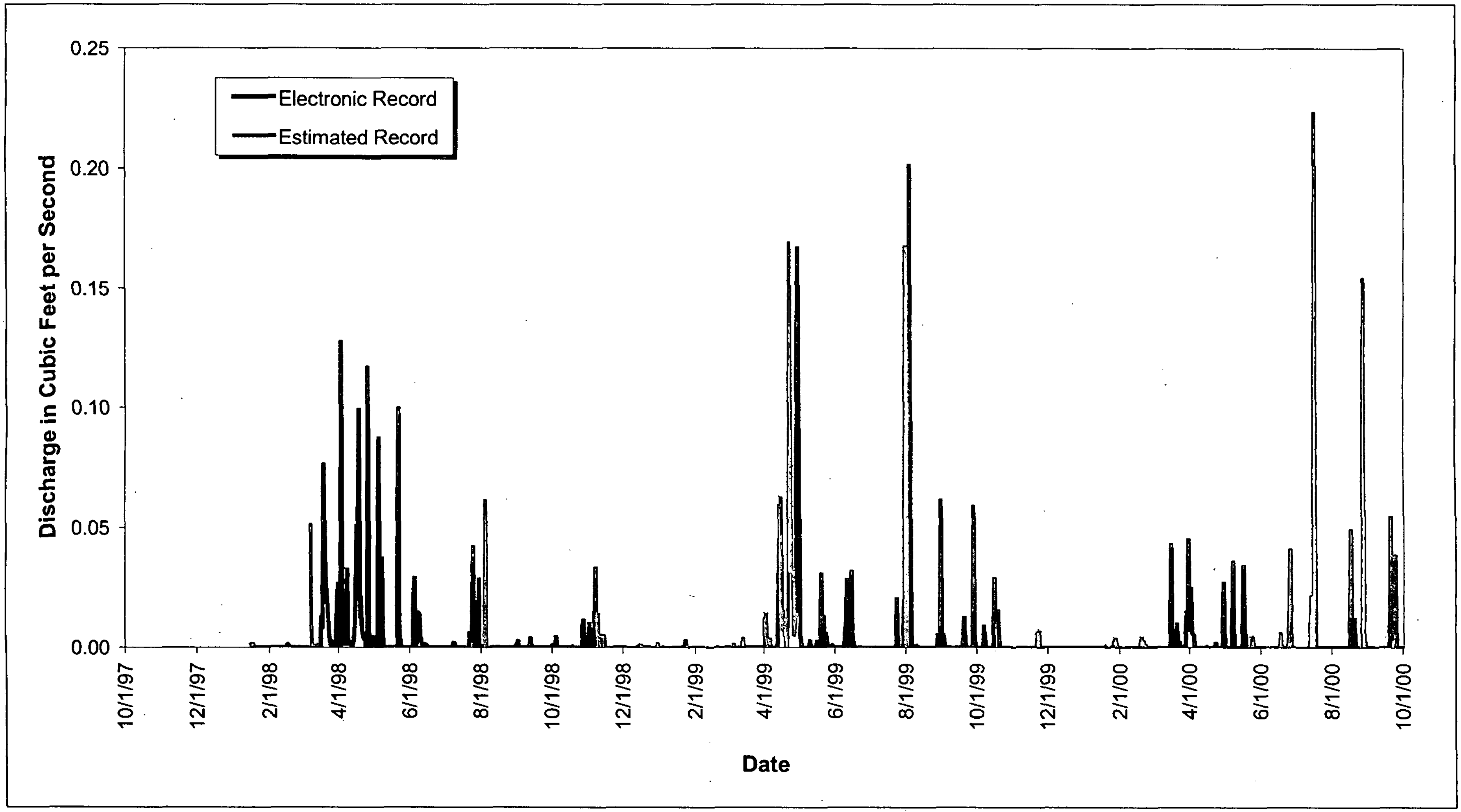

Figure 3-52. WY98-00 Mean Daily Hydrograph at GS39: 903/904 Pad Subdrainage Area.

3.2.26 GS40: South Walnut Creek East of 750 Pad

Location

700 Area outfall to N. Walnut Cr. east of 750 Pad; State Plane: 2084748, 749938

Drainage Area

- The basin includes a portion of the 700 Area inside the PA (total of 24.4 acres)
- IA Areas draining to GS40: 700

Period of Record

3/4/98 to current year

Gage

Water-stage recorder and 1' Parshall flume

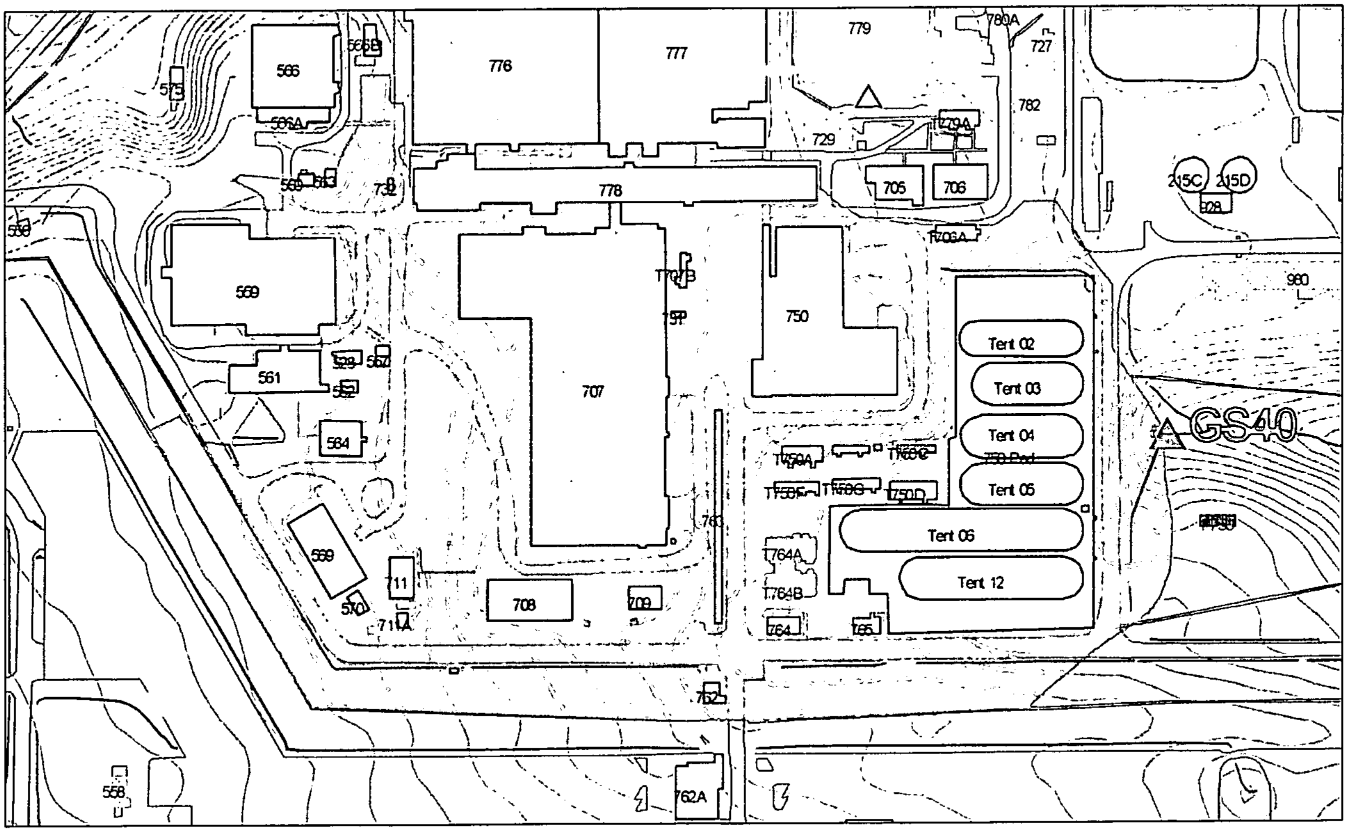

Figure 3-53. Map Showing GS40 Drainage Area.

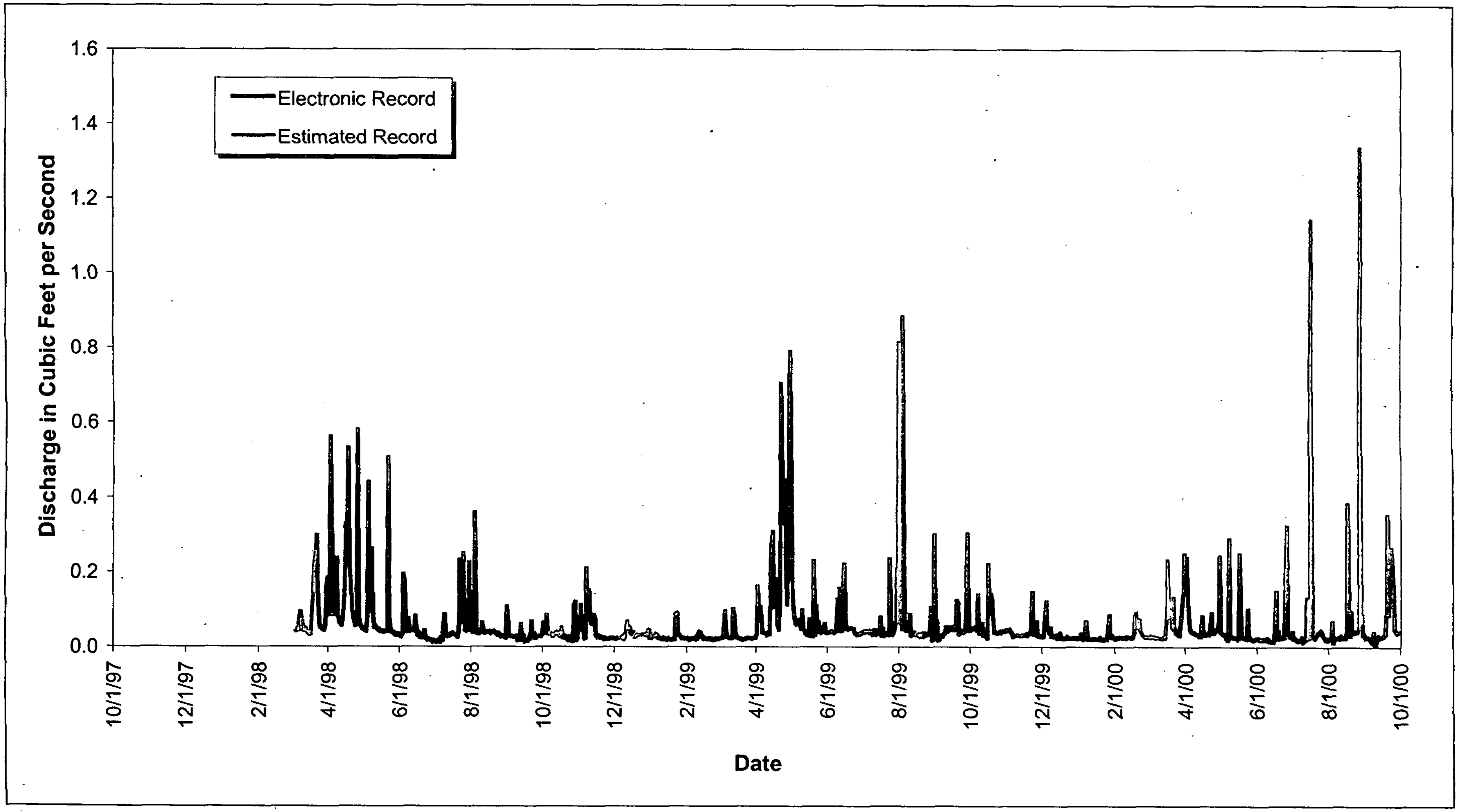

Figure 3-54. WY98-00 Mean Daily Hydrograph at GS40: South Walnut Creek East of 750 Pad.

3.2.27 GS41: Unnamed Gulch Tributary to Walnut Creek Southwest of GS03

Location

Small gulch SW of GS03; State Plane: 2093188, 753472

Drainage Area

- The basin includes the gulch only (total of 13.6 acres)
- IA Areas draining to GS41: none

Period of Record

6/10/98 to current year

Gage

Water-stage recorder and 0.5' H-flume

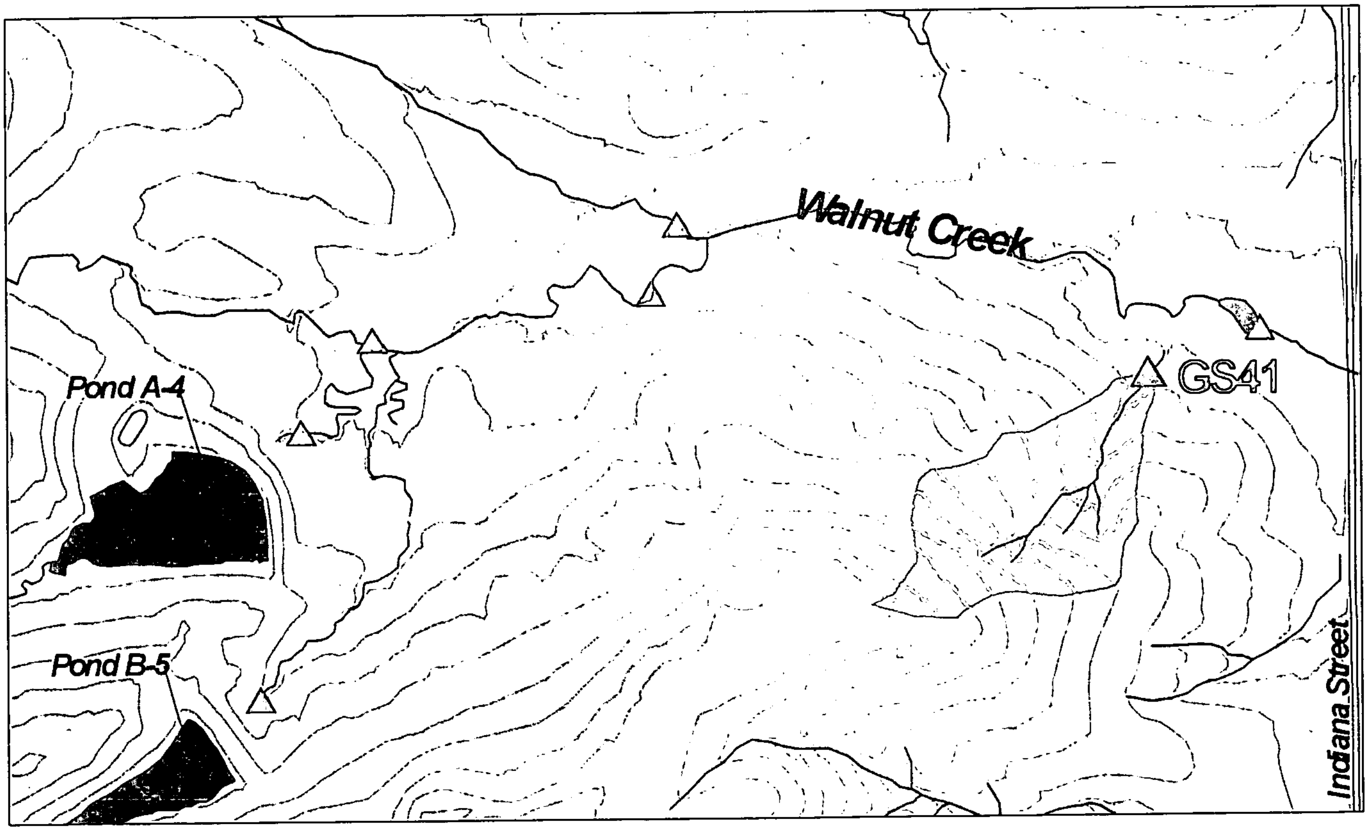

Figure 3-55. Map Showing GS41 Drainage Area.

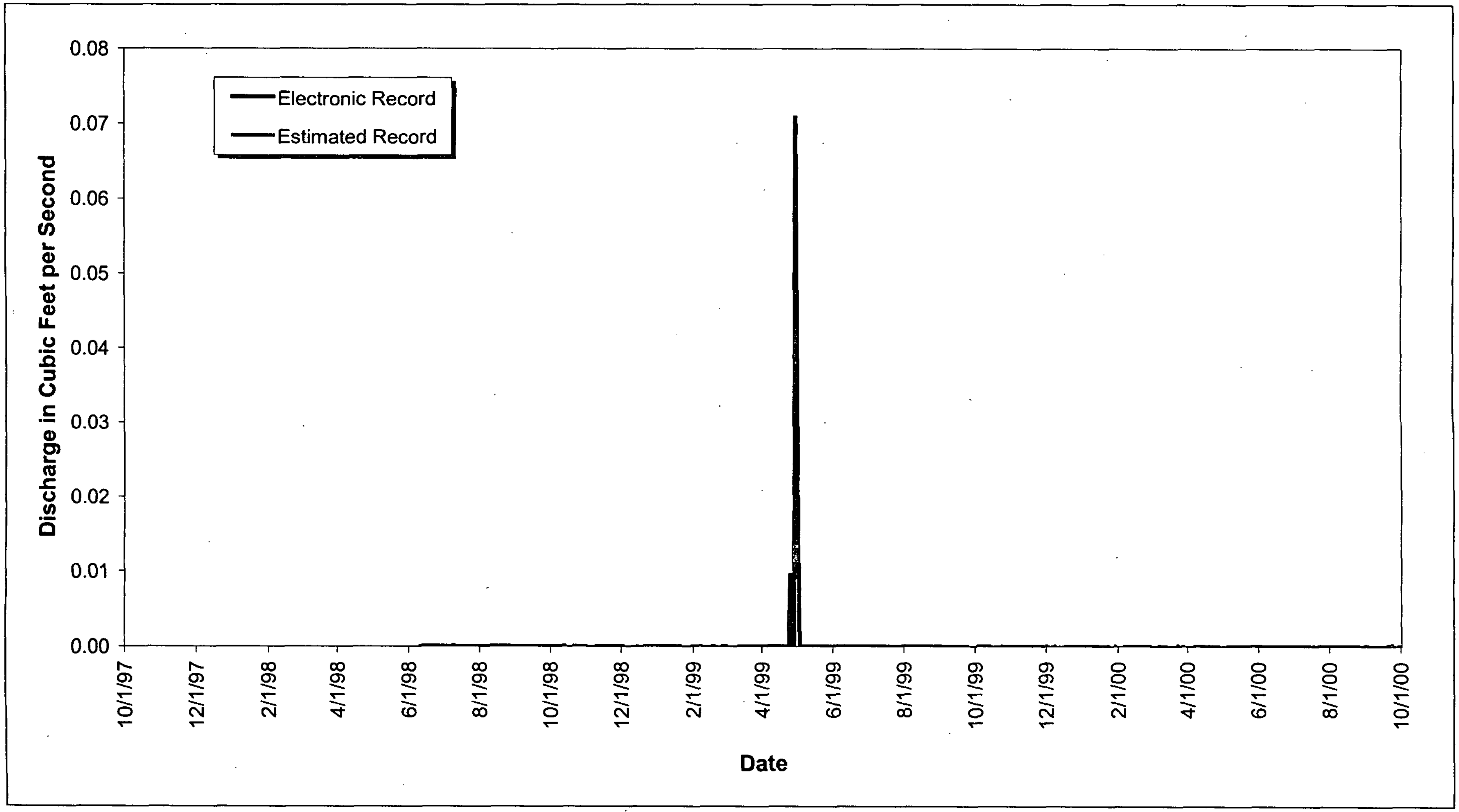

Figure 3-56. WY98-00 Mean Daily Hydrograph at GS41: Unnamed Walnut Creek Tributary.

3.2.28 GS42: Unnamed Gulch Tributary to the SID North of SW027

Location

Unnamed gulch tributary to the SID north of SW027; State Plane: 2088476, 748237

Drainage Area

- The basin includes a portion of the West Access Road (total of 45.2 acres)
- IA Areas draining to GS42: none

Period of Record

6/23/98 to current year

Gage

Water-stage recorder and 3" Parshall flume

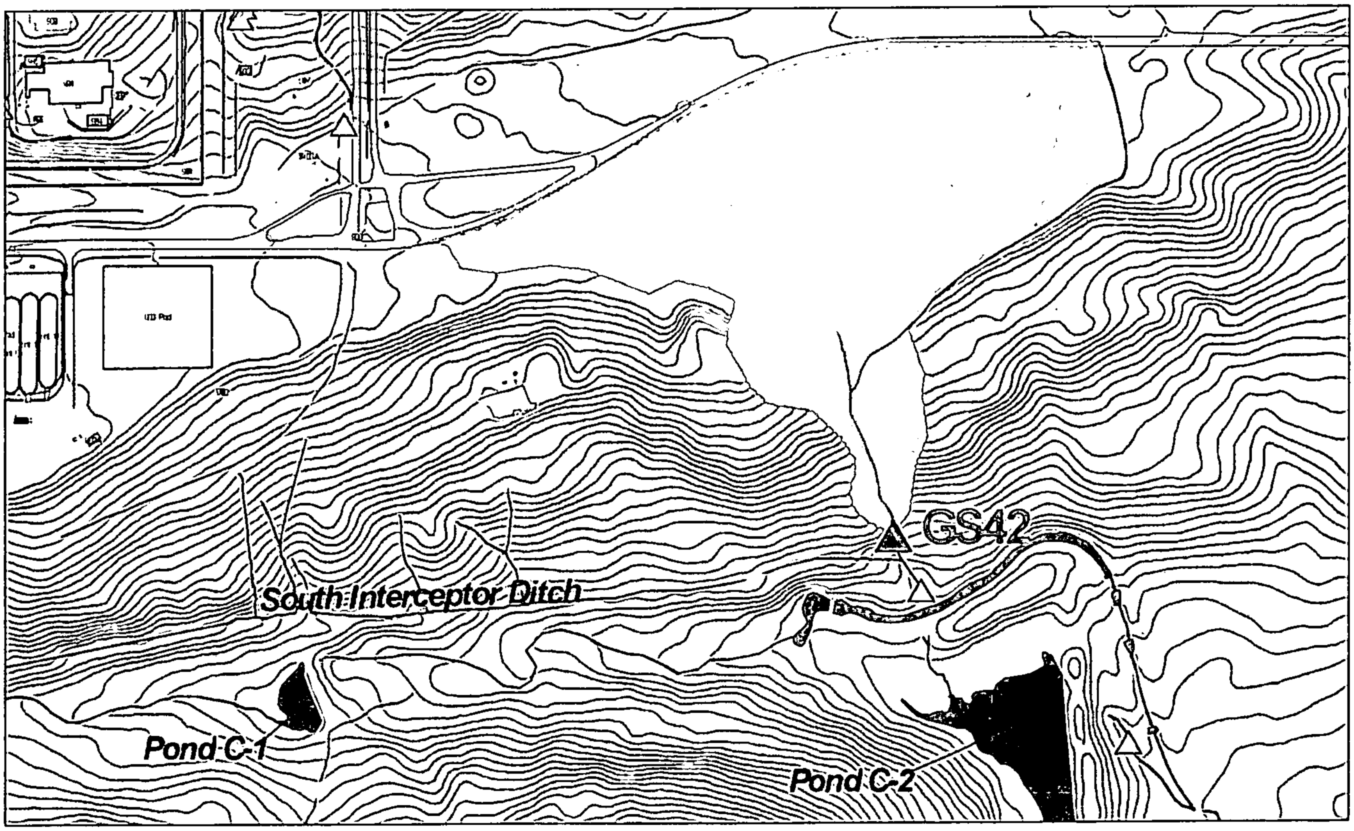

Figure 3-57. Map Showing GS42 Drainage Area.

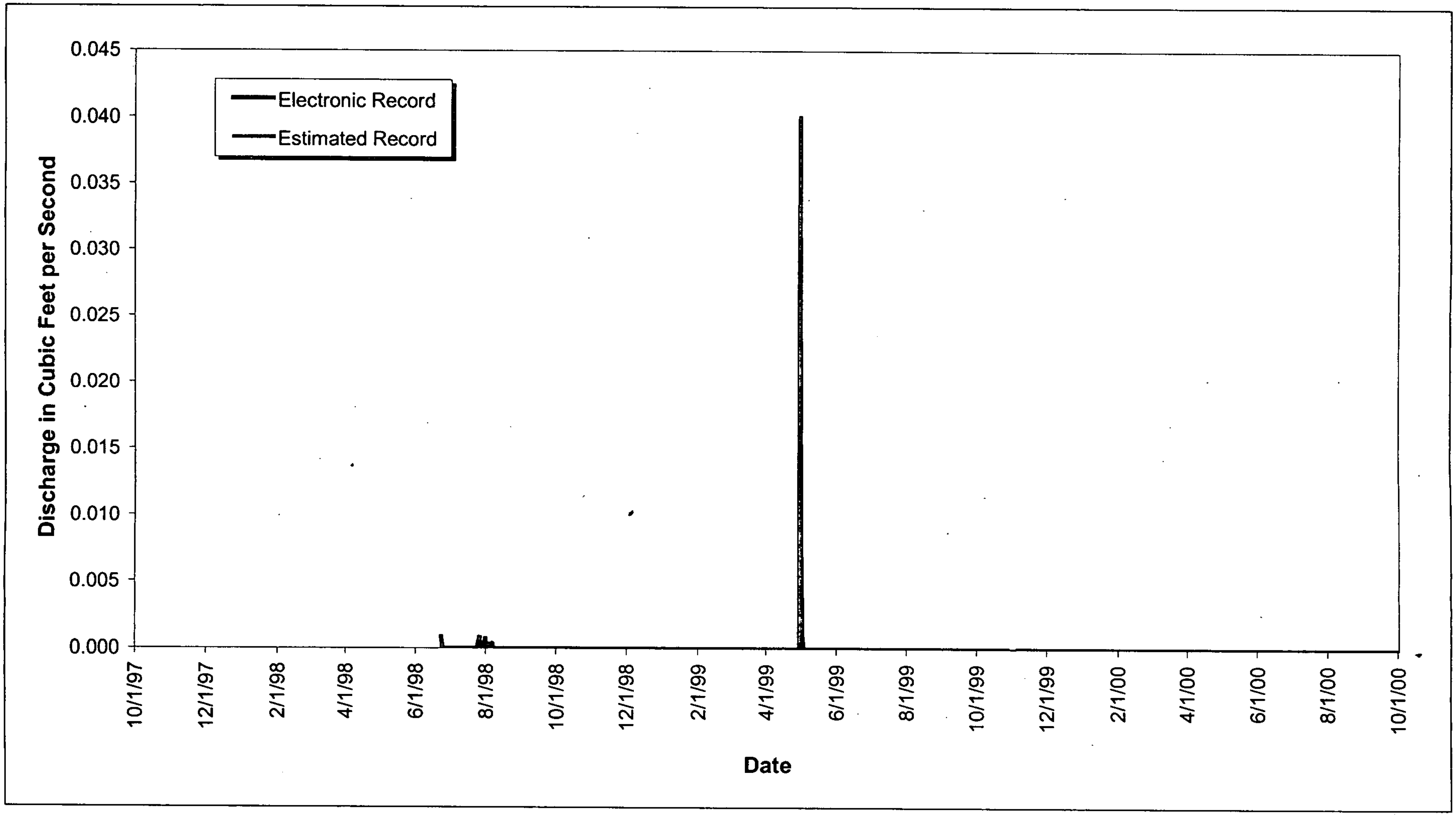

Figure 3-58. WY98-00 Mean Daily Hydrograph at GS42: Unnamed Gulch Tributary to SID.

3.2.29 GS43: Building 886 Subdrainage Area

Location

B886 subdrainage; State Plane: 2084513, 749206

Drainage Area

- The basin includes the areas surrounding B886 (total of 1.1 acres)
- IA Areas draining to GS43: 800

Period of Record

6/1/99 to current year

Gage

Water-stage recorder and 0.75' H-flume

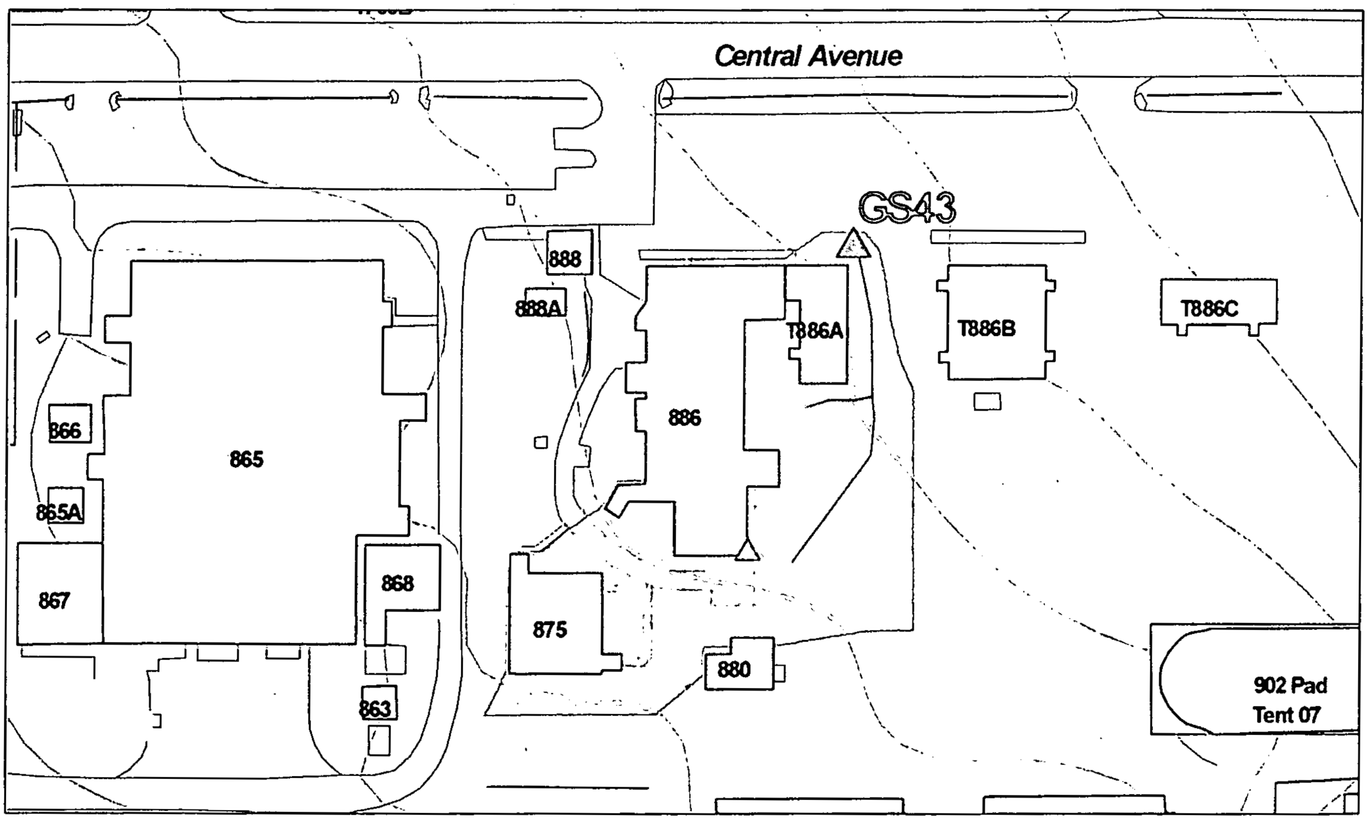

Figure 3-59. Map Showing GS43 Drainage Area.

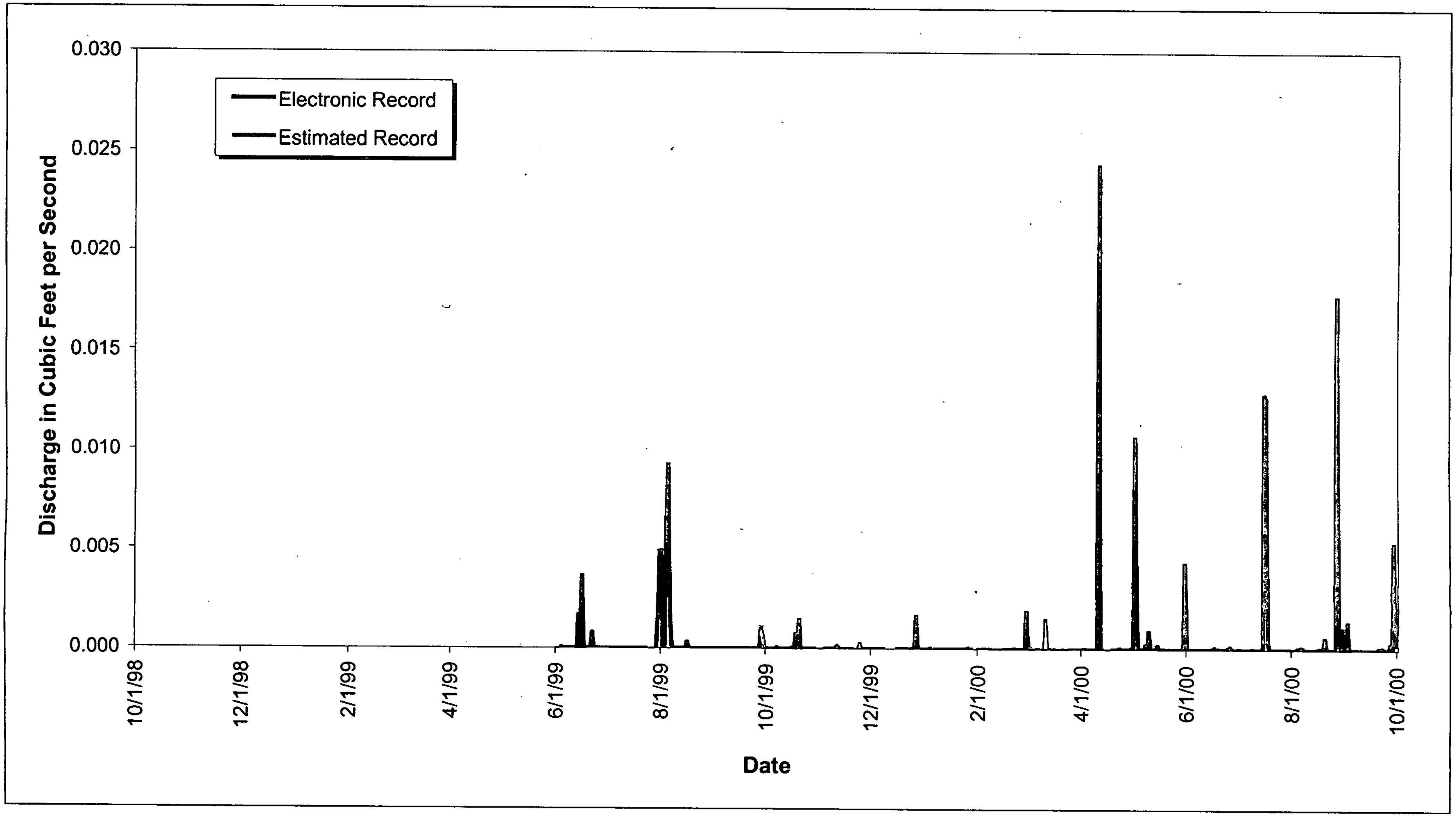

Figure 3-60. WY99-00 Mean Daily Hydrograph at GS43: B886 Subdrainage.

3.2.30 GS45: Upper Church Ditch at West Gravel Pits

Location

Upper Church Ditch at West Gravel Pits; State Plane: 2076006, 748922

Drainage Area

- The basin includes areas tributary to Upper Church Ditch west of the Site (total drainage acreage unknown)
- IA Areas draining to GS45: none

Period of Record

4/10/00 to current year

Gage

Water-stage recorder and 9.5" Parshall flume

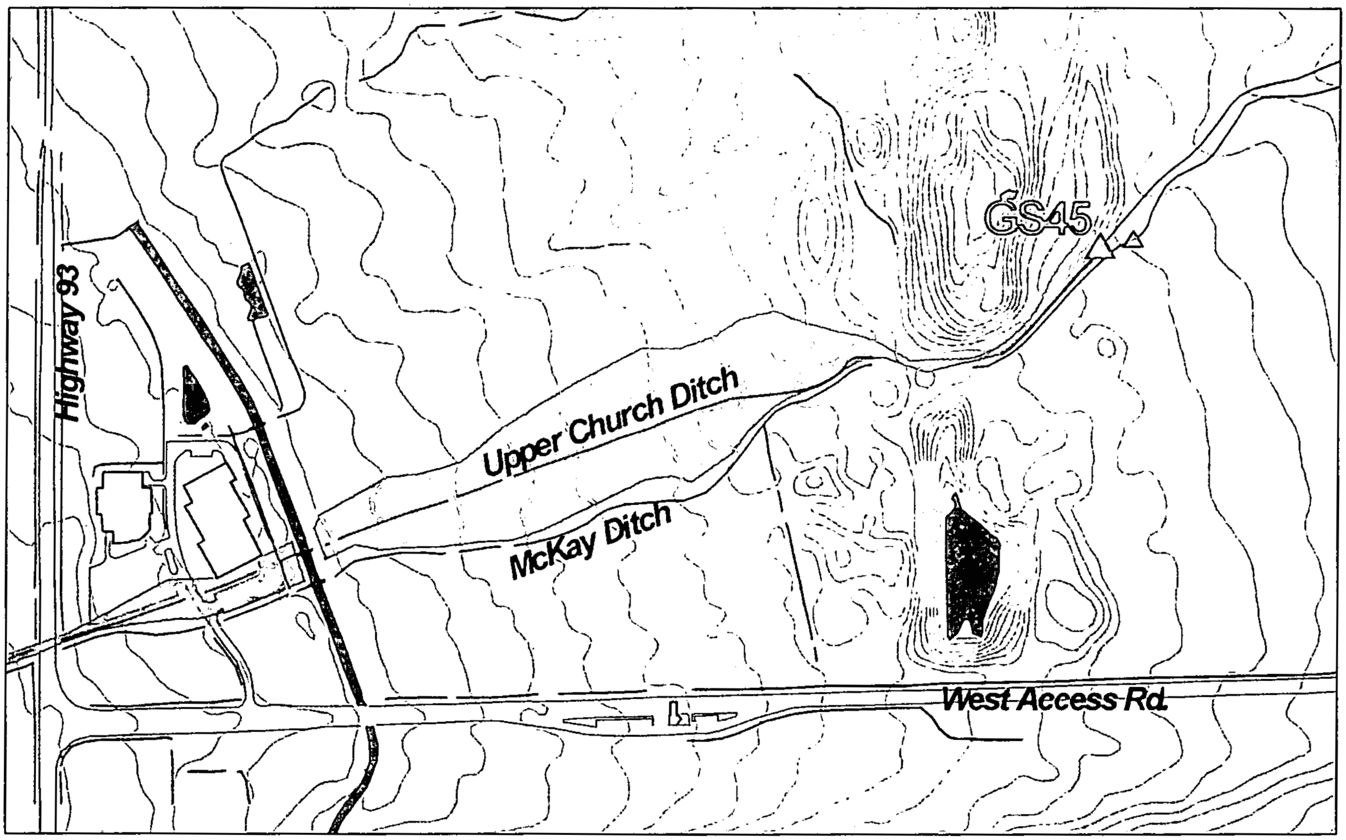

Figure 3-61. Map Showing GS45 Drainage Area.

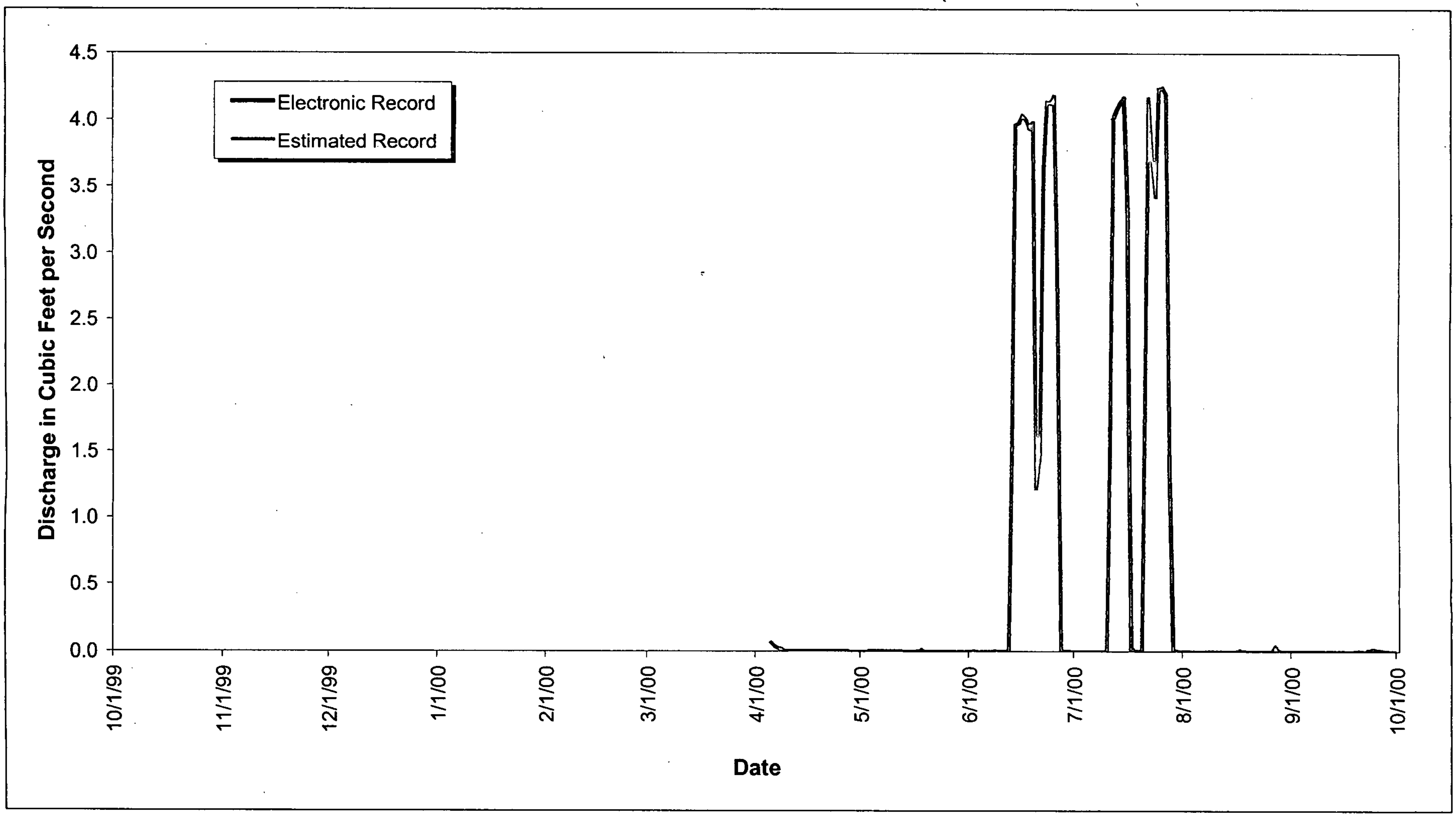

Figure 3-62. WY00 Mean Daily Hydrograph at GS45: Upper Church Ditch at West Gravel Pits.

3.2.31 GS46: McKay Ditch at West Gravel Pits

Location

McKay Ditch at West Gravel Pits; State Plane: 2076099, 748941

Drainage Area

- The basin includes areas tributary to McKay Ditch west of the Site (total drainage acreage unknown)
- IA Areas draining to GS46: none

Period of Record

4/11/00 to current year

Gage

Water-stage recorder and 9.5" Parshall flume

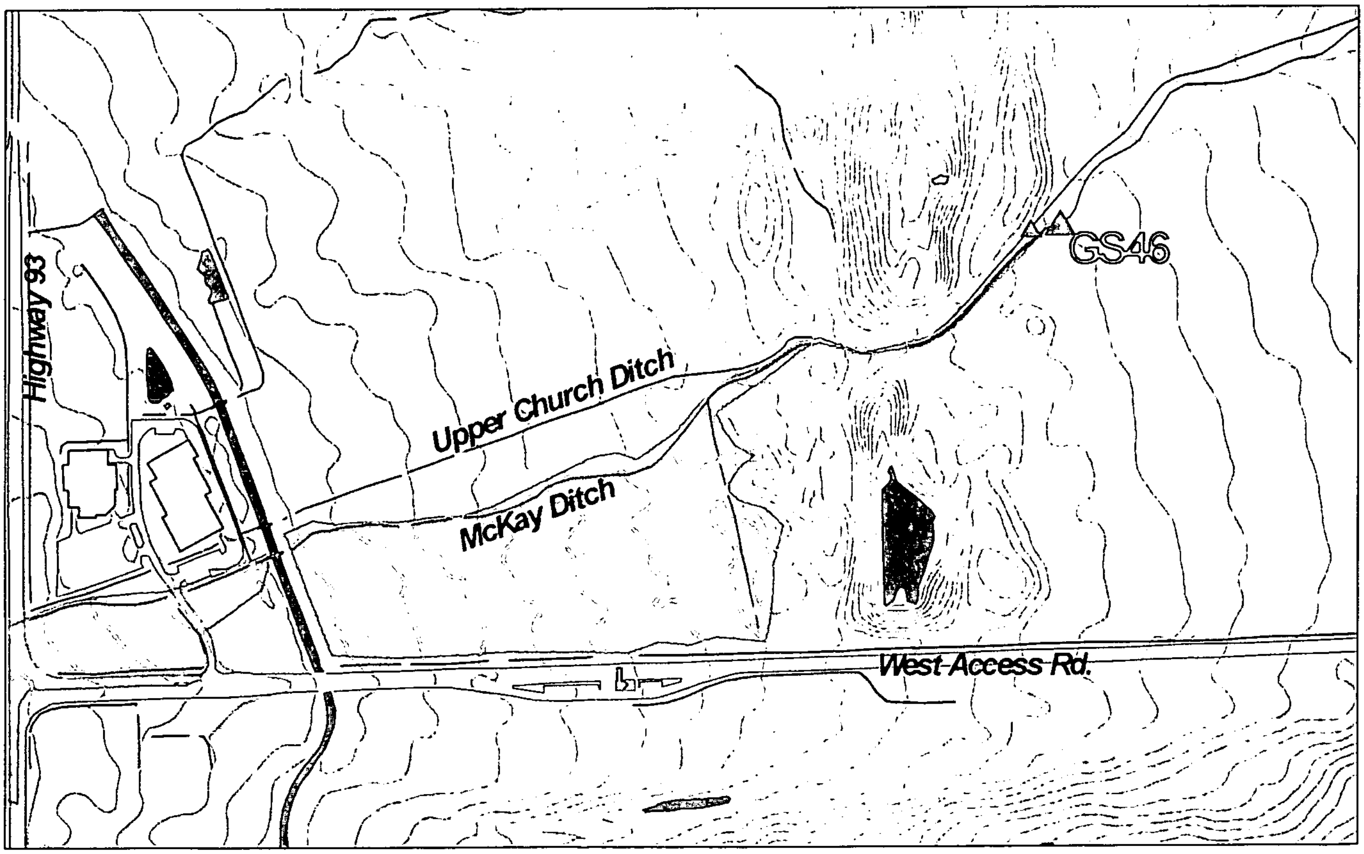

Figure 3-63. Map Showing GS46 Drainage Area.

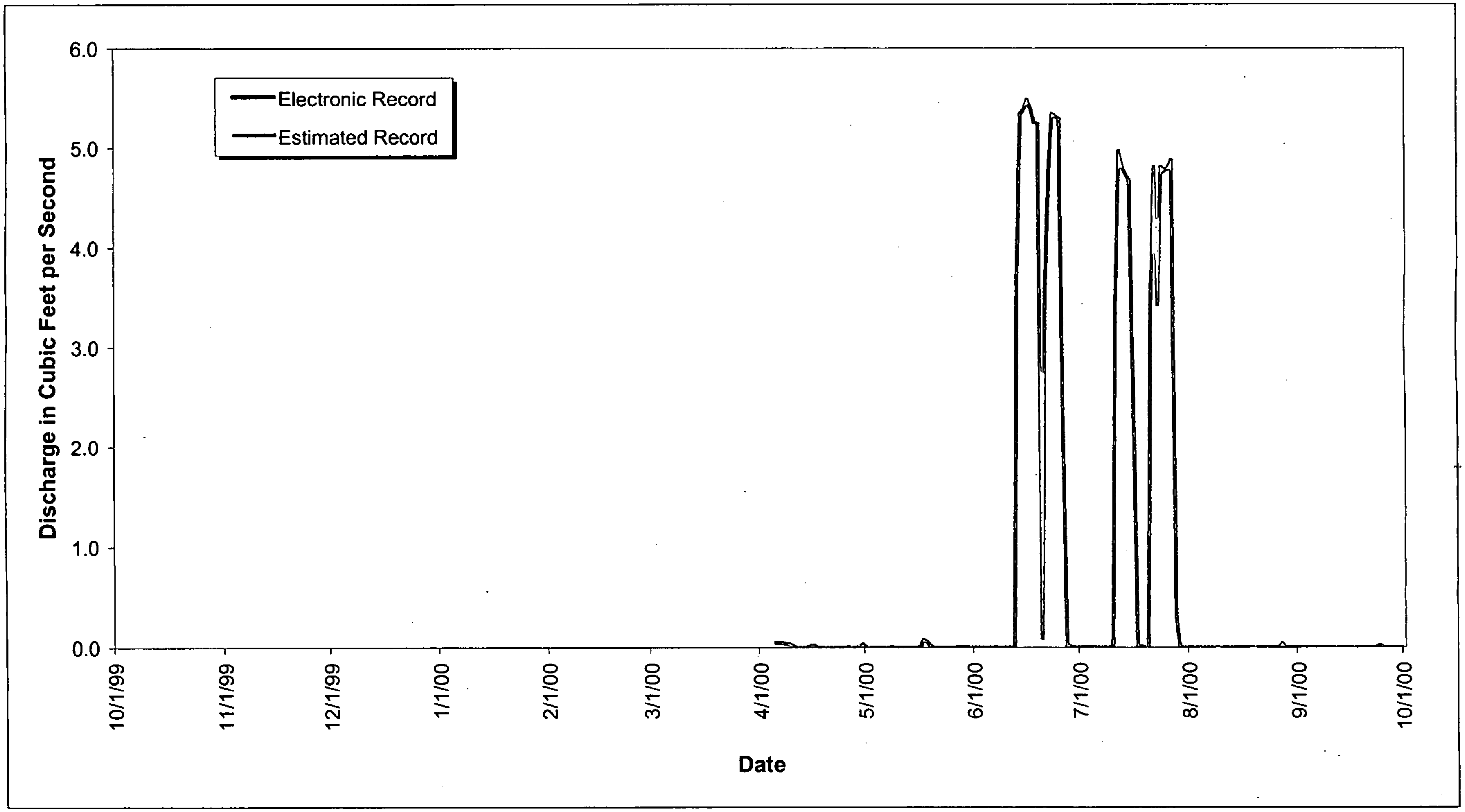

Figure 3-64. WY00 Mean Daily Hydrograph at GS46: Upper Church Ditch at West Gravel Pits.

3.2.32 SW009: McKay Bypass Upstream of West Diversion

Location

McKay Bypass upstream of West Diversion; State Plane: 2079449, 750287

Drainage Area

- The basin includes areas tributary to Upper Church and McKay ditches (total drainage acreage unknown)
- IA Areas draining to SW009: none

Period of Record

4/19/00 to current year

Gage

Water-stage recorder and 1' Parshall flume

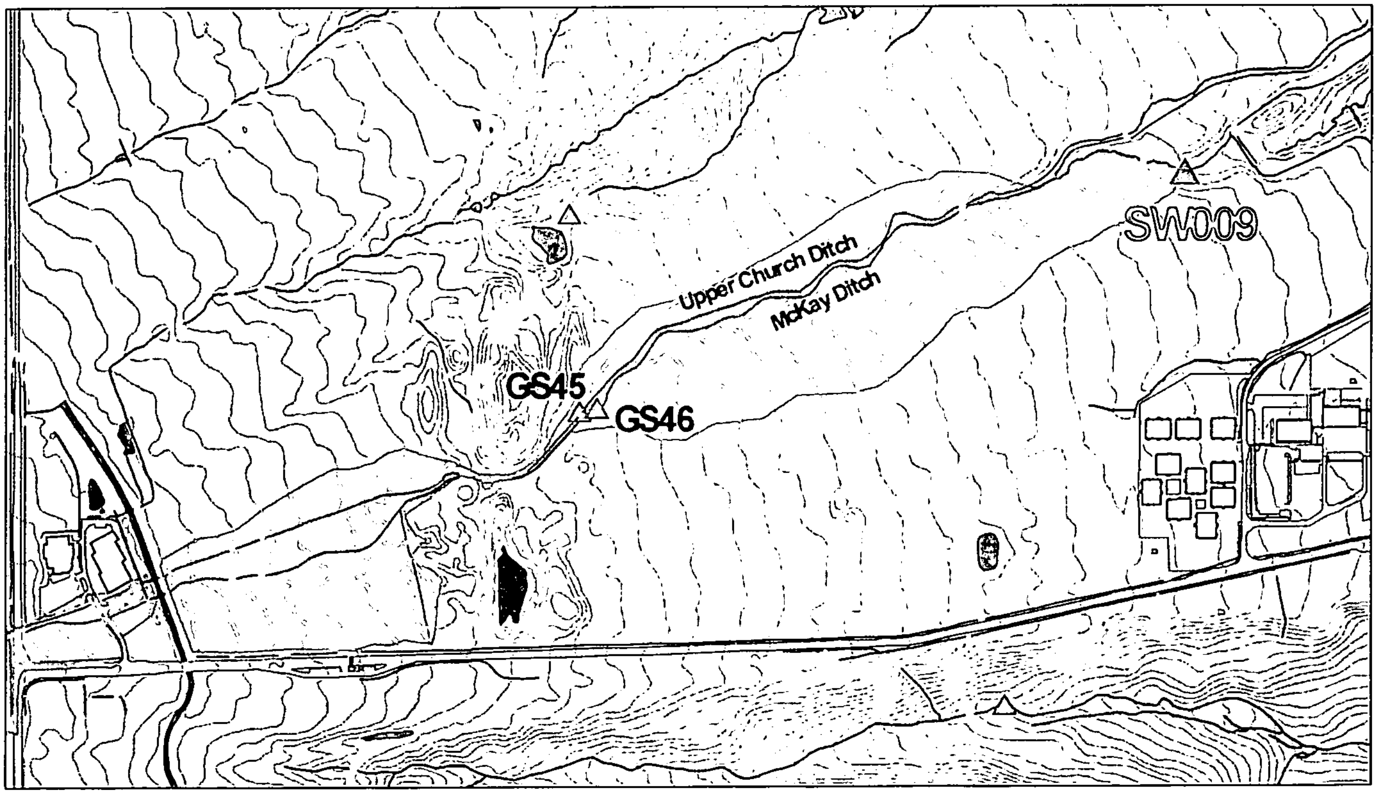

Figure 3-65. Map Showing SW009 Drainage Area.

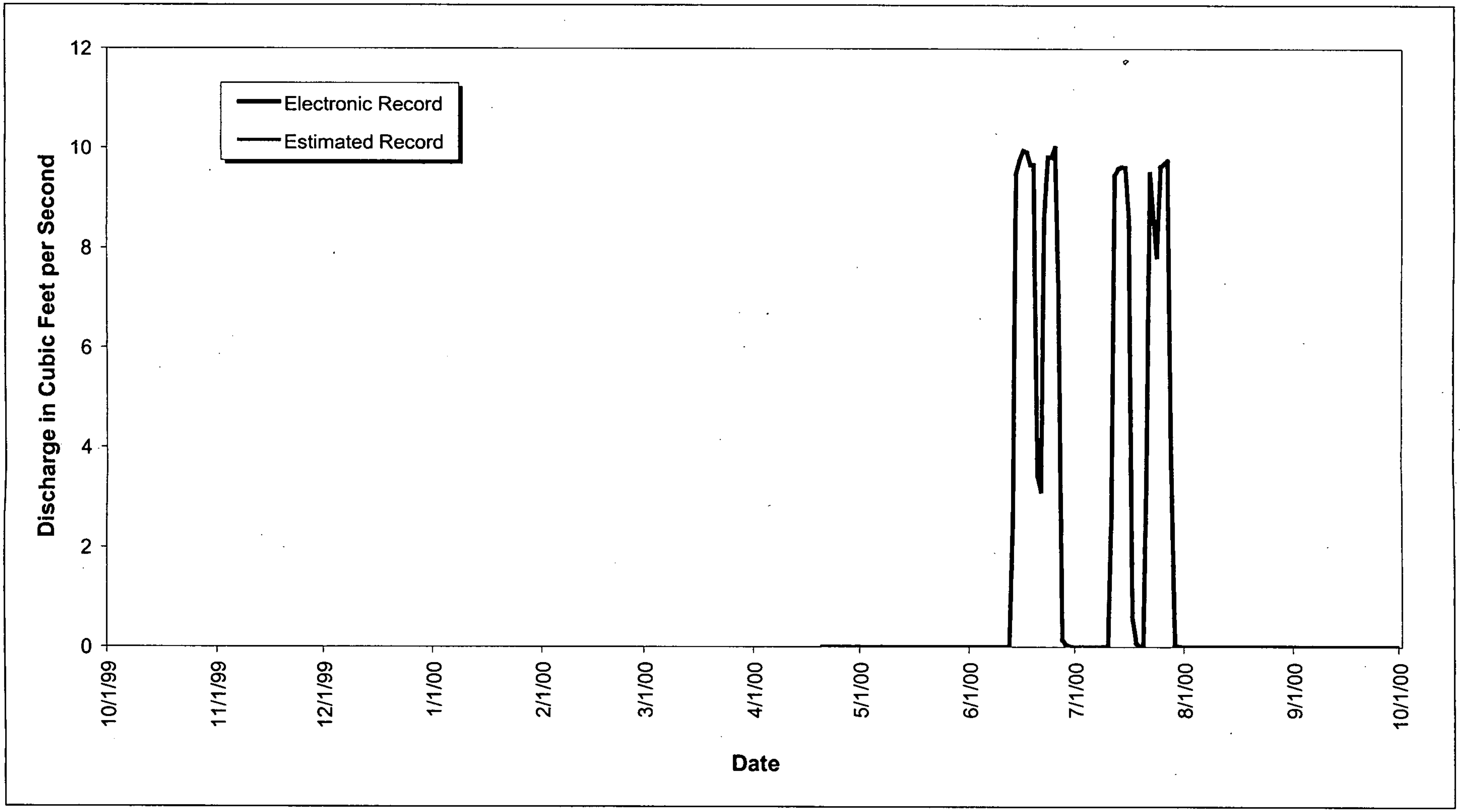

Figure 3-66. WY00 Mean Daily Hydrograph at SW009: McKay Bypass Canal Upstream of West Diversion.

3.2.33 SW021: S. Walnut Cr. Culvert Draining B991 Area

Location

S. Walnut Cr. Culvert Draining B991 Area; State Plane: 2086077, 750187

Drainage Area

- The basin includes areas south of Solar Ponds and the B991 area (total of 19.9 acres)
- IA Areas draining to SW021: 900

Period of Record

4/10/00 to 11/6/00

Gage

No flow measurement

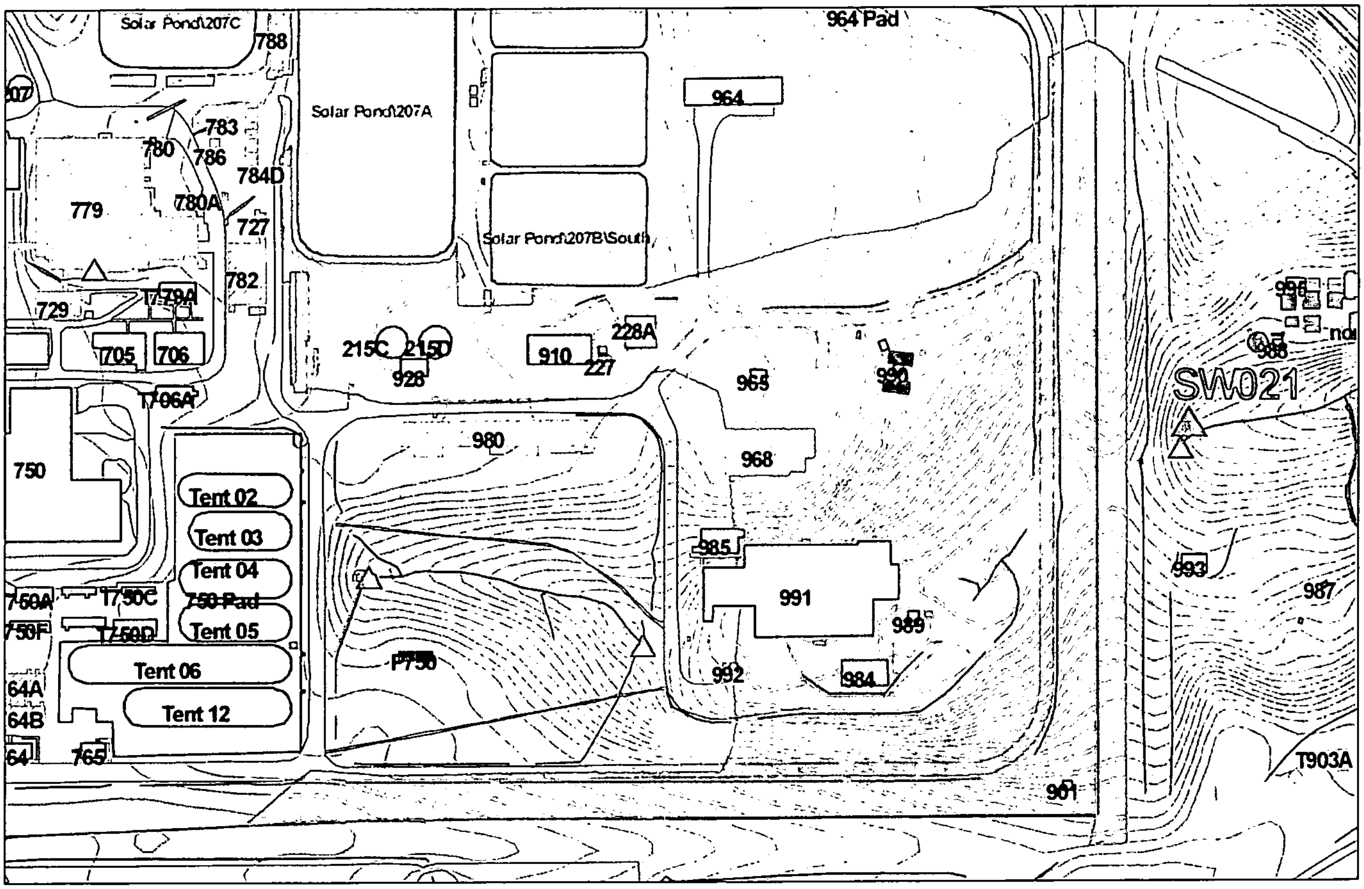

Figure 3-67. Map Showing SW021 Drainage Area.

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3.2.34 SW022: East End of Central Avenue Ditch

Location

East end of Central Ave. Ditch; State Plane: 2086438, 749759

Drainage Area

- The basin includes the IA south of Central Ave. Ditch (total of 76.7 acres)
- IA Areas draining to SW022: 900, 800, 600, 400, and 100

Period of Record

9/11/91 to current year

Gage

Water-stage recorder and 9.5" Parshall flume

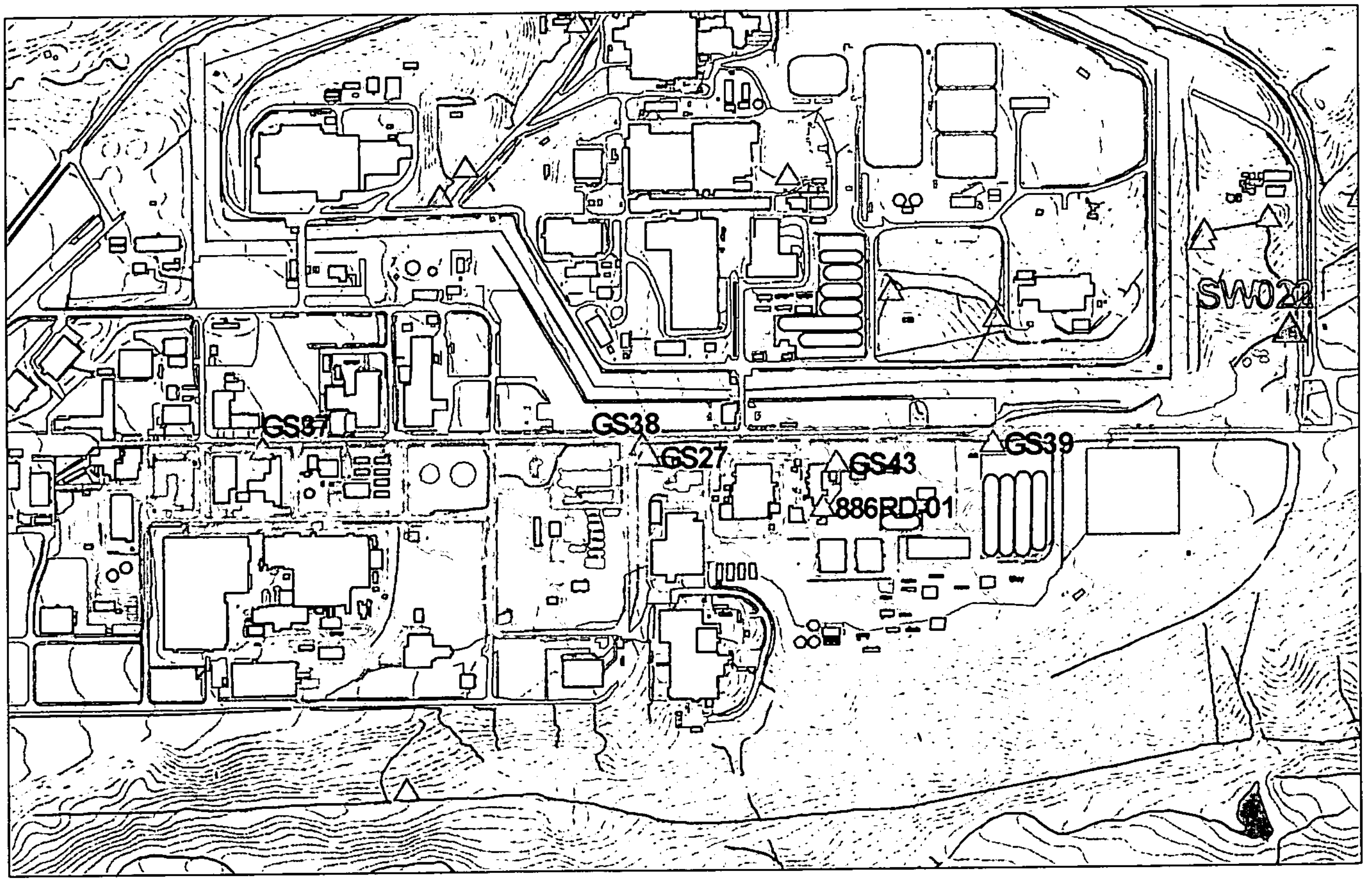

Figure 3-68. Map Showing SW022 Drainage Area.

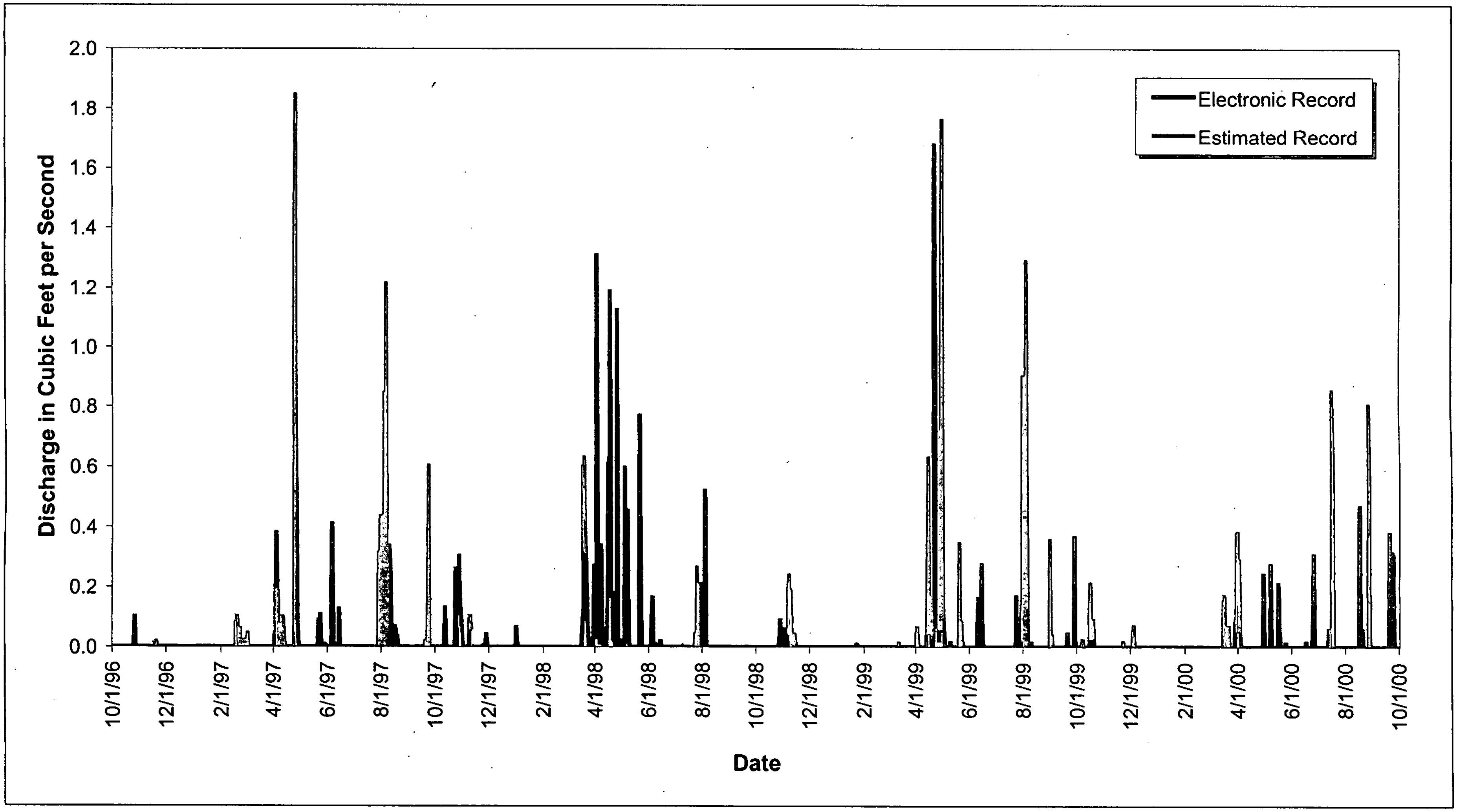

Figure 3-69. WY97-00 Mean Daily Hydrograph at SW022: East End of Central Avenue Ditch.

3.2.35 SW023: South Walnut Creek at B-1 Bypass

Location

South Walnut Cr. above B-1 Bypass; State Plane: 2086754, 750321

Drainage Area

- The basin includes the central and southern portions of the IA (total of 167.2 acres)
- IA Areas draining to SW023: 900, 800, 700, 600, 500, 400, 300, and 100

Period of Record

4/11/00 to 10/22/00

Gage

No flow measurement

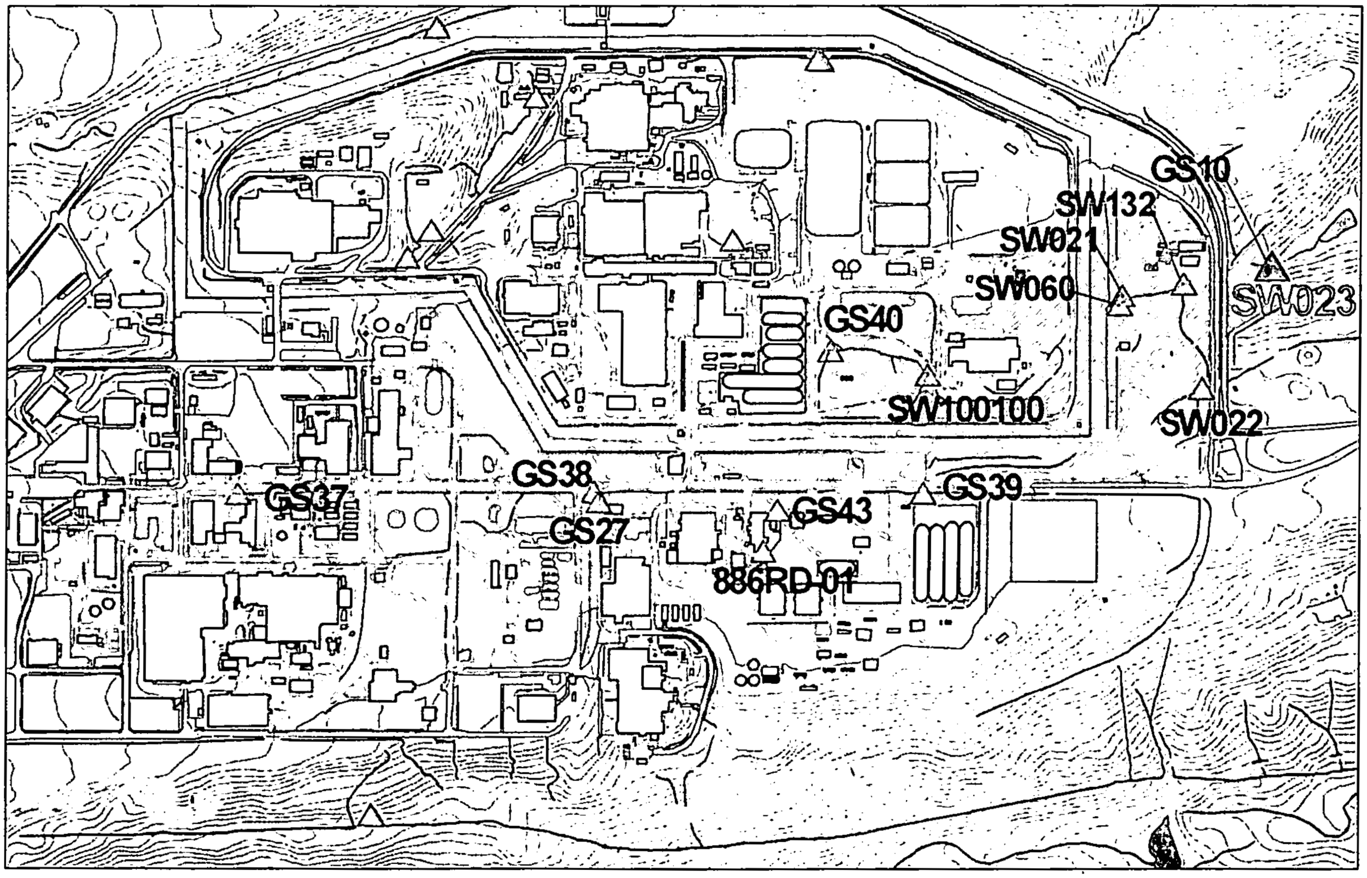

Figure 3-70. Map Showing SW023 Drainage Area.

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3.2.36 SW027: South Interceptor Ditch at Pond C-2

Location

East end of South Interceptor Ditch at Pond C-2; State Plane: 2088515, 748067

Drainage Area

- The basin includes the a portion of the southern IA and the area east of the inner fence and south of the East Access Rd. (total of 215.3 acres)
- IA Areas draining to SW027: 900, 800, 600, and 400

Period of Record

9/11/91 to current year

Gage

Water-stage recorder and dual, parallel 120° v-notch weirs

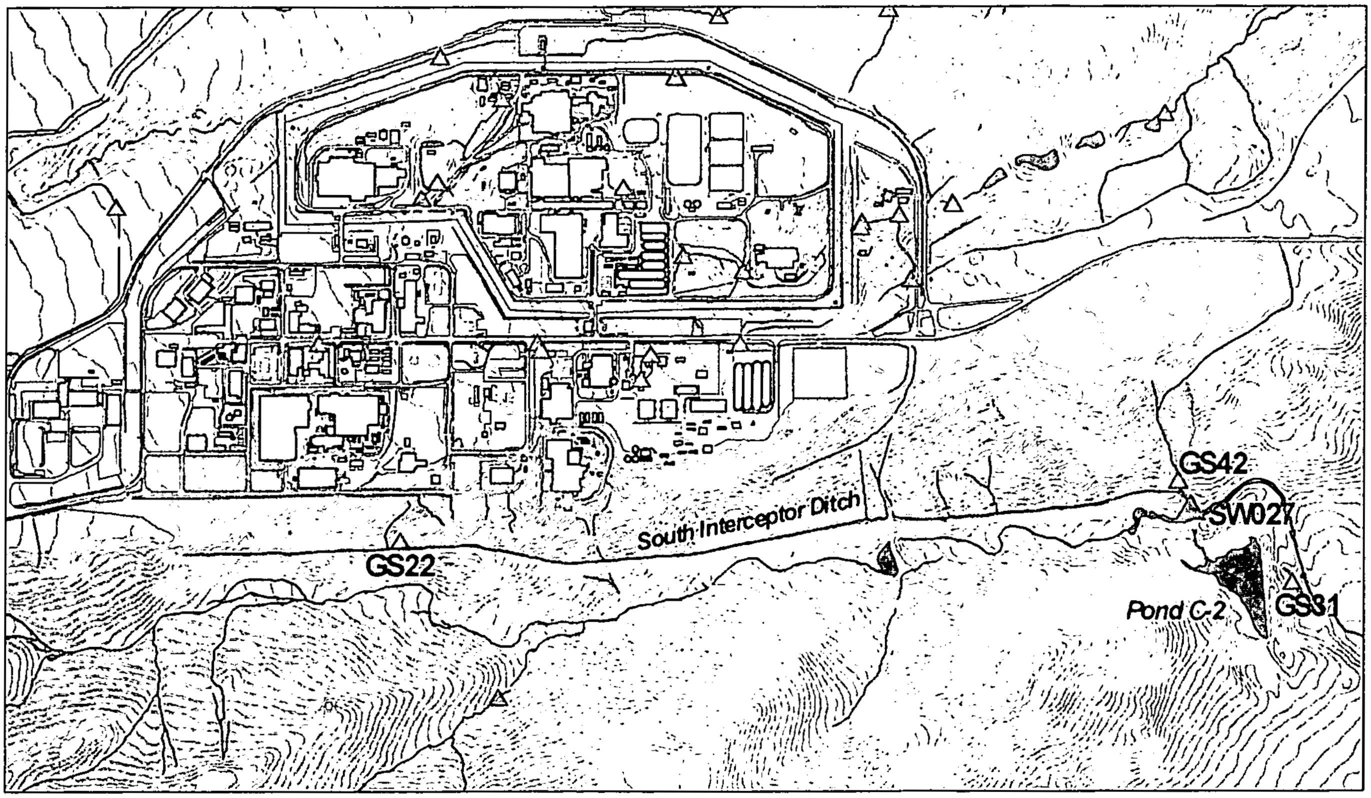

Figure 3-71. Map Showing SW027 Drainage Area.

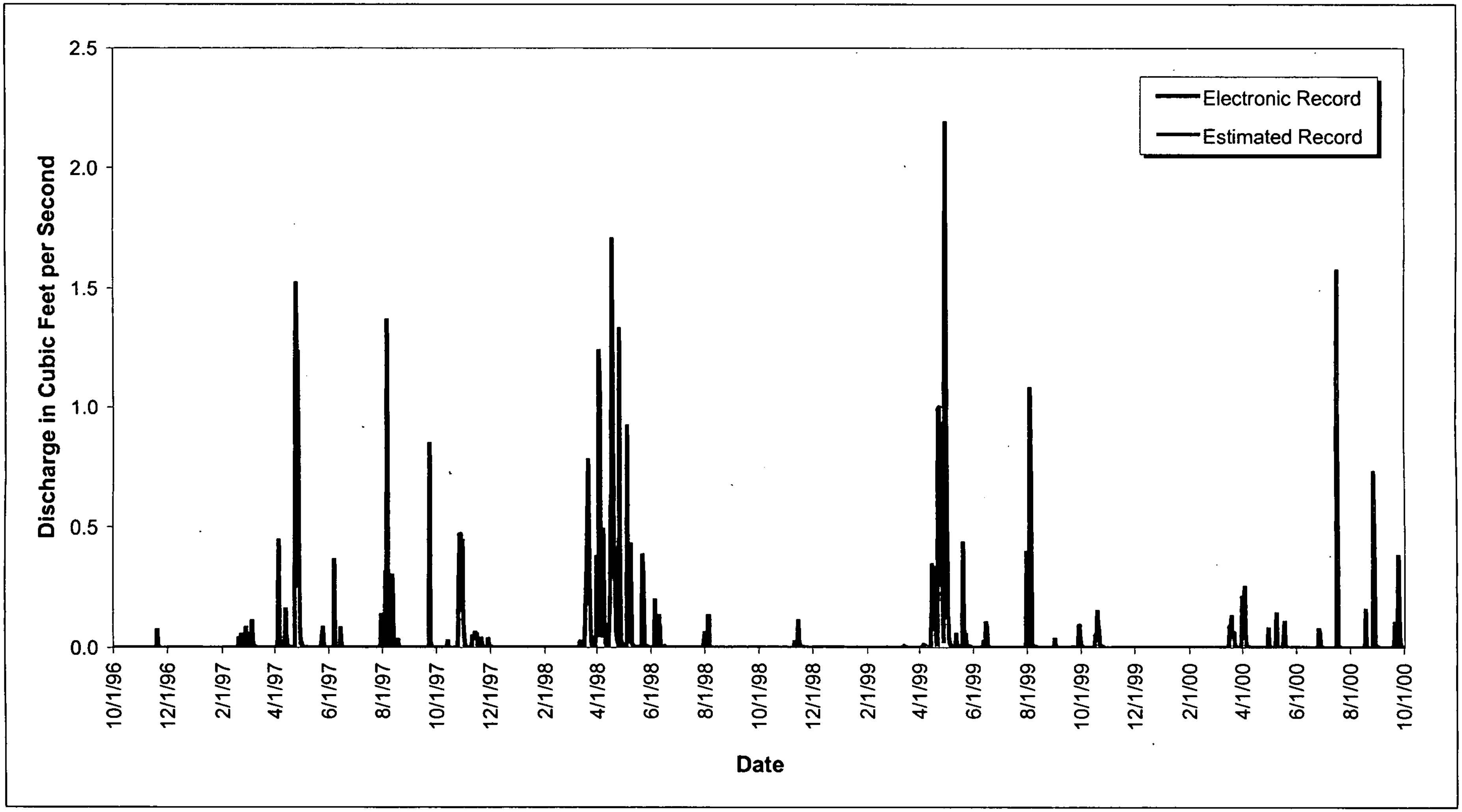

Figure 3-72. WY97-00 Mean Daily Hydrograph at SW027: South Interceptor Ditch at Pond C-2.

3.2.37 SW060: S. Walnut Creek Culvert Draining Area South of PSZ

Location

S. Walnut Creek culvert draining area south of PSZ; State Plane: 2086065, 750145

Drainage Area

- The basin includes the area surrounding the PSZ north of Central Ave. (total of 25.7 acres)
- IA Areas draining to SW060: 500 and 300

Period of Record

4/10/00 to 11/6/00

Gage

No flow measurement

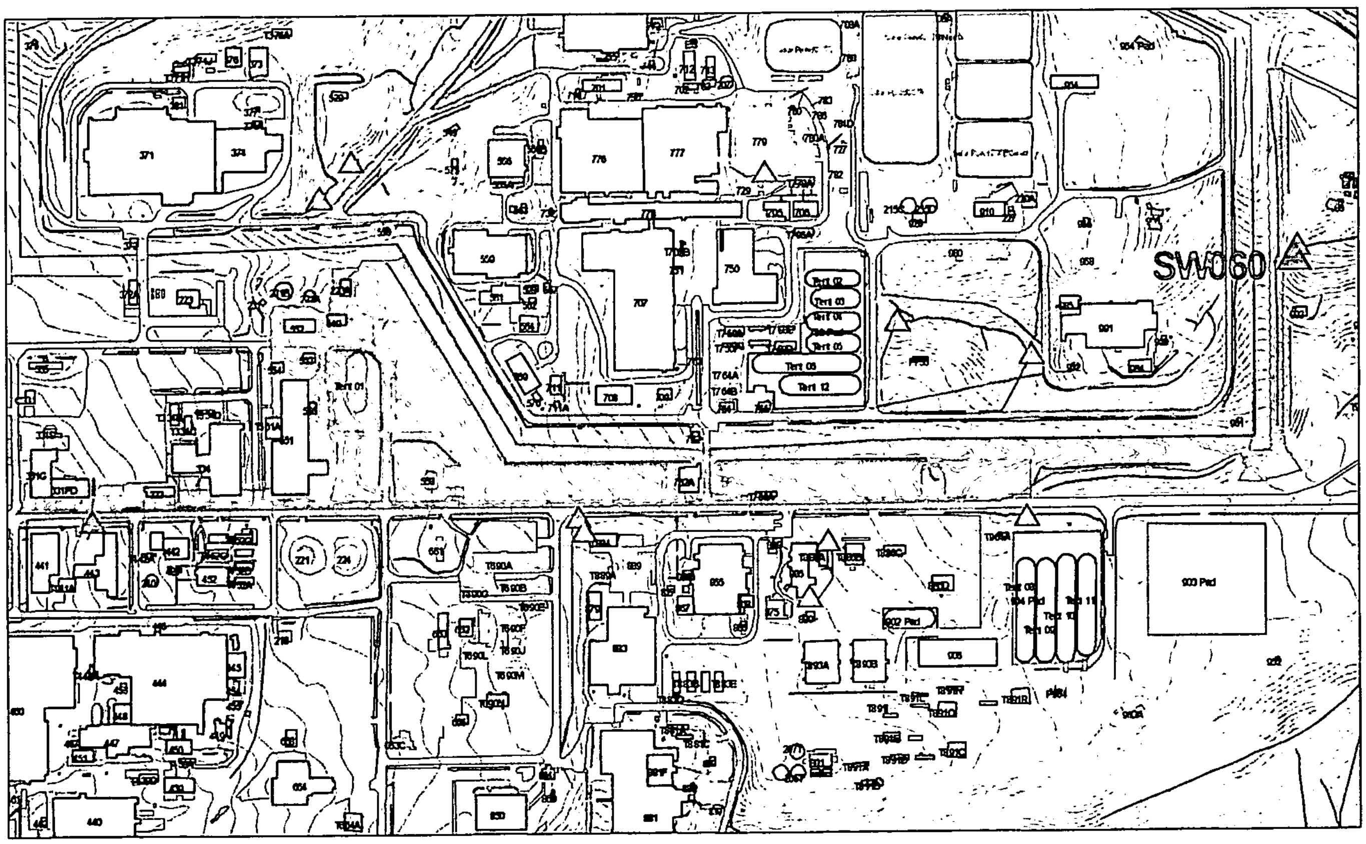

Figure 3-73. Map Showing SW060 Drainage Area.

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3.2.38 SW091: North Walnut Creek Tributary Northeast of Solar Ponds

Location

N. Walnut Creek tributary draining area NE of Solar Ponds; State Plane: 2086267, 751775

Drainage Area

- The basin includes the area NE of the Solar Ponds (total of 10.2 acres)
- IA Areas draining to SW091: 900

Period of Record

4/18/95 to current year

Gage

Water-stage recorder and 6" cutthroat flume; 1.5' H-flume located 400 feet upstream prior to 5/4/98 (see Figure 2-2).

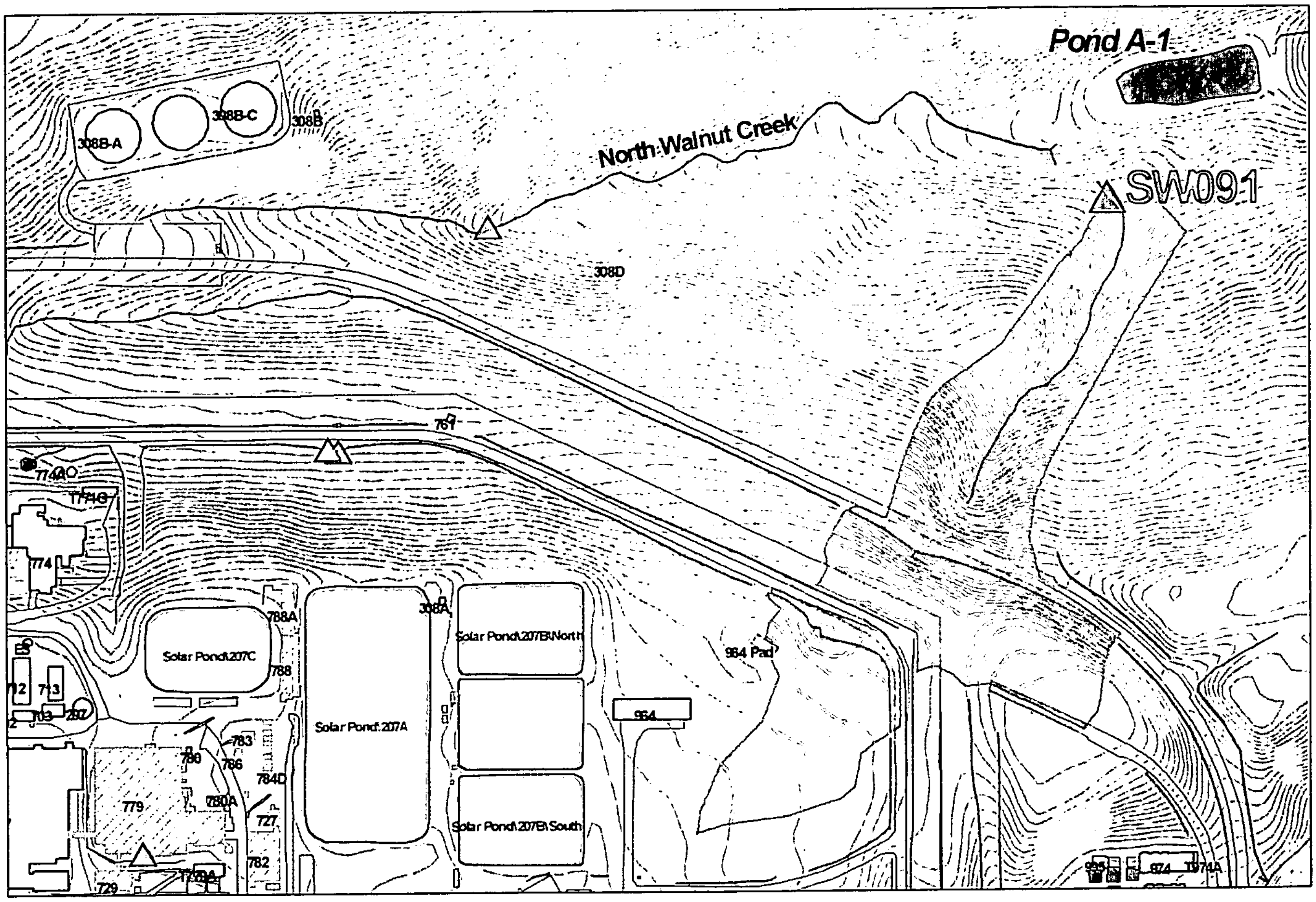

Figure 3-74. Map Showing SW091 Drainage Area.

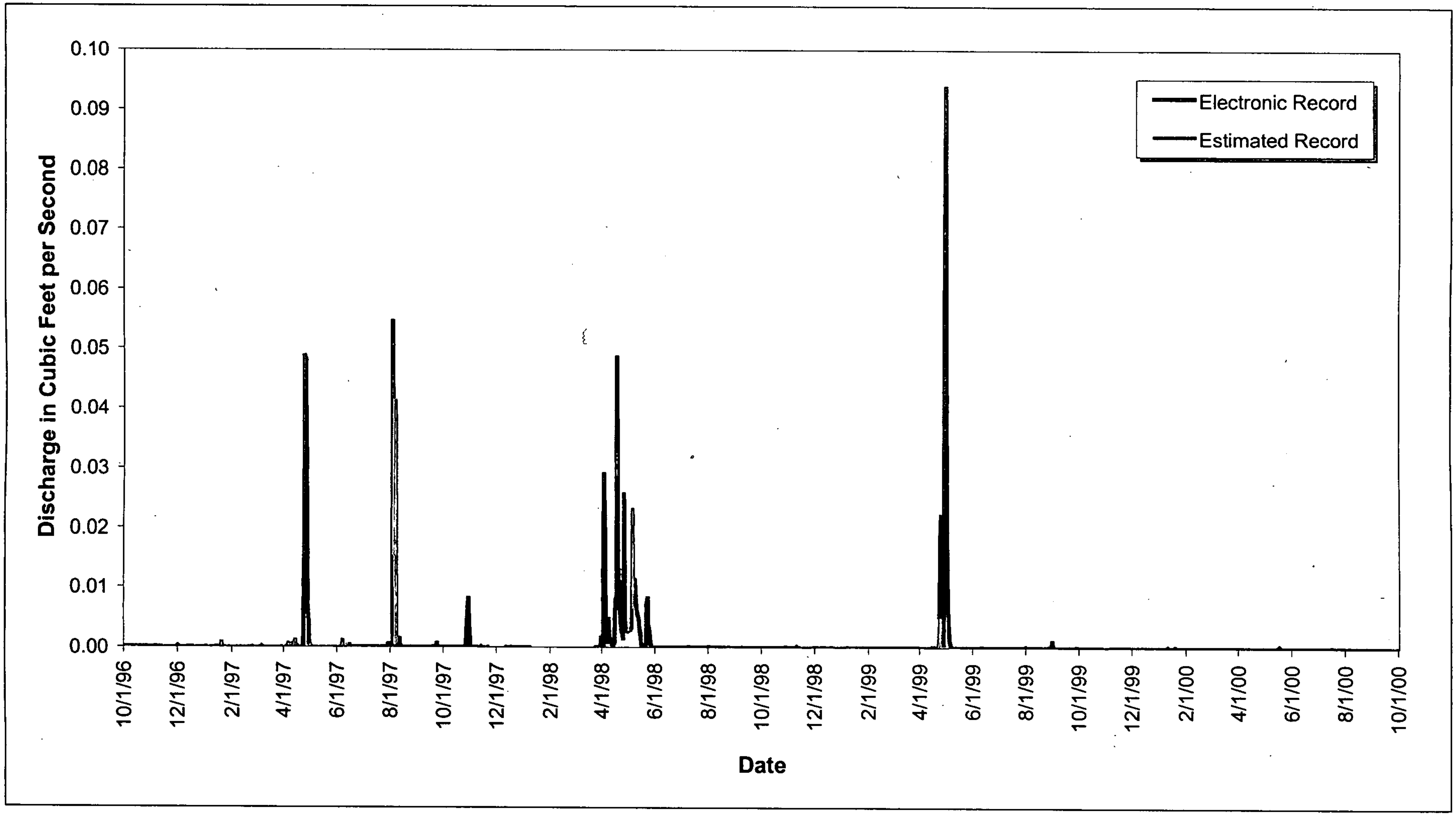

Figure 3-75. WY97-00 Mean Daily Hydrograph at SW091: North Walnut Creek Tributary Northeast of Solar Ponds.

3.2.39 SW093: North Walnut Creek 1300' Upstream of A-1 Bypass

Location

North Walnut Cr. 1300' above A-1 Bypass; State Plane: 2085026, 751720

Drainage Area

- The basin includes the northern portion of the PA and portions of the western IA south (total of 242.7 acres)
- IA Areas draining to SW093: 900, 700, 500, 300, and 100

Period of Record

9/11/91 to current year

Gage

Water-stage recorder and 36" suppressed, rectangular, sharp-crested weir

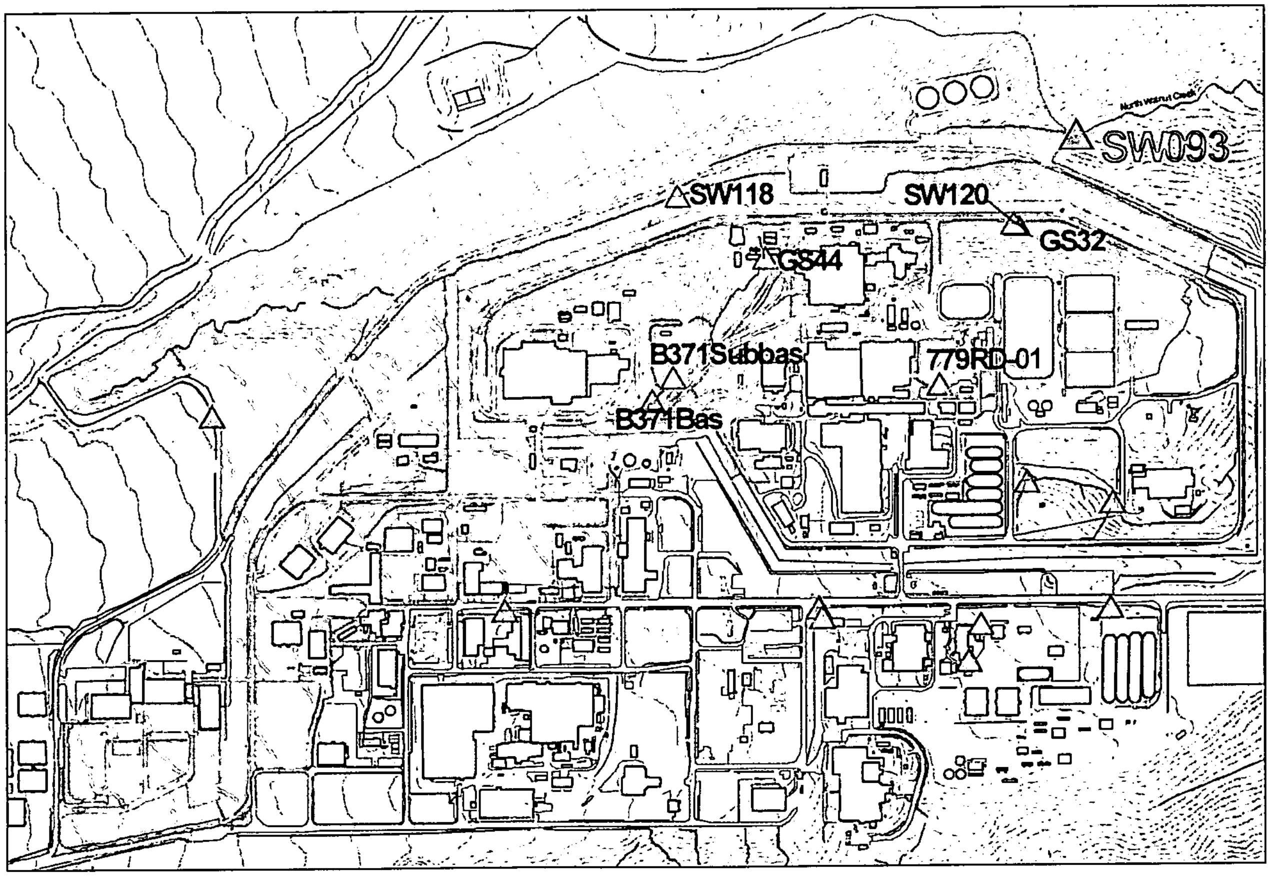

Figure 3-76. Map Showing SW093 Drainage Area.

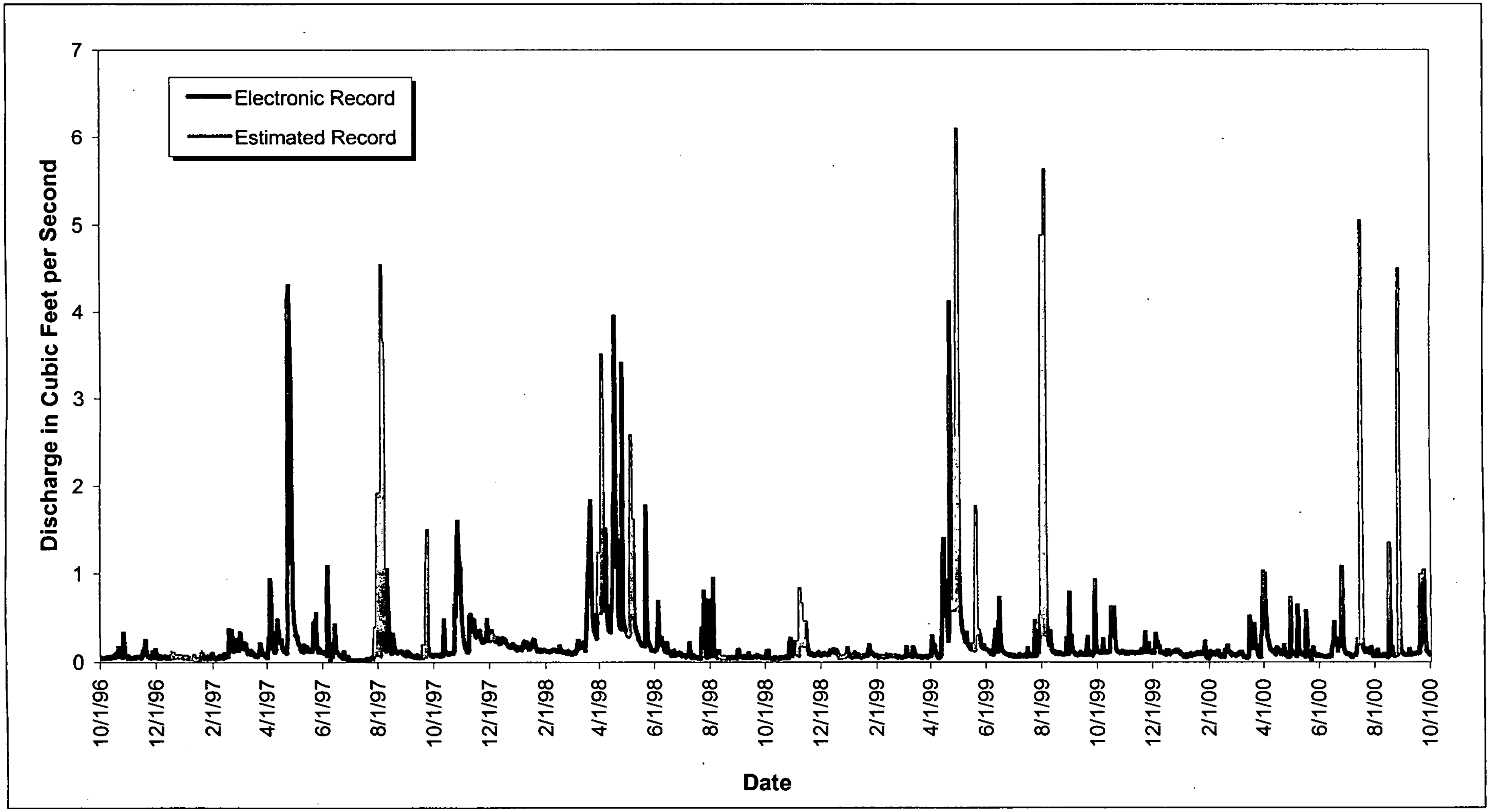

Figure 3-77. WY97-00 Mean Daily Hydrograph at SW093: North Walnut Creek Upstream of A-1 Bypass.

3.2.40 SW100100: S. Walnut Creek Above B991

Location

S. Walnut Creek at upstream end of culvert draining PA, west of B991; State Plane: 2085191, 749825

Drainage Area

- The basin includes the south central portion of the PA (total of 31.5 acres)
- IA Areas draining to SW100100: 900, 700, and 500

Period of Record

4/10/00 to 11/3/00

Gage

No flow measurement

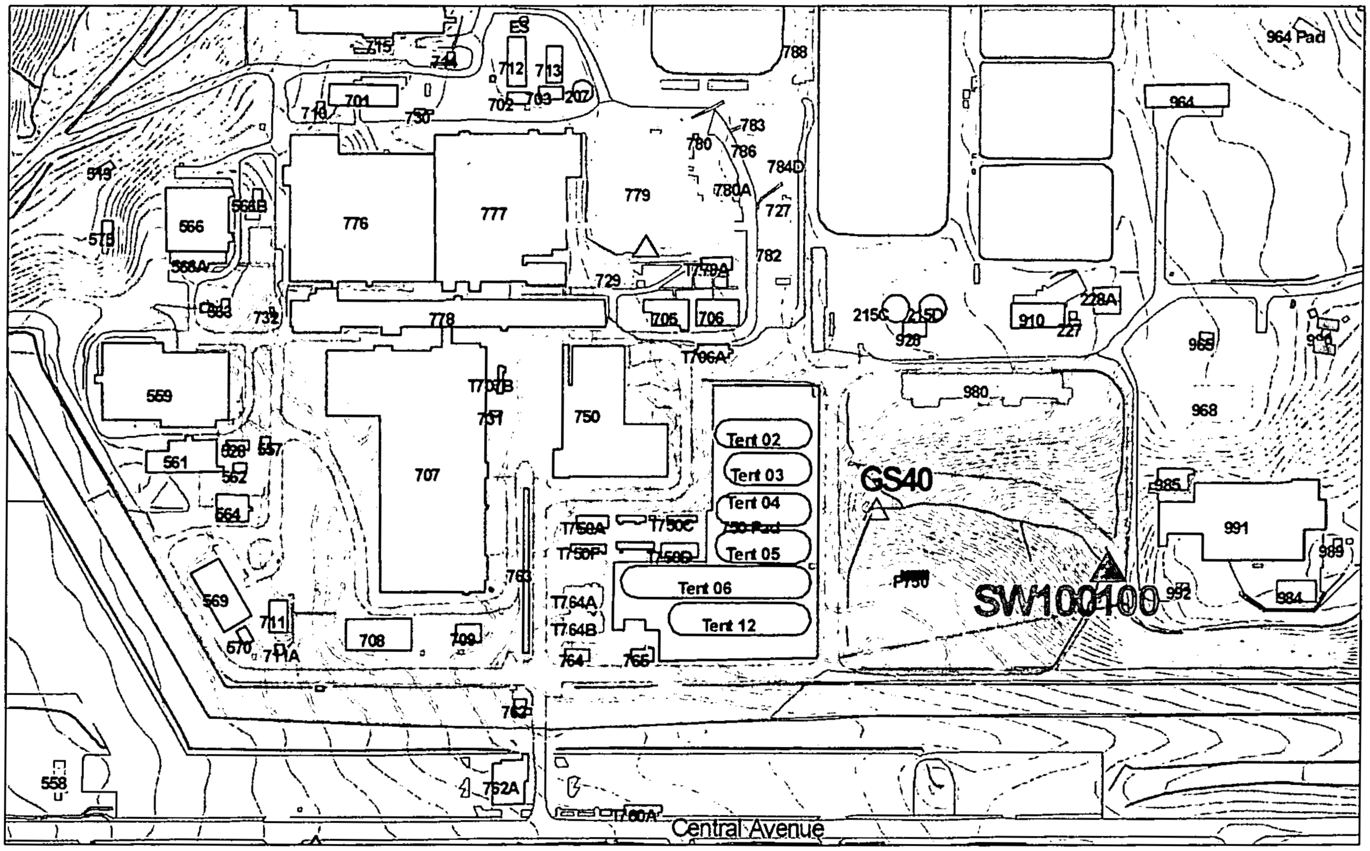

Figure 3-78. Map Showing SW100100 Drainage Area.

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3.2.41 SW118: North Walnut Creek 560' Upstream of Portal 3

Location

N. Walnut Creek west of Portal 3; State Plane: 2082961, 751417

Drainage Area

- The basin includes the N. Walnut Cr. drainage west of the PA and downstream of the West Diversion Ditch (total of 50.3 acres)
- IA areas draining to SW118: 300

Period of Record

9/11/91 to current year

Gage

Water-stage recorder 169.5° sharp-crested, v-notch weir

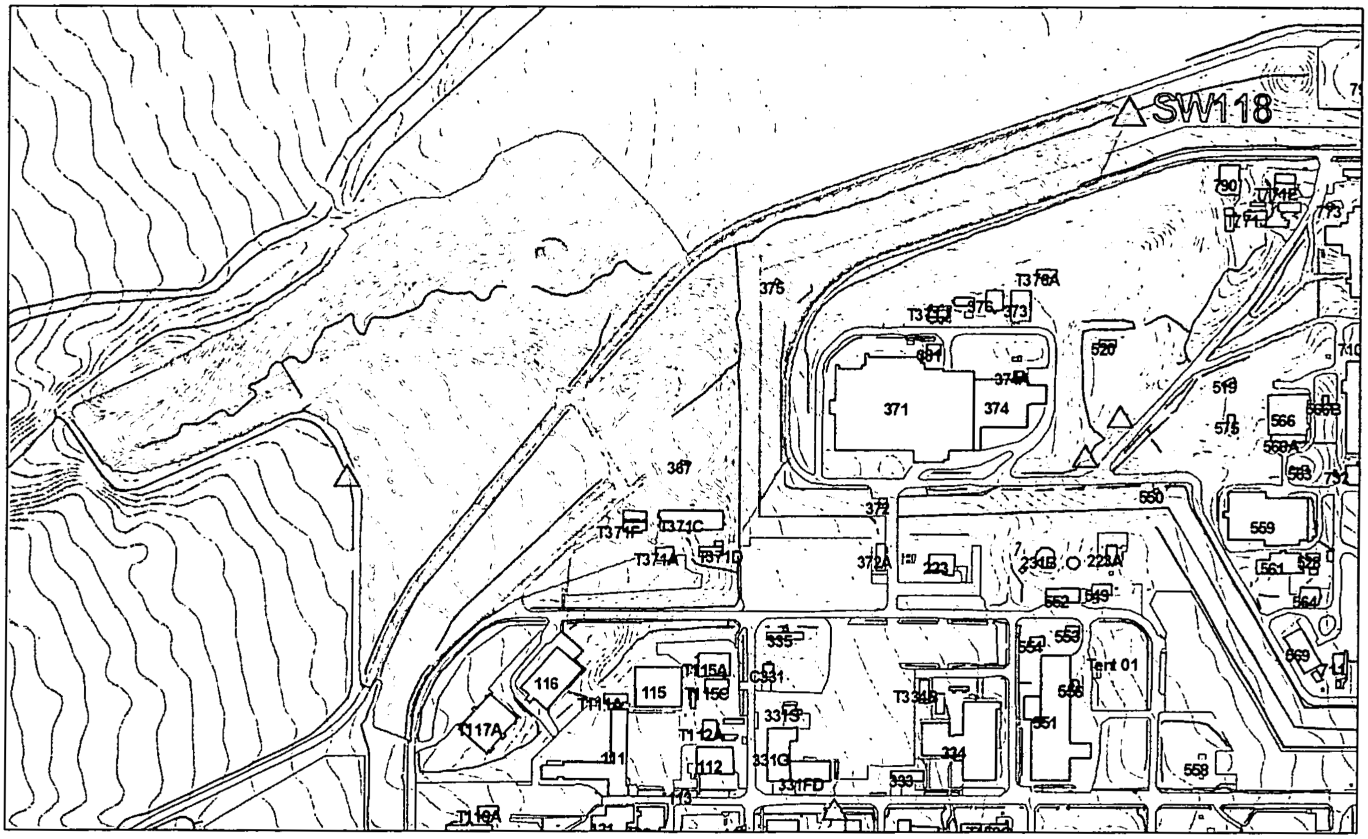

Figure 3-79. Map Showing SW118 Drainage Area.

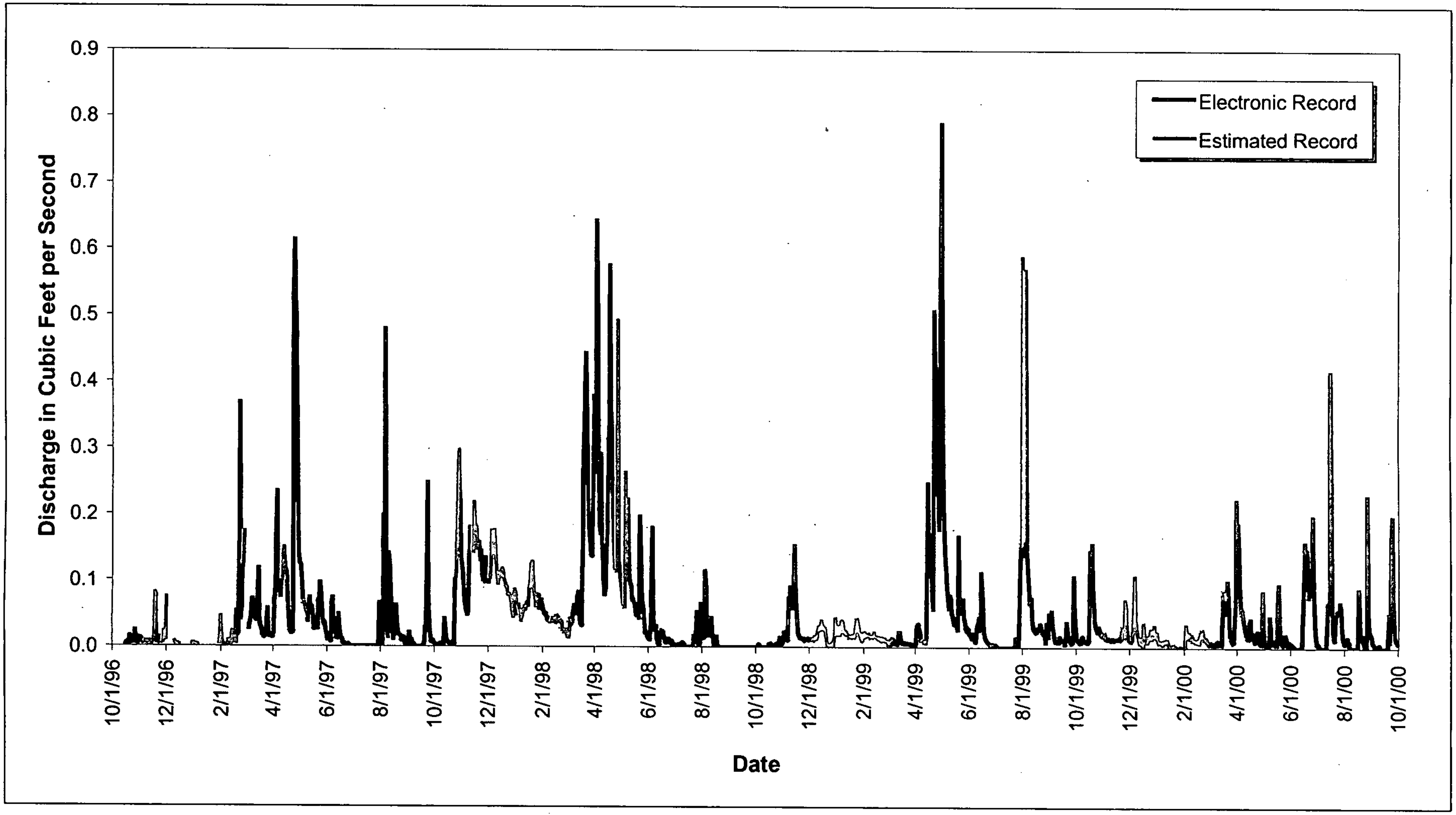

Figure 3-80. WY97-00 Mean Daily Hydrograph at SW118: North Walnut Creek Upstream of Portal 3.

3.2.42 SW120: Ditch Along PA Perimeter Road North of Solar Pond 207A

Location

Ditch along PA Perimeter Rd. draining 771/774 Area; State Plane: 2084682, 751269

Drainage Area

- The basin includes the northeast potion of the B771/774 subdrainage (total of 12.8 acres)
- IA Areas draining to SW120: 700

Period of Record

3/14/00 to current year

Gage

Water-stage recorder and 4" cutthroat flume

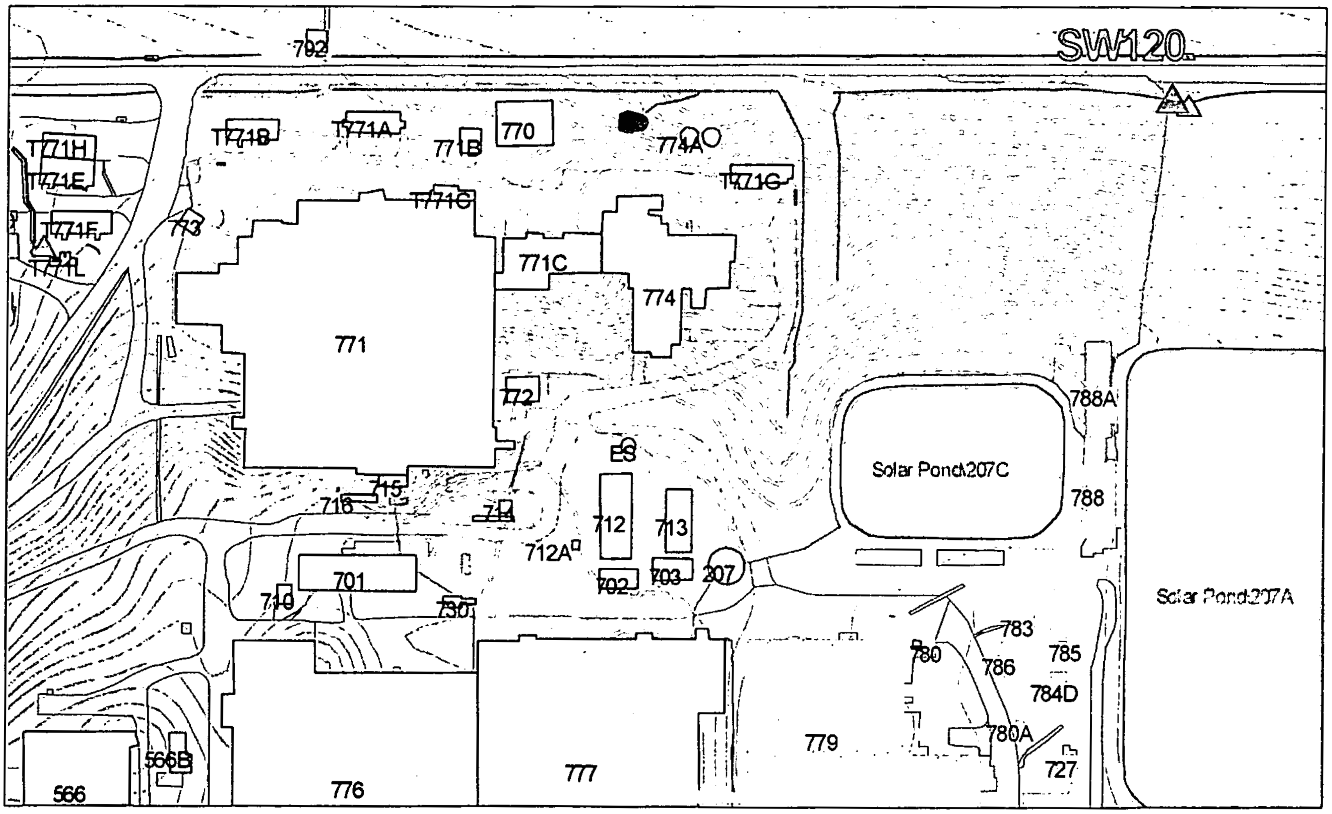

Figure 3-81. Map Showing SW120 Drainage Area.

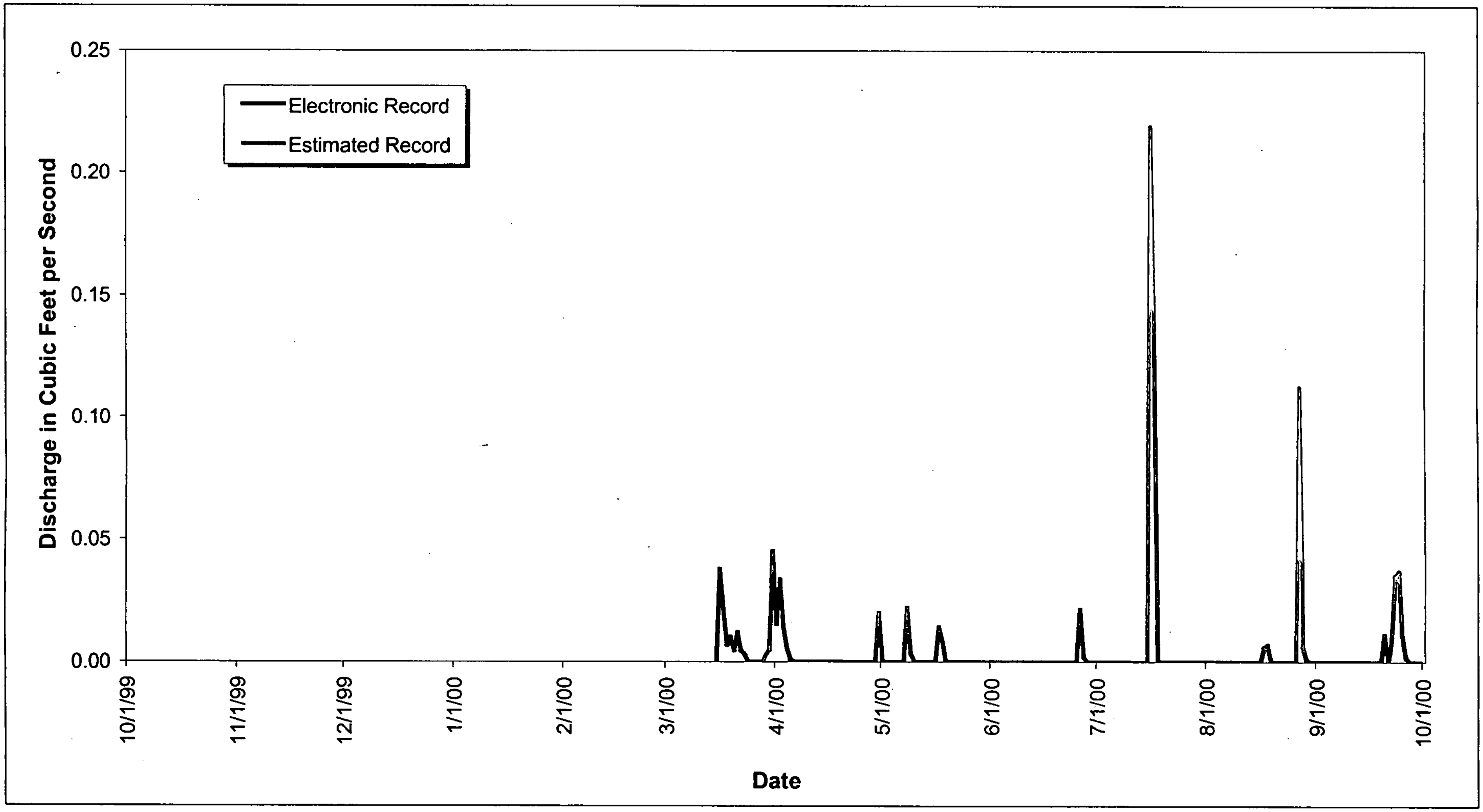

Figure 3-82. WY00 Mean Daily Hydrograph at SW120: PA Perimeter Road Ditch North of Solar Pond 207A.

3.2.43 SW132: S. Walnut Creek South of B995

Location

Downstream end of S. Walnut Creek culvert draining 700 areas west of B991; State Plane: 2086353, 750240

Drainage Area

- The basin includes the south-central portion of the PA west of B991 (total of 33.3 acres)
- IA Areas draining to SW132: 900, 700 and 500

Period of Record

4/10/00 to 11/6/00

Gage

No flow measurement

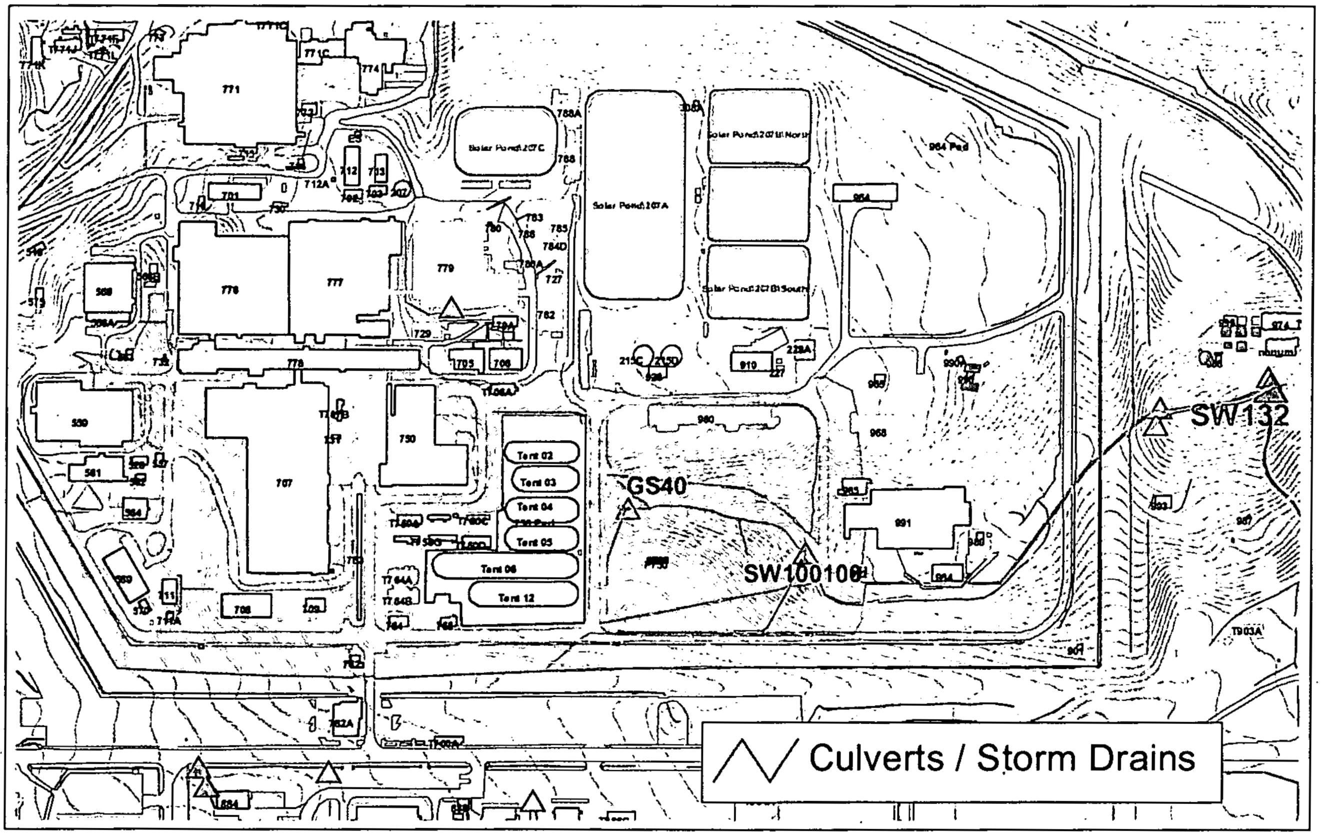

Figure 3-83. Map Showing SW132 Drainage Area.

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3.2.44 SW134: Rock Creek Tributary at Gravel Pits Northeast of West Gate

Location

Pump discharge outfall for gravel pits northeast of West Gate; State Plane: 2075942, 750049

Drainage Area

- The basin includes the gravel pit areas that are pump discharged to Rock Creek
- IA Areas draining to SW134: none

Period of Record

5/4/94 to current year

Gage

Water-stage recorder and 6" Parshall flume with weir insert

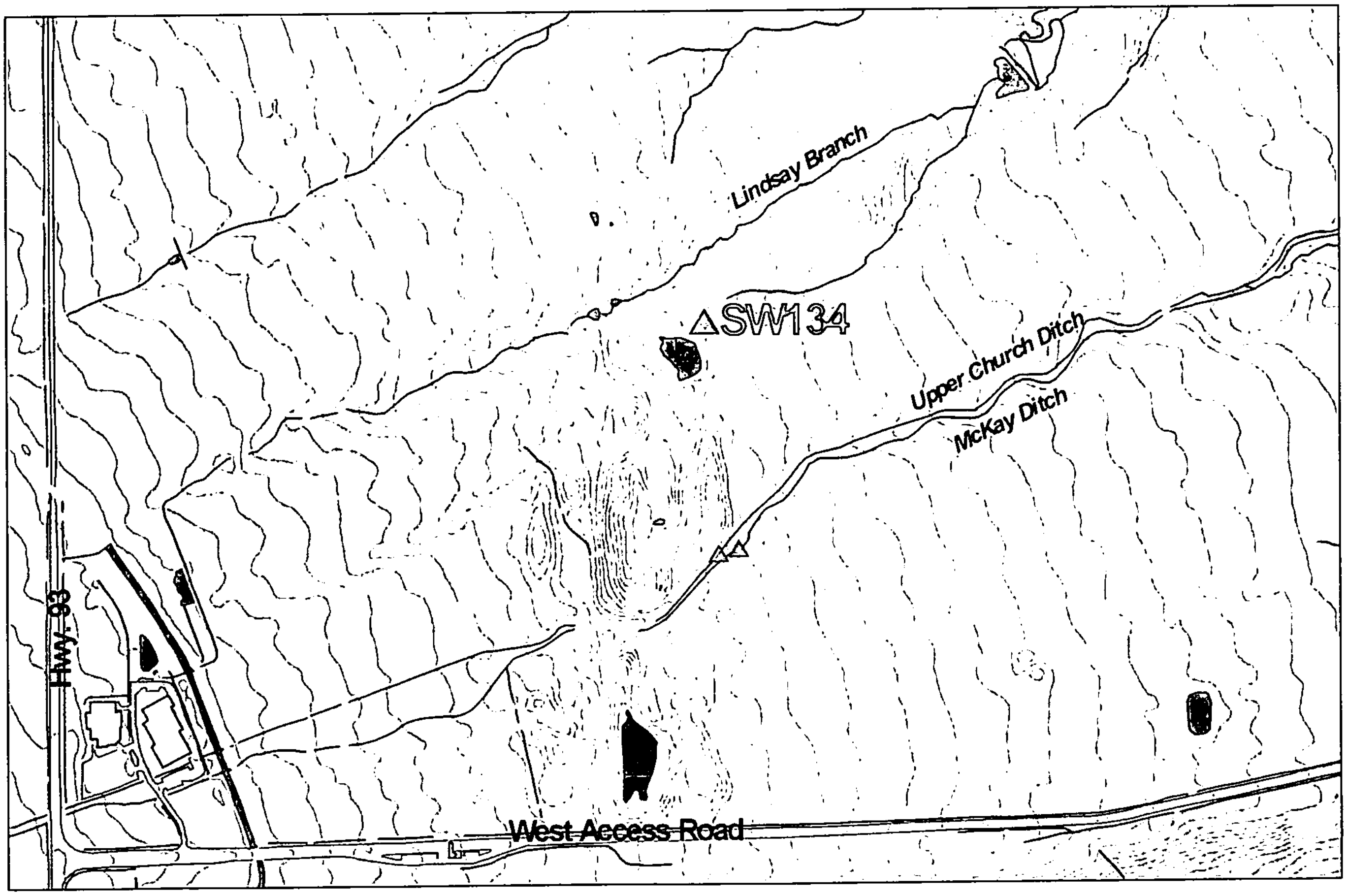


Figure 3-84. Map Showing SW134 Location.

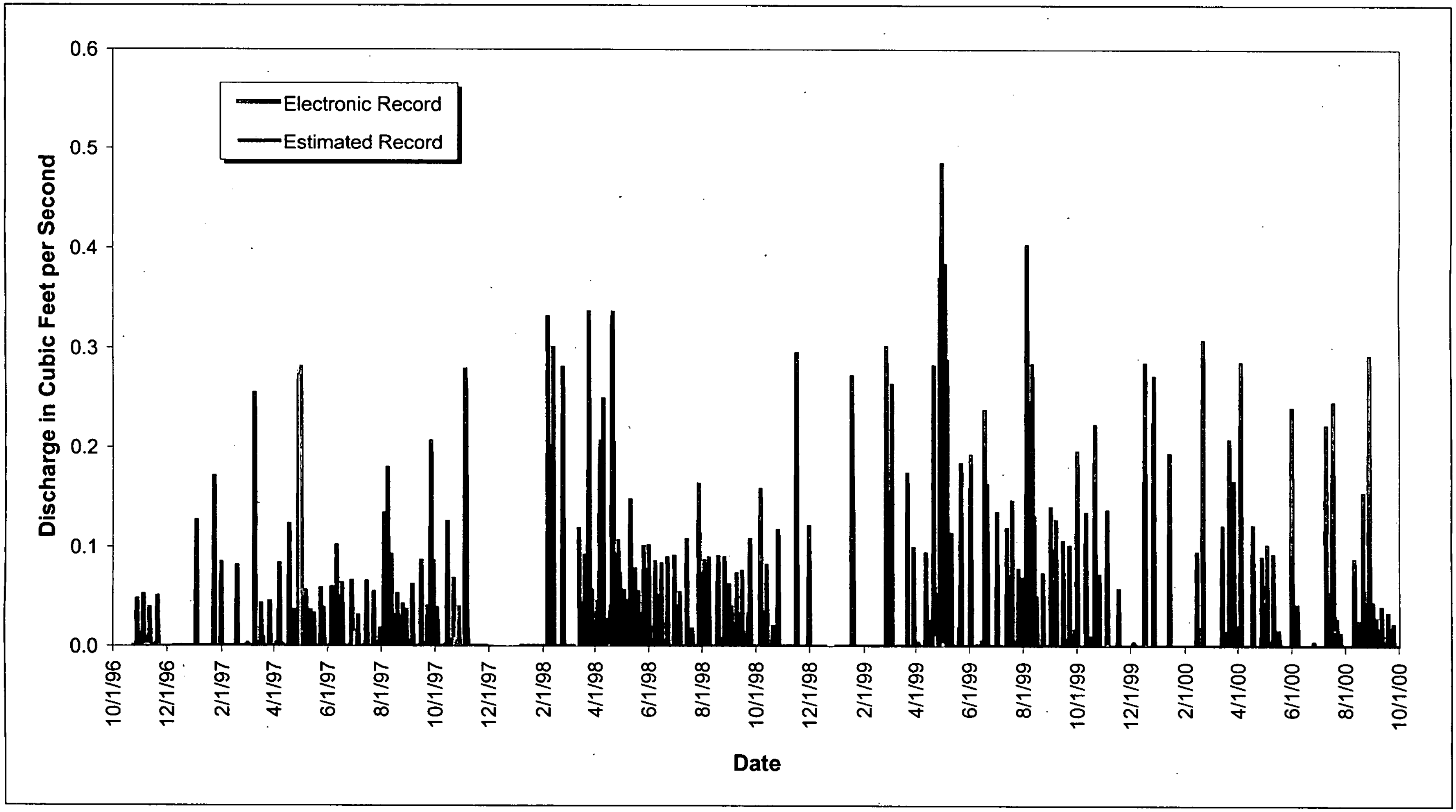


Figure 3-85. WY97-00 Mean Daily Hydrograph at SW134: Rock Creek Tributary at Gravel Pits Northeast of West Gate.

3.2.45 B371Bas: B371 Basement and Subbasement Footing Drain Outfalls

Location

B371 footing drain outfalls to a ditch tributary to N. Walnut Cr.

B371Bas: State Plane 2082831, 750362

B371Subbas: State Plane 2082939, 750485

Drainage Area

- NA

Period of Record

WY98 to current year

Gage

11.4 Degree V-Notch Weirs

Flow data are not given in this report. Data can be found as reported in Appendix 1 of the *Building 371 Subsurface Drain System* procedure (4-K14-SDS-371).

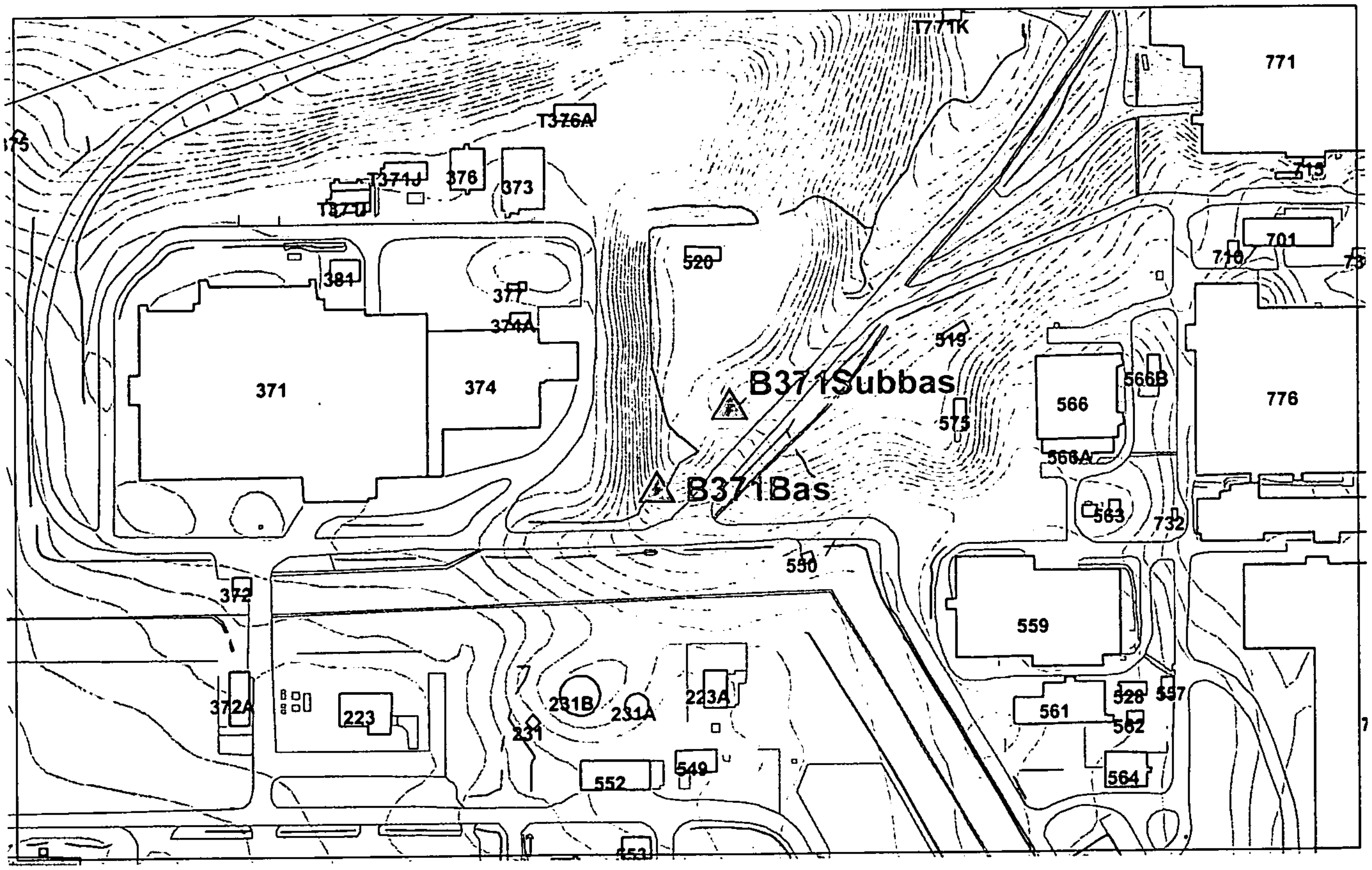


Figure 3-86. Map Showing B371 Basement and Subbasement Footing Drain Outfall Locations.

3.2.46 B779RD-01: Building 779 Roof Drain

Location

Downspout on south side of B779 (pre-demolition); State Plane: 2084304, 750441

Drainage Area

- An unknown portion of the B779 roof

Period of Record

11/20/98 through 9/7/99

Gage

No flow measurement

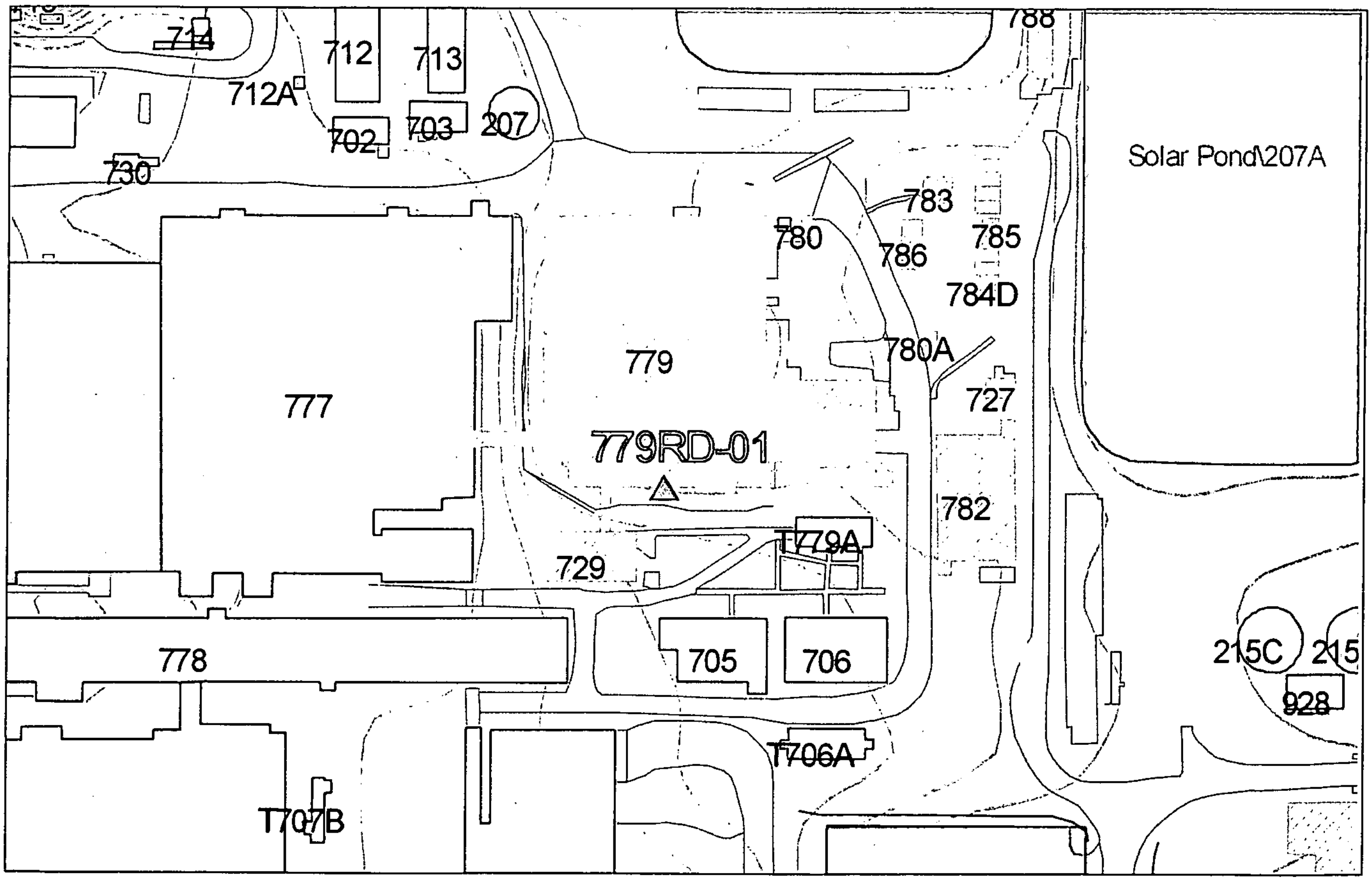


Figure 3-87. Map Showing B779RD-01 Location.

3.2.47 B886RD-01: Building 886 Roof Drain

Location

Downspout on southeast corner of B886; State Plane: 2084450, 749019

Drainage Area

- An unknown portion of the B886 roof

Period of Record

12/15/98 through 4/11/00

Gage

No flow measurement

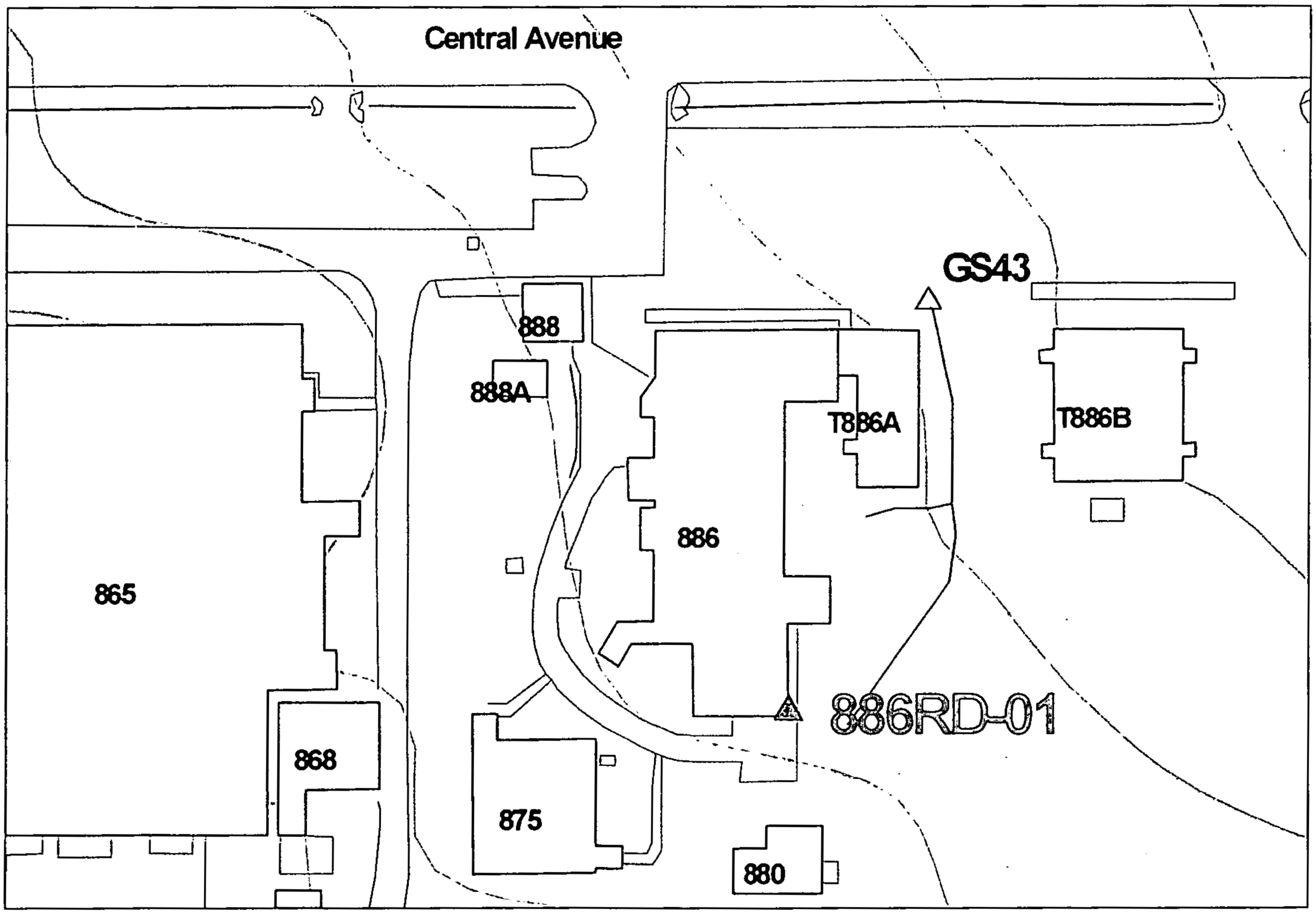


Figure 3-88. Map Showing B886RD-01 Location.

3.3 PRECIPITATION DATA

During Water Years 1997-2000, 11 precipitation gages were operated as part of the automated surface-water monitoring network. The locations employ tipping-bucket rain gages generally mounted at ground level. Precipitation totals are logged on 5- and/or 15-minute intervals. The gages are not heated and may not accurately record the equivalent precipitation in snowfall.

The following sections present multiple figures summarizing the precipitation data collected for Water Years 1997-2000. Annual hyetographs and tables for each location are presented in Appendix A.

Table 3-1. Monitoring Network Precipitation Gage Information.

Location Code [Surface-Water Gage]	X Coordinate	Y Coordinate	Period of Operation
PG51 [NA]	2078704	751264	<10/1/92 – current year
PG52 [SW022]	2086407	749734	<10/1/92 – current year
PG55 [NA]	2087896	747239	7/19/94 – current year
PG56 [NA]	2091513	752593	7/18/94 – current year
PG57 [SW091]	2086115	751309	7/12/95 – 10/27/96
PG58 [GS01]	2093820	744893	10/11/96 – current year
PG59 [GS03]	2093611	753649	4/1/96 – current year
PG60 [GS04]	2085558	758144	4/1/96 – current year
PG61 [GS05]	2078428	747260	4/1/96 – current year
PG62 [SW118]	2082961	751417	10/29/96 – current year
PG64 [GS27]	2083689	749208	2/15/00 – current year

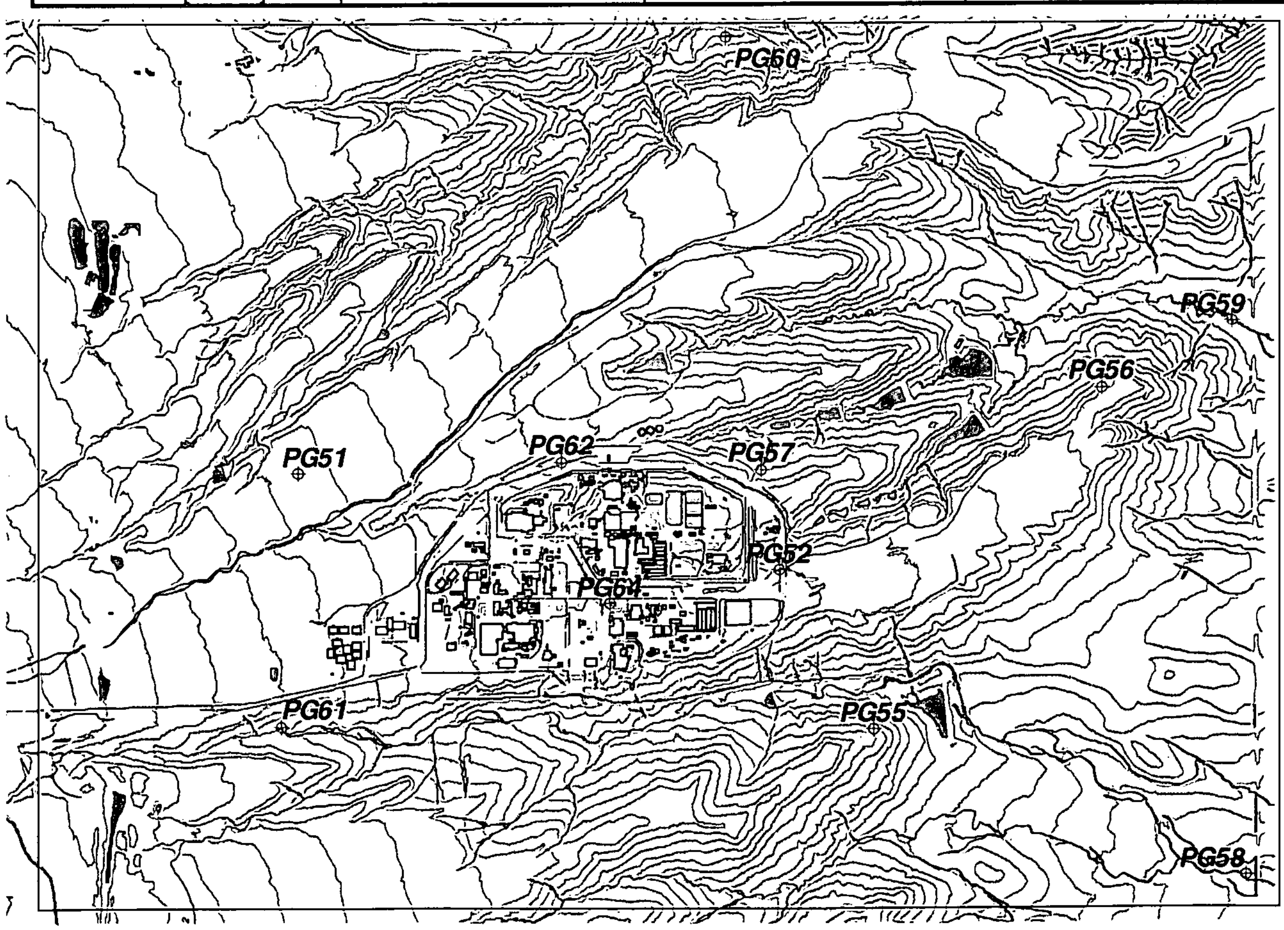
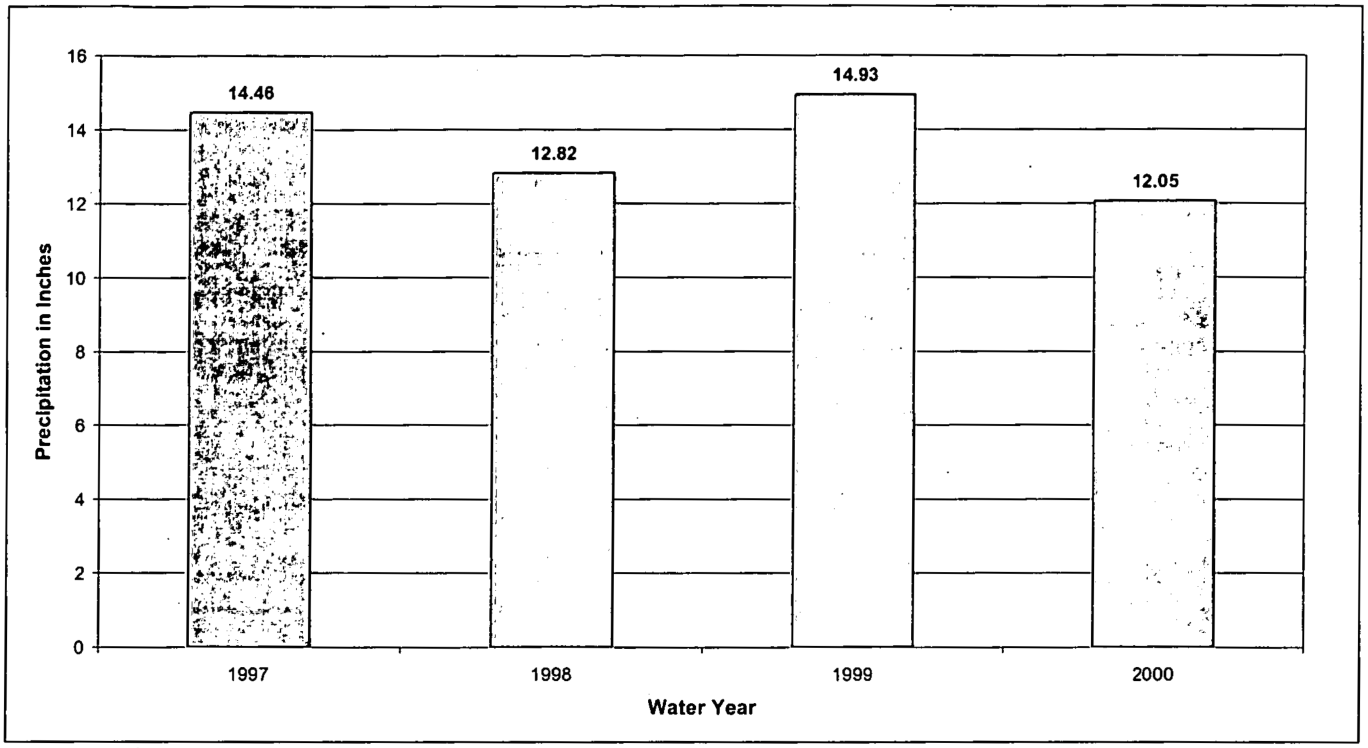


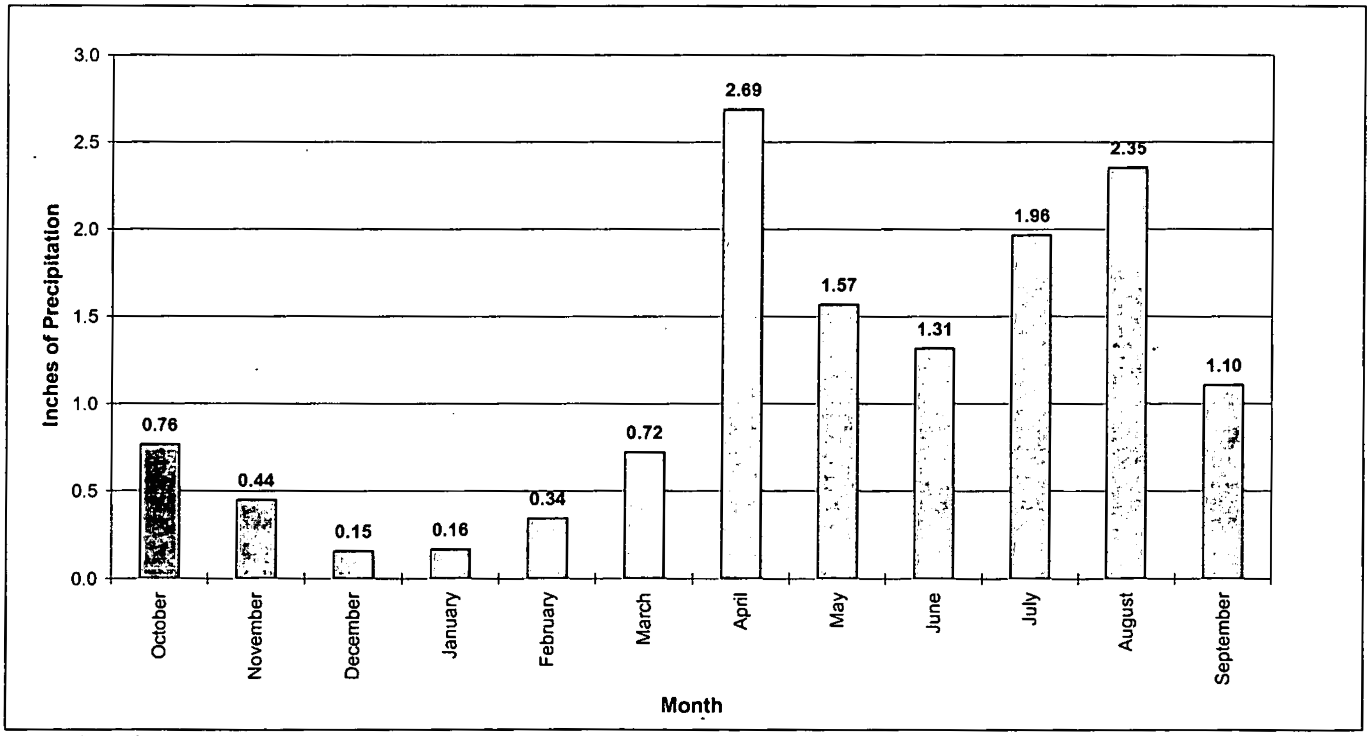
Figure 3-89. Map Showing Location of Automated Precipitation Gages.

3.3.1 WY97–00 Summary



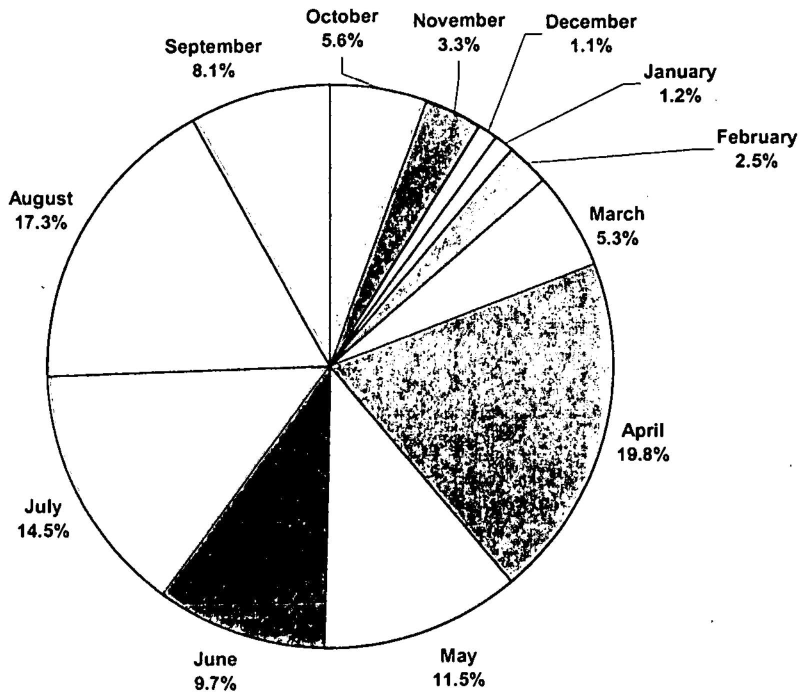
Note: Arithmetic average of gages in operation.

Figure 3-90. Total Precipitation for Water Years 1997 – 2000.



Note: Arithmetic average of gages in operation.

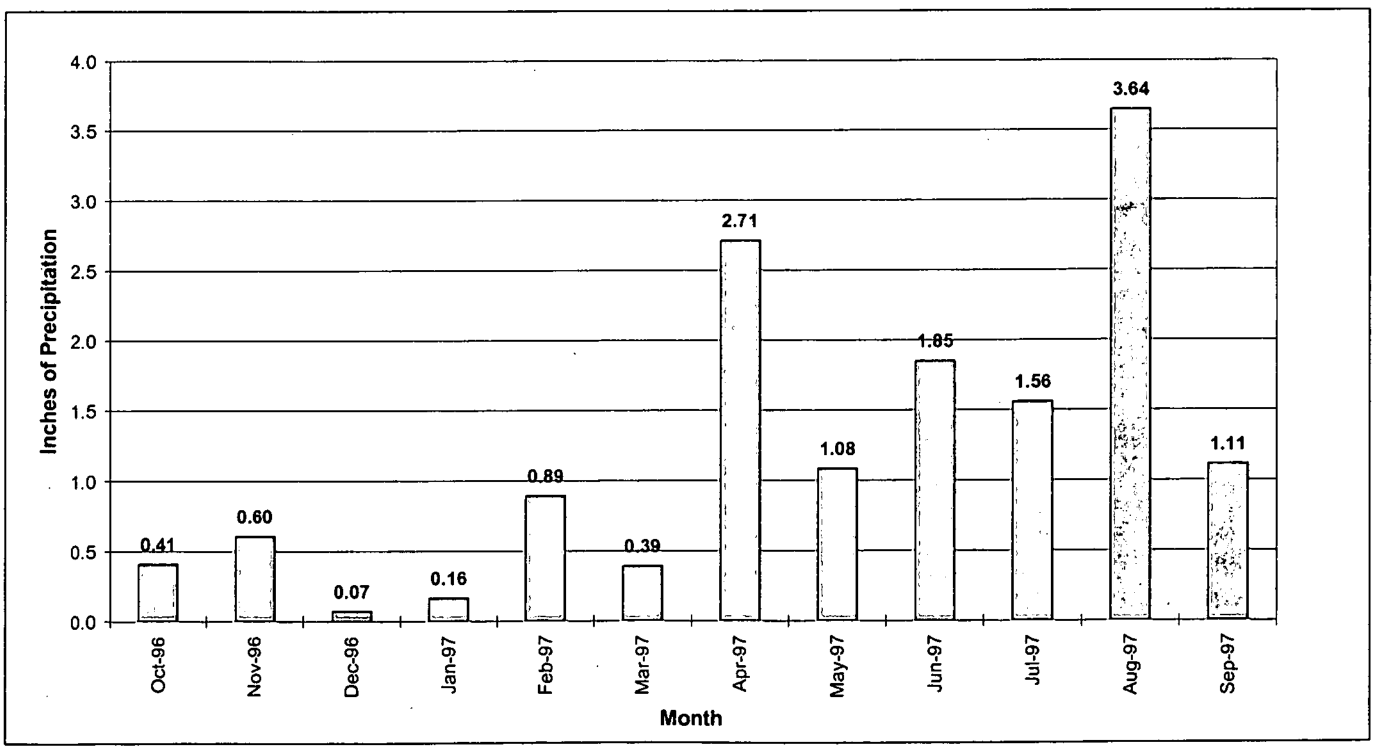
Figure 3-91. Average Monthly Precipitation for Water Years 1997 – 2000.



Note: Arithmetic average of gages in operation.

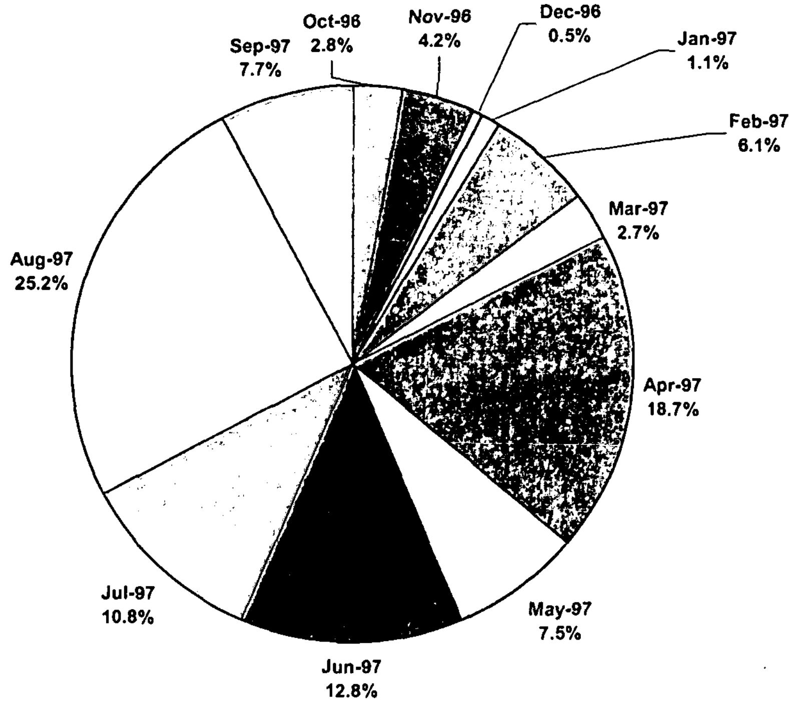
Figure 3-92. Relative Monthly Precipitation Totals for Water Years 1997 – 2000.

3.3.2 Water Year 1997



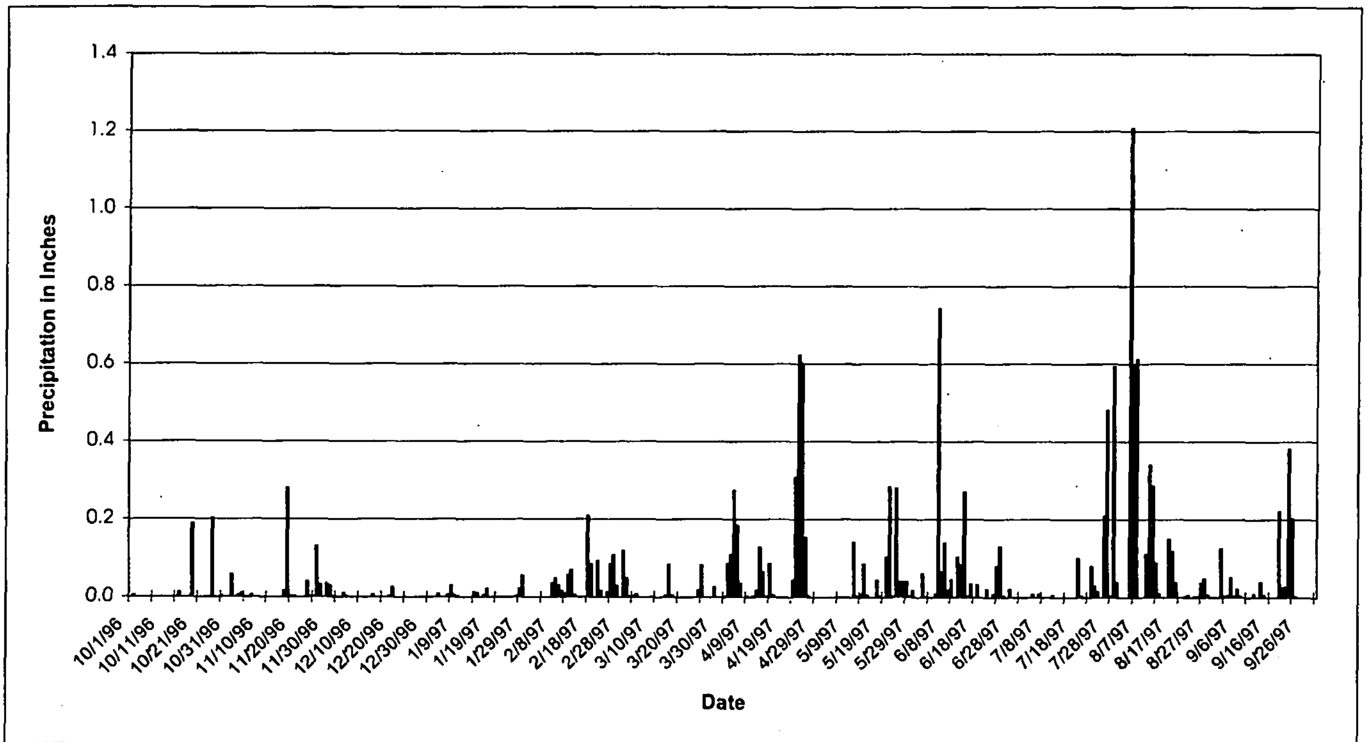
Note: Arithmetic average of gages in operation.

Figure 3-93. Average Monthly Precipitation for Water Year 1997.



Note: Arithmetic average of gages in operation.

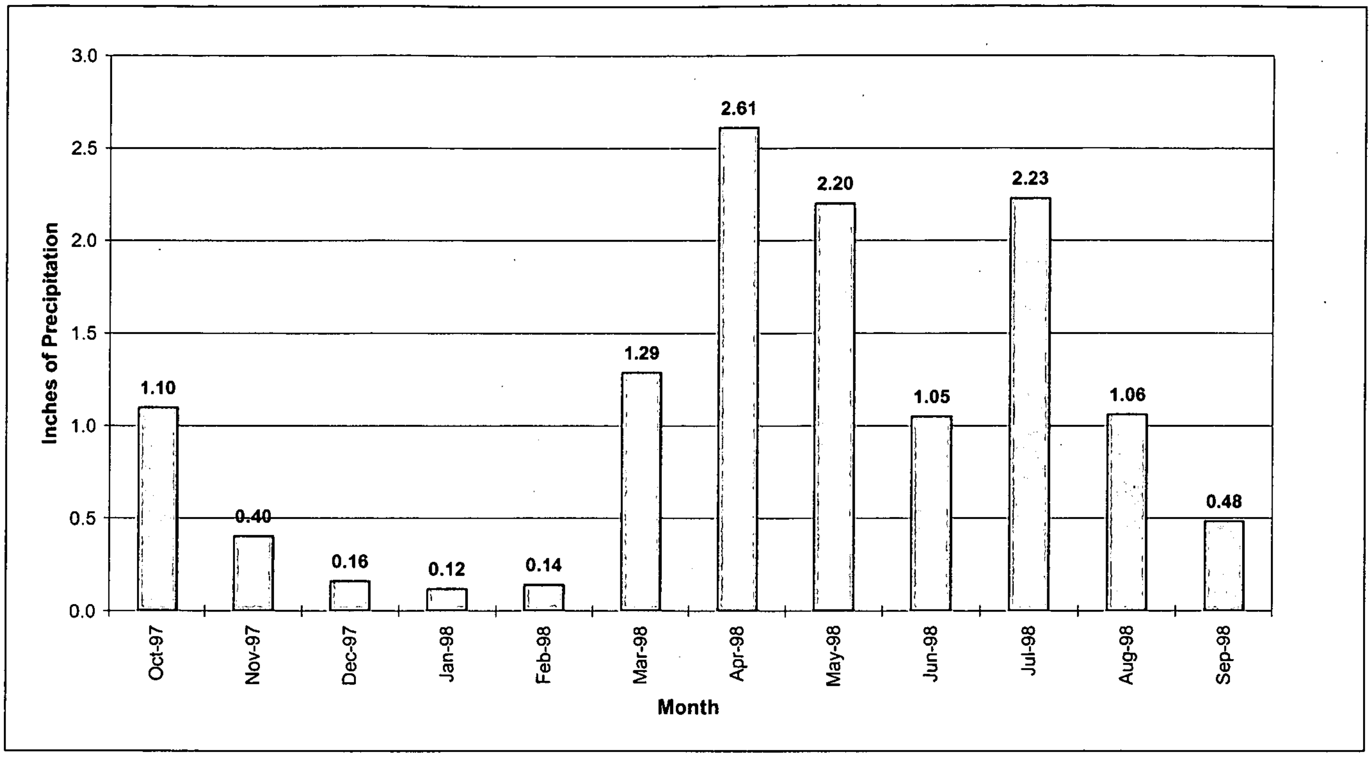
Figure 3-94. Relative Monthly Precipitation Volumes for Water Year 1997.



Note: arithmetic average of gages in operation.

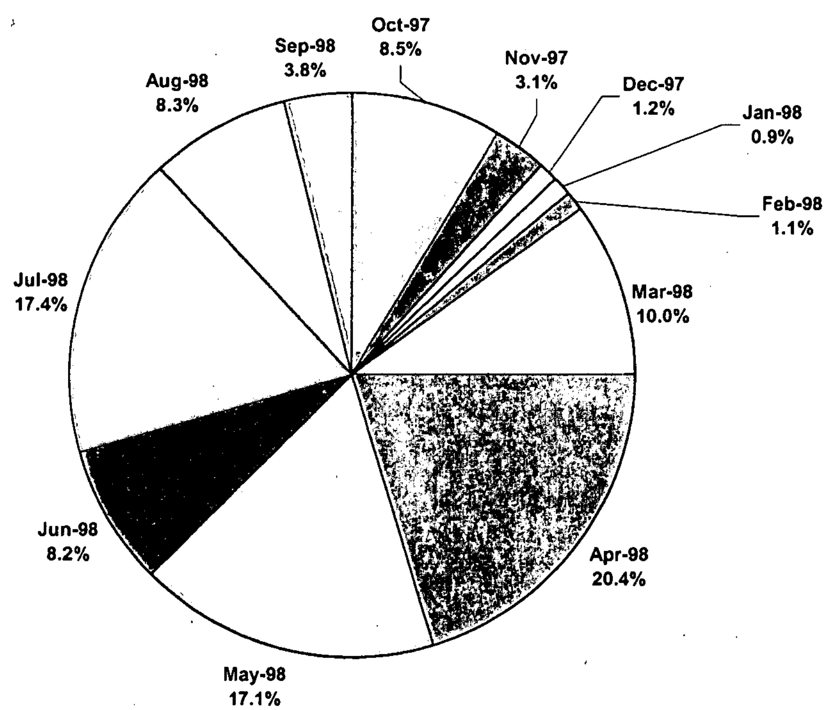
Figure 3-95. Daily Precipitation Totals for Water Year 1997.

3.3.3 Water Year 1998



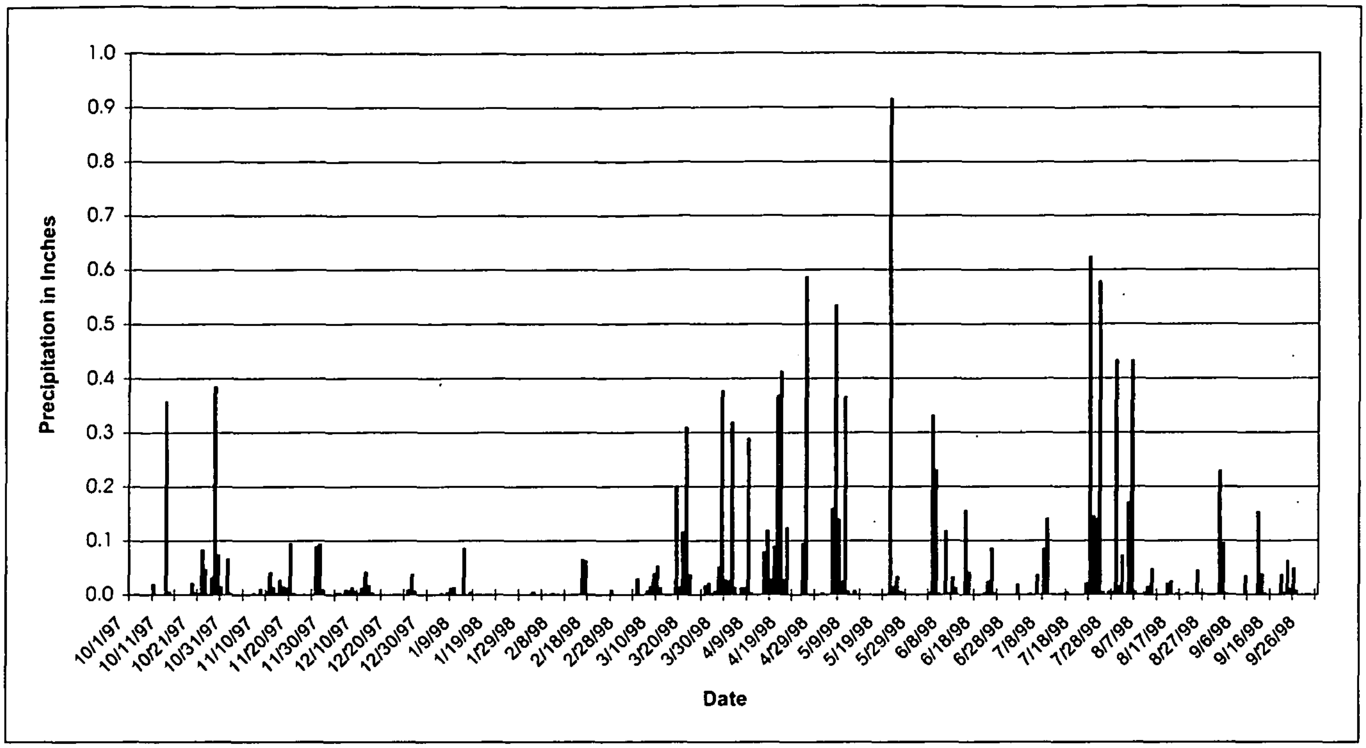
Note: Arithmetic average of gages in operation.

Figure 3-96. Average Monthly Precipitation for Water Year 1998.



Note: Arithmetic average of gages in operation.

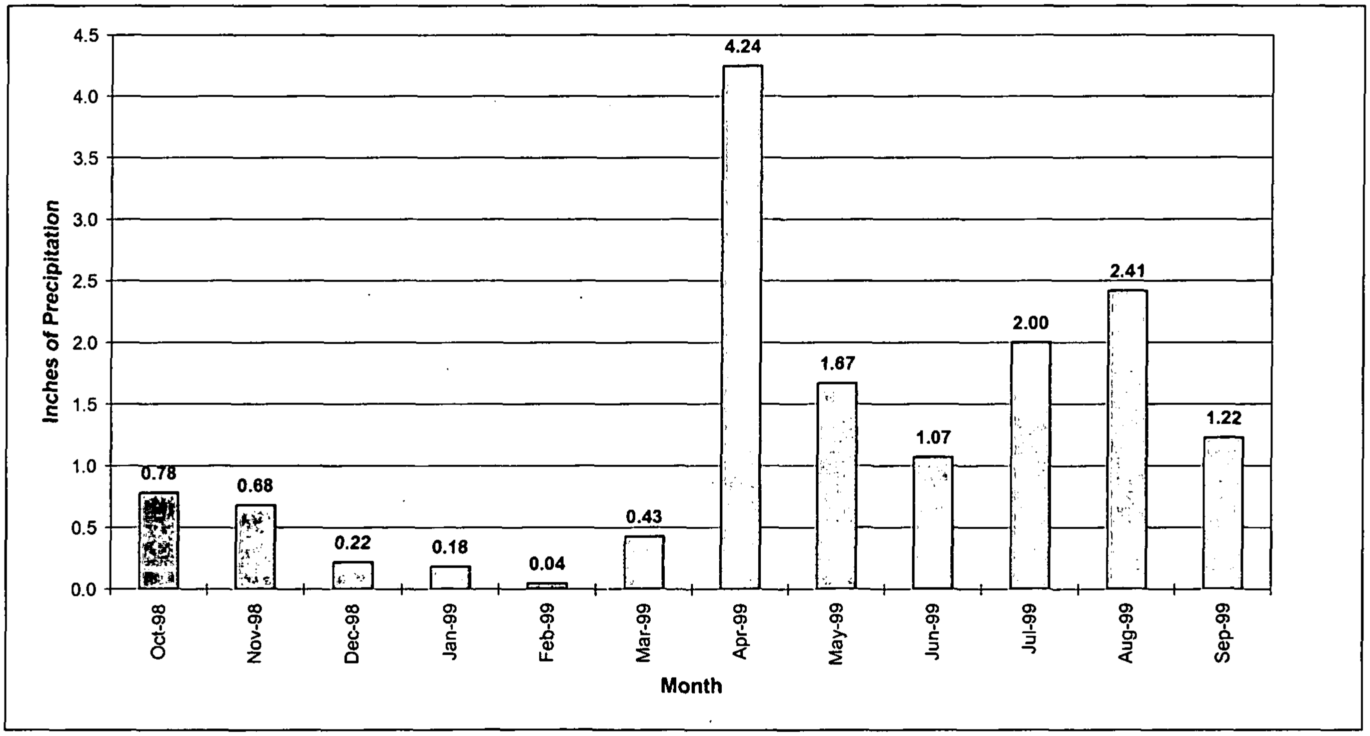
Figure 3-97. Relative Monthly Precipitation Volumes for Water Year 1998.



Note: Arithmetic average of gages in operation.

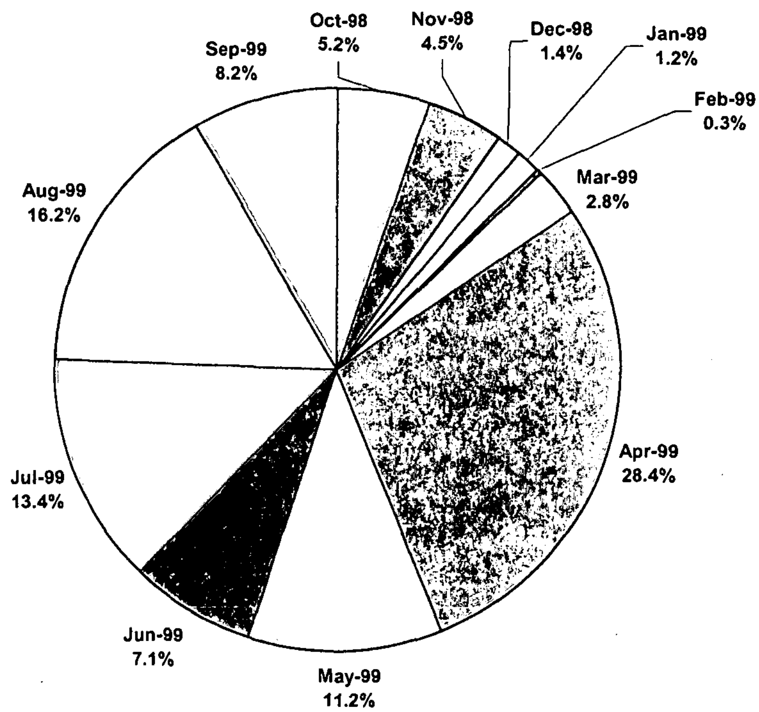
Figure 3-98. Daily Precipitation Totals for Water Year 1998.

3.3.4 Water Year 1999



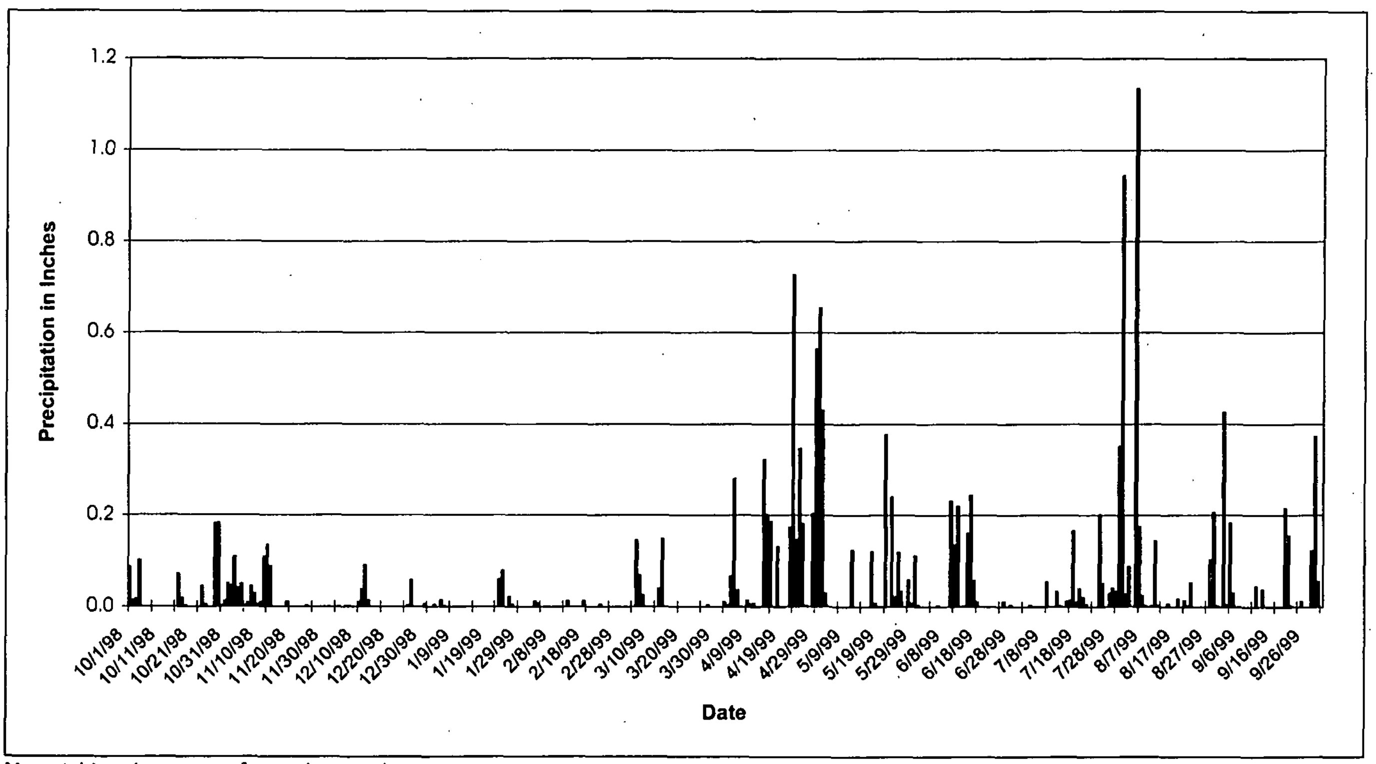
Note: Arithmetic average of gages in operation.

Figure 3-99. Average Monthly Precipitation for Water Year 1999.



Note: Arithmetic average of gages in operation.

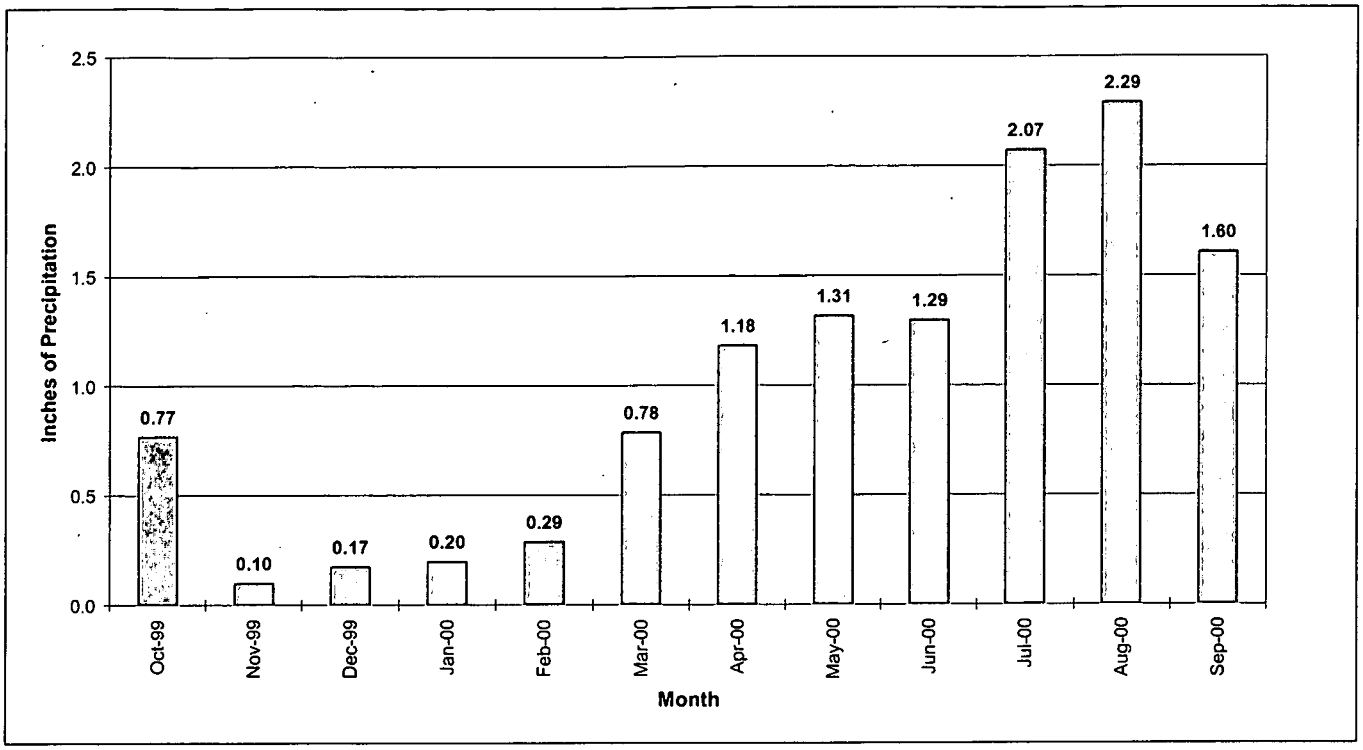
Figure 3-100. Relative Monthly Precipitation Volumes for Water Year 1999.



Note: Arithmetic average of gages in operation.

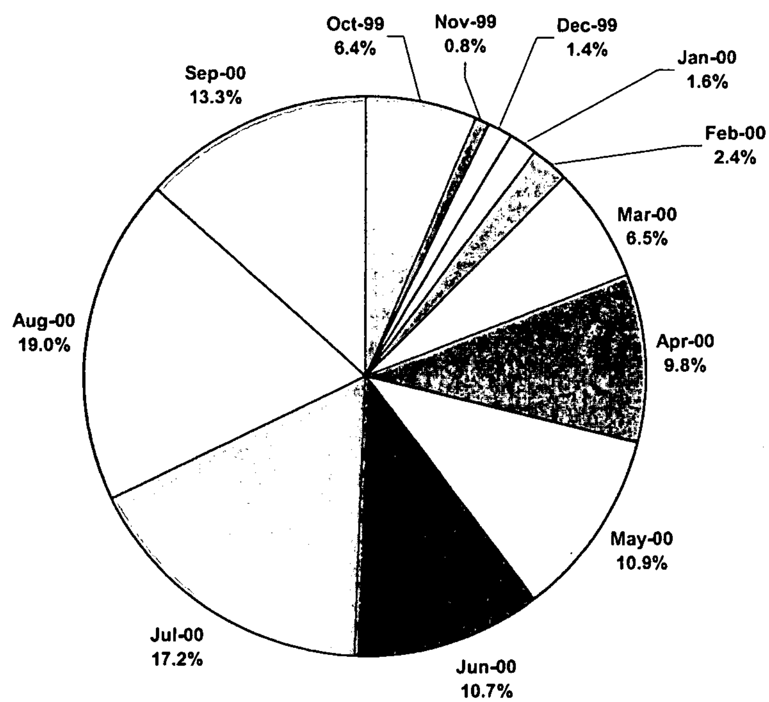
Figure 3-101. Daily Precipitation Totals for Water Year 1999.

3.3.5 Water Year 2000



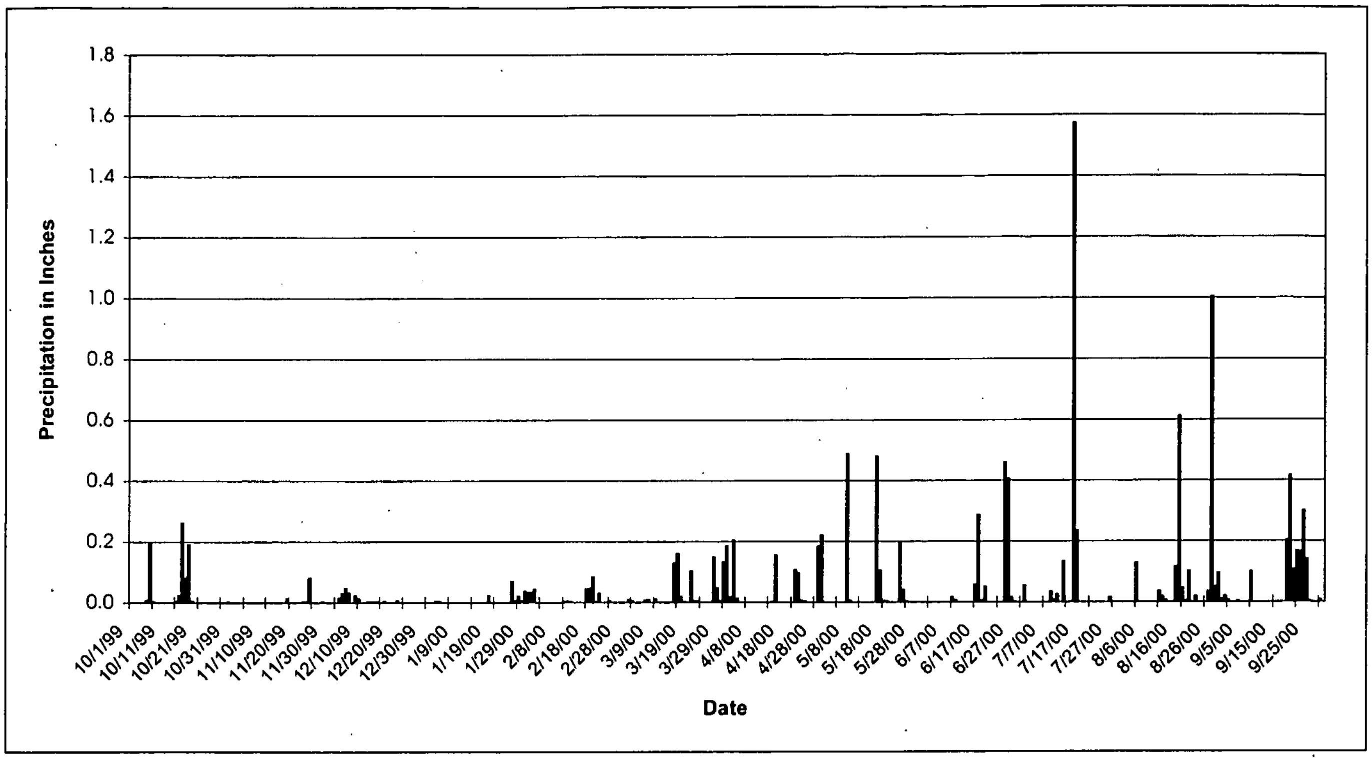
Note: Arithmetic average of gages in operation.

Figure 3-102. Average Monthly Precipitation for Water Year 2000.



Note: Arithmetic average of gages in operation.

Figure 3-103. Relative Monthly Precipitation Volumes for Water Year 2000.



Note: Arithmetic average of gages in operation.

Figure 3-104. Daily Precipitation Totals for Water Year 2000.

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4. WATER-QUALITY SUMMARIES

This section presents water-quality summaries for selected analytes for the period October 1, 1996 through September 30, 2000 (WY97–00).[7] Radionuclides summarized in Section 4.1 include Pu, Am[8], U-233,234, U-235, U-238, and tritium. Additionally, the POE metals (total Be, dissolved Cd, total Cr, dissolved Ag) are summarized in Section 4.2. Many additional analyses are also performed based on the specific monitoring objective. The results and evaluation for these analytes are presented in detail in the specific sections (Section 6 through 15) by monitoring objective.

4.1 RADIONUCLIDES

The following summaries include all results that were not rejected through the verification/validation process. When a negative radionuclide result (e.g. -0.002 pCi/l) is returned from the laboratory due to blank correction, then a value of 0.0 pCi/l is used for calculation purposes. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' value and the 'duplicate'. When a sample has multiple 'real' analyses (Site requested 're-runs'), the value used in calculations is the arithmetic average of the multiple 'real' analyses. Total uranium is calculated by summing the activities for the analyzed isotopes (U-233,234 + U-235 + U-238).

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

The U-233,234/U-238 ratio is calculated for each sample by dividing the U-233,234 result by the corresponding U-238 result. Ratios are only calculated for samples where *both* the U-233,234 and U-238 results are greater than 0.025 pCi/L (generally the MDA for these isotope analyses) to exclude ratios for very low results with high relative error.

Each table includes only those locations that collected samples that were analyzed for the referenced analyte. Maps are also included showing the spatial variation of the location-specific median value for the referenced parameter. Only locations that had four or more individual results are mapped. Since tritium was analyzed for only six locations, no map is presented.

[7] The synoptic sampling in support of the GS10 Source Evaluation began in April 2000 with the final sample collected on October 22, 2000 (WY2001). For completeness, this WY2001 sample is included in this report for the synoptic locations (SW021, SW022, SW023, SW060, SW132, and SW100100).

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

Table 4-1 and Figure 4-1 show that median Pu activities for almost all locations outside the IA are well below the action level of 0.15 pCi/L[9]. Only GS42 had a median activity greater than 0.15 pCi/L (2 samples; median 1.09 pCi/L Pu). This activity is likely due to the proximity of the GS42 drainage area to the 903 Pad. Several locations within the IA showed median Pu activities greater than 0.15 pCi/L.

Table 4-1. Summary Statistics for Pu-239,240 Analytical Results in WY97-00.

Location	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]
GS01	82	0.003	0.010	0.022
GS03	131	0.005	0.023	0.220
GS08	46	0.006	0.017	0.864
GS10	135	0.054	0.203	2.270
GS11	61	0.002	0.012	0.070
GS27	46	1.945	6.368	64.3
GS28	7	0.075	0.686	0.852
GS31	14	0.015	0.037	0.348
GS32	34	1.070	4.968	11.5
GS33	13	0.005	0.019	0.022
GS34	30	0.006	0.018	0.667
GS35	15	0.002	0.011	0.011
GS37	17	0.027	0.060	0.464
GS38	27	0.064	0.137	0.307
GS39	27	0.068	0.139	0.825
GS40	32	0.014	0.039	0.063
GS41	4	0.024	0.026	0.026
GS42	2	1.090	1.132	1.150
GS43	8	0.005	0.018	0.028
SW021	5	0.077	0.188	0.305
SW022	40	0.088	0.698	9.490
SW023	4	0.345	1.173	1.840
SW027	34	0.031	0.137	1.030
SW060	5	0.007	0.165	0.350
SW091	13	0.070	0.324	0.958
SW093	145	0.007	0.052	1.060
SW118	36	0.002	0.017	0.045
SW120	4	0.296	0.533	0.724
SW132	4	0.108	0.188	0.198
SW100100	5	0.050	0.162	0.267

[9] The action levels noted in this section only apply to Points of Evaluation (GS10, SW027, and SW093; Section 12) compared to 30-day averages. The same numeric values are applied as standards only at Points of Compliance (GS01, GS03, GS08, GS11, and GS31; Section 13) compared to 30-day averages. Comparisons to other locations are noted in this section for reference only.

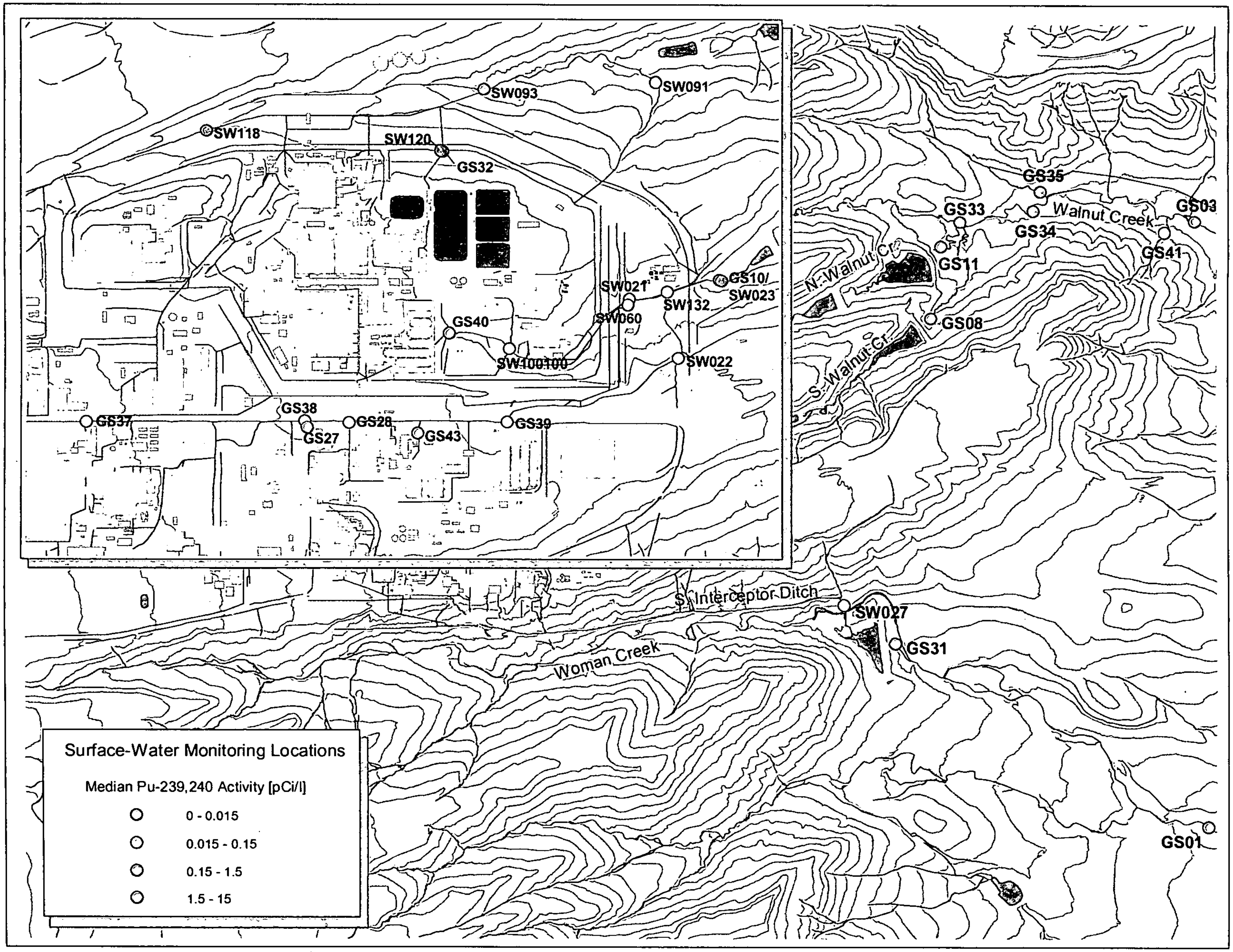

Figure 4-1. Map Showing Median Pu-239,240 Activities for WY97–00.

Table 4-2 and Figure 4-2 show that median Am activities for almost all locations outside the IA are well below the action level of 0.15 pCi/L. Only GS42 had a median activity greater than 0.15 pCi/L (2 samples; median 0.185 pCi/L Am). This activity is likely due to the proximity of the GS42 drainage area to the 903 Pad. Several locations within the IA showed median Am activities greater than 0.15 pCi/L.

Table 4-2. Summary Statistics for Am-241 Analytical Results in WY97-00.

Location	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]
GS01	81	0.002	0.009	0.039
GS03	132	0.006	0.021	0.059
GS08	46	0.007	0.016	0.275
GS10	132	0.062	0.212	8.385
GS11	61	0.003	0.009	0.047
GS27	45	0.458	1.478	14.8
GS28	7	0.027	0.123	0.240
GS31	14	0.009	0.030	0.116
GS32	34	0.625	3.262	4.060
GS33	13	0.003	0.014	0.033
GS34	30	0.010	0.025	0.178
GS35	15	0.000	0.008	0.032
GS37	17	0.015	0.027	0.029
GS38	27	0.019	0.038	0.077
GS39	27	0.018	0.051	0.160
GS40	32	0.031	0.062	0.140
GS41	4	0.006	0.012	0.016
GS42	2	0.185	0.195	0.200
GS43	8	0.005	0.008	0.018
SW021	5	0.046	0.245	0.452
SW022	41	0.023	0.144	1.760
SW023	5	0.449	0.784	1.240
SW027	34	0.008	0.028	0.177
SW060	5	0.000	0.327	0.718
SW091	13	0.048	0.241	0.686
SW093	143	0.008	0.037	0.628
SW118	35	0.002	0.011	0.024
SW120	4	0.105	0.202	0.269
SW132	4	0.151	0.273	0.336
SW100100	5	0.110	0.264	0.376

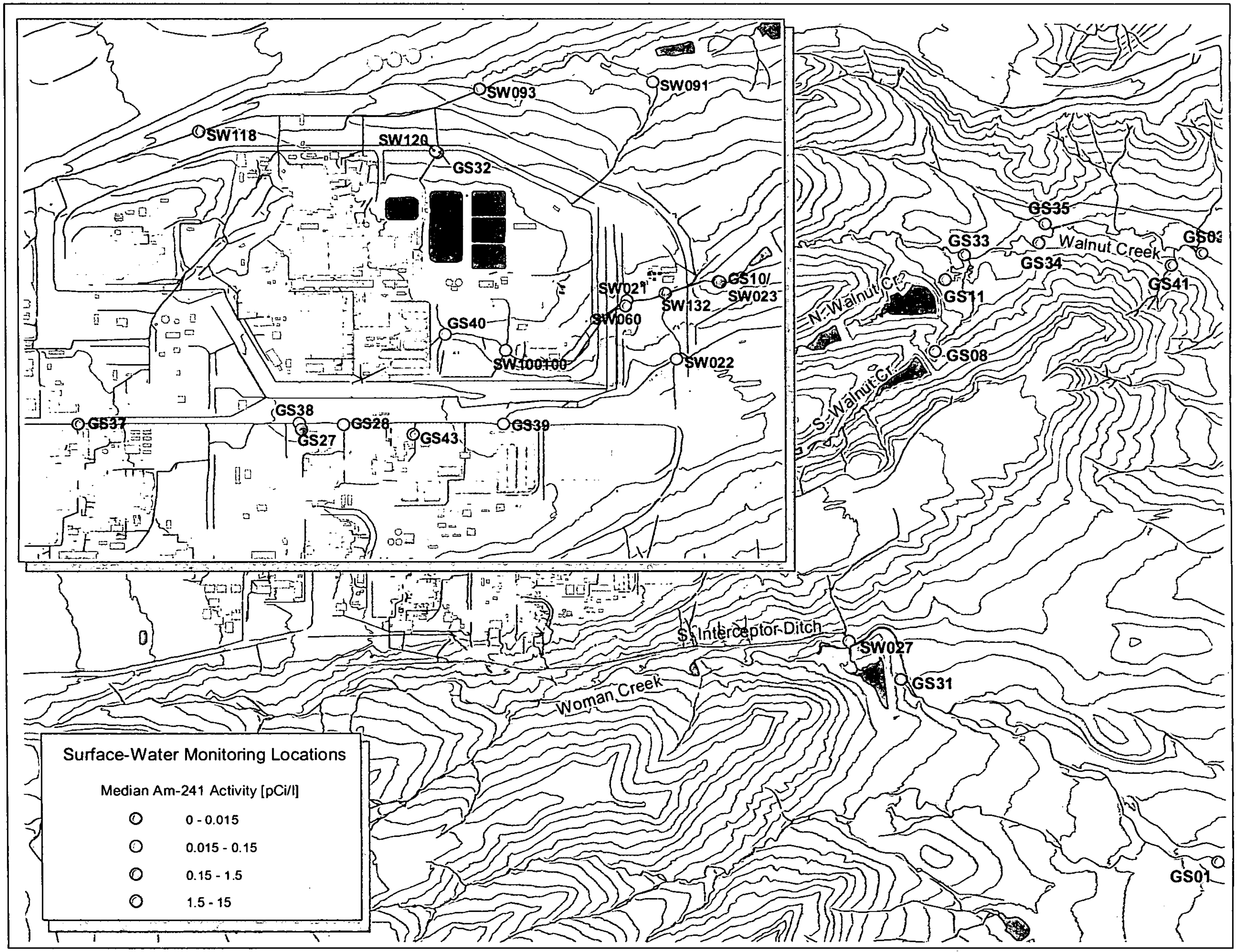

Figure 4-2. Map Showing Median Am-241 Activities for WY97–00.

Table 4-3 and Figure 4-3 show that median total uranium activities for most locations are below the action level of 10 pCi/L (11 pCi/L for Woman Creek). Only GS43 had a median activity greater the action level (5 samples; median 10.815 pCi/L). Both GS43 and GS32 showed sample results greater than the action level. These activities are likely due to the proximity of GS43 and GS32 to Building 886 and the Solar Ponds, respectively. Similarly, the higher results measured at SW091, SW093, and SW120 are also likely due to their proximity to the Solar Ponds.

Table 4-3. Summary Statistics for Total Uranium Analytical Results in WY97-00.

Location	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]
GS08	46	1.420	2.262	4.579
GS10	135	2.867	4.009	5.750
GS11	61	1.940	2.707	3.643
GS27	46	0.273	0.750	2.123
GS28	7	0.905	1.432	1.648
GS31	14	2.408	2.778	3.917
GS32	34	1.328	2.659	17.529
GS37	17	0.543	1.166	2.075
GS40	4	2.434	2.893	3.137
GS43	5	10.815	15.671	16.103
SW021	5	2.246	3.562	3.855
SW022	42	0.957	2.864	3.913
SW023	5	1.798	2.417	2.846
SW027	34	1.925	3.086	4.476
SW060	5	2.383	4.338	4.743
SW091	13	4.390	5.361	6.970
SW093	145	2.741	4.319	6.640
SW120	4	1.809	4.766	6.929
SW132	4	1.309	2.392	3.147
SW100100	5	0.706	1.048	1.154

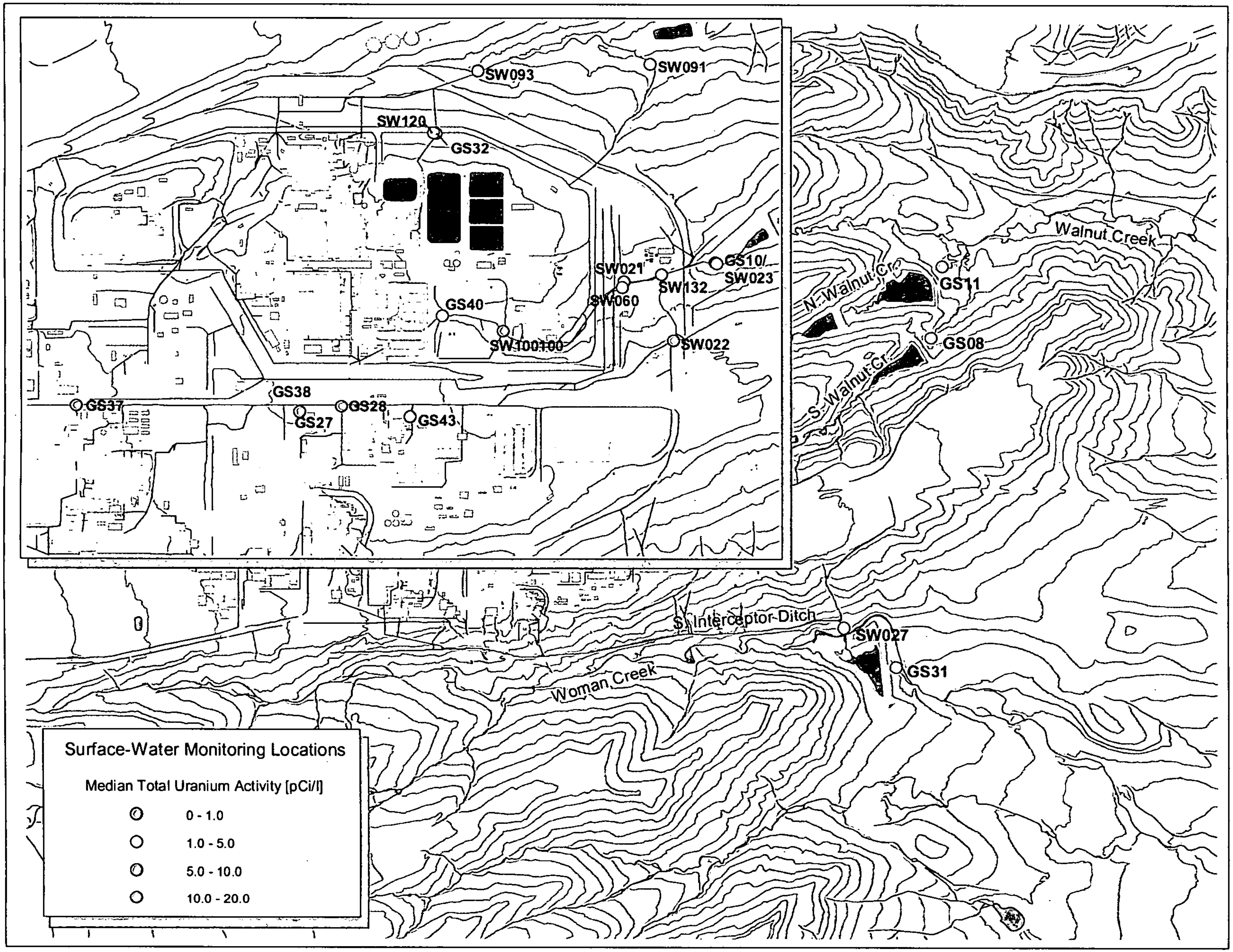

Figure 4-3. Map Showing Median Total Uranium Activities for WY97–00.

Table 4-4 and Figure 4-4 show that the highest activities were measured at GS43 and GS32. These activities are likely due to the proximity of GS43 and GS32 to Building 886 and the Solar Ponds, respectively. Similarly, the higher results measured at SW091, SW093, and SW120 are likely due to their proximity to the Solar Ponds.

Table 4-4. Summary Statistics for U-233,234 Analytical Results in WY97-00.

Location	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]
GS08	46	0.759	1.145	2.550
GS10	135	1.420	2.029	2.900
GS11	61	0.943	1.310	1.720
GS27	46	0.150	0.358	1.070
GS28	7	0.370	0.530	0.627
GS31	14	1.060	1.308	1.790
GS32	34	0.771	1.592	10.800
GS37	17	0.253	0.586	1.070
GS40	4	1.064	1.228	1.300
GS43	5	8.090	11.840	11.900
SW021	5	1.240	1.984	2.110
SW022	41	0.384	1.120	1.750
SW023	5	0.865	1.196	1.400
SW027	34	0.815	1.362	1.560
SW060	5	1.020	2.192	2.330
SW091	13	2.350	2.886	3.840
SW093	145	1.270	1.994	2.820
SW120	4	1.015	2.827	4.190
SW132	4	0.589	1.139	1.500
SW100100	5	0.370	0.455	0.460

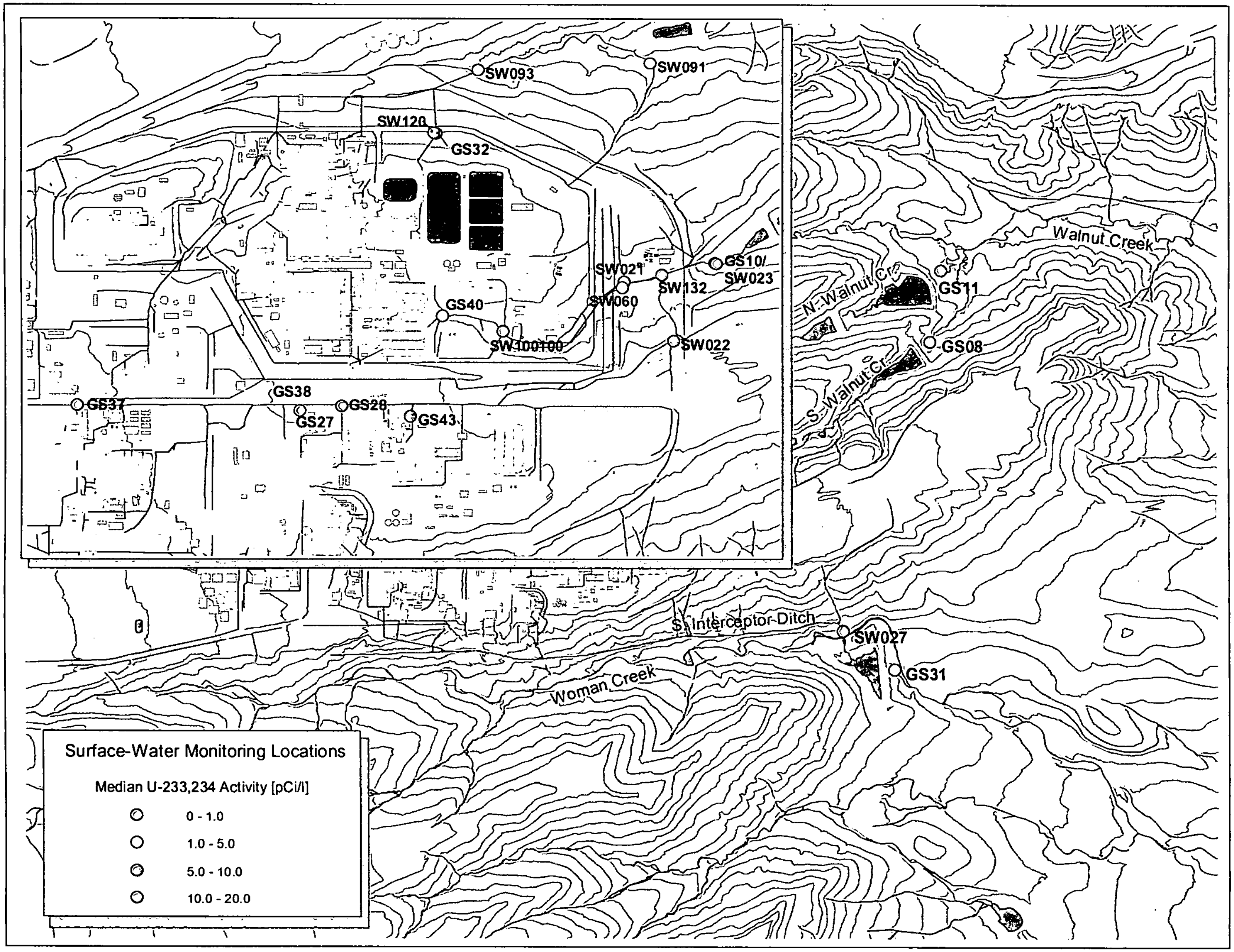

Figure 4-4. Map Showing Median U-233,234 Activities for WY97–00.

Table 4-5 and Figure 4-5 show that the highest activities were measured at GS43 and GS32. These activities are likely due to the proximity of GS43 and GS32 to Building 886 and the Solar Ponds, respectively. Similarly, the higher results measured at SW091, SW093, and SW120 are likely due to their proximity to the Solar Ponds.

Table 4-5. Summary Statistics for U-235 Analytical Results in WY97-00.

Location	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]
GS08	46	0.030	0.054	0.165
GS10	135	0.055	0.096	0.150
GS11	61	0.043	0.067	0.085
GS27	46	0.009	0.032	0.116
GS28	7	0.045	0.068	0.173
GS31	14	0.048	0.074	0.107
GS32	34	0.043	0.085	0.319
GS37	17	0.016	0.035	0.062
GS40	4	0.052	0.082	0.094
GS43	5	0.315	0.473	0.593
SW021	5	0.059	0.086	0.115
SW022	41	0.021	0.073	0.187
SW023	5	0.031	0.051	0.058
SW027	34	0.032	0.058	0.080
SW060	5	0.054	0.074	0.083
SW091	13	0.095	0.143	0.190
SW093	145	0.050	0.097	0.150
SW120	4	0.023	0.109	0.179
SW132	4	0.050	0.058	0.062
SW100100	5	0.044	0.053	0.058

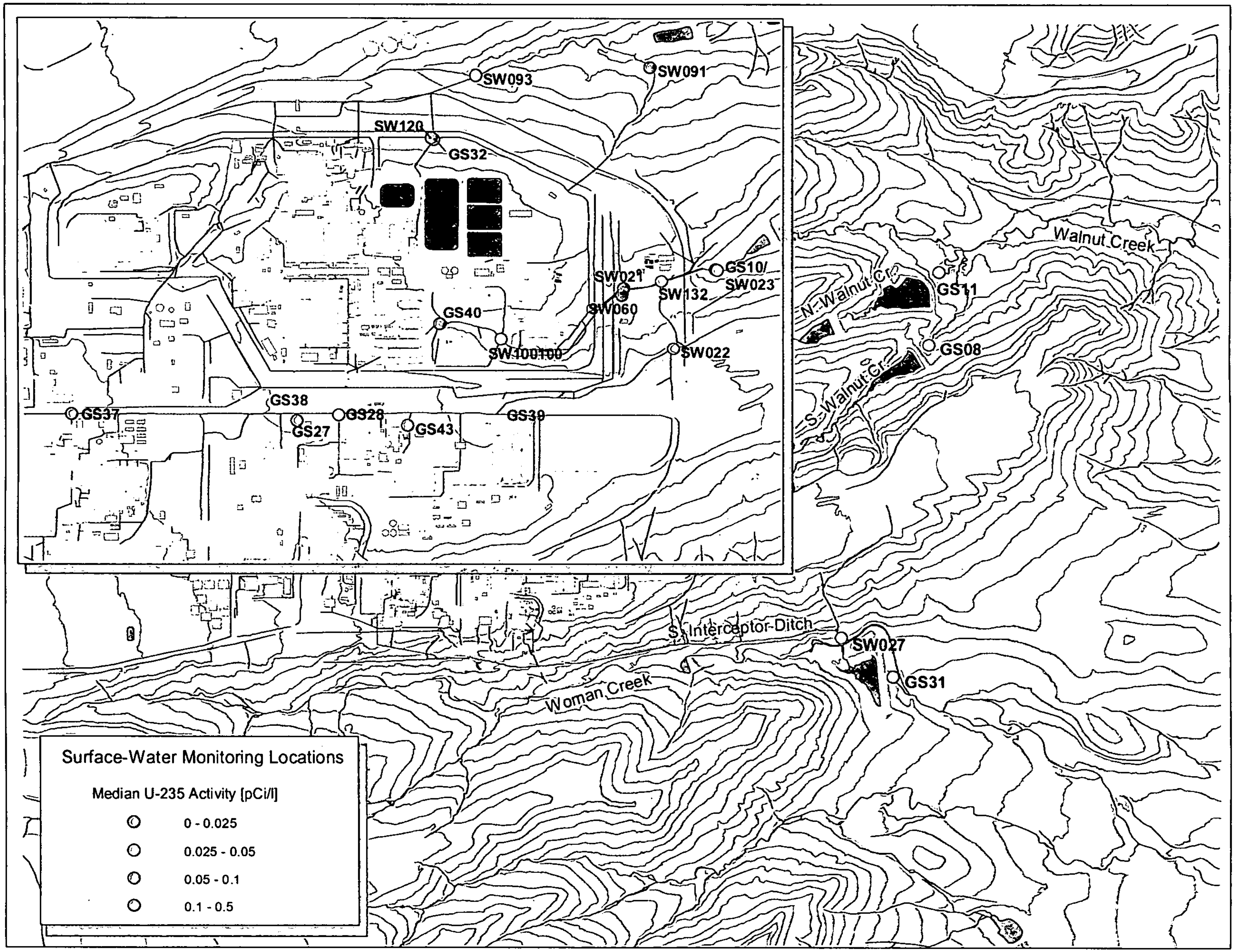

Figure 4-5. Map Showing Median U-235 Activities for WY97–00.

Table 4-6 and Figure 4-6 show that the highest activities were measured at GS43 and GS32. These activities are likely due to the proximity of GS43 and GS32 to Building 886 and the Solar Ponds, respectively. Similarly, the higher results measured at SW091, SW093, and SW120 are likely due to their proximity to the Solar Ponds.

Table 4-6. Summary Statistics for U-238 Analytical Results in WY97-00.

Location	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]
GS08	46	0.686	1.055	1.920
GS10	135	1.360	1.880	2.700
GS11	61	0.969	1.310	1.870
GS27	46	0.142	0.366	1.050
GS28	7	0.437	0.744	0.993
GS31	14	1.275	1.436	2.020
GS32	34	0.572	0.974	6.410
GS37	17	0.314	0.574	1.150
GS40	4	1.320	1.602	1.800
GS43	5	2.470	3.358	3.610
SW021	5	0.974	1.492	1.630
SW022	41	0.463	1.500	2.601
SW023	5	0.875	1.184	1.400
SW027	34	1.060	1.808	2.910
SW060	5	1.440	2.072	2.330
SW091	13	1.940	2.584	2.950
SW093	145	1.340	2.344	3.960
SW120	4	0.772	1.831	2.560
SW132	4	0.663	1.204	1.600
SW100100	5	0.343	0.557	0.645

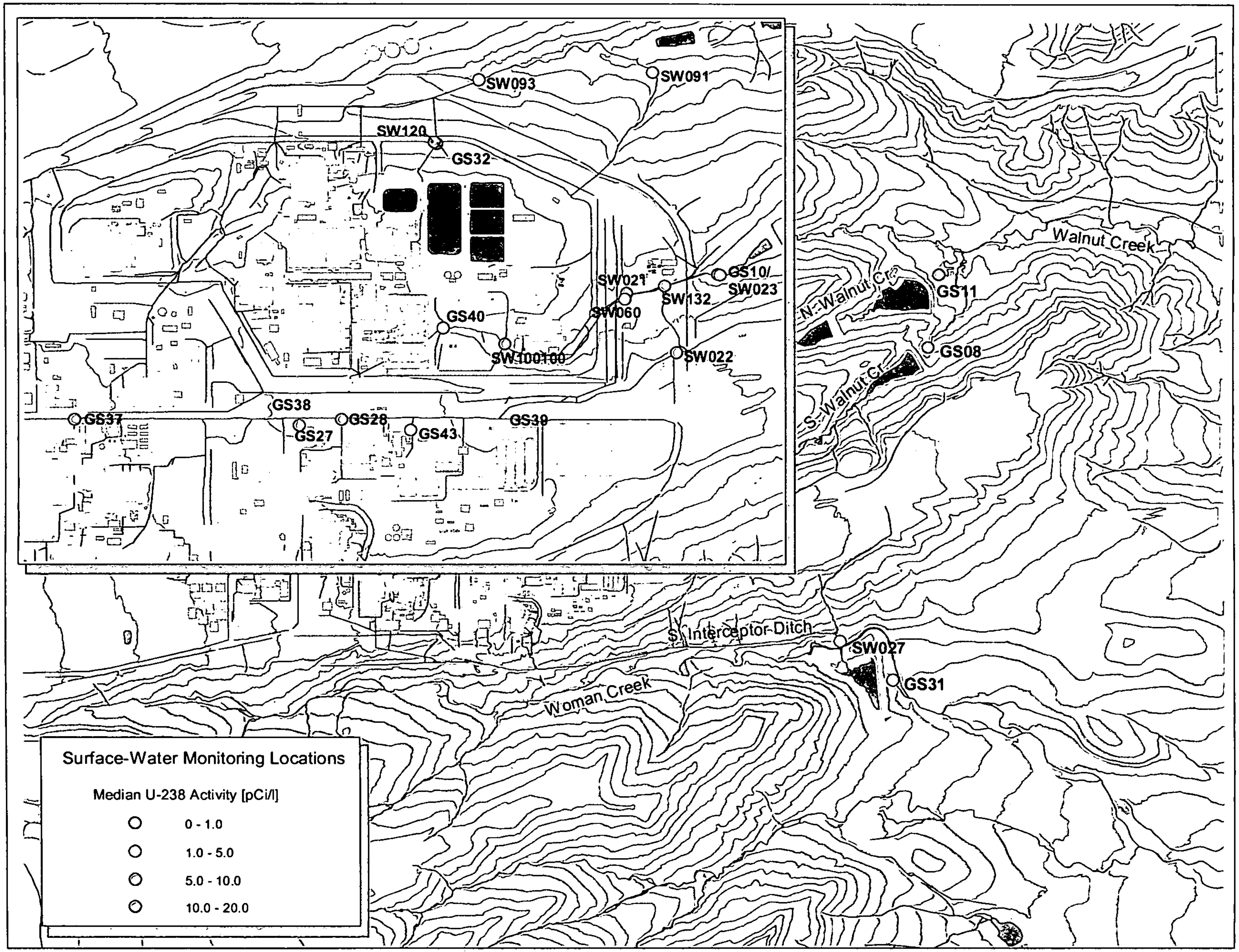

Figure 4-6. Map Showing Median U-238 Activities for WY97–00.

Table 4-7. Summary Statistics for Tritium Analytical Results in WY97-00.

Location	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]
GS01	78	92	240	480
GS03	128	105	250	490
GS32	1	NA	NA	82
GS37	16	175	288	320
GS40	2	95	126	140
SW120	1	NA	NA	99

Table 4-8 lists the average Pu/Am activity ratios for all locations where samples are analyzed for Pu and Am. A ratio greater than one indicates Pu activity in excess of Am activity. Conversely, a ratio less than one indicates Am activity in excess of Pu activity. Generally, Pu activities are greater than Am activities in surface water at the Site. However, several locations in South Walnut Creek show ratios less than one (Figure 4-7). The significance of these ratios has been extensively evaluated in the various Source Evaluation reports for GS10 (see Section 6).

Table 4-8. Average Pu/Am Ratios for Analytical Results in WY97-00.

Location	Samples [N][a]	Average Pu/Am Ratio
GS01	1	0.63
GS03	15	1.98
GS08	2	12.06
GS10	100	1.09
GS11	*	*
GS27	44	4.37
GS28	4	4.53
GS31	2	3.83
GS32	33	1.70
GS33	*	*
GS34	5	1.30
GS35	*	*
GS37	7	1.62
GS38	17	3.45
GS39	16	3.26
GS40	15	0.78
GS41	1	1.06
GS42	2	5.92
GS43	1	1.56
SW021	4	1.22
SW022	25	4.63
SW023	4	1.02
SW027	9	4.48
SW060	1	0.49
SW091	10	1.34
SW093	46	1.84
SW118	1	0.88
SW120	3	2.81
SW132	4	0.96
SW100100	4	0.49

Note: [a] – Number of samples where both Pu and Am were greater than 0.015 pCi/L.
* - No results greater than 0.015 pCi/L

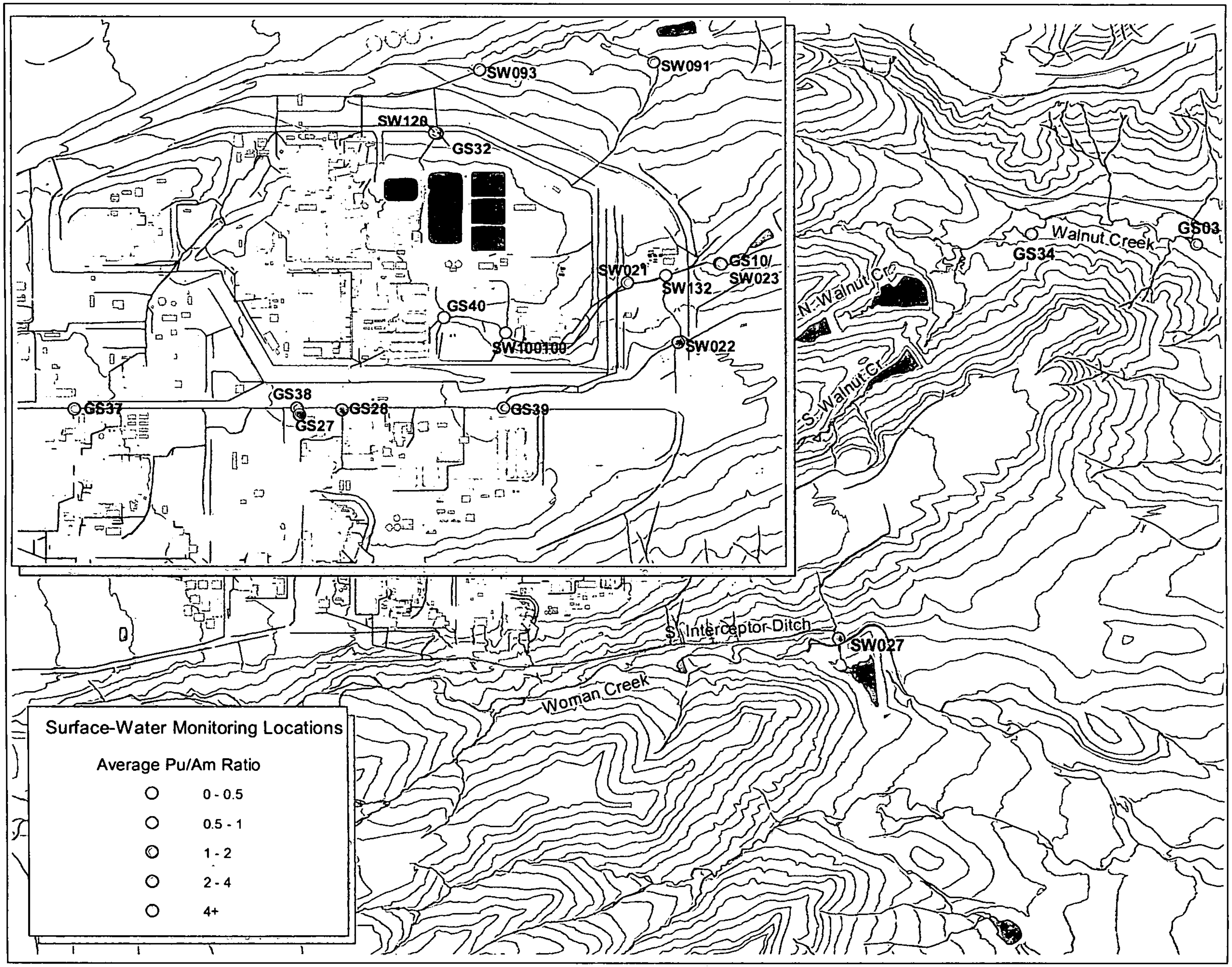

Figure 4-7. Map Showing Average Pu/Am Ratios for WY97–00.

The U-233,234/U-238 activity ratios may be used as an indication of the relative abundance of both depleted and enriched uranium. Natural uranium generally shows U-233,234/U-238 activity ratios of approximately one. Ratios of significantly less than one may indicate the existence of depleted uranium, while ratios of significantly greater than one may indicate the existence of enriched uranium. Although this evaluation does not deal systematically with analytical counting errors, Table 4-9 and Figure 4-8 are presented here for reference.

Location GS43 shows an average ratio significantly greater than one, indicating the possible existence of enriched uranium. The ratios at this location are likely due to the proximity of GS43 to Building 886.

Table 4-9. Average U-233,234 / U-238 Ratios for Analytical Results in WY97-00.

Location	Samples [N][a]	Average U-233,234 / U-238 Ratio
GS08	46	1.08
GS10	135	1.06
GS11	61	0.99
GS27	40	1.06
GS28	7	0.77
GS31	14	0.85
GS32	33	1.49
GS37	16	1.07
GS40	4	0.78
GS43	5	3.26
SW021	5	1.17
SW022	40	0.82
SW023	5	1.26
SW027	34	0.80
SW060	5	0.95
SW091	13	1.23
SW093	145	0.89
SW120	4	1.32
SW132	4	0.83
SW100100	5	0.92

Note: [a] – Number of samples where both U-233,234 and U-238 were greater than 0.025 pCi/L.

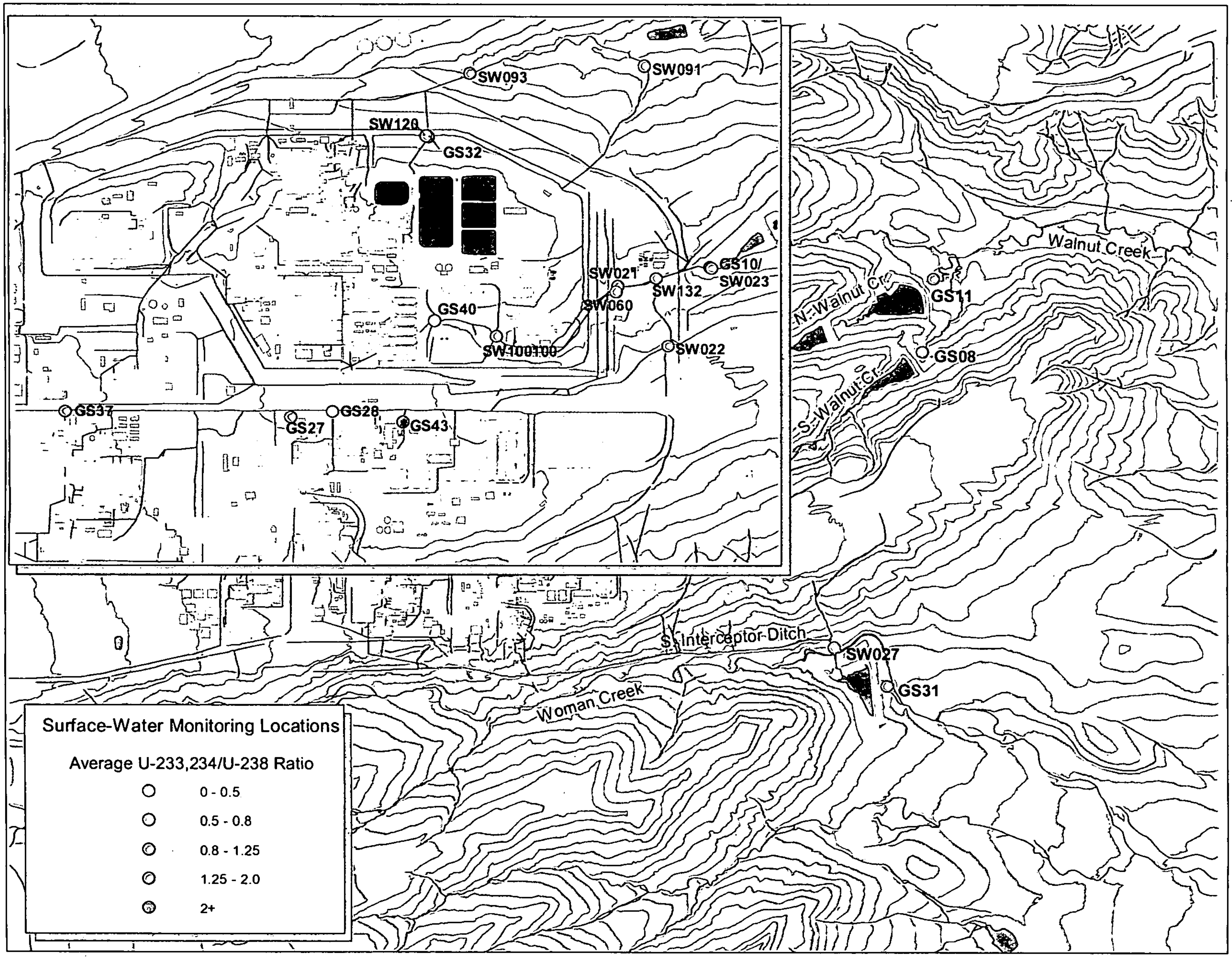

Figure 4-8. Map Showing Average U-233,234 / U-238 Ratios for WY97–00.

4.2 POE METALS

The following summaries include all results that were not rejected through the verification/validation process. When an undetect is returned from the lab for metals analyses, then half the detection limit is used for calculation purposes. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' value and the 'duplicate'. When a sample has multiple 'real' analyses (Site requested 're-runs'), the value used in calculations is the arithmetic average of the multiple 'real' analyses.

Table 4-10. Summary Statistics for POE Metals Results from GS10 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median [µg/L]	85th Percentile [µg/L]	Maximum [µg/L]
Total Be	132	51.5%	0.12	0.60	2.50
Dissolved Cd	123	52.8%	0.06	0.17	0.62
Total Cr	133	27.8%	2.05	5.36	20.9
Dissolved Ag	123	82.9%	0.11	0.24	1.10

Table 4-11. Summary Statistics for POE Metals Results from SW027 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median [µg/L]	85th Percentile [µg/L]	Maximum [µg/L]
Total Be	33	75.8%	0.08	0.70	0.75
Dissolved Cd	33	51.5%	0.07	0.16	0.70
Total Cr	33	18.2%	1.30	2.40	9.60
Dissolved Ag	33	81.8%	0.13	0.25	0.72

Table 4-12. Summary Statistics for POE Metals Results from SW093 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median [µg/L]	85th Percentile [µg/L]	Maximum [µg/L]
Total Be	144	58.3%	0.09	0.58	1.10
Dissolved Cd	137	65.0%	0.05	0.20	2.20
Total Cr	143	34.3%	1.60	3.97	18.3
Dissolved Ag	135	84.4%	0.10	0.24	1.00

5. LOADING ANALYSIS

This section provides a summary of actinide loads for RFCA POEs and POCs. These locations collect continuous flow paced composites samples for laboratory analysis. The nature of the continuous sampling during all flow conditions allows for more accurate load estimations compared to storm-event sampling. The method for load estimation (in pCi) is given in Appendix B.1: Data Evaluation Methods. The total pCi value is then converted to μg using the conversion factors in Table 5-1.[10]

Table 5-1. Activity to Mass Conversion Factors for Pu, Am, and U Isotopes.

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

The Pu-239,240 conversion factor was derived from Table 2.7.2-2 in the April 1980 *Final Environmental Impact Statement (Final Statement to ERDA 1545-D)*, Rocky Flats Plant Site.

The conversion factors for Am-241, U-233,234, U-235, and U-238 were taken from the *U.S. Code of Federal Regulations, Title 40, Chapter I, Part 302.4, Appendix B, October 7, 2000.*[11]

5.1 SITEWIDE

This section summarizes the calculated offsite Pu and Am loads from Walnut and Woman Creeks. The following points are noted:

- Walnut Creek accounts for 78% and 77% of the Pu (Figure 5-4) and Am (Figure 5-5) loads, respectively, from the Site. The fact that Walnut Creek accounts for 61% of the combined Walnut and Woman Creek flow volumes (Section 3.2.1) indicates that the activities in Walnut Creek are not significantly different from Woman Creek.

Table 5-2. Offsite Pu and Am Loads from Walnut and Woman Creeks: WY97–00.

	Pu-239,-240 (μg)			Am-241 (μg)		
Water Year	**Walnut Creek**	**Woman Creek**	**Site Total**	**Walnut Creek**	**Woman Creek**	**Site Total**
1997	254.7	47.8	302.5	2.60	0.49	3.09
1998	181.3	59.1	240.4	2.84	1.01	3.84
1999	148.9	56.1	205.0	2.06	0.77	2.83
2000	23.7	6.6	30.3	0.75	0.18	0.93
Total	608.6	169.6	778.2	8.24	2.44	10.69

Note: During WY97, flows from Woman Creek were routinely diverted to Mower Ditch for subsequent monitoring at GS02 (Figure 3-1). Therefore, the load calculated for Woman Creek at Indiana Street (GS01) includes the water that was measured at GS02. The estimated load diverted to GS02 is calculated by multiplying the WY97 volume-weighted activities at GS01 by the streamflow volume measured at GS02, and converting for units. This diverted load is then added to the calculated load at GS01 to obtain the total WY97 load at GS01. For subsequent water years, the Mower diversion structure has been upgraded and configured to prevent Woman Creek flows from entering the Mower Ditch.

[10] In the following tables and plots, values are rounded for clarity.

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

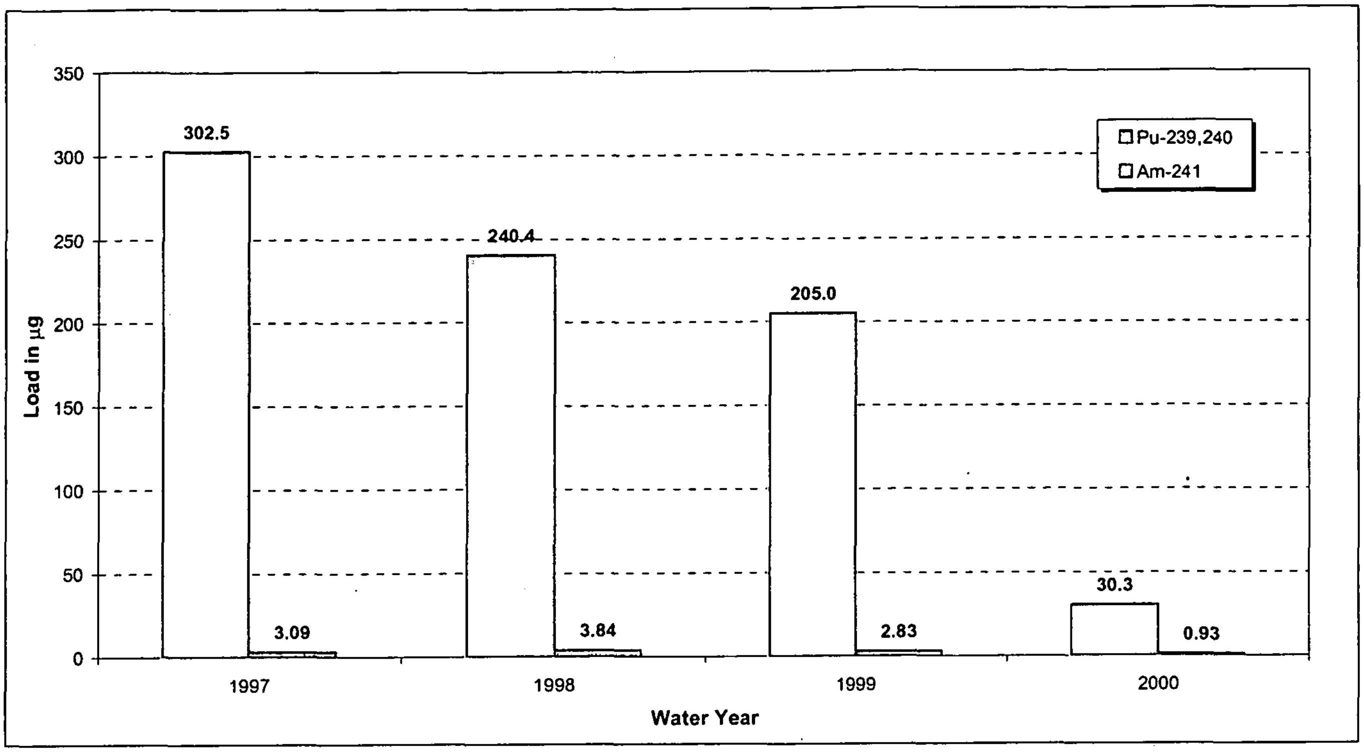

Figure 5-1. Combined Annual Pu and Am Loads from Walnut and Woman Creeks: WY97–00.

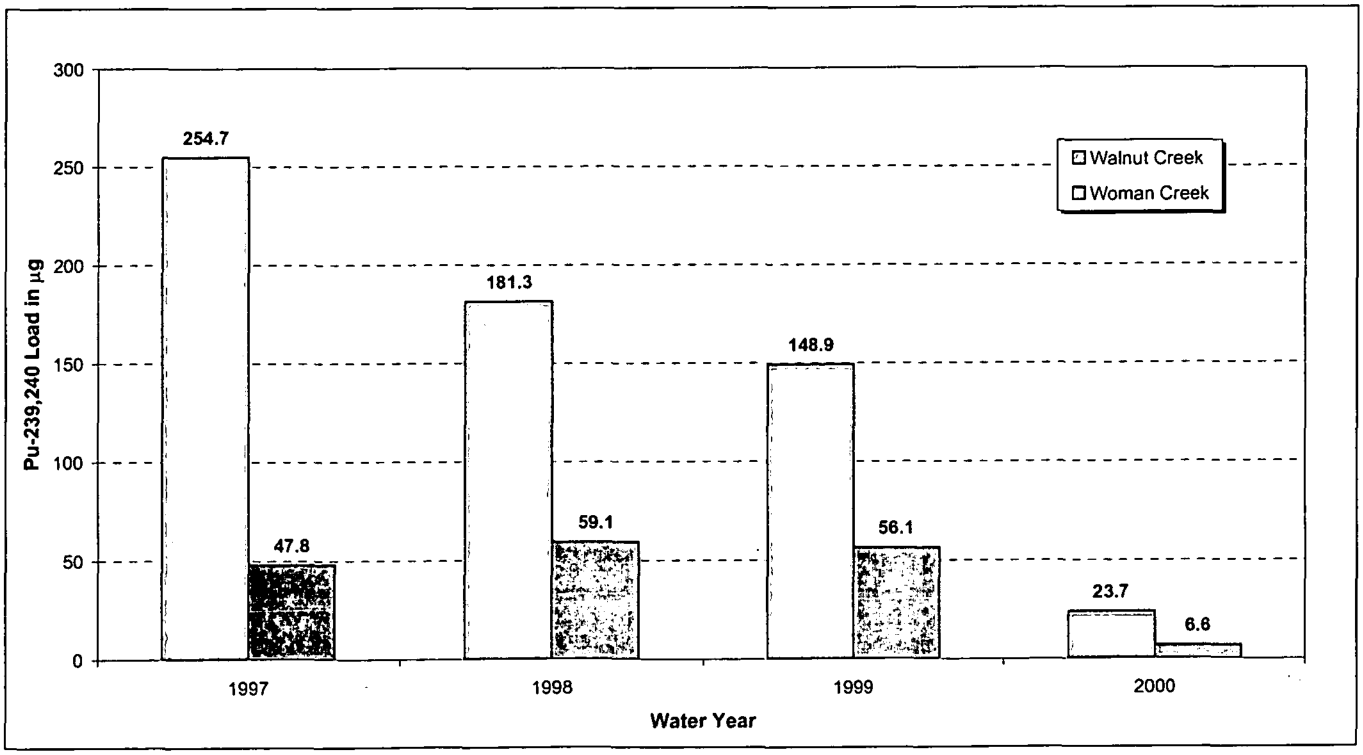

Figure 5-2. Annual Pu Loads from Walnut and Woman Creeks: WY97–00.

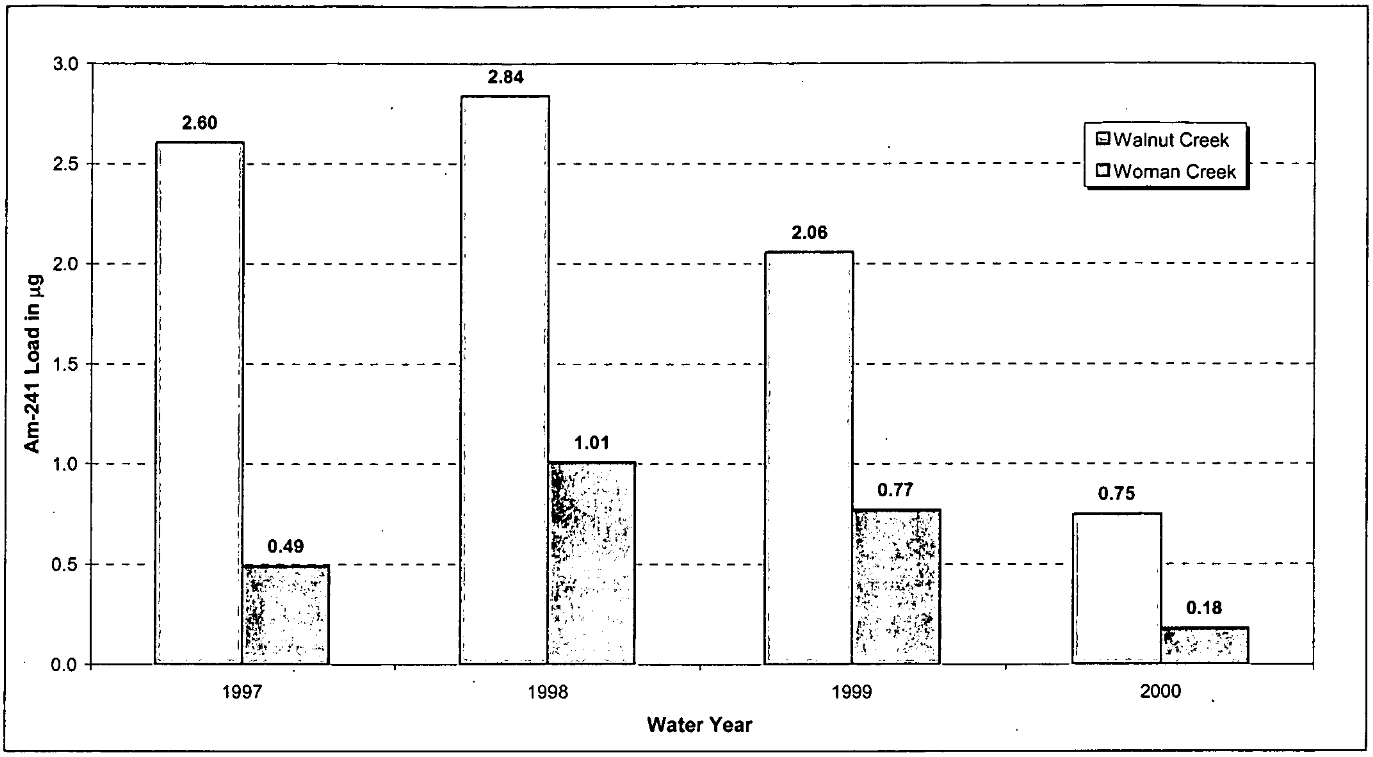

Figure 5-3. Annual Am Loads from Walnut and Woman Creeks: WY97–00.

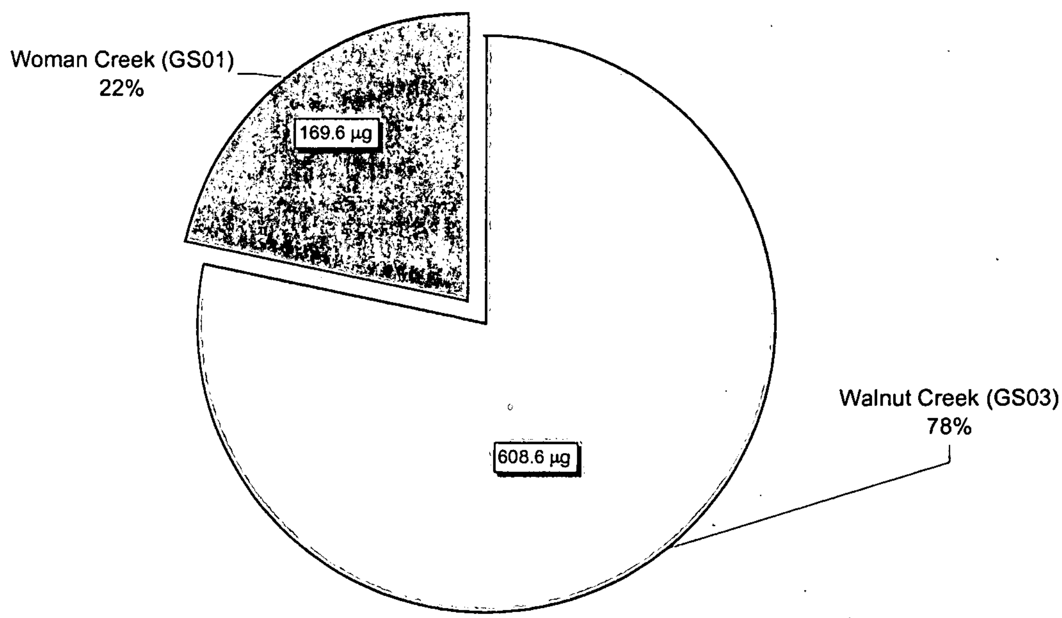

Figure 5-4. Relative Pu Load Totals from Walnut and Woman Creeks: WY97–00.

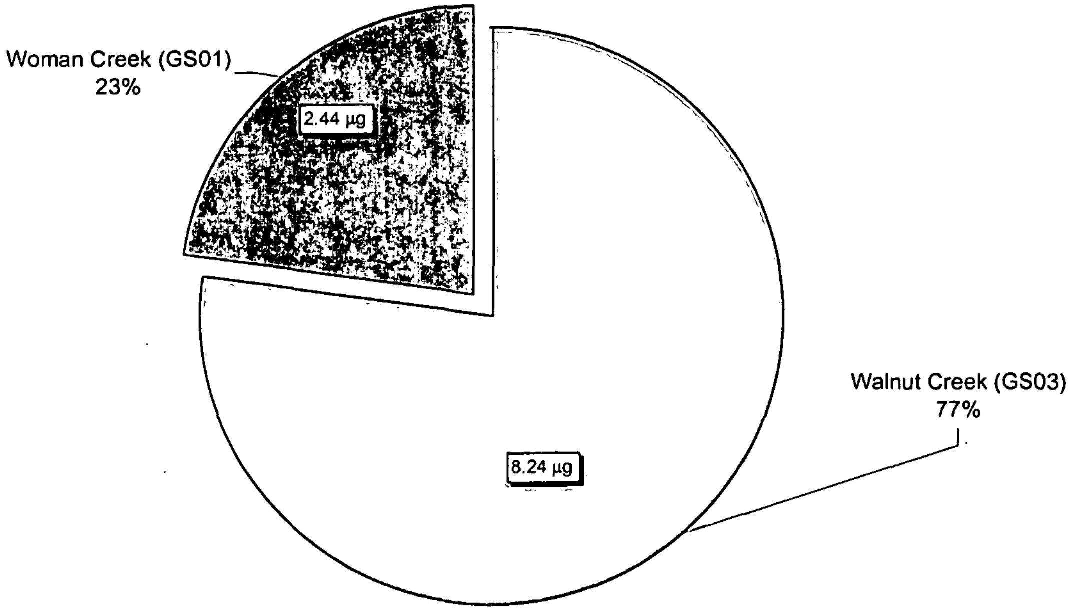

Figure 5-5. Relative Am Load Totals from Walnut and Woman Creeks: WY97–00.

5.2 WALNUT CREEK (POC GS03)

This section summarizes the calculated Pu and Am loads in Walnut Creek at GS03 (Walnut and Indiana St.), GS08 (Pond B-5), and GS11 (Pond A-4). The following points are noted:

- Annual Pu and Am loads generally vary by an order of magnitude year-to-year (Figure 5-7 and Figure 5-8).
- Loads from B-5 are significantly greater than loads from A-4 (Table 5-3).
- Total Pu loads from A-4 and B-5 are marginally greater than the loads at GS03 (Figure 5-9), indicating a small loss of load to the Walnut Cr. streambed below A-4 and B-5.
- Total Am loads from A-4 and B-5 are marginally less than the loads at GS03 (Figure 5-10), indicating a small gain of load from the Walnut Cr. streambed below A-4 and B-5.

Table 5-3. Pu and Am Loads at GS03, GS08, and GS11: WY97–00.

	Pu-239,-240 (µg)			
Water Year	Pond A-4 [GS11]	Pond B-5 [GS08]	Walnut Cr. Terminal Ponds	POC GS03
1997	46.0	11.8	57.9	254.7
1998	30.7	22.4	53.1	181.3
1999	27.0	255.9	283.0	148.9
2000	27.9	245.3	273.2	23.7
Total	131.6	535.5	667.1	608.6

	Am-241 (µg)			
Water Year	Pond A-4	Pond B-5	Terminal Ponds	POC GS03
1997	0.52	0.28	0.80	2.60
1998	1.33	0.40	1.73	2.84
1999	0.35	1.73	2.08	2.06
2000	0.02	3.16	3.18	0.75
Total	2.22	5.57	7.79	8.24

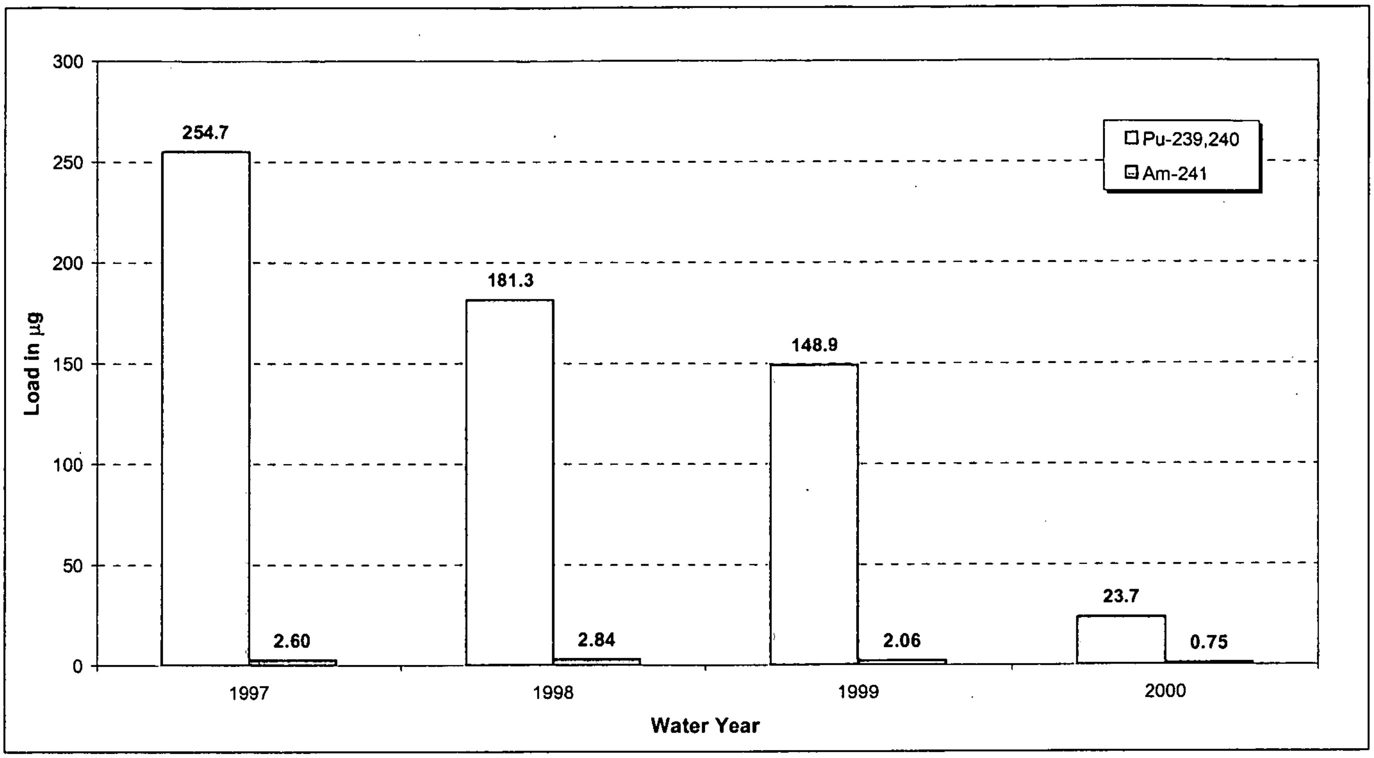

Figure 5-6. Annual Pu and Am Loads at GS03: WY97–00.

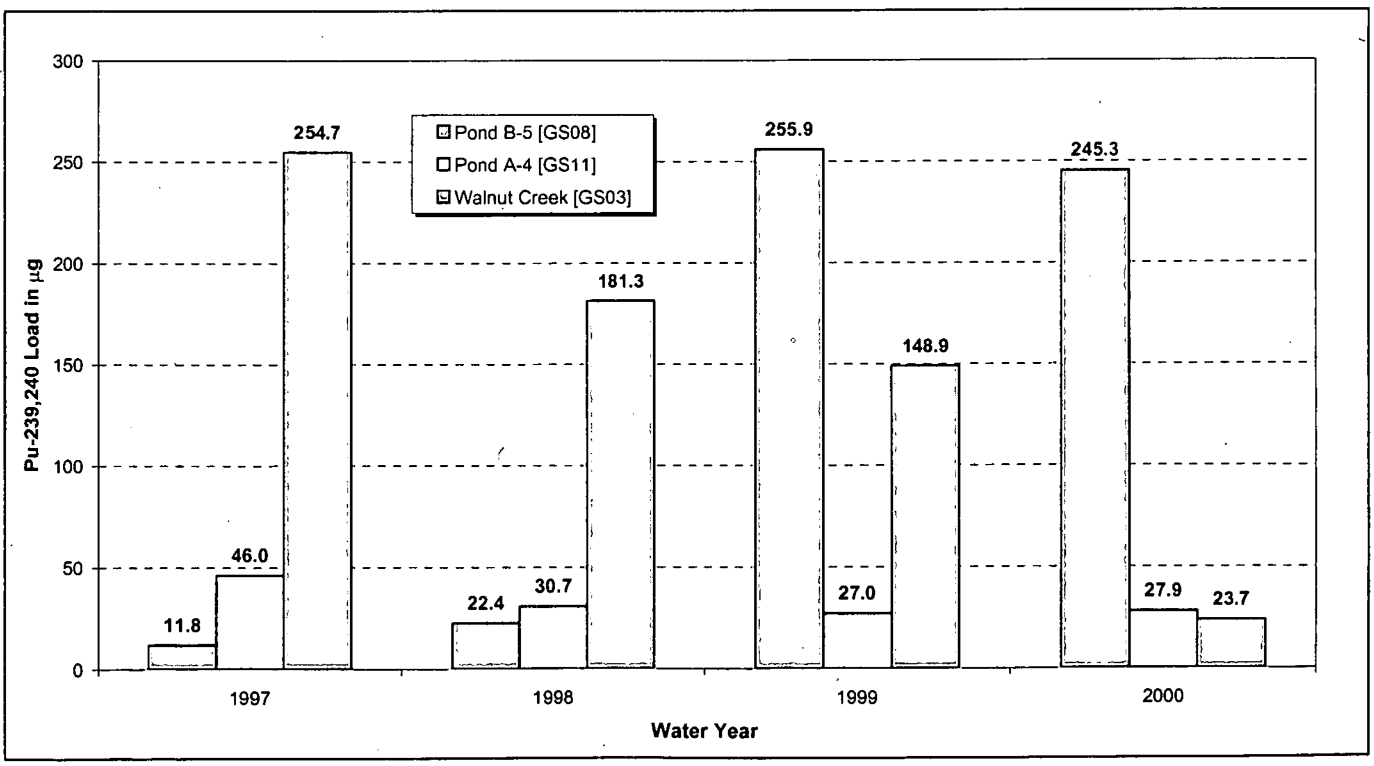

Figure 5-7. Annual Pu Loads at GS03, GS08, and GS11: WY97–00.

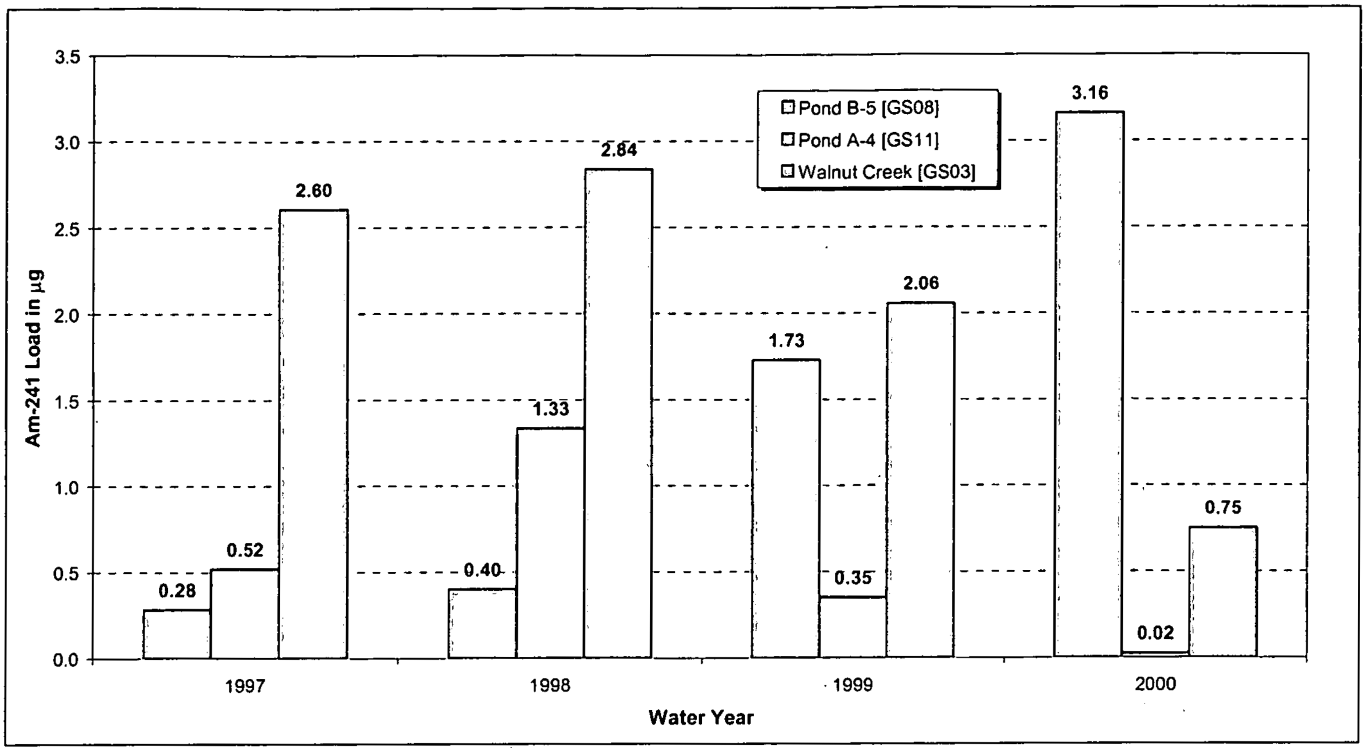

Figure 5-8. Annual Am Loads at GS03, GS08, and GS11: WY97–00

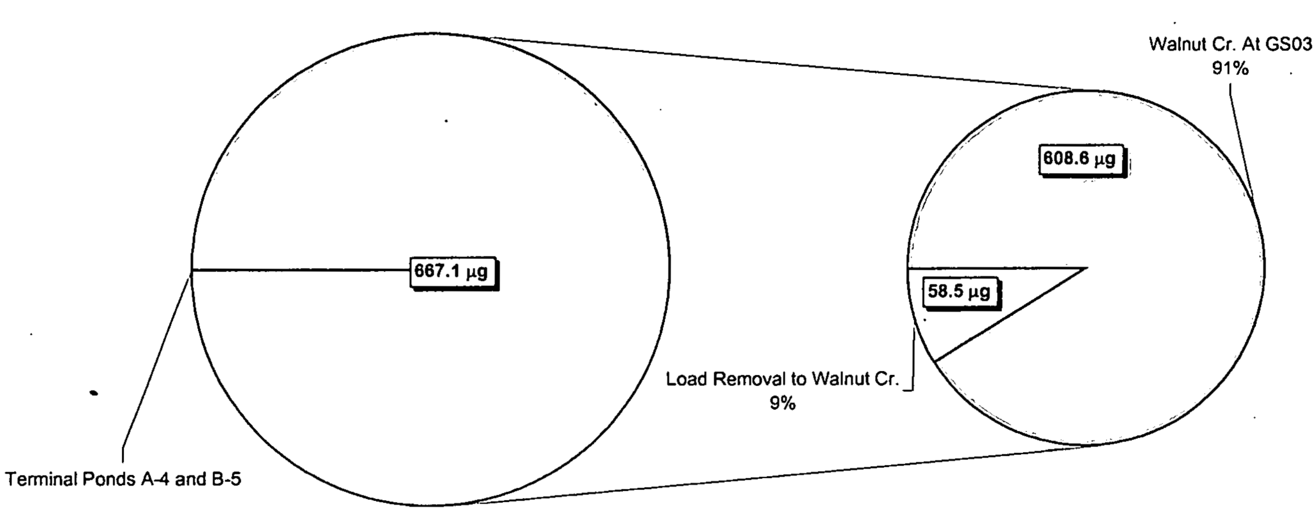

Figure 5-9. Relative Pu Load Totals at GS03, GS08, and GS11: WY97–00.

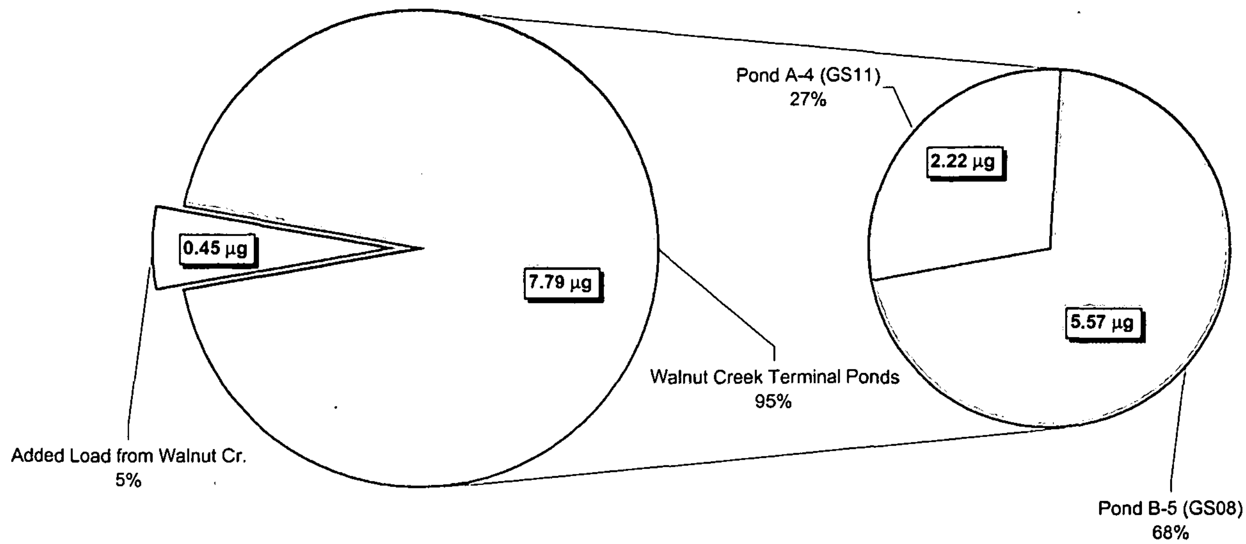

Figure 5-10. Relative Am Load Totals at GS03, GS08, and GS11: WY97–00.

5.3 WOMAN CREEK (POC GS01)

This section summarizes the calculated Pu and Am loads in Woman Creek at GS01 (Woman and Indiana St.) and GS31 (Pond C-2). The following points are noted:

- Annual Pu and Am loads generally vary by an order of magnitude year-to-year (Figure 5-12 and Figure 5-13).
- Total Pu loads from C-2 are significantly less than the loads at GS01 (Figure 5-14), indicating a significant gain of load from the Woman Cr. drainage.
- Total Am loads from C-2 are significantly less than the loads at GS01 (Figure 5-15), indicating a significant gain of load from the Woman Cr. drainage.

Table 5-4. Pu and Am Loads at GS01 and GS31: WY97–00.

	Pu-239,-240 (µg)		Am-241 (µg)	
Water Year	**Pond C-2 [GS31]**	**POC GS01**	**Pond C-2 [GS31]**	**POC GS01**
1997	6.8	47.8	0.04	0.49
1998	12.1	59.1	0.40	1.01
1999	26.9	56.1	0.13	0.77
2000	0.0	6.6	0.00	0.18
Total	45.8	169.6	0.57	2.44

Note: During WY97, flows from Woman Creek were routinely diverted to Mower Ditch for subsequent monitoring at GS02 (Figure 3-1). Therefore, the load calculated for Woman Creek at Indiana Street (GS01) includes the water that was measured at GS02. The estimated load diverted to GS02 is calculated by multiplying the WY97 volume-weighted activities at GS01 by the streamflow volume measured at GS02, and converting for units. This diverted load is then added to the calculated load at GS01 to obtain the total WY97 load at GS01. For subsequent water years, the Mower diversion structure has been upgraded and configured to prevent Woman Creek flows from entering the Mower Ditch.

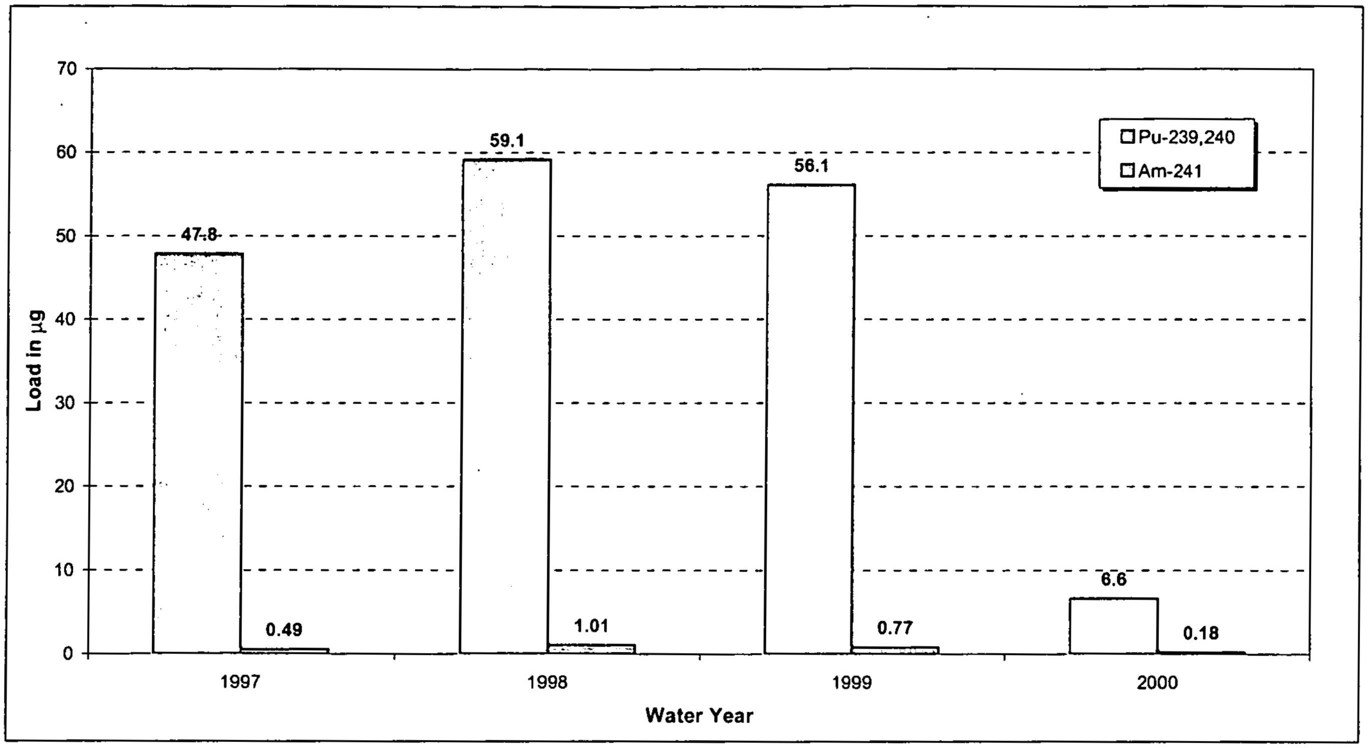

Figure 5-11. Annual Pu and Am Loads at GS01: WY97–00.

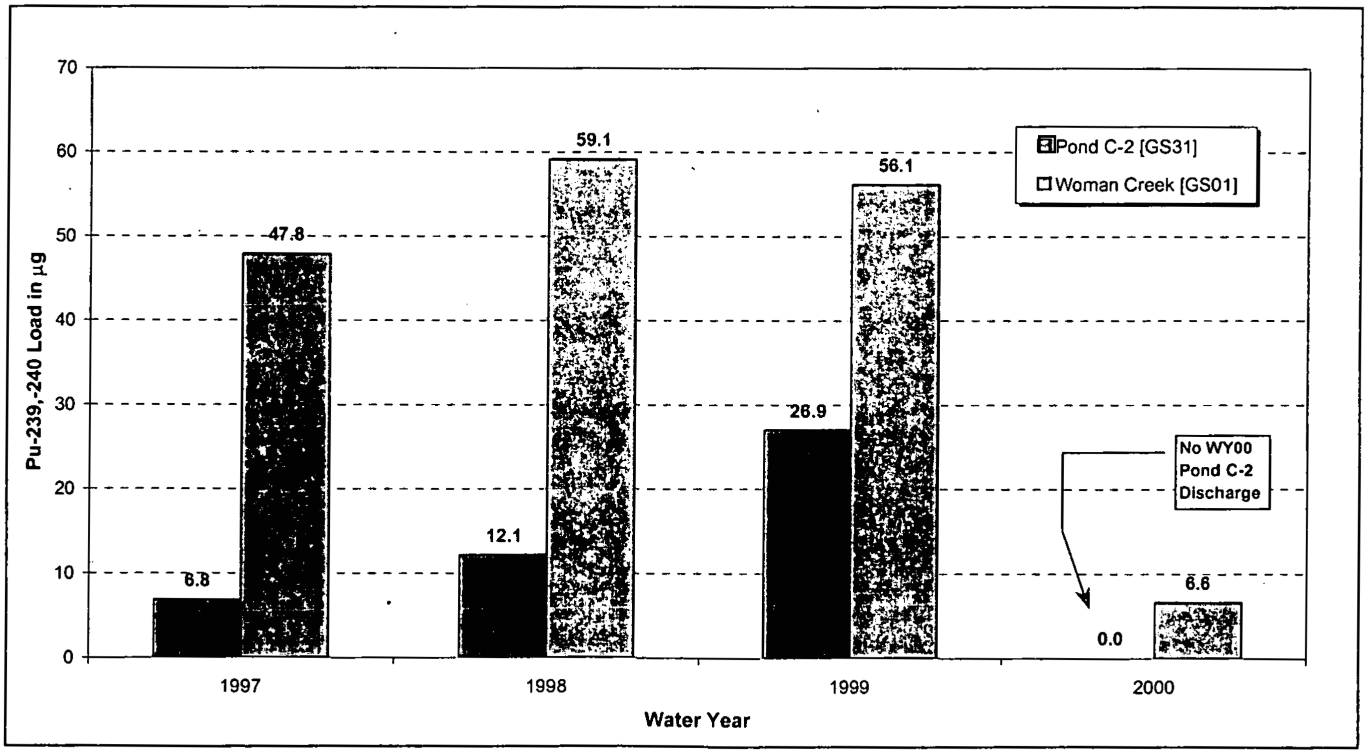

Figure 5-12. Annual Pu Loads at GS01 and GS31: WY97–00.

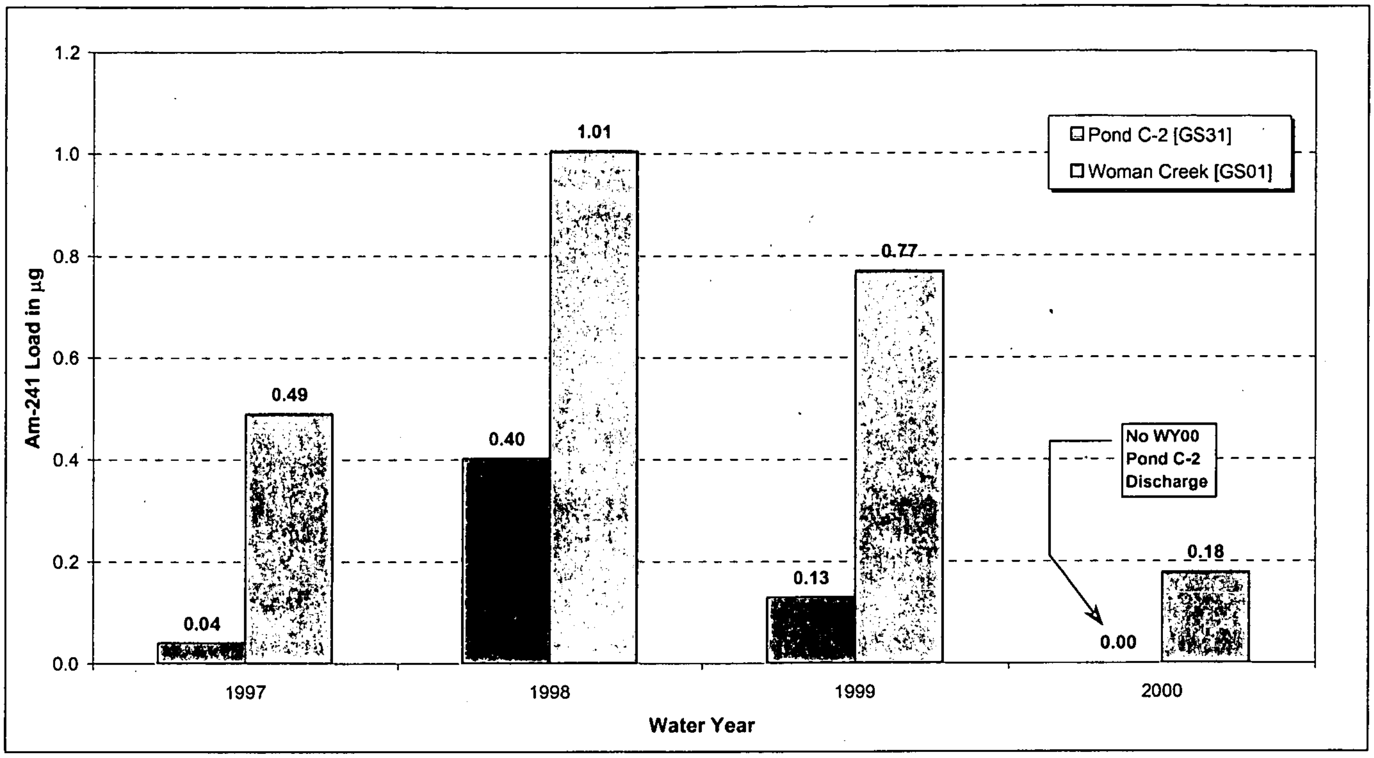

Figure 5-13. Annual Am Loads at GS01 and GS31: WY97–00.

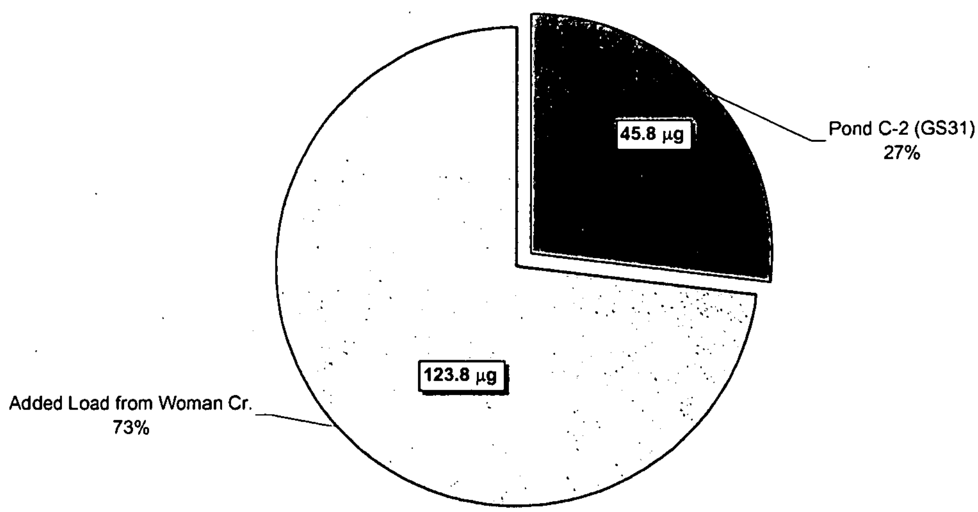

Figure 5-14. Relative Pu Load Totals at GS01 and GS31: WY97–00.

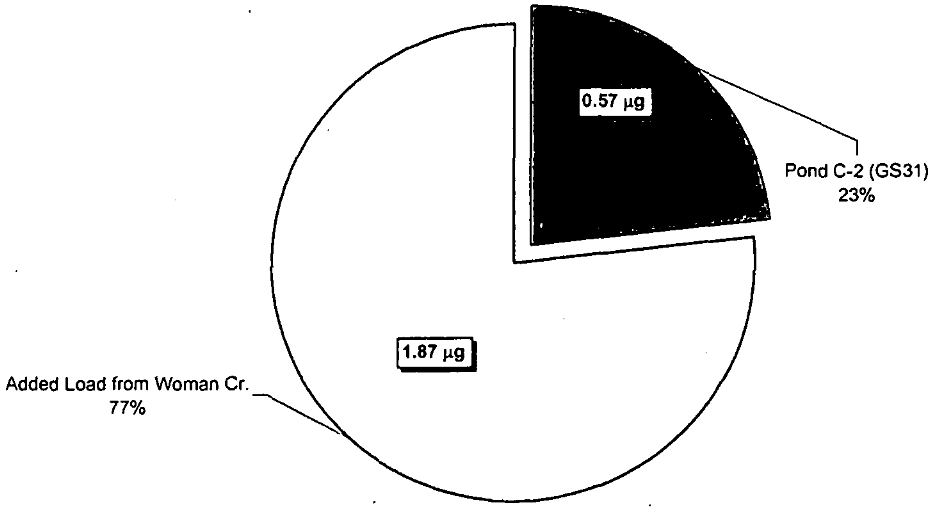

Figure 5-15. Relative Am Load Totals at GS01 and GS31: WY97–00.

5.4 TERMINAL DETENTION PONDS

This section summarizes the calculated Pu, Am, and isotopic uranium loads from terminal ponds A-4, B-5, and C-2. The following points are noted:

- Annual Pu and Am loads vary significantly year-to-year (Figure 5-16 and Figure 5-18).
- Pond B-5 accounts for a majority (76%) of the Pu load from the Site terminal ponds (Figure 5-17).
- Pond B-5 accounts for a majority (66%) of the Am load from the Site terminal ponds (Figure 5-19).
- Annual isotopic uranium loads are more consistent year-to-year (Figure 5-20, Figure 5-22 and Figure 5-24).
- Pond A-4 accounts for a majority (54-56%) of the isotopic uranium loads from the Site terminal ponds (Figure 5-21, Figure 5-23 and Figure 5-25).

Table 5-5. Pu and Am Loads from Terminal Ponds A-4, B-5, and C-2: WY97–00.

	Pu-239,-240 (μg)			Am-241 (μg)		
Water Year	Pond A-4 [GS11]	Pond B-5 [GS08]	Pond C-2 [GS31]	Pond A-4 [GS11]	Pond B-5 [GS08]	Pond C-2 [GS31]
1997	46.0	11.8	6.8	0.52	0.28	0.04
1998	30.7	22.4	12.1	1.33	0.40	0.40
1999	27.0	255.9	26.9	0.35	1.73	0.13
2000	27.9	245.3	0.0*	0.02	3.16	0.00
Total	131.6	535.5	45.8	2.22	5.57	0.57

Notes: * No Pond C-2 discharge in WY00.

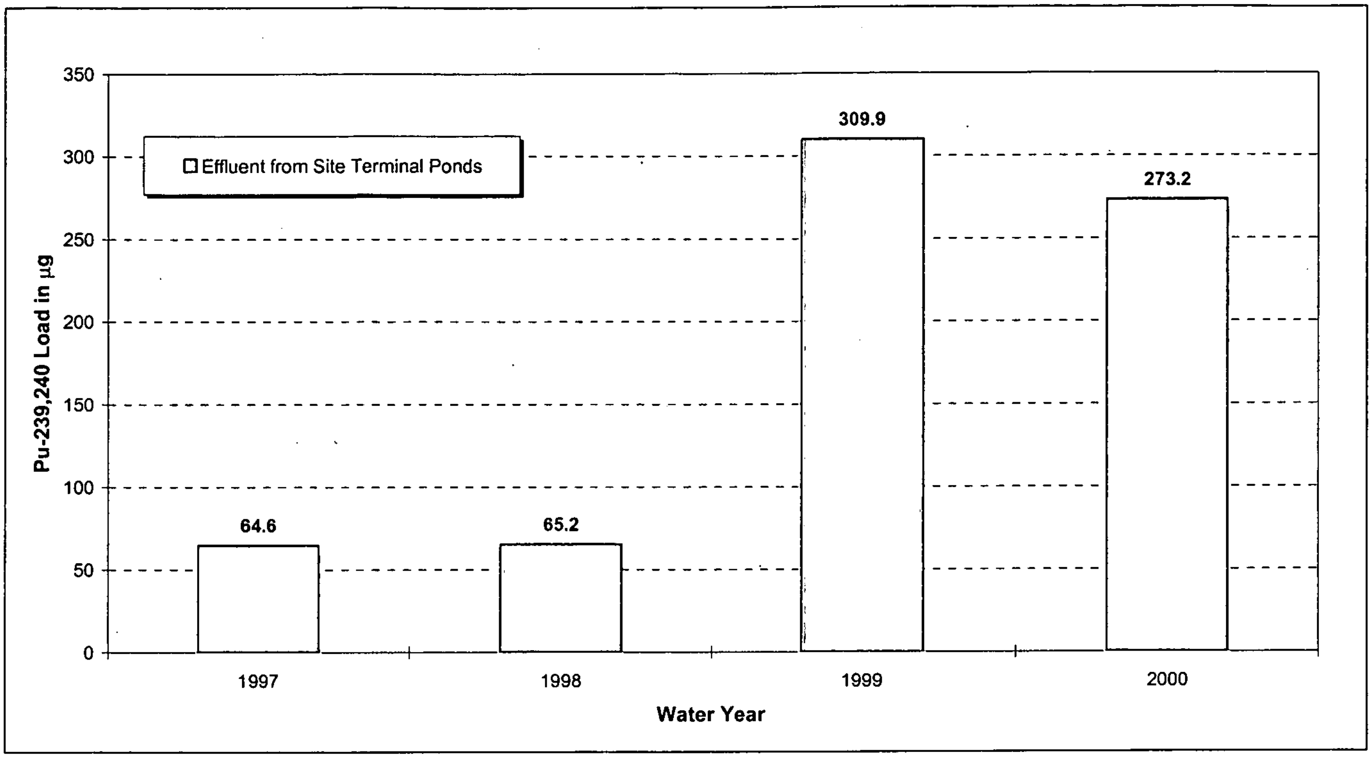

Figure 5-16. Annual Pu Loads from Terminal Ponds A-4, B-5, and C-2: WY97–00.

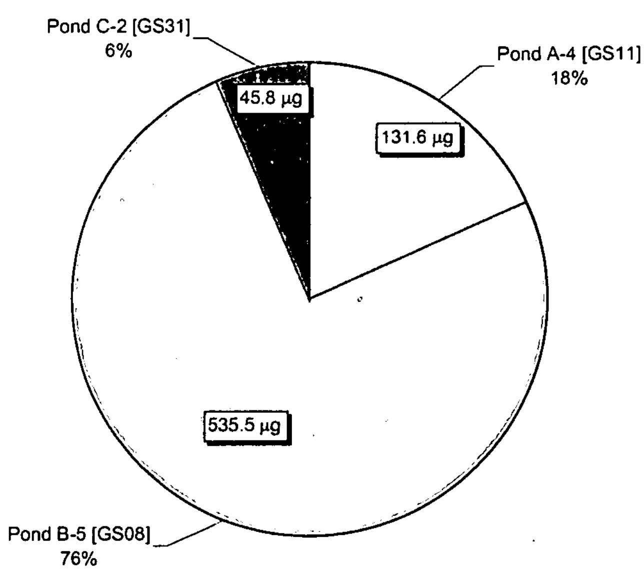

Figure 5-17. Relative Pu Load Totals from Terminal Ponds A-4, B-5, and C-2: WY97–00.

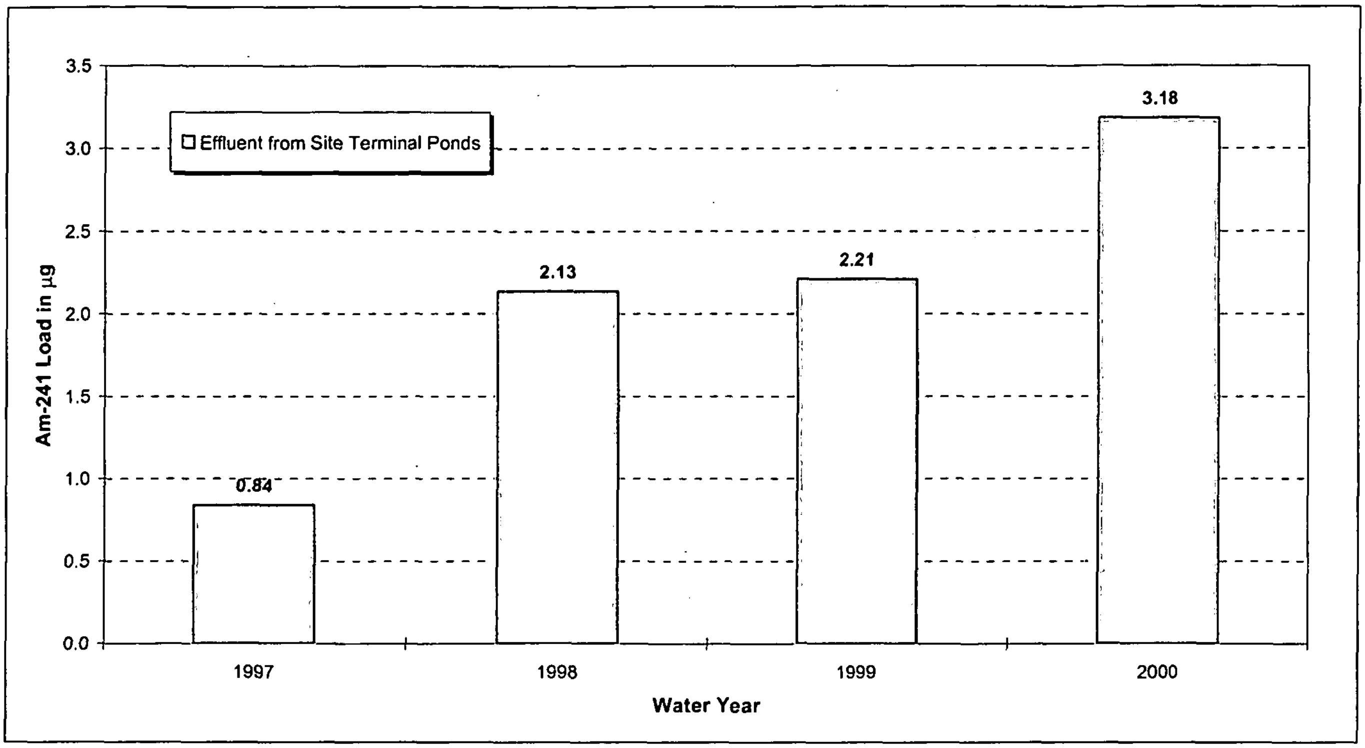

Figure 5-18. Annual Am Loads from Terminal Ponds A-4, B-5, and C-2: WY97–00.

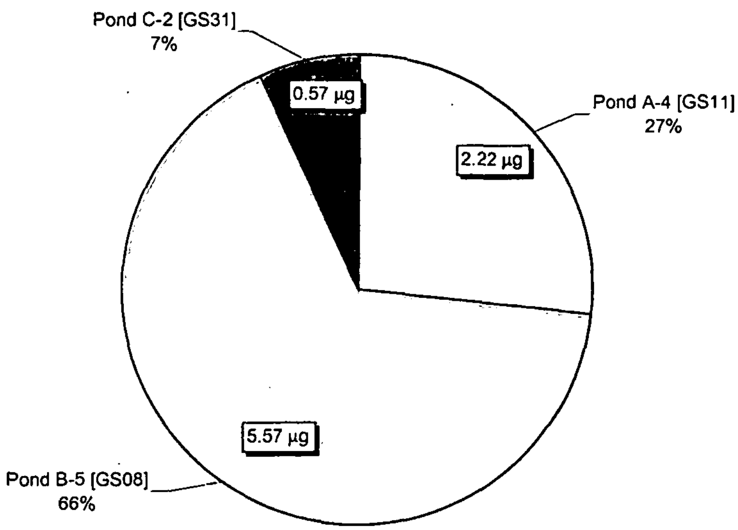

Figure 5-19. Relative Am Load Totals from Terminal Ponds A-4, B-5, and C-2: WY97–00.

Table 5-6. U-233,234 Loads from Terminal Ponds A-4, B-5, and C-2: WY97–00.

	U-233,234 (g)		
Water Year	Pond A-4 [GS11]	Pond B-5 [GS08]	Pond C-2 [GS31]
1997	0.055	0.018	0.005
1998	0.083	0.037	0.014
1999	0.041	0.033	0.009
2000	0.018	0.036	0.000
Total	0.196	0.125	0.028

Table 5-7. U-235 Loads from Terminal Ponds A-4, B-5, and C-2: WY97–00.

	U-235 (g)		
Water Year	Pond A-4 [GS11]	Pond B-5 [GS08]	Pond C-2 [GS31]
1997	7.82	3.45	0.75
1998	9.04	4.63	1.09
1999	5.29	5.29	1.66
2000	2.25	3.95	0.00
Total	24.39	17.33	3.50

Table 5-8. U-238 Loads from Terminal Ponds A-4, B-5, and C-2: WY97–00.

	U-238 (g)		
Water Year	Pond A-4 [GS11]	Pond B-5 [GS08]	Pond C-2 [GS31]
1997	1006.6	323.7	102.4
1998	1602.2	647.9	342.1
1999	762.5	625.4	187.5
2000	309.5	583.0	0.0
Total	3680.8	2180.0	631.9

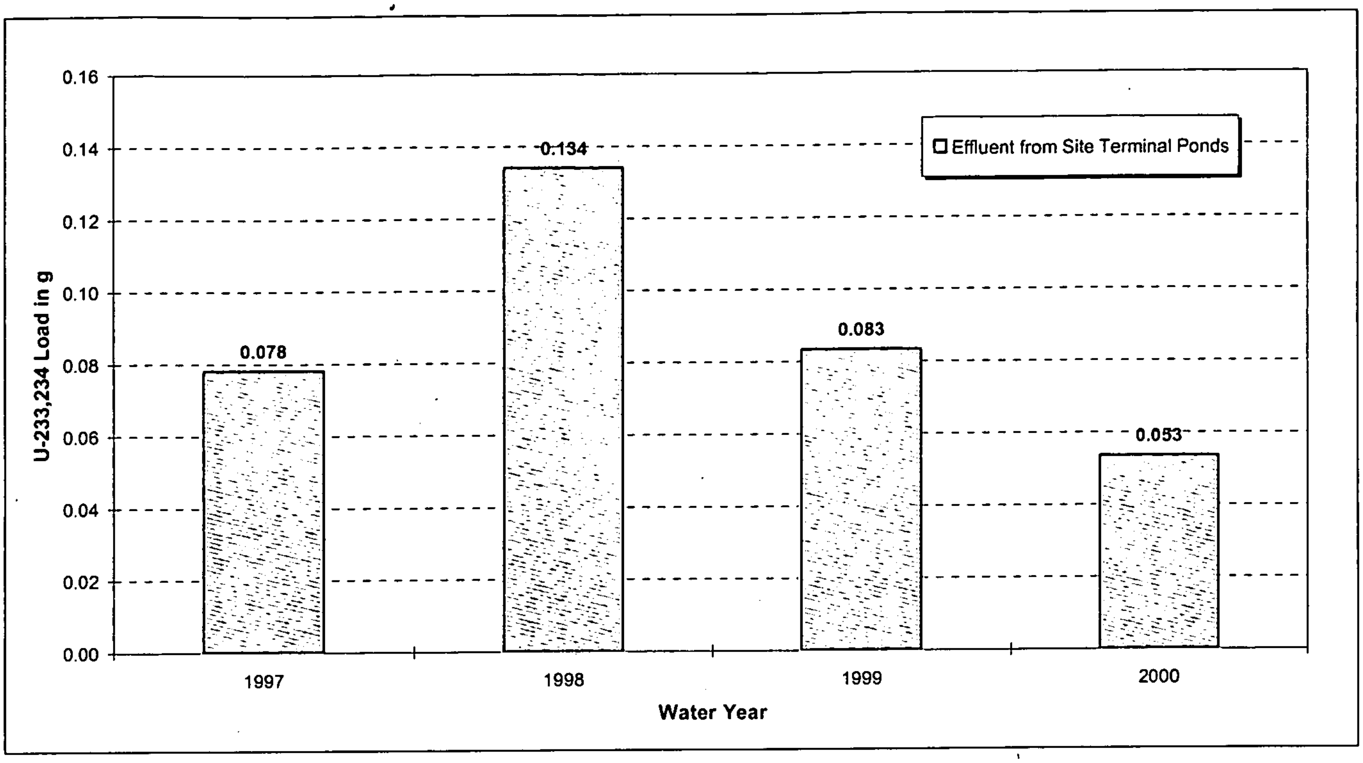

Figure 5-20. Annual U-233,234 Loads from Terminal Ponds A-4, B-5, and C-2: WY97–00.

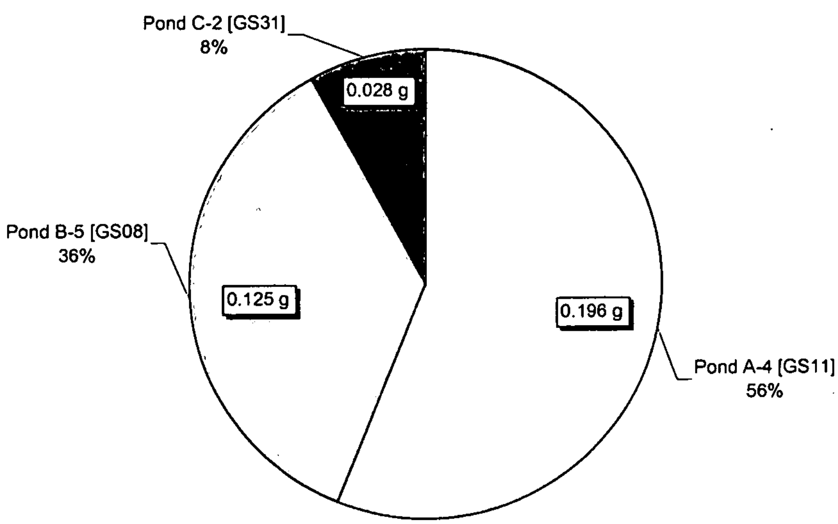

Figure 5-21. Relative U-233,234 Load Totals from Terminal Ponds A-4, B-5, and C-2: WY97–00.

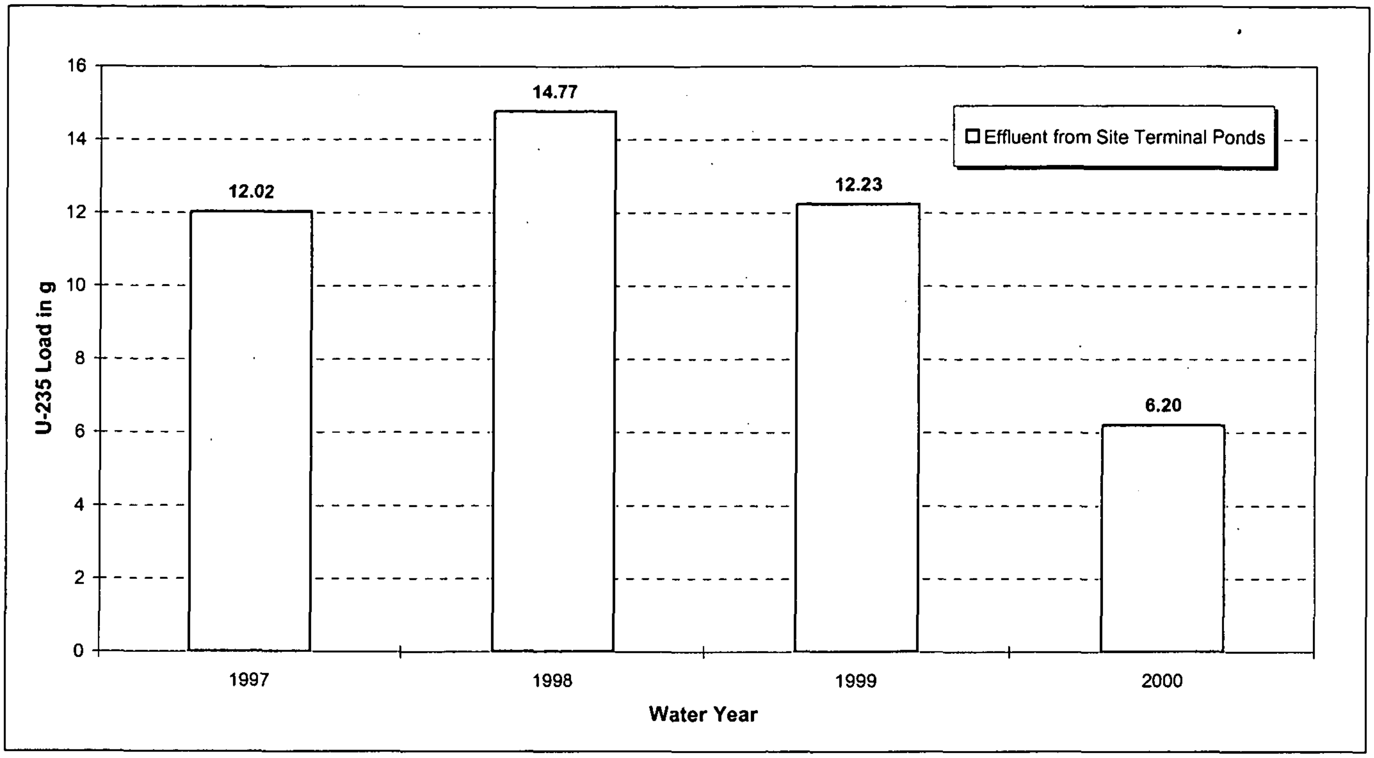

Figure 5-22. Annual U-235 Loads from Terminal Ponds A-4, B-5, and C-2: WY97–00.

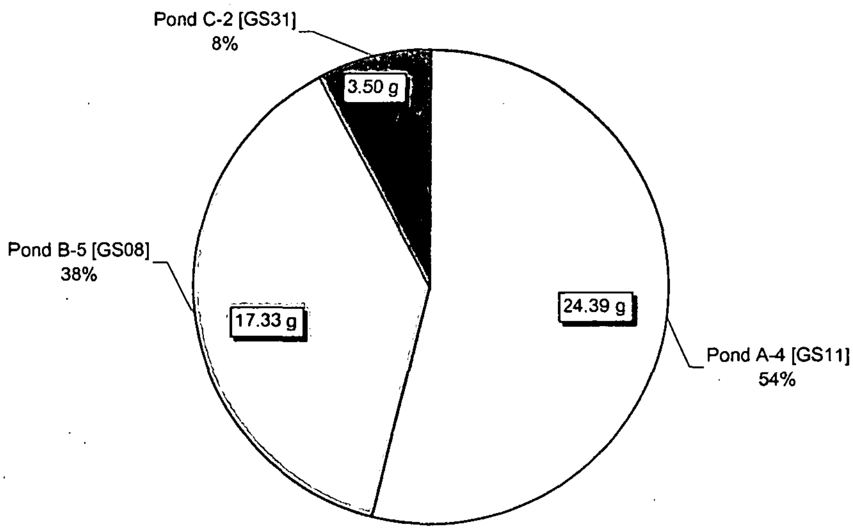

Figure 5-23. Relative U-235 Load Totals from Terminal Ponds A-4, B-5, and C-2: WY97–00.

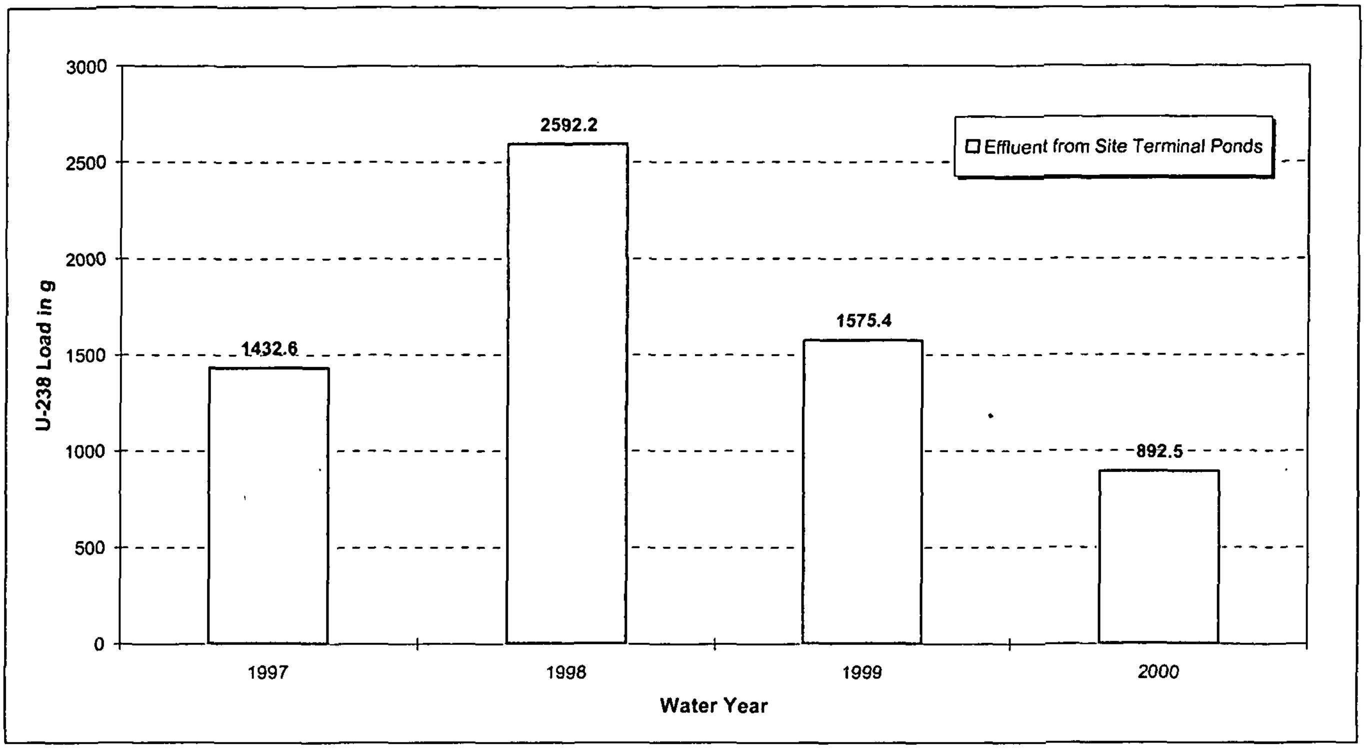

Figure 5-24. Annual U-238 Loads from Terminal Ponds A-4, B-5, and C-2: WY97–00.

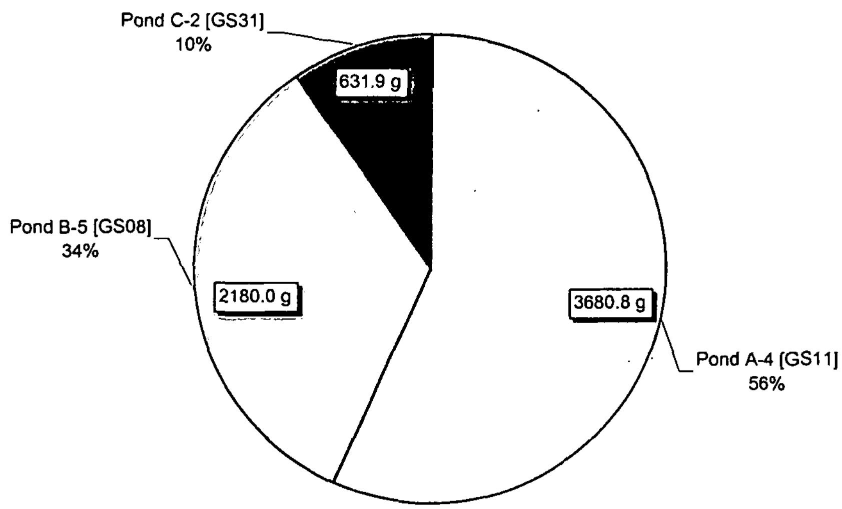

Figure 5-25. Relative U-238 Load Totals from Terminal Ponds A-4, B-5, and C-2: WY97–00.

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

This section summarizes the calculated Pu, Am, and isotopic uranium loads for the A- and B-Series Ponds. Since water transfers routinely occur between ponds, the load analysis below is performed for both pond series combined. The influent load sources are GS10 and the WWTP (S. Walnut), and SW093 (N. Walnut).[12] The effluent loads are GS08 (Pond B-5 outlet) and GS11 (Pond A-4 outlet). The following points are noted:

- Total Pu load removal by Pond A-4 and B-5 is calculated as 68% (Table 5-9).
- Total Am load removal by Pond A-4 and B-5 is calculated as 85% (Table 5-10).
- Annual Pu and Am loads vary significantly year-to-year (Figure 5-26 and Figure 5-29).
- Annual isotopic uranium loads are more consistent year-to-year (Figure 5-32, Figure 5-35 and Figure 5-38).
- There is essentially no isotopic uranium load removal in Ponds A-4 and B-5. Some years show gains while others show losses (Figure 5-34, Figure 5-37 and Figure 5-40).

Table 5-9. Pu Load Summary for the A- and B-Series Ponds: WY97–00.

	Pu-239,240 (µg)					
Water Year	**Influent (WWTP)**	**Influent (GS10)**	**Influent (SW093)**	**Effluent (GS08)**	**Effluent (GS11)**	**Percent Removal**
1997	13.4	564.0	178.7	11.8	46.0	92%
1998	8.7	345.3	70.9	22.4	30.7	87%
1999	23.2	306.8	126.9	255.9	27.0	38%
2000	18.4	329.6	88.5	245.3	27.9	37%
Total	63.7	1545.7	464.9	535.5	131.6	68%

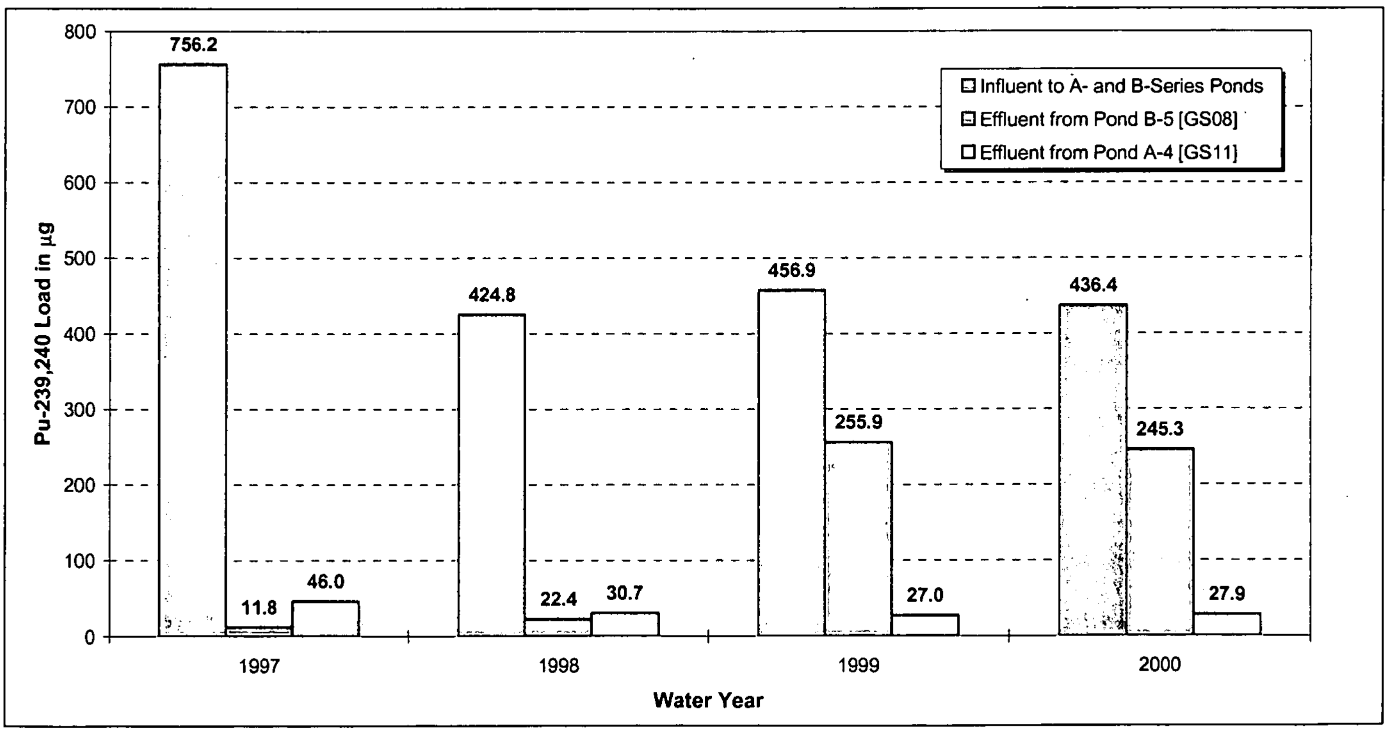

Figure 5-26. Annual Pu Loads for the A- and B-Series Ponds: WY97–00.

[12] Although SW091 is also a load source to N. Walnut (Figure 3-2), the flow volumes at SW091 are approximately 0.3% of the volumes at SW093. Additionally, SW091 does not collect continuous flow-paced sample to allow for more accurate load calculations. Therefore, SW091 load is not included due to it's relative insignificance.

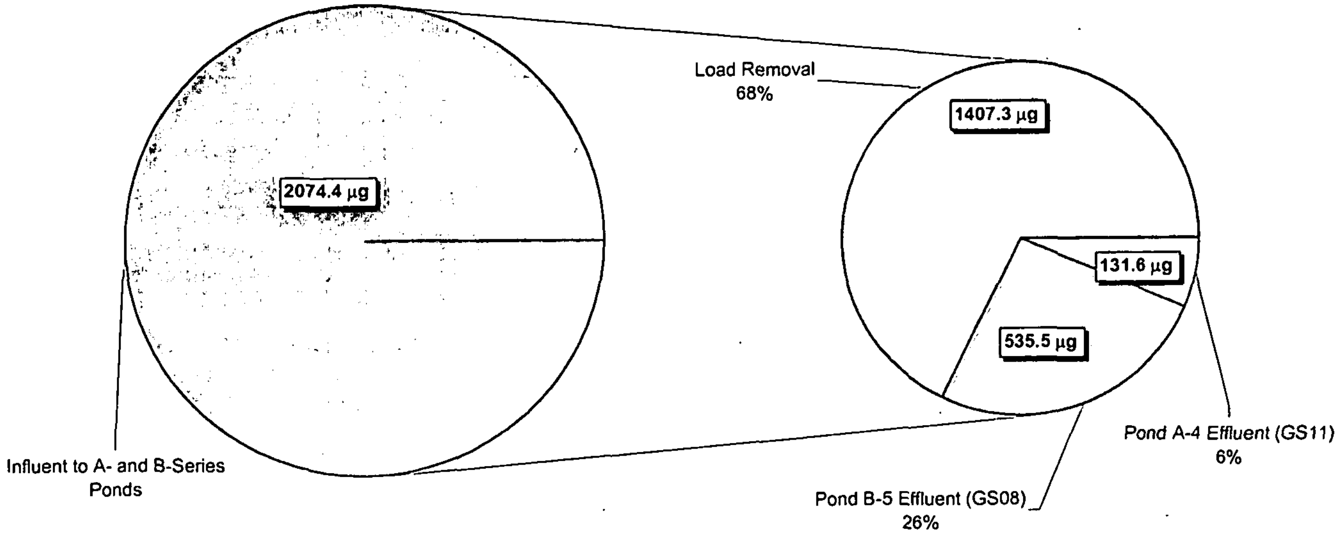

Figure 5-27. Relative Pu Load Totals for the A- and B-Series Terminal Ponds: WY97–00.

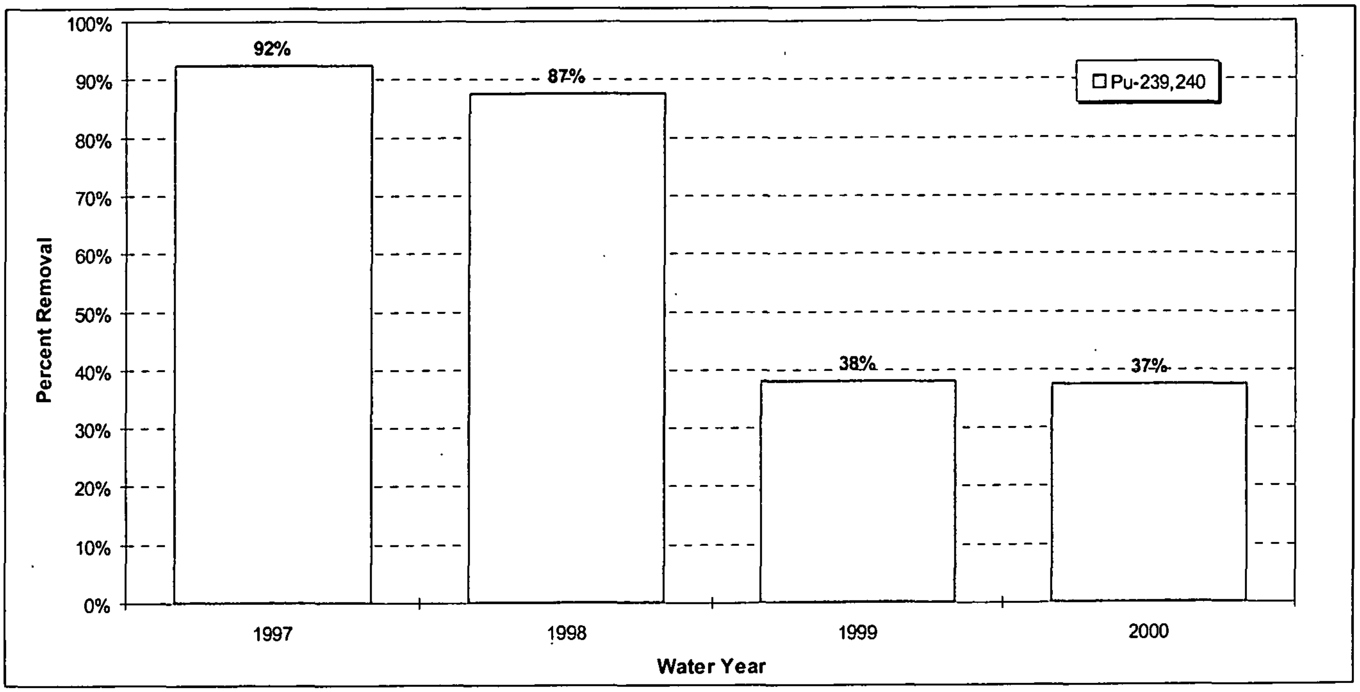

Figure 5-28. Annual Pu Load Removal for the A- and B-Series Ponds: WY97–00.

Table 5-10. Am Load Summary for the A- and B-Series Ponds: WY97–00.

	Am-241 (µg)					
Water Year	**Influent (WWTP)**	**Influent (GS10)**	**Influent (SW093)**	**Effluent (GS08)**	**Effluent (GS11)**	**Percent Removal**
1997	0.44	11.98	2.27	0.28	0.52	95%
1998	0.58	4.95	1.38	0.40	1.33	75%
1999	0.11	12.55	1.69	1.73	0.35	86%
2000	0.33	14.65	1.03	3.16	0.02	80%
Total	1.45	44.13	6.38	5.57	2.22	85%

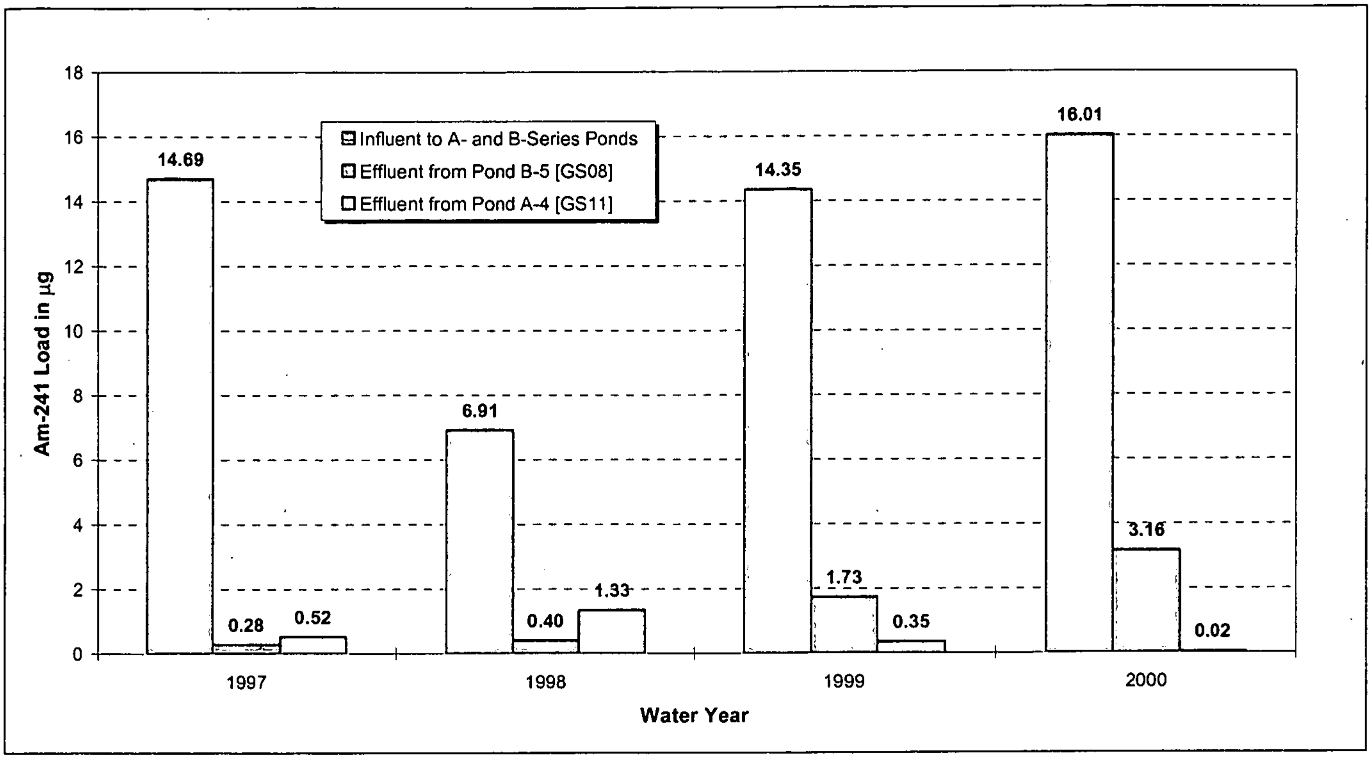

Figure 5-29. Annual Am Loads for the A- and B-Series Ponds: WY97–00.

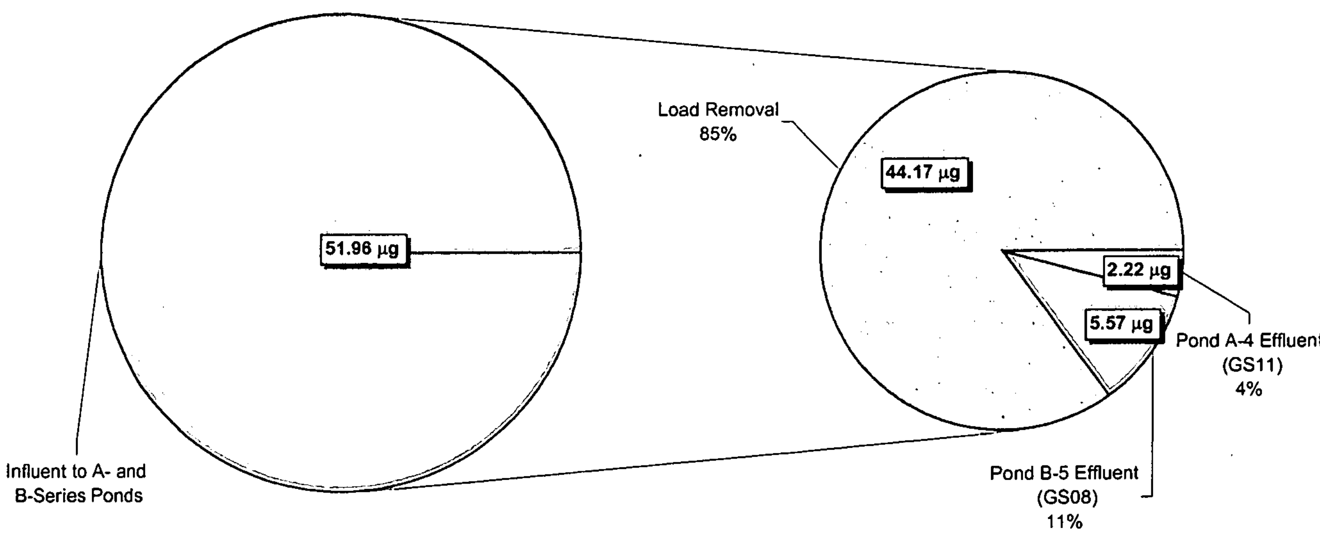

Figure 5-30. Relative Am Load Totals for the A- and B-Series Ponds: WY97–00.

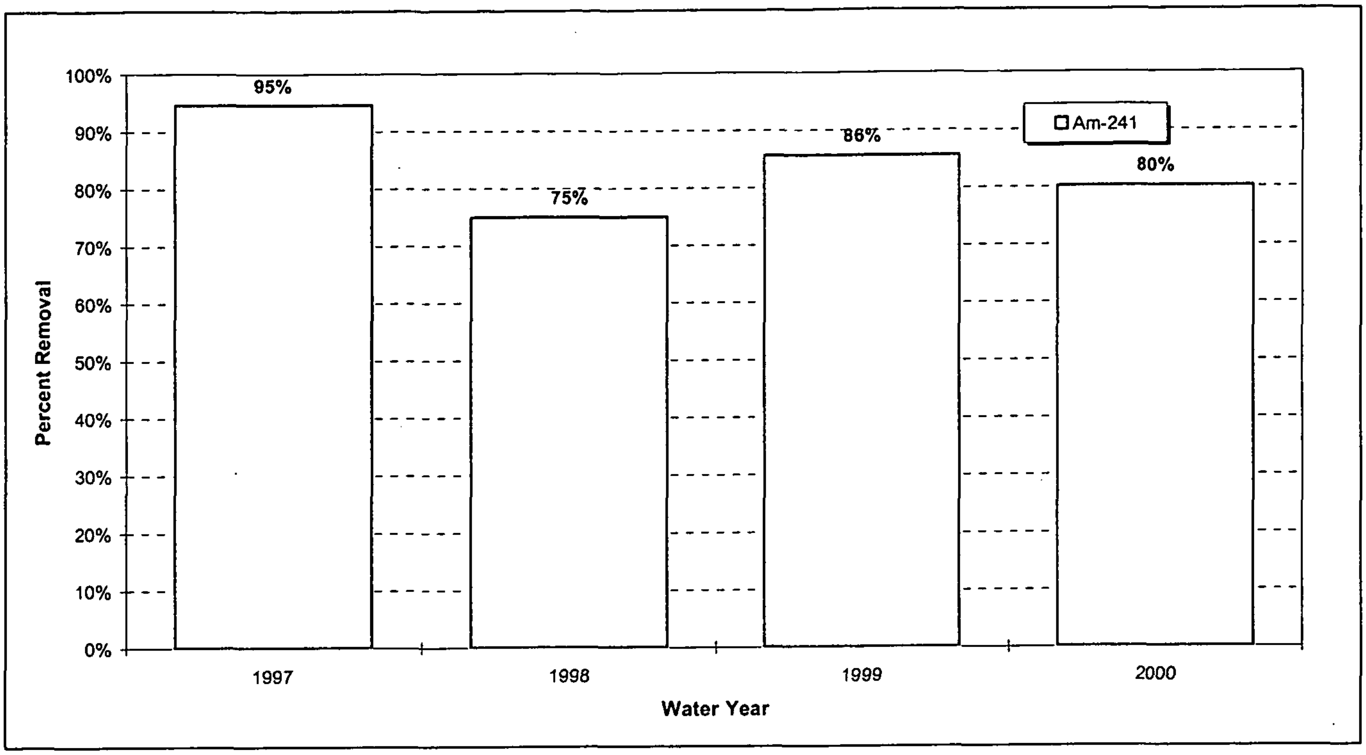

Figure 5-31. Annual Am Load Removal for the A- and B-Series Ponds: WY97–00.

Table 5-11. U-233,234 Load Summary for the A- and B-Series Ponds: WY97–00.

	U-233,234 (g)					
Water Year	**Influent (WWTP)**	**Influent (GS10)**	**Influent (SW093)**	**Effluent (GS08)**	**Effluent (GS11)**	**Percent Removal**
1997	0.013	0.031	0.033	0.018	0.055	4%
1998	0.023	0.039	0.041	0.037	0.083	-16%
1999	0.005	0.030	0.033	0.033	0.041	-9%
2000	0.006	0.022	0.026	0.036	0.018	1%
Total	0.047	0.122	0.134	0.125	0.196	-6%

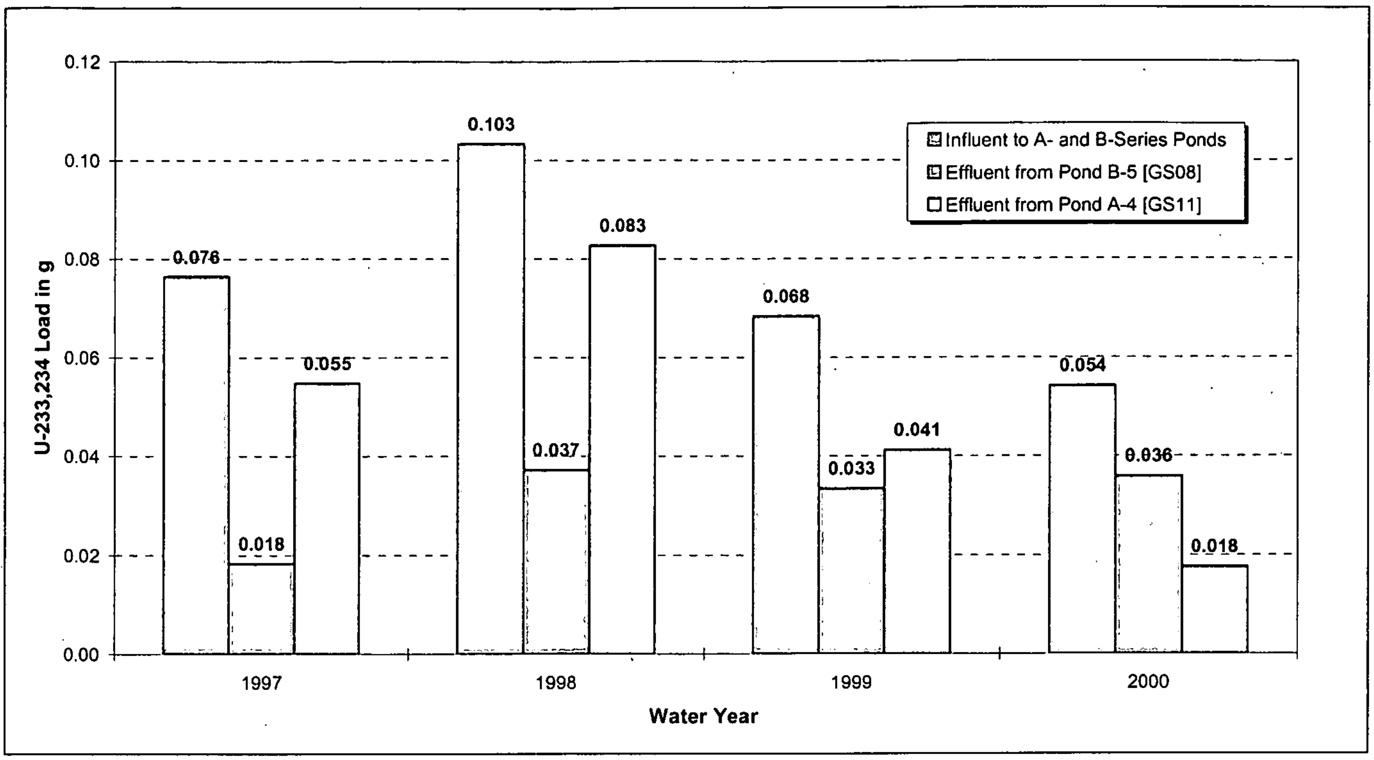

Figure 5-32. Annual U-233,234 Loads for the A- and B-Series Ponds: WY97–00.

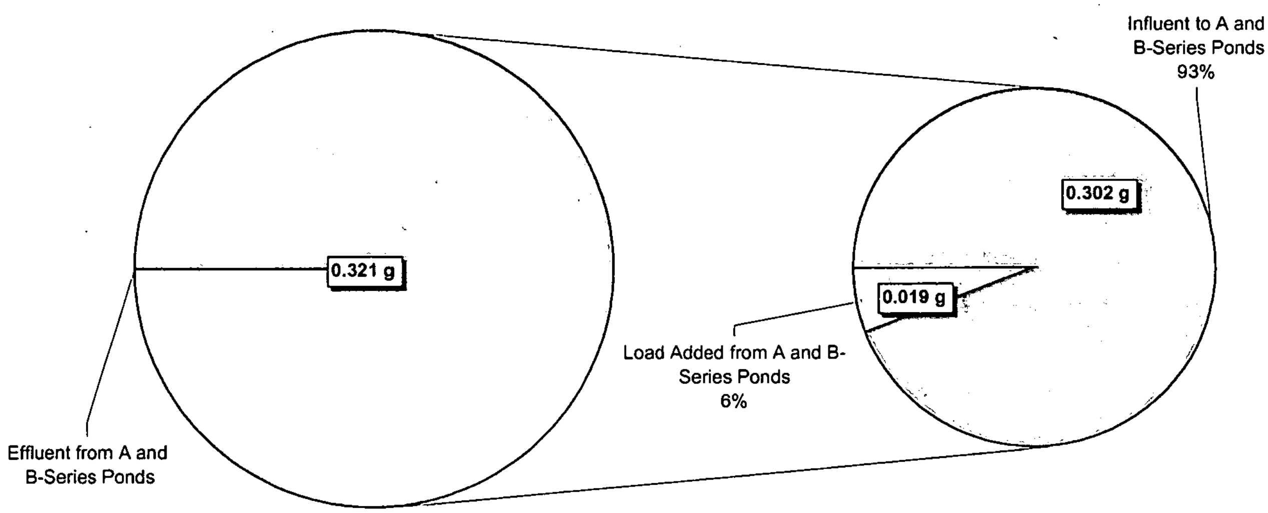

Figure 5-33. Relative U-233,234 Load Totals for the A- and B-Series Ponds: WY97–00.

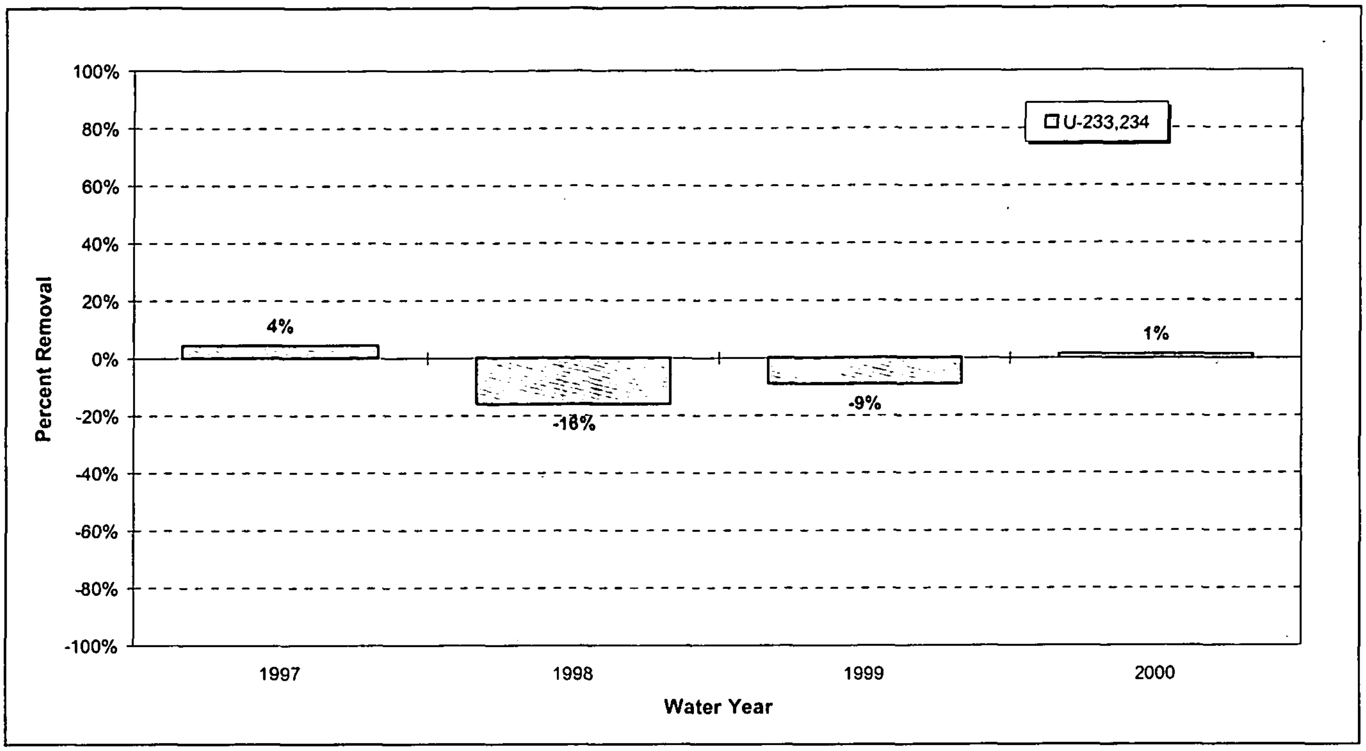

Figure 5-34. Annual U-233,234 Load Removal for the A- and B-Series Ponds: WY97–00.

Table 5-12. U-235 Load Summary for the A- and B-Series Ponds: WY97–00.

	U-235 (g)					
Water Year	**Influent (WWTP)**	**Influent (GS10)**	**Influent (SW093)**	**Effluent (GS08)**	**Effluent (GS11)**	**Percent Removal**
1997	2.57	4.05	4.77	3.45	7.82	1%
1998	2.09	4.48	5.32	4.63	9.04	-15%
1999	1.21	3.57	3.53	5.29	5.29	-27%
2000	0.71	2.64	3.36	3.95	2.25	8%
Total	6.57	14.75	16.97	17.33	24.39	-9%

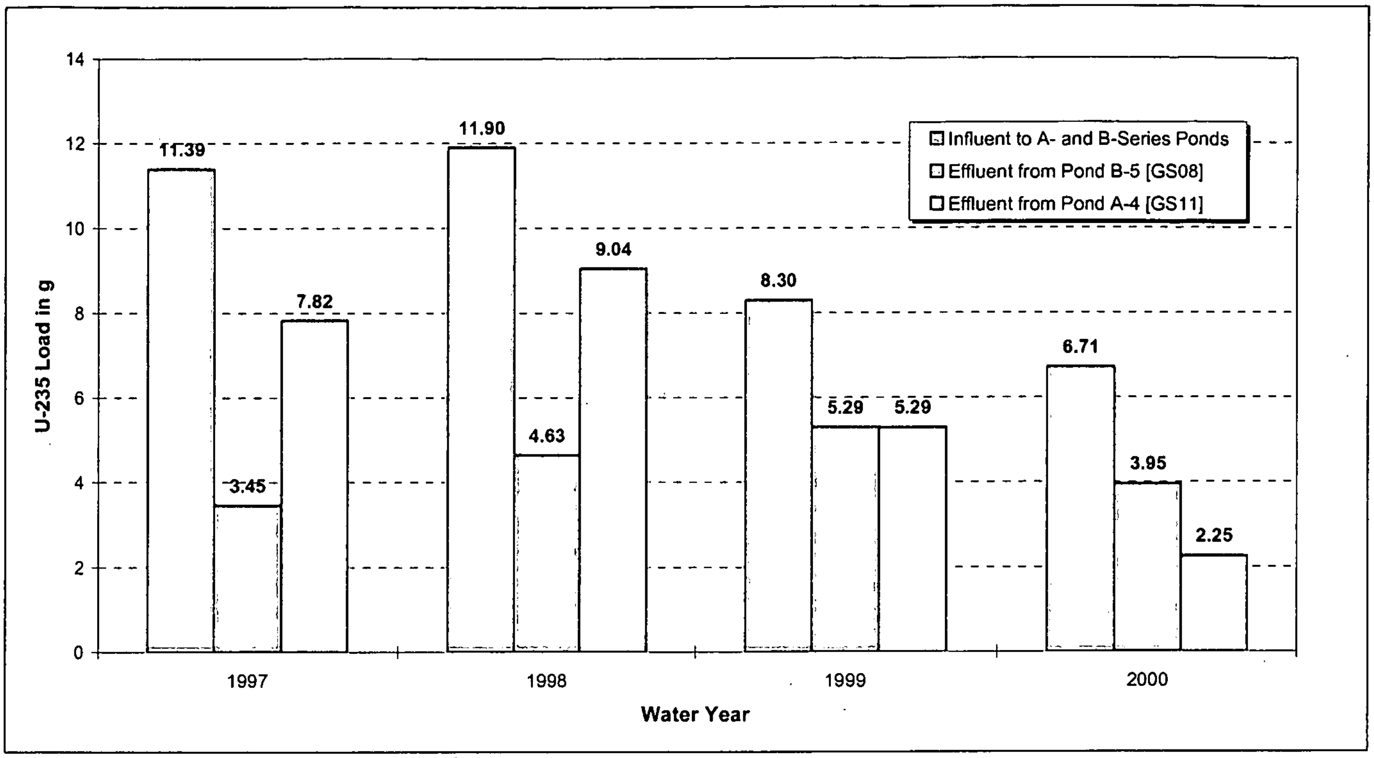

Figure 5-35. Annual U-235 Loads for the A- and B-Series Ponds: WY97–00.

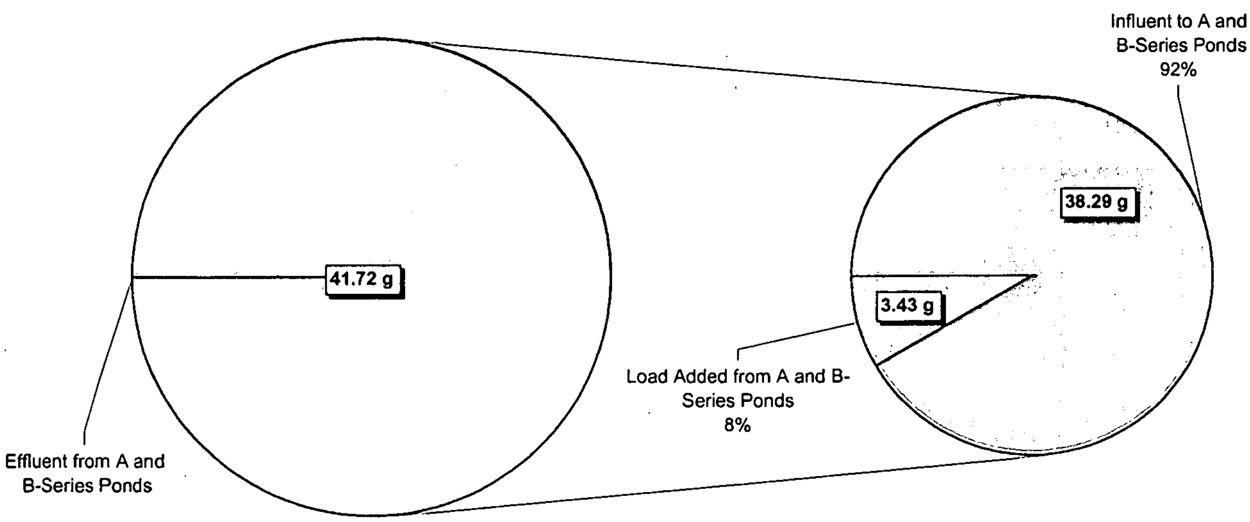

Figure 5-36. Relative U-235 Load Totals for the A- and B-Series Ponds: WY97–00.

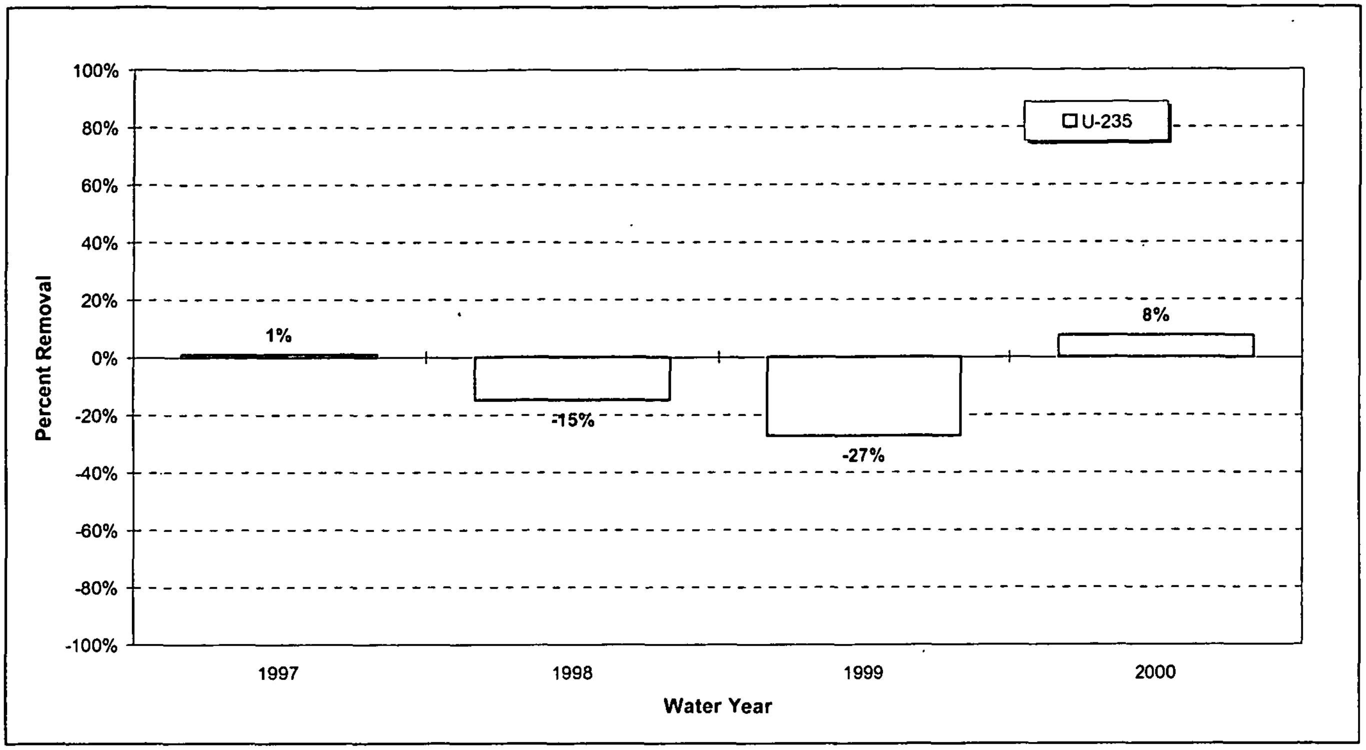

Figure 5-37. Annual U-235 Load Removal for the A- and B-Series Ponds: WY97–00.

Table 5-13. U-238 Load Summary for the A- and B-Series Ponds: WY97–00.

	U-238 (g)					
Water Year	**Influent (WWTP)**	**Influent (GS10)**	**Influent (SW093)**	**Effluent (GS08)**	**Effluent (GS11)**	**Percent Removal**
1997	215.3	555.6	778.3	323.7	1006.6	14%
1998	514.1	678.9	875.5	647.9	1602.2	-9%
1999	106.4	573.8	676.7	625.4	762.5	-2%
2000	108.9	396.0	530.5	583.0	309.5	14%
Total	944.7	2204.3	2861.1	2180.0	3680.8	2%

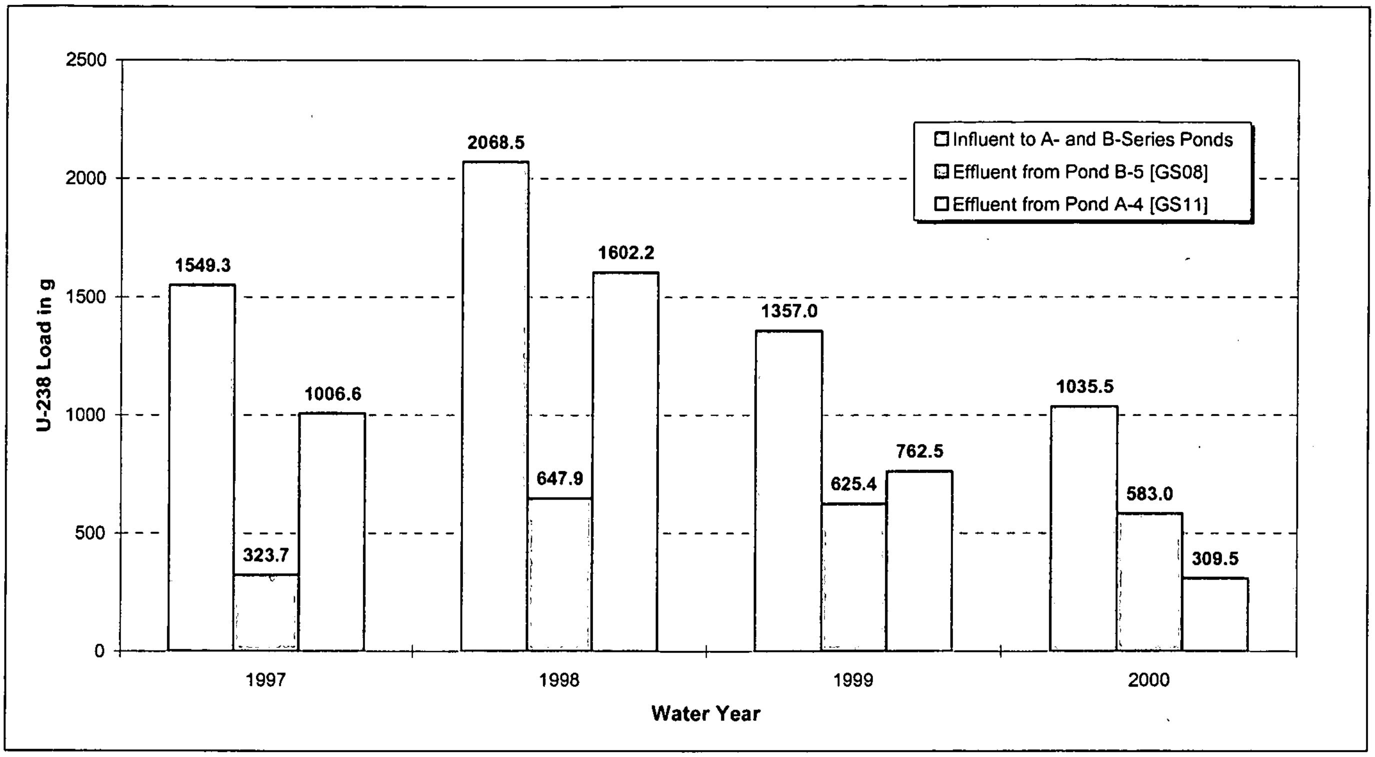

Figure 5-38. Annual U-238 Loads for the A- and B-Series Ponds: WY97–00.

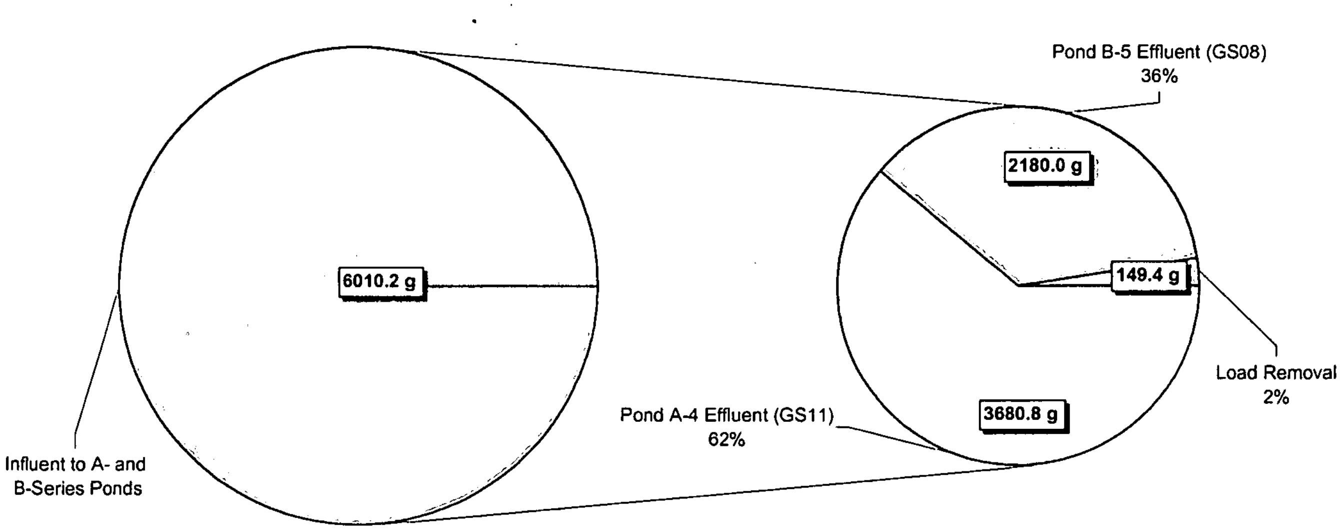

Figure 5-39. Relative U-238 Load Totals for the A- and B-Series Ponds: WY97–00.

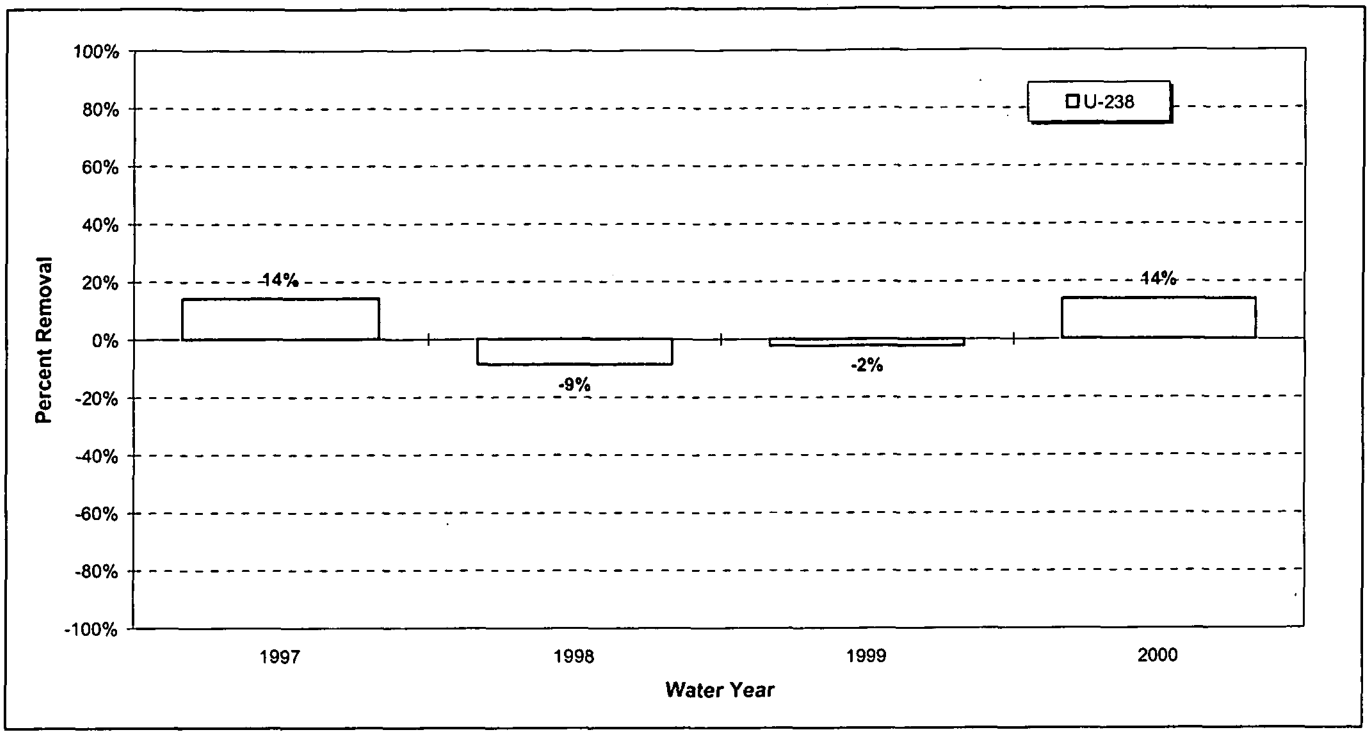

Figure 5-40. Annual U-238 Load Removal for the A- and B-Series Ponds: WY97–00.

5.4.2 Pond C-2 (POC GS31)

This section summarizes the calculated Pu, Am, and isotopic uranium loads for Pond C-2. The influent load source is SW027 (SID at Pond C-2 inlet). The effluent loads are calculated at GS31 (Pond C-2 outlet). The following points are noted:

- Total Pu load removal by Pond C-2 is calculated as 78% (Table 5-14).
- Total Am load removal by Pond C-2 is calculated as 29% (Table 5-15).
- Annual Pu and Am loads vary significantly year-to-year (Figure 5-41 and Figure 5-44).
- Annual isotopic uranium loads also vary significantly year-to-year (Figure 5-47, Figure 5-50 and Figure 5-53).
- There is significant isotopic uranium load gain in Pond C-2. This may be caused by groundwater with naturally occurring uranium entering Pond C-2 (Figure 5-48, Figure 5-51 and Figure 5-54).

Table 5-14. Pu Load Summary for Terminal Pond C-2: WY97–00.

	Pu-239,240 (µg)		
Water Year	**Influent (SW027)**	**Effluent (GS31)**	**Percent Removal**
1997	14.2	6.8	52%
1998	90.8	12.1	87%
1999	34.1	26.9	21%
2000	67.5	0.0	100%[a]
Total	206.6	45.8	78%

Notes: [a] No Pond C-2 discharge.

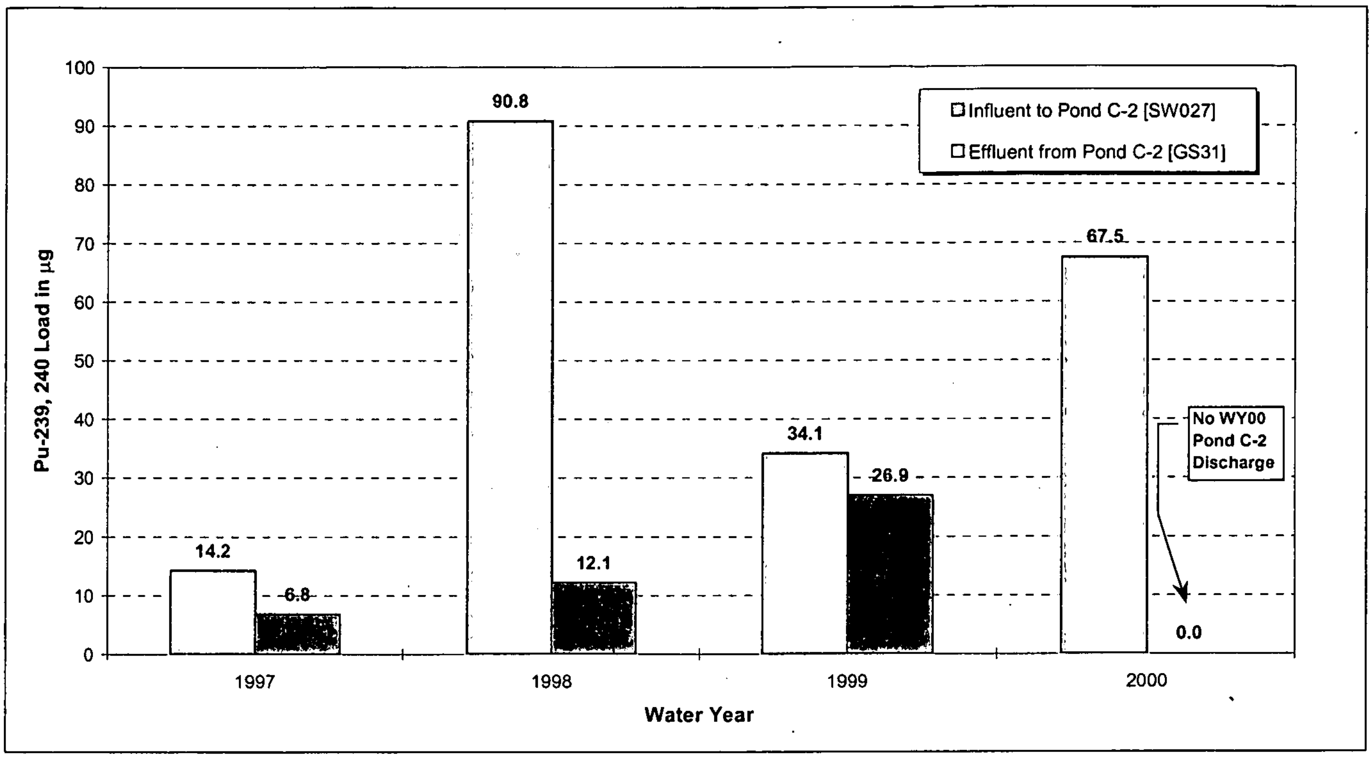

Figure 5-41. Annual Pu Loads for Pond C-2: WY97–00.

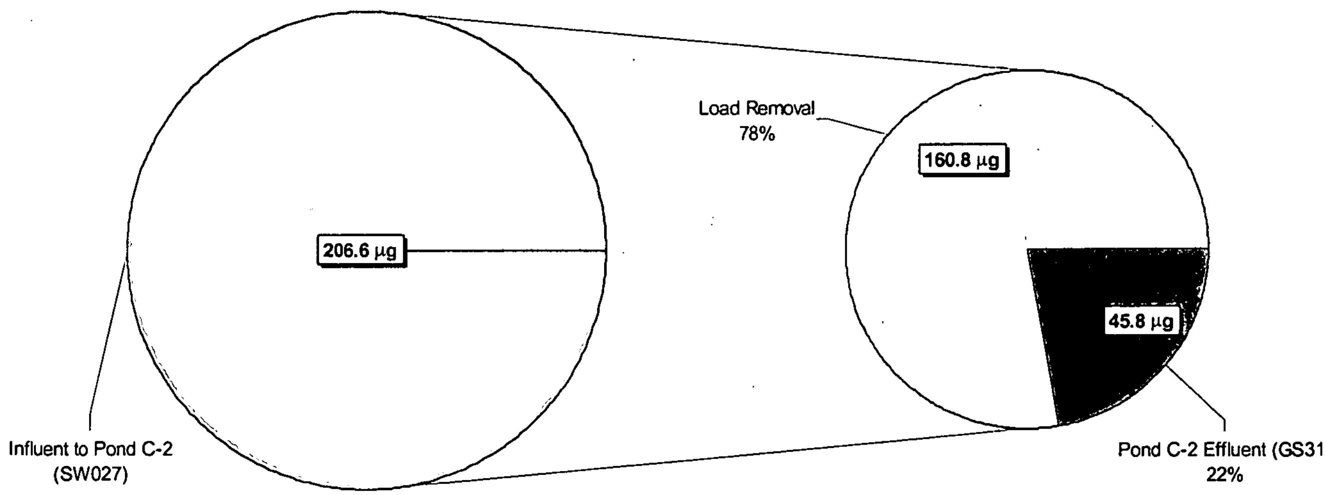

Figure 5-42. Relative Pu Load Totals for Pond C-2: WY97–00.

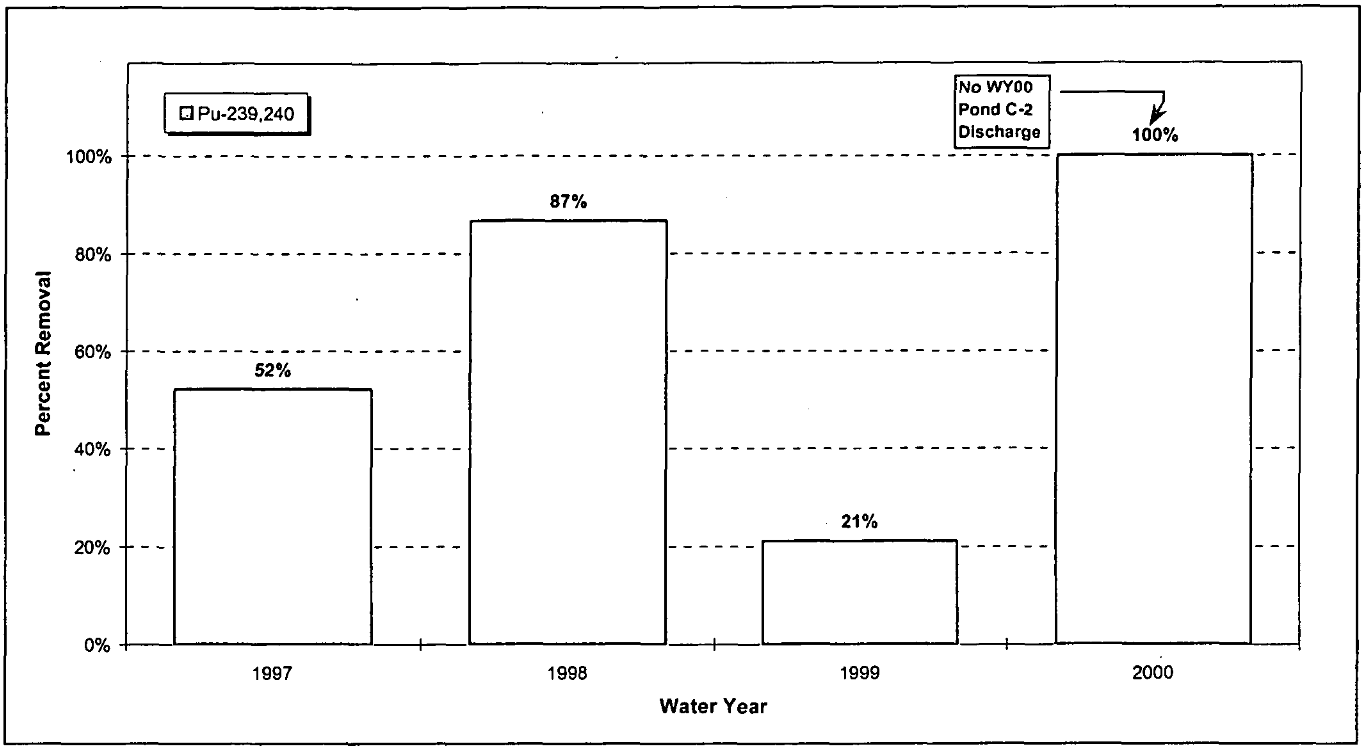

Figure 5-43. Annual Pu Load Removal for Pond C-2: WY97–00.

Table 5-15. Am Load Summary for Terminal Pond C-2: WY97–00.

	Am-241 (µg)		
Water Year	**Influent (SW027)**	**Effluent (GS31)**	**Percent Removal**
1997	0.06	0.04	27%
1998	0.28	0.40	-45%
1999	0.19	0.13	34%
2000	0.25	0.00	100%[a]
Total	0.78	0.57	27%

Notes: [a] No Pond C-2 discharge.

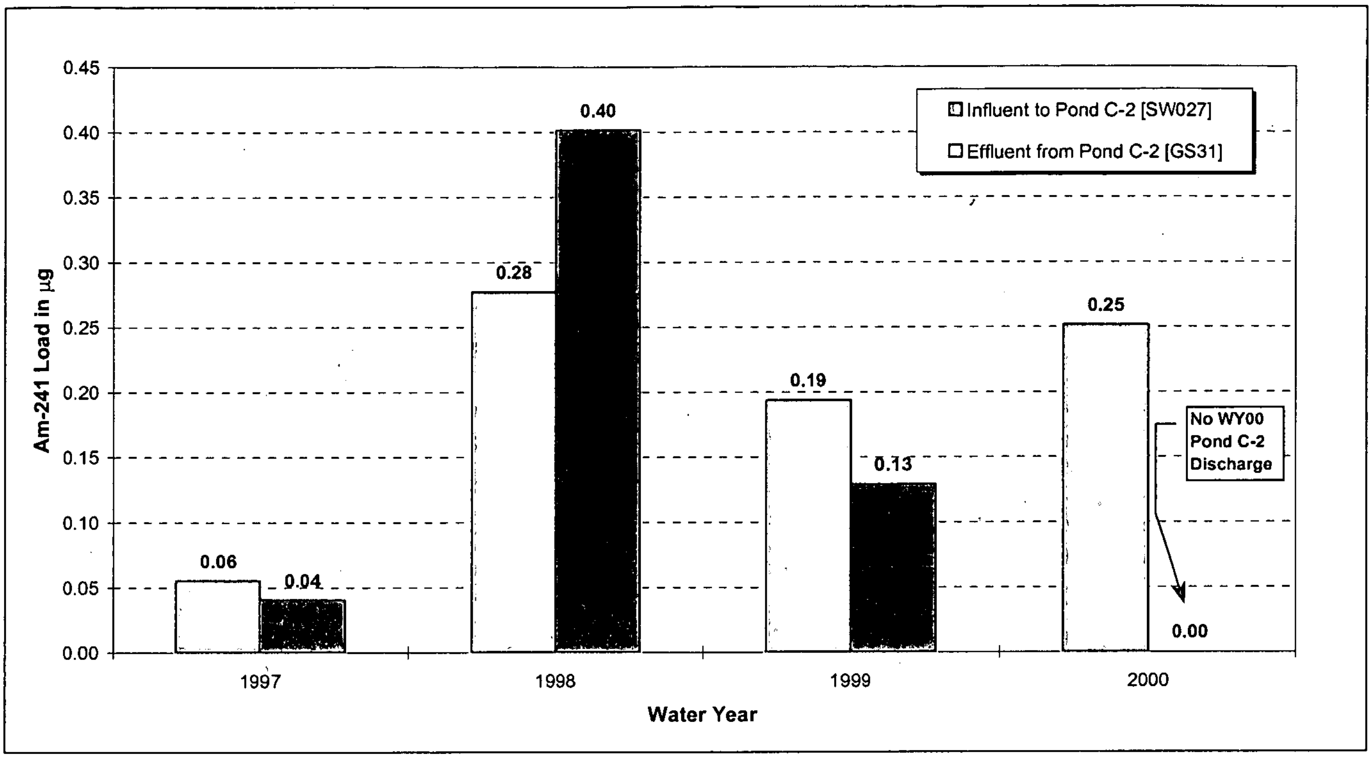

Figure 5-44. Annual Am Loads for Pond C-2: WY97–00.

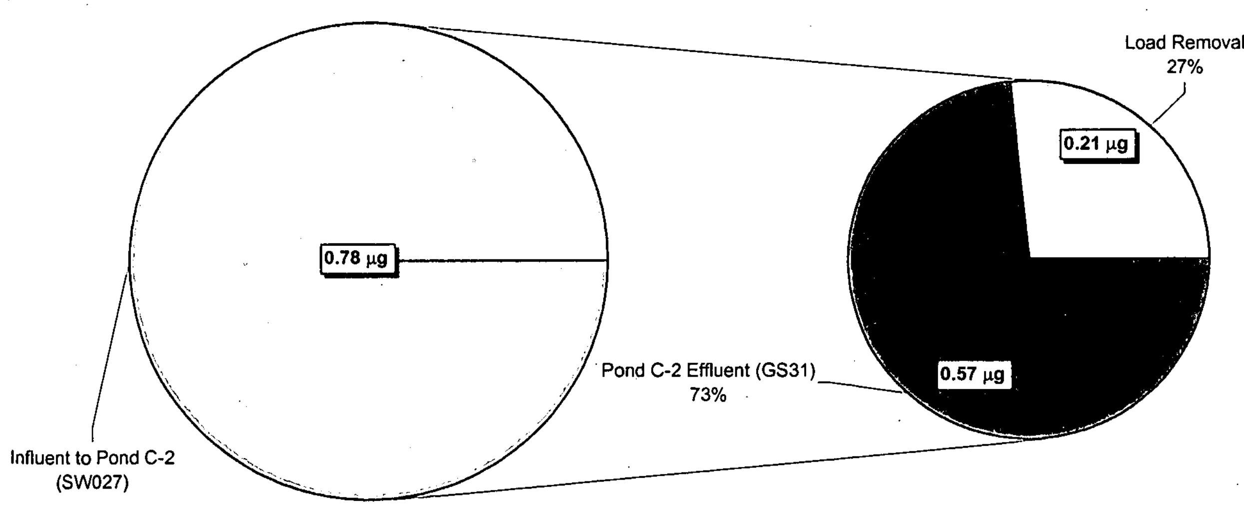

Figure 5-45. Relative Am Load Totals for Pond C-2: WY97–00.

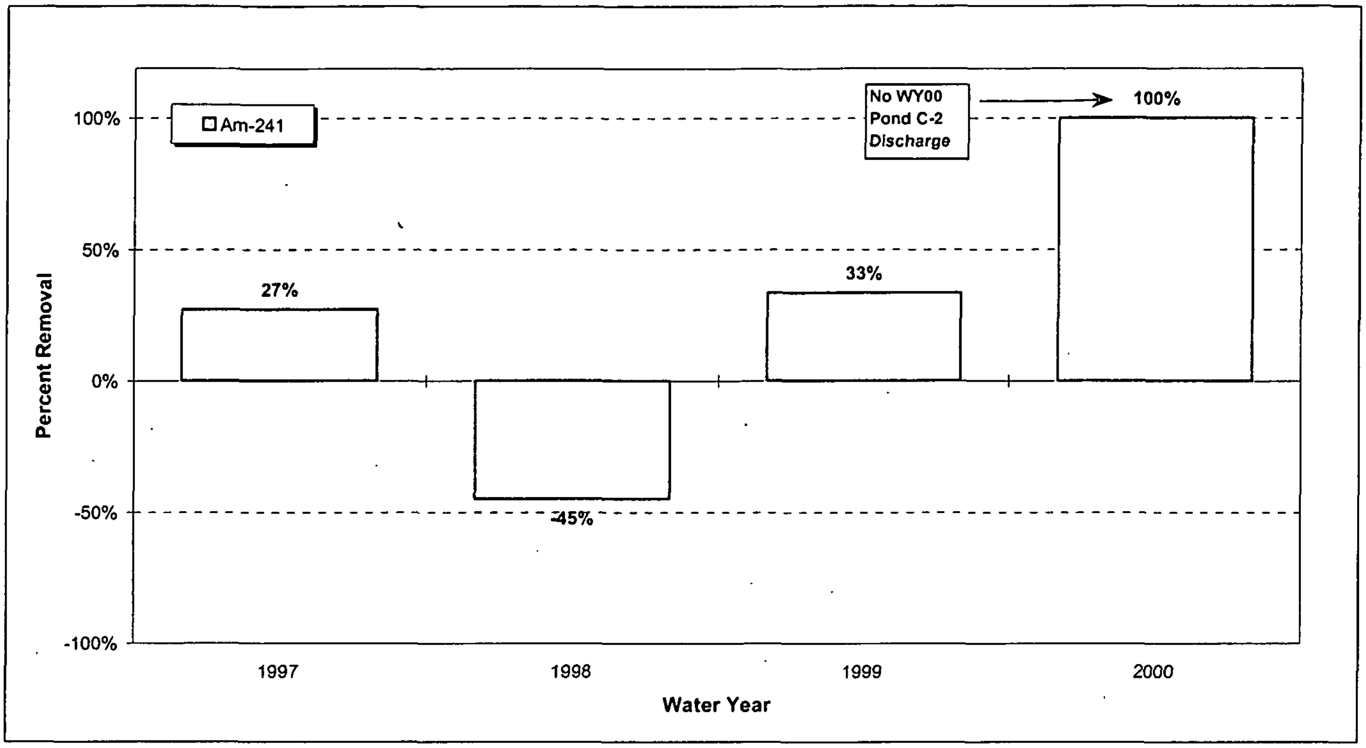

Figure 5-46. Annual Am Load Removal for Pond C-2: WY97–00.

Table 5-16. U-233,234 Load Summary for Terminal Pond C-2: WY97–00.

	U-233,234 (g)		
Water Year	**Influent (SW027)**	**Effluent (GS31)**	**Percent Removal**
1997	0.003	0.005	-92%
1998	0.010	0.014	-46%
1999	0.005	0.009	-91%
2000	0.001	0.000	100%[a]
Total	0.018	0.028	-52%

Notes: [a] No Pond C-2 discharge.

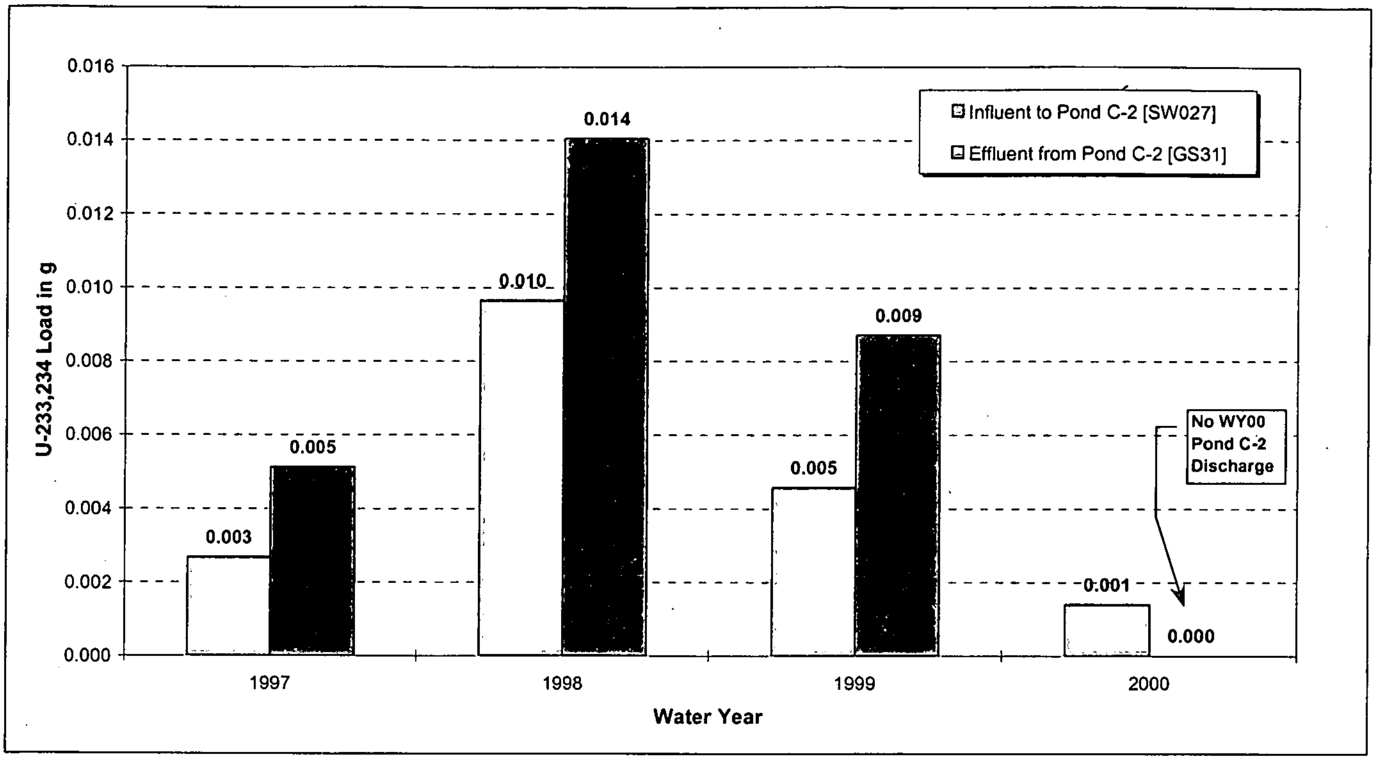

Figure 5-47. Annual U-233,234 Loads for Pond C-2: WY97–00.

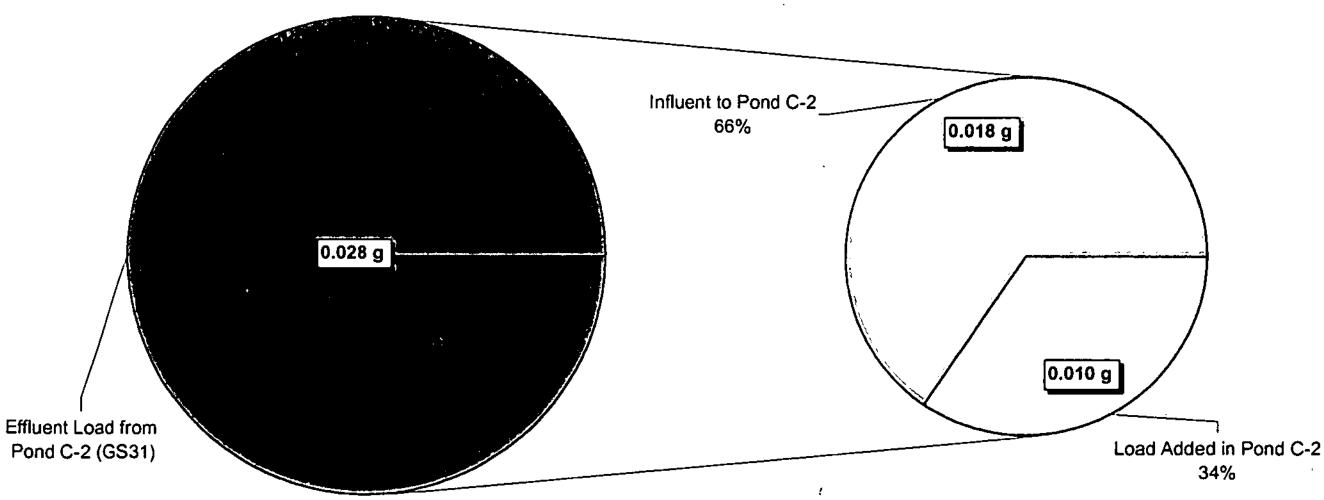

Figure 5-48. Relative U-233,234 Load Totals for Pond C-2: WY97–00.

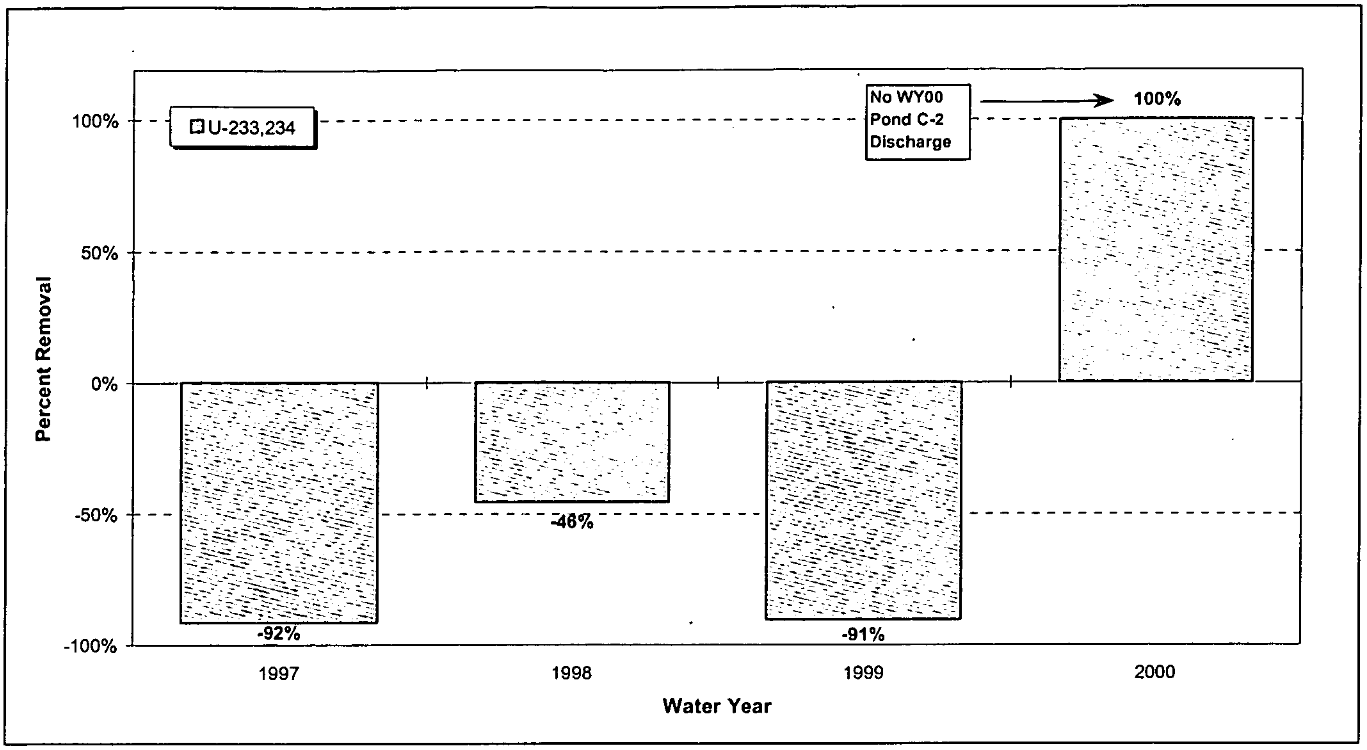

Figure 5-49. Annual U-233,234 Load Removal for Pond C-2: WY97–00.

Table 5-17. U-235 Load Summary for Terminal Pond C-2: WY97–00.

	U-235 (g)		
Water Year	**Influent (SW027)**	**Effluent (GS31)**	**Percent Removal**
1997	0.43	0.75	-75%
1998	1.00	1.09	-9%
1999	0.63	1.66	-164%
2000	0.18	0.00	100%[a]
Total	2.24	3.50	-57%

Notes: [a] No Pond C-2 discharge.

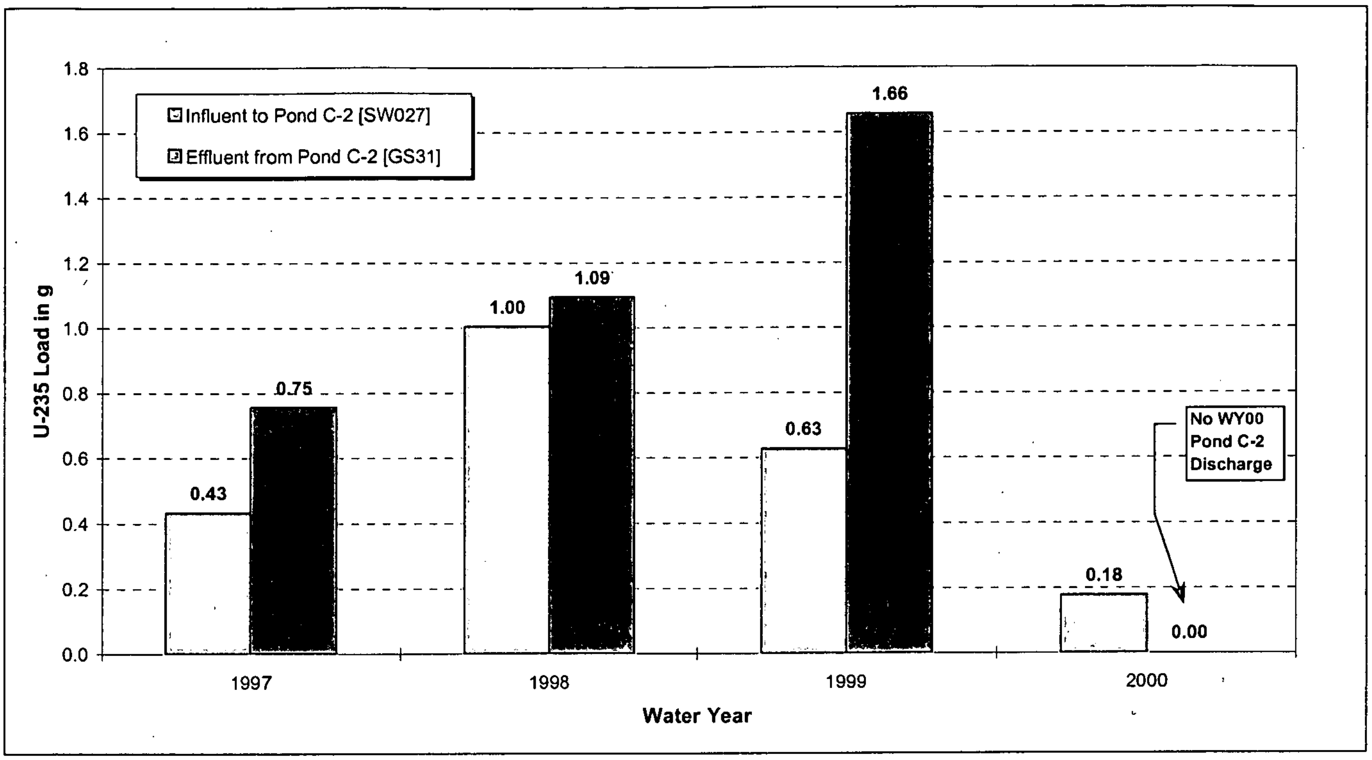

Figure 5-50. Annual U-235 Loads for Pond C-2: WY97–00.

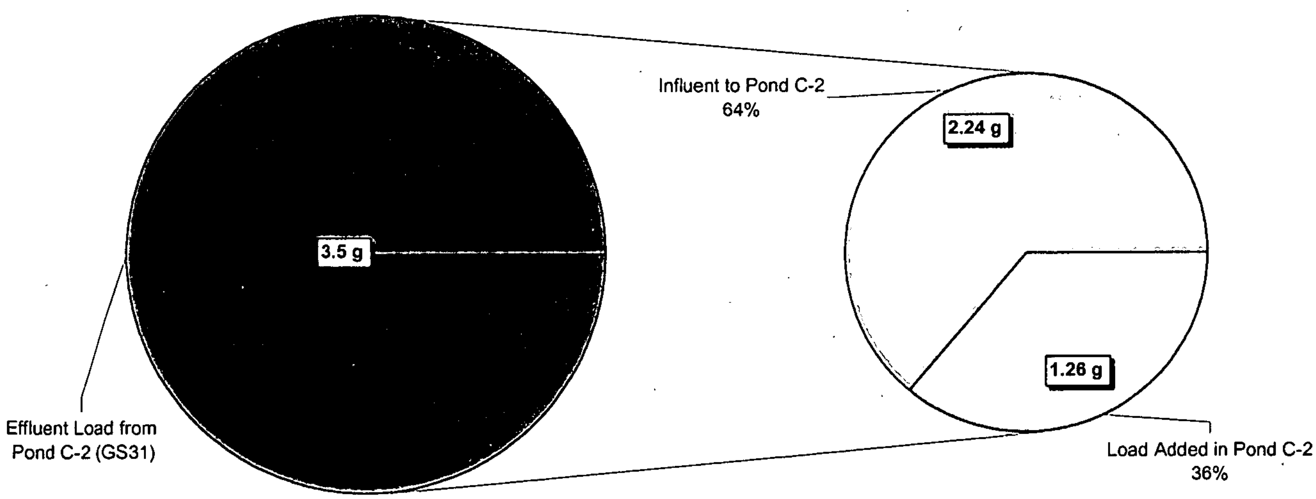

Figure 5-51. Relative U-235 Load Totals for Pond C-2: WY97–00.

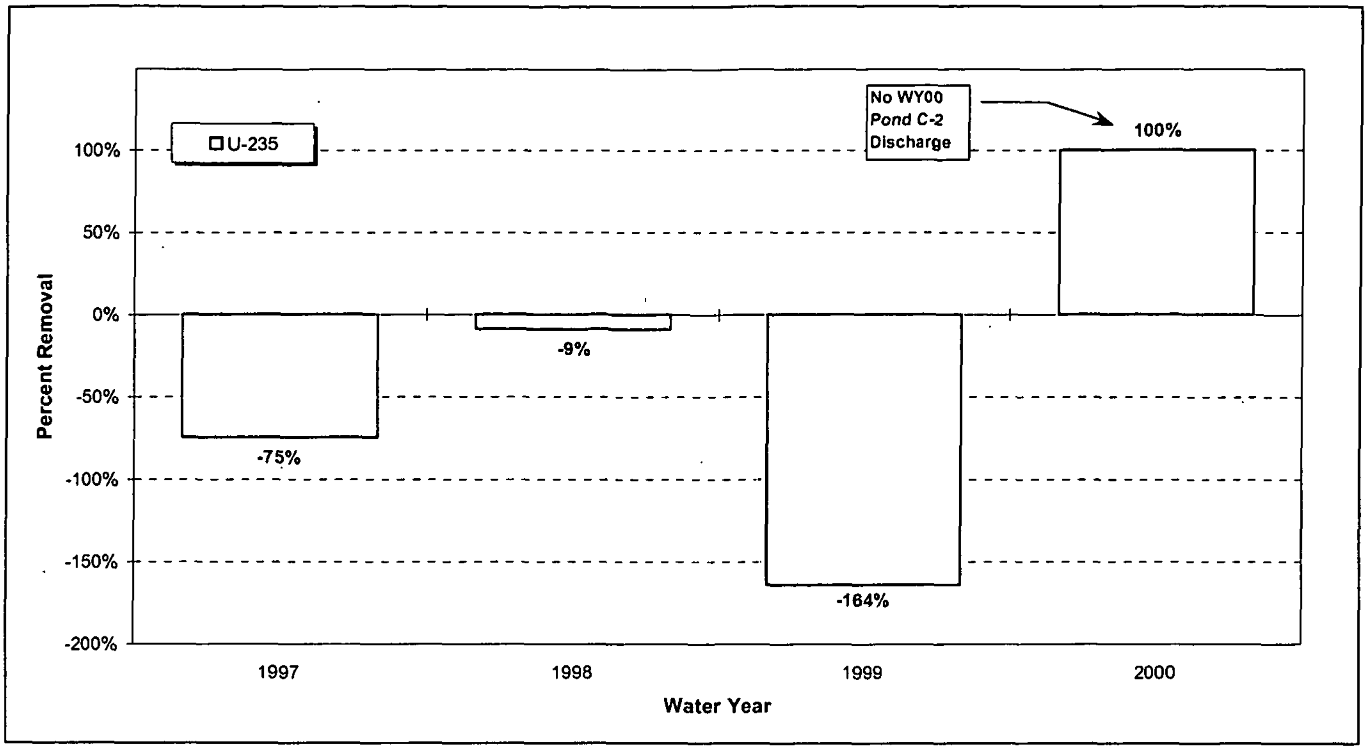

Figure 5-52. Annual U-235 Load Removal for Pond C-2: WY97–00.

Table 5-18. U-238 Load Summary for Terminal Pond C-2: WY97–00.

Water Year	U-238 (g)		
	Influent (SW027)	Effluent (GS31)	Percent Removal
1997	65.2	102.4	-57%
1998	255.0	342.1	-34%
1999	112.4	187.5	-67%
2000	25.7	0.0	100%[a]
Total	458.3	631.9	-38%

Notes: [a] No Pond C-2 discharge.

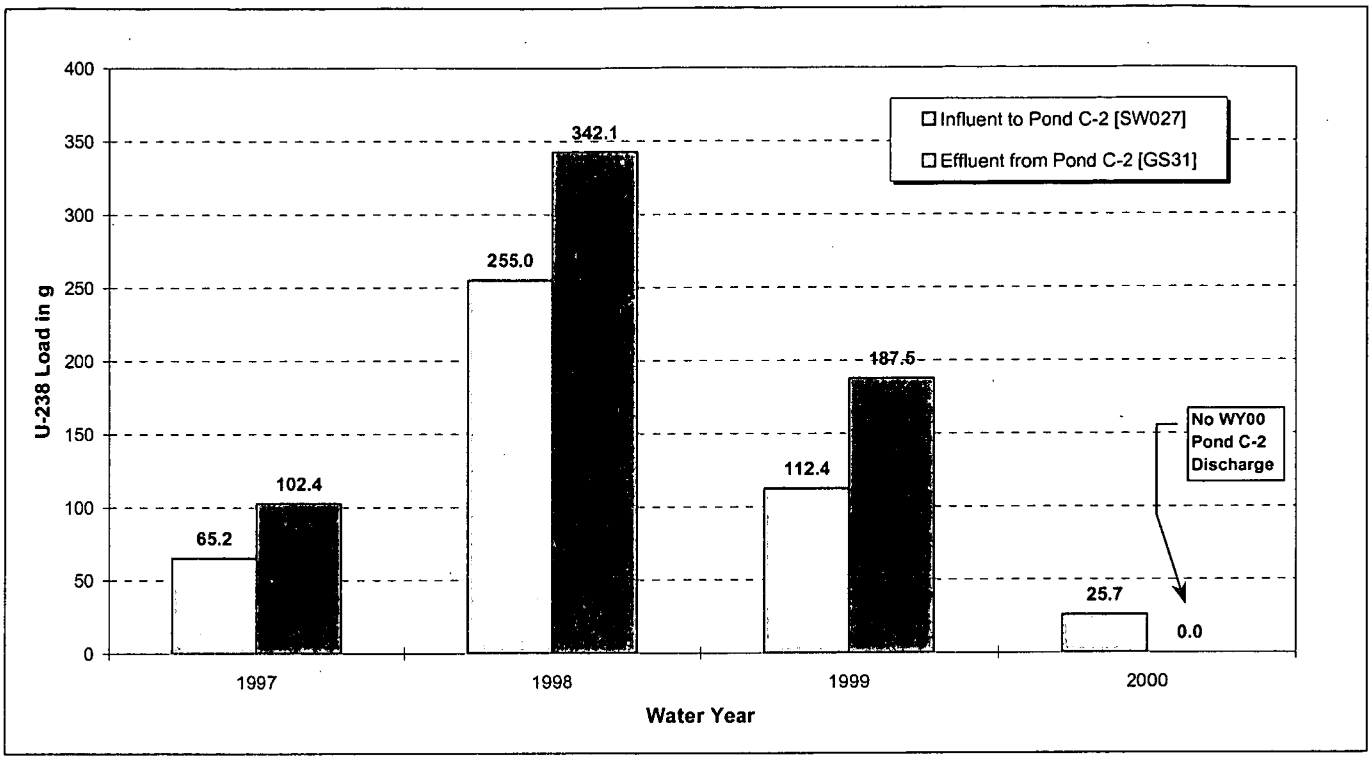

Figure 5-53. Annual U-238 Loads for Pond C-2: WY97–00.

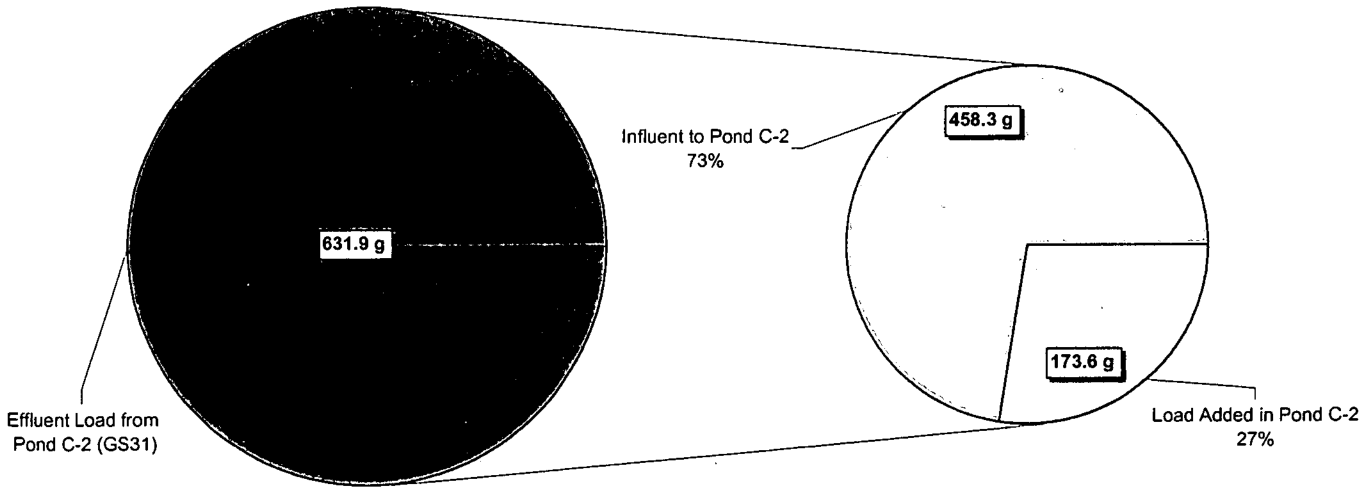

Figure 5-54. Relative U-238 Load Totals for Pond C-2: WY97–00.

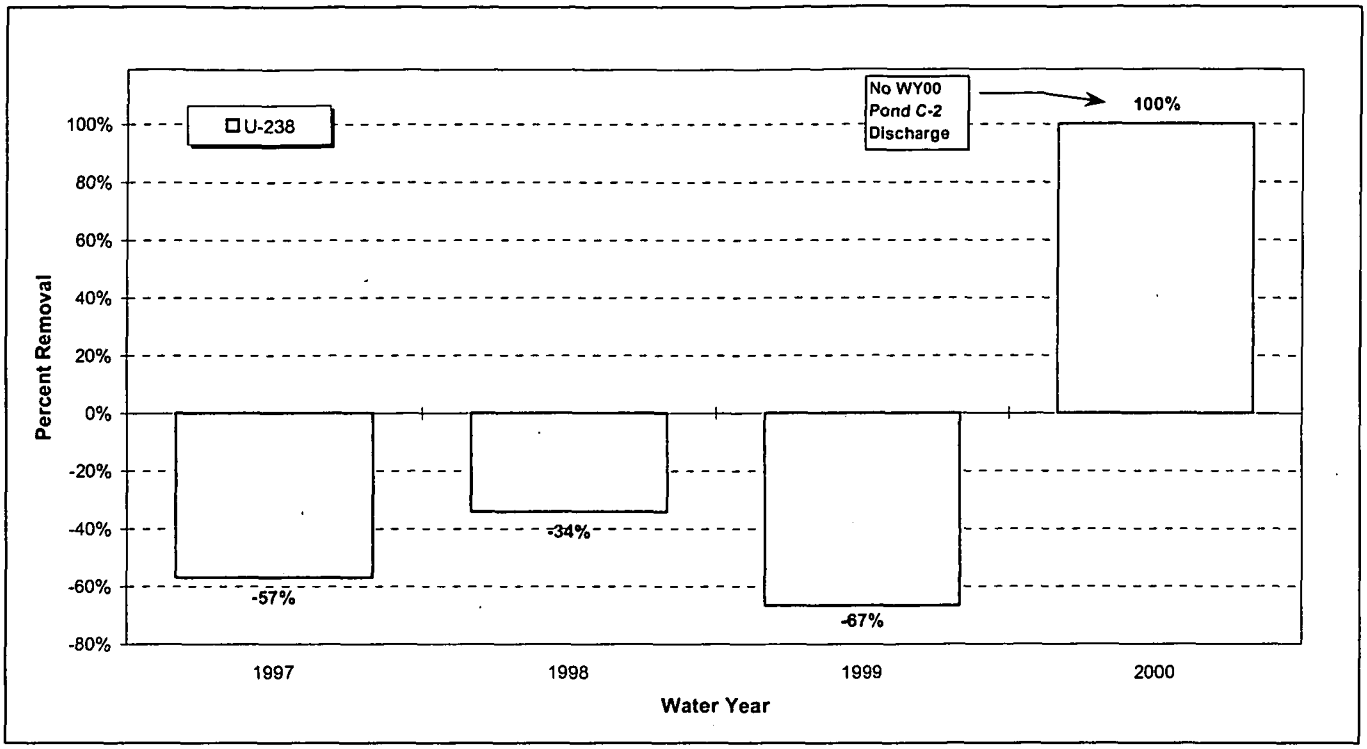

Figure 5-55. Annual U-238 Load Removal for Pond C-2: WY97–00.

5.5 RFCA POINTS OF EVALUATION

5.5.1 Major IA Drainages

This section summarizes the calculated Pu, Am, and isotopic uranium loads for the three major IA drainages: North Walnut Creek (SW093)[13], South Walnut Creek (GS10 and the WWTP), and the SID (SW027). The following points are noted:

- Total Pu load from the IA is fairly consistent year-to-year (Figure 5-56).
- Total Am load from the IA varies more year-to-year (Figure 5-58). This variation is predominantly the result of Am variability at GS10.
- South Walnut accounts for a majority (71%) of the Pu load from the IA (Figure 5-57). Of the S. Walnut Pu load, GS10 accounts for 96% while the WWTP accounts for the remaining 4%.
- South Walnut accounts for a majority (86%) of the Am load from the IA (Figure 5-59). Of the S. Walnut Am load, GS10 accounts for 97% while the WWTP accounts for the remaining 3%.
- Annual isotopic uranium loads are fairly consistent year-to-year (Figure 5-60, Figure 5-62 and Figure 5-64).
- Isotopic uranium loads are fairly evenly divided between North and South Walnut Creeks (Figure 5-61, Figure 5-63 and Figure 5-65).

[13] Although SW091 is also a load source to N. Walnut (Figure 3-2), the flow volumes at SW091 are approximately 0.3% of the volumes at SW093. Additionally, SW091 does not collect continuous flow-paced sample to allow for more accurate load calculations. Therefore, SW091 load is not included due to it's relative insignificance.

Table 5-19. Industrial Area Pu and Am Loads: WY97–00.

	Pu-239,-240 (μg)				Am-241 (μg)			
Water Year	N. Walnut [SW093]	S. Walnut [GS10]	S. Walnut [WWTP]	SID [SW027]	N. Walnut [SW093]	S. Walnut [GS10]	S. Walnut [WWTP]	SID [SW027]
1997	178.7	564.0	13.4	14.2	2.27	11.98	0.44	0.06
1998	70.9	345.3	8.7	90.8	1.38	4.95	0.58	0.28
1999	126.9	306.8	23.2	34.1	1.69	12.55	0.11	0.19
2000	88.5	329.6	18.4	67.5	1.03	14.65	0.33	0.25
Total	464.9	1545.7	63.7	206.6	6.38	44.13	1.45	0.78

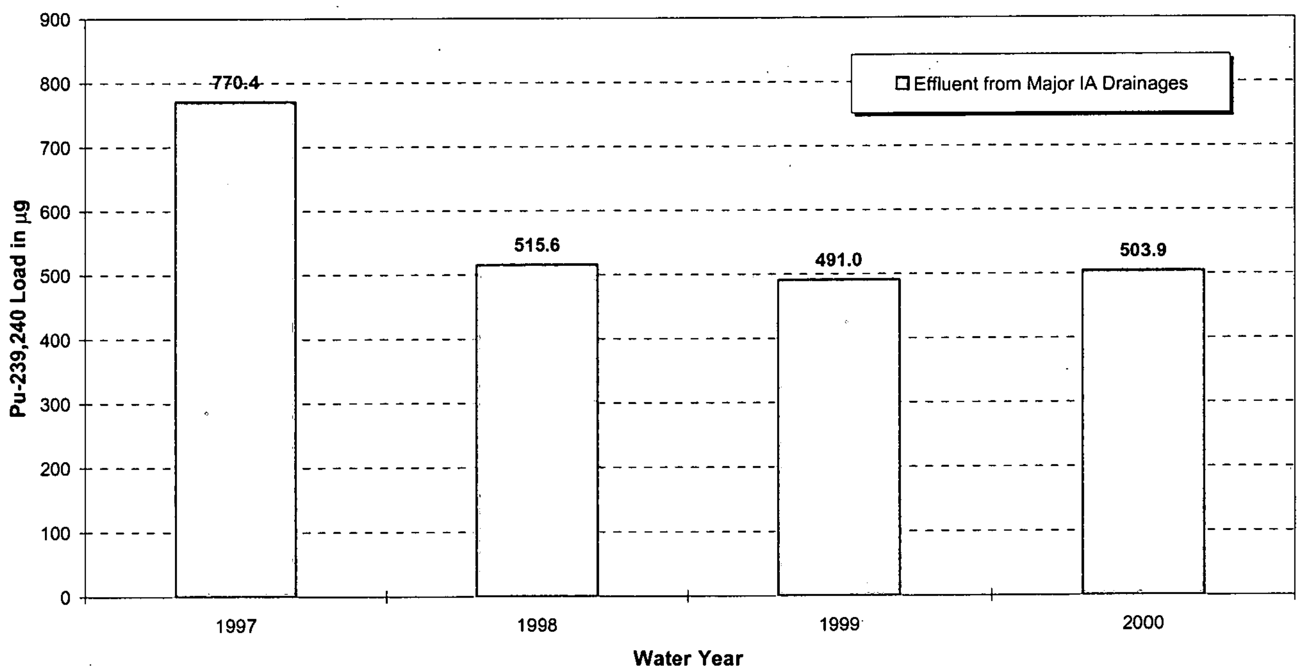

Figure 5-56. Combined Annual Pu Loads from Major IA Drainages and WWTP: WY97–00.

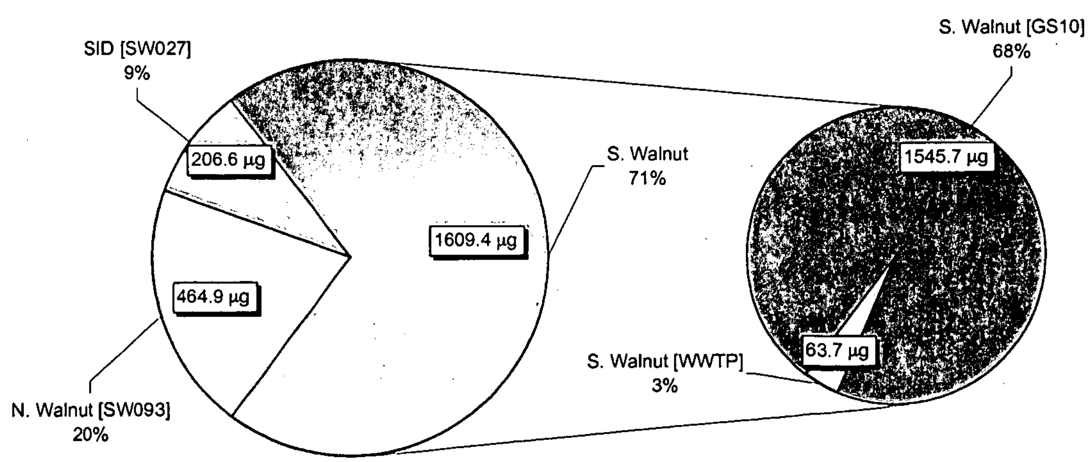

Figure 5-57. Relative Pu Load Totals from Major IA Drainages and WWTP: WY97–00.

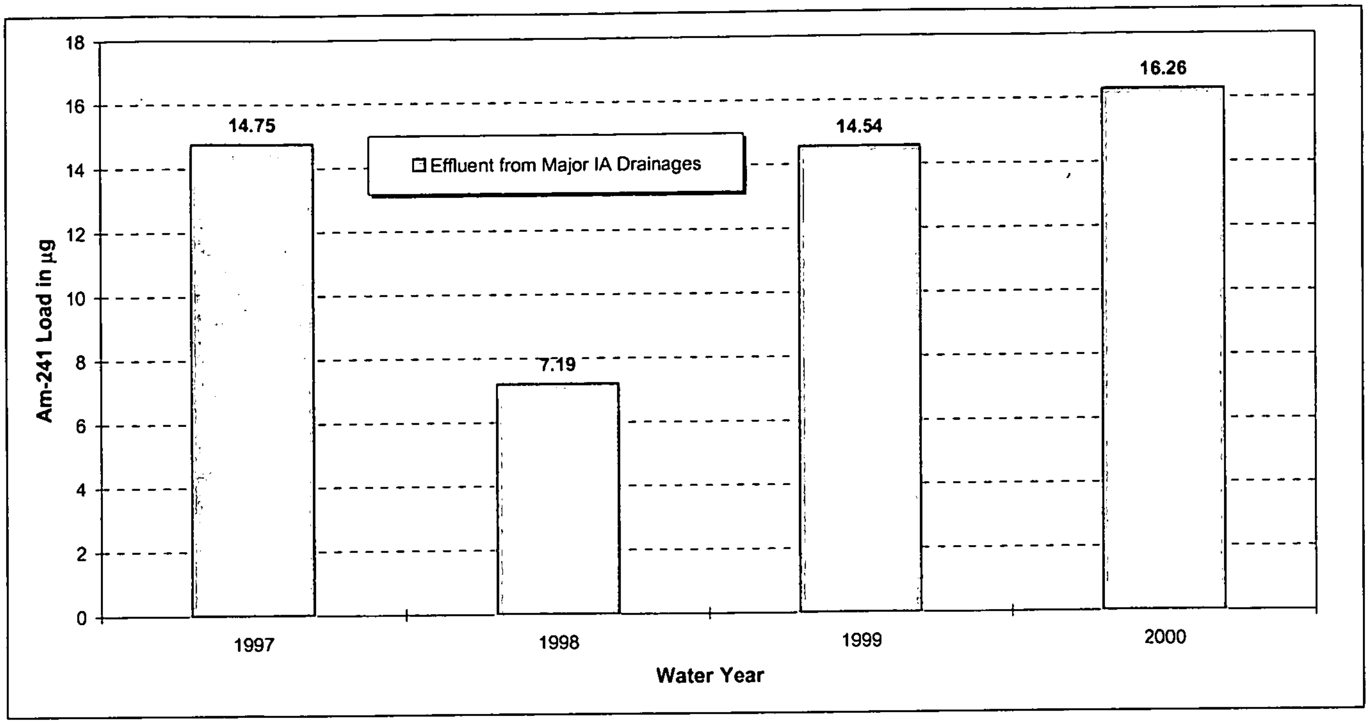

Figure 5-58. Annual Am Loads from Major IA Drainages and WWTP: WY97–00.

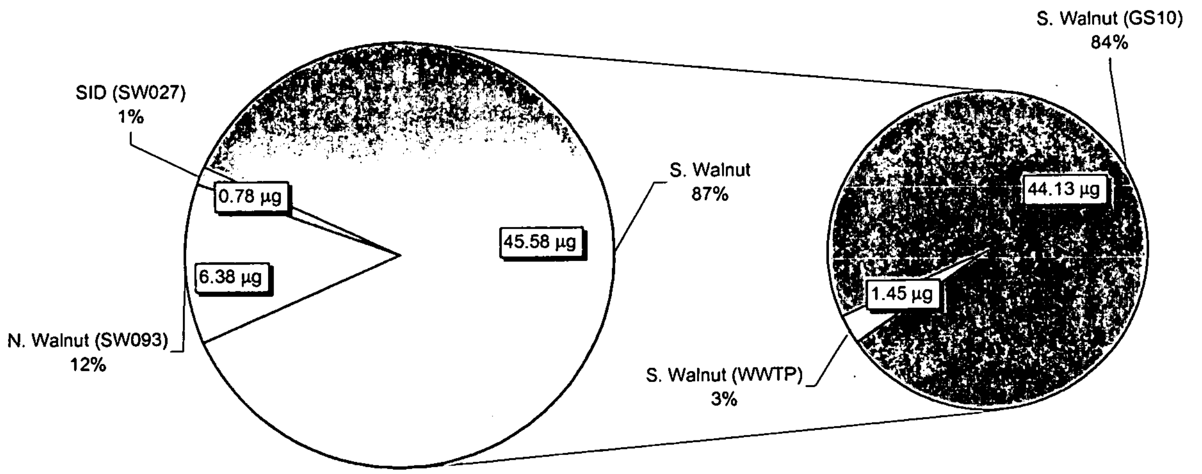

Figure 5-59. Relative Am Load Totals from Major IA Drainages and WWTP: WY97–00.

Table 5-20. Industrial Area U-233,234 Loads: WY97–00.

	U-233,234 (g)			
Water Year	**N. Walnut [SW093]**	**S. Walnut [GS10]**	**S. Walnut [WWTP]**	**SID [SW027]**
1997	0.033	0.031	0.013	0.003
1998	0.041	0.039	0.023	0.010
1999	0.033	0.030	0.005	0.005
2000	0.026	0.022	0.006	0.001
Total	0.134	0.122	0.047	0.018

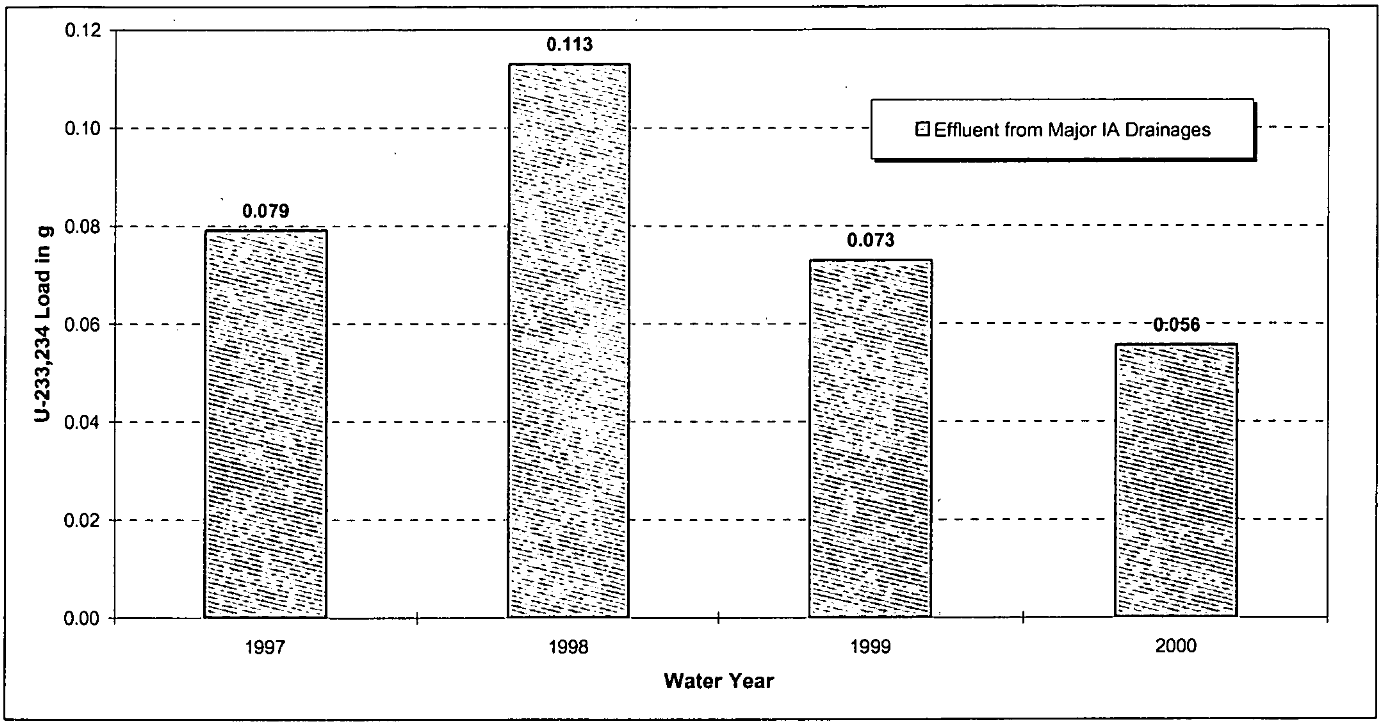

Figure 5-60. Annual U-233,234 Loads from Major IA Drainages and WWTP: WY97–00.

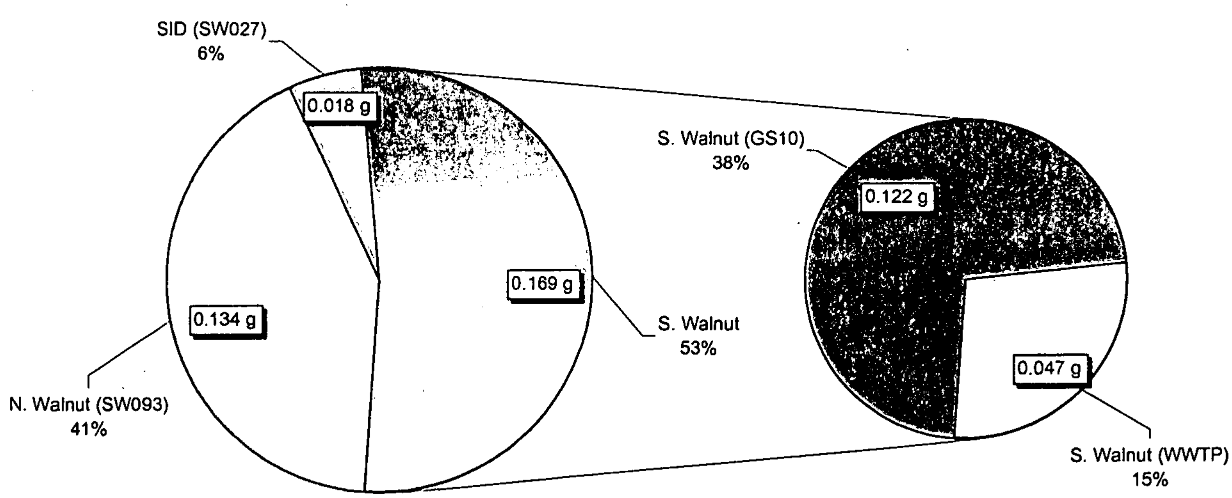

Figure 5-61. Relative U-233,234 Load Totals from Major IA Drainages and WWTP: WY97–00.

Table 5-21. Industrial Area U-235 Loads: WY97–00.

	U-235 (g)			
Water Year	N. Walnut [SW093]	S. Walnut [GS10]	S. Walnut [WWTP]	SID [SW027]
1997	4.77	4.05	2.57	0.43
1998	5.32	4.48	2.09	1.00
1999	3.53	3.57	1.21	0.63
2000	3.36	2.64	0.71	0.18
Total	16.97	14.75	6.57	2.24

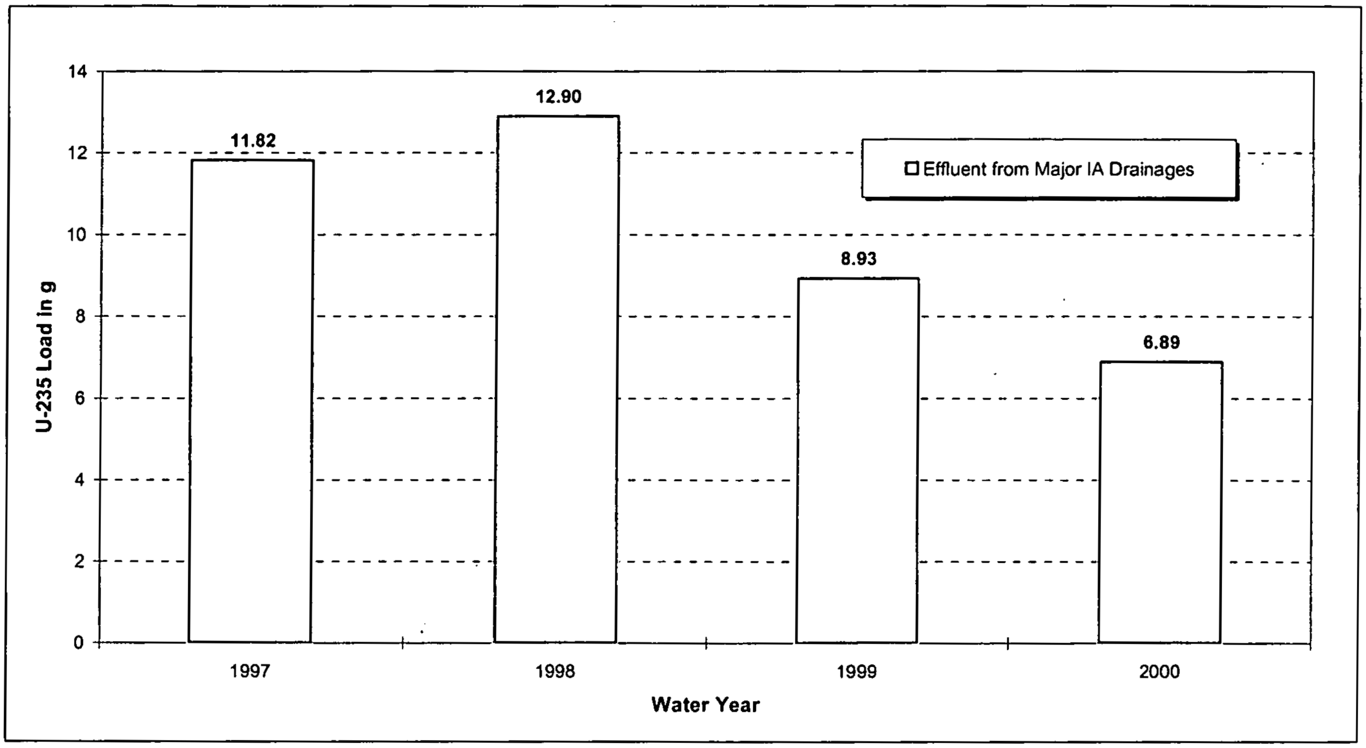

Figure 5-62. Annual U-235 Loads from Major IA Drainages and WWTP: WY97–00.

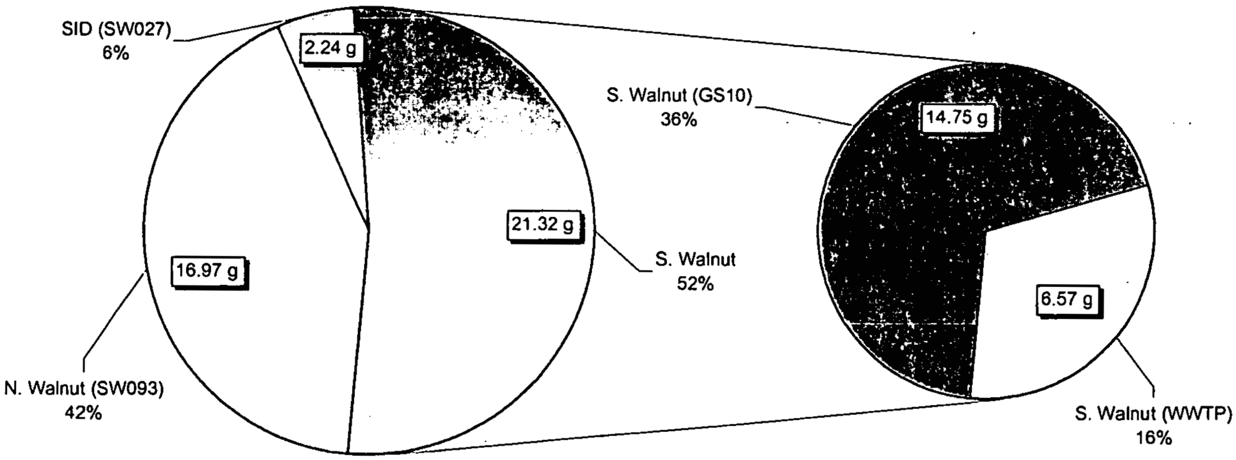

Figure 5-63. Relative U-235 Load Totals from Major IA Drainages and WWTP: WY97–00.

Table 5-22. Industrial Area U-238 Loads: WY97–00.

	U-238 (g)			
Water Year	N. Walnut [SW093]	S. Walnut [GS10]	S. Walnut [WWTP]	SID [SW027]
1997	778.3	555.6	215.3	65.2
1998	875.5	678.9	514.1	255.0
1999	676.7	573.8	106.4	112.4
2000	530.5	396.0	108.9	25.7
Total	2861.1	2204.3	944.7	458.3

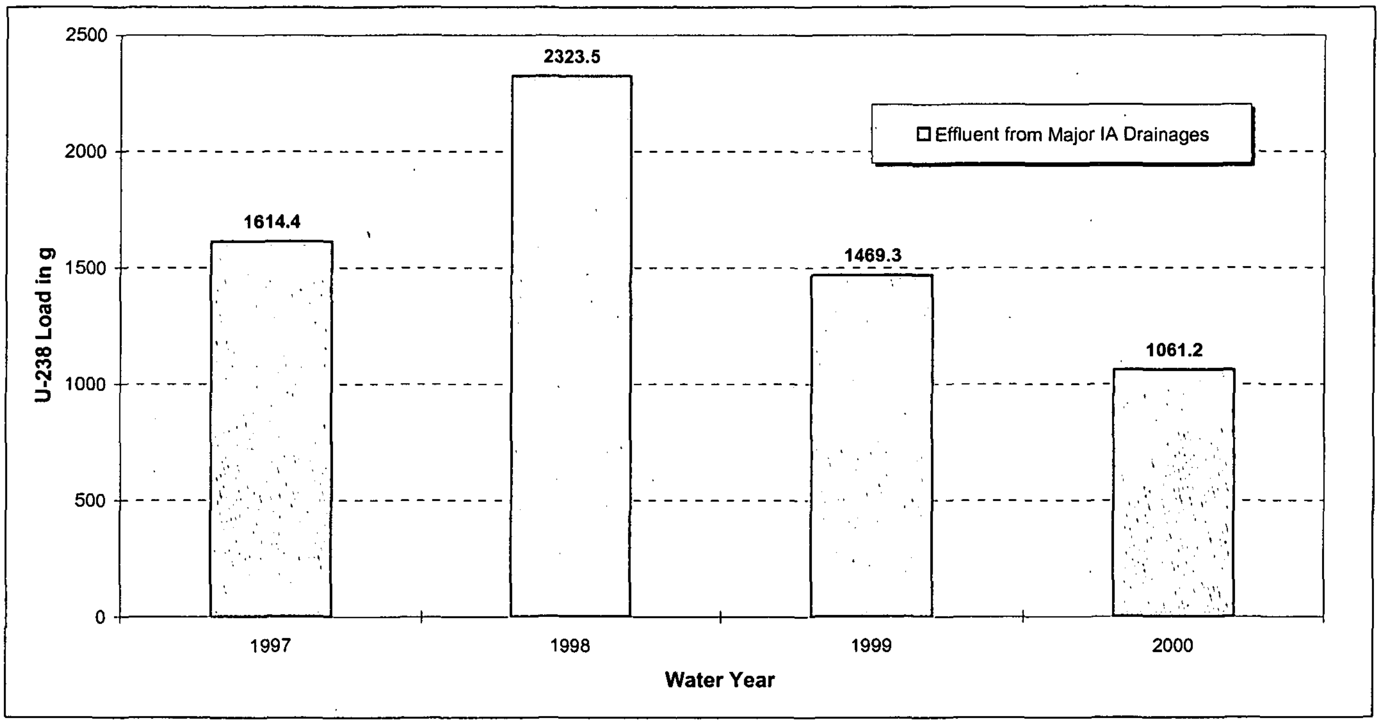

Figure 5-64. Annual U-238 Loads from Major IA Drainages and WWTP: WY97–00.

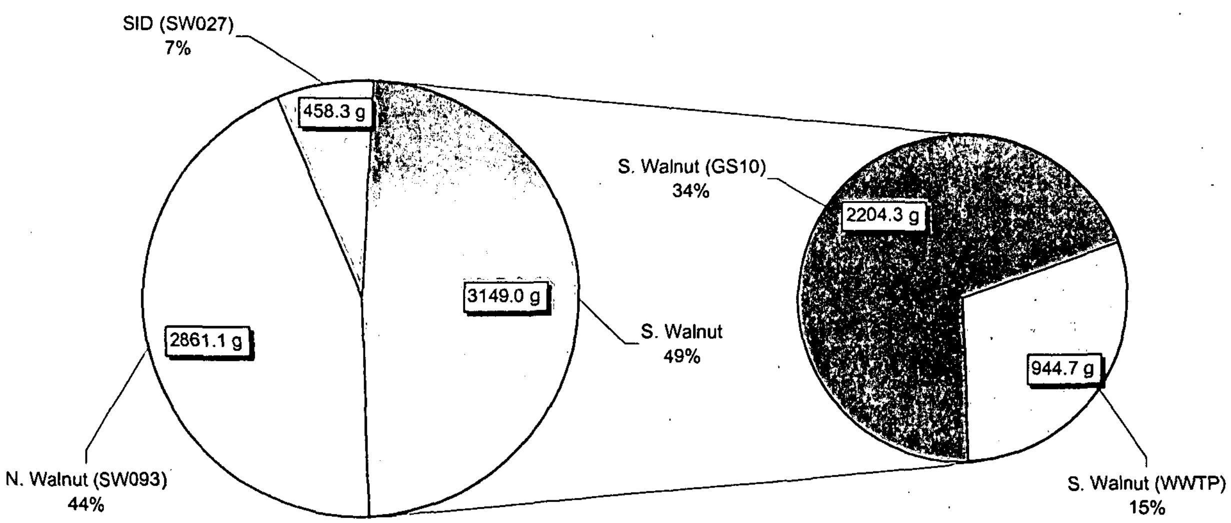

Figure 5-65. Relative U-238 Load Totals from Major IA Drainages and WWTP: WY97–00.

5.5.2 North Walnut Creek at SW093

This section summarizes the calculated Pu, Am, and isotopic uranium loads for North Walnut Creek at SW093. The following points are noted:

- Annual Pu loads at SW093 vary significantly year-to-year (Figure 5-66).
- Annual Am loads at SW093 are more consistent year-to-year (Figure 5-66).
- Annual isotopic uranium loads are fairly consistent year-to-year (Figure 5-67).

Table 5-23. Actinide Loads in N. Walnut Cr. at SW093: WY97–00.

Water Year	Pu-239,240 [μg]	Am-241 [μg]	U-233,234 [g]	U-235 [g]	U-238 [g]
1997	178.7	2.27	0.033	4.77	778.3
1998	70.9	1.38	0.041	5.32	875.5
1999	126.9	1.69	0.033	3.53	676.7
2000	88.5	1.03	0.026	3.36	530.5
Total	464.9	6.38	0.134	16.97	2861.1

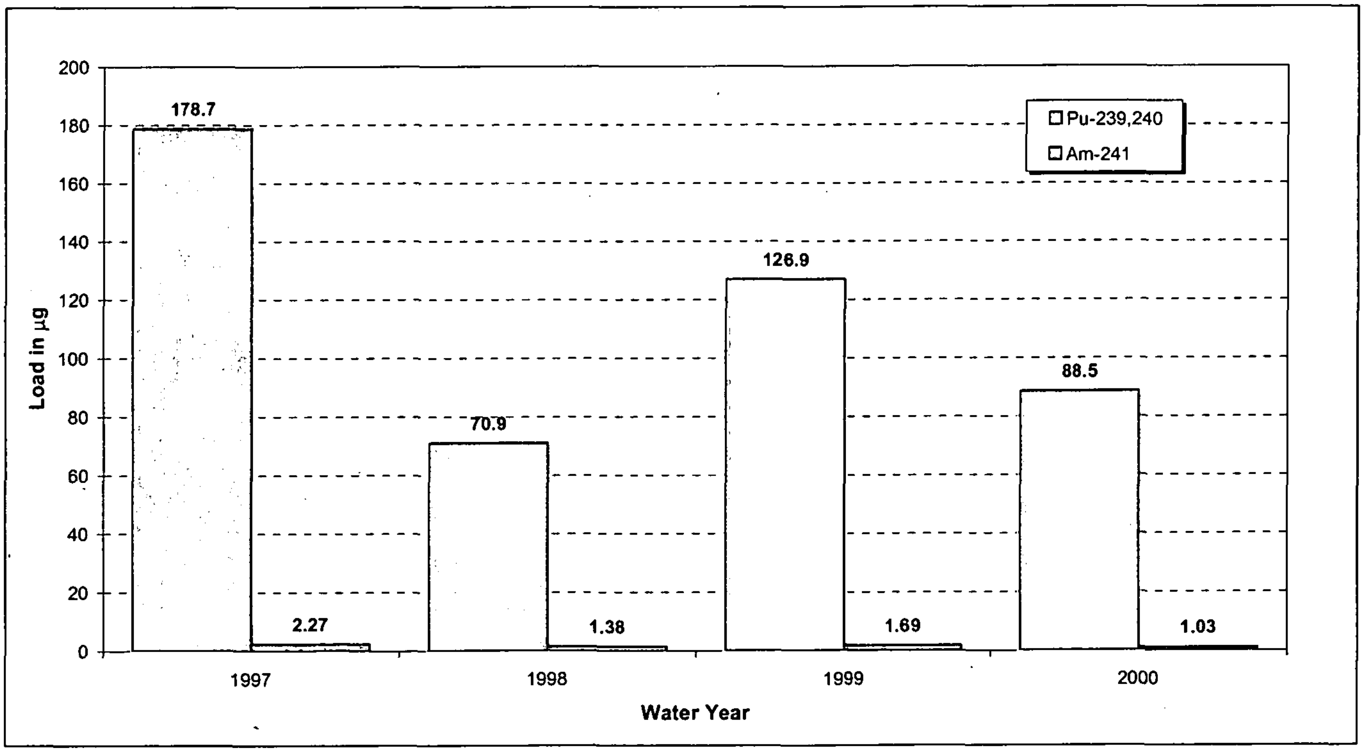

Figure 5-66. Annual Pu and Am Loads at SW093: WY97–00.

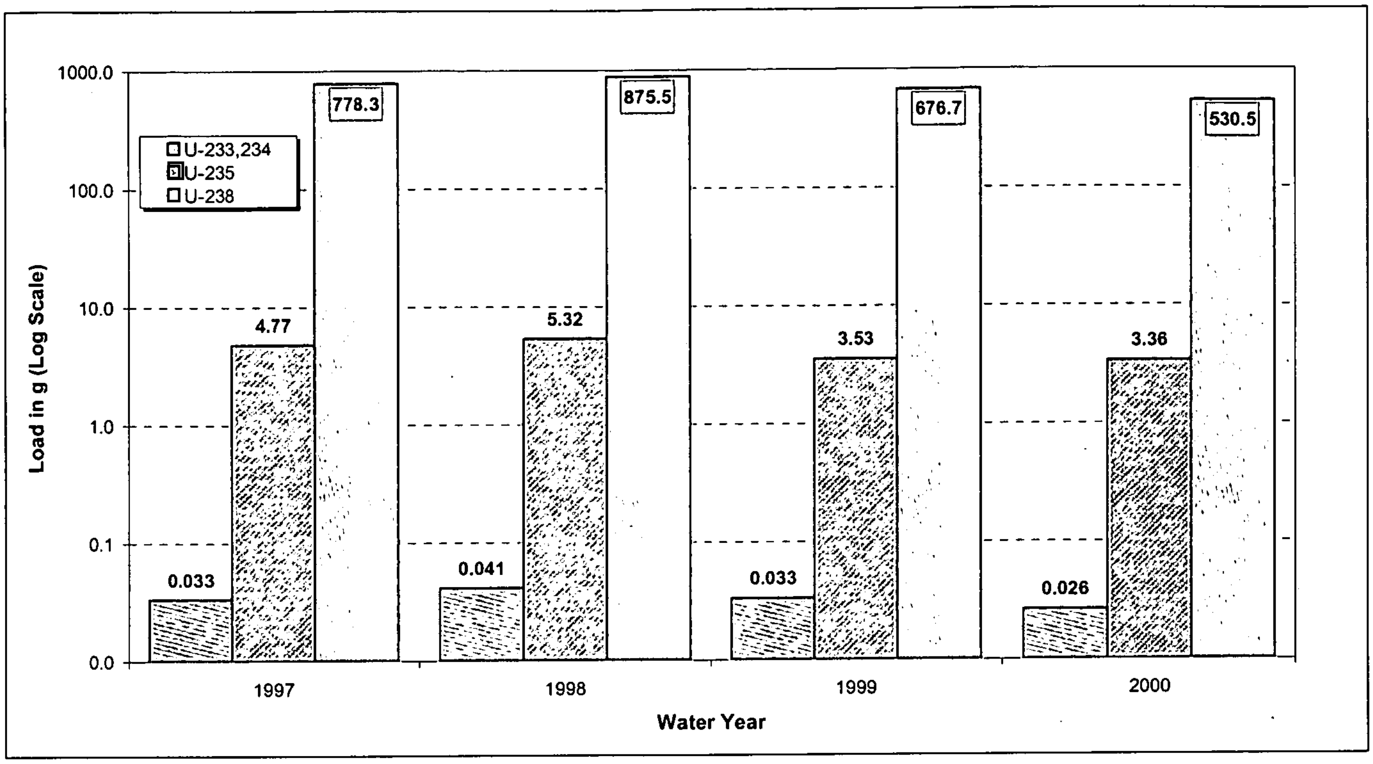

Figure 5-67. Annual Isotopic Uranium Loads at SW093: WY97–00.

5.5.3 South Walnut Creek at GS10

This section summarizes the calculated Pu, Am, and isotopic uranium loads for South Walnut Creek at GS10. The following points are noted:

- Annual Pu loads at GS10 are fairly consistent year-to-year (Figure 5-68).
- Annual Am loads at GS10 are slightly more variable year-to-year (Figure 5-68).
- Annual isotopic uranium loads are fairly consistent year-to-year (Figure 5-69).

Table 5-24. Actinide Loads in S. Walnut Cr. at GS10: WY97–00.

Water Year	Pu-239,240 [µg]	Am-241 [µg]	U-233,234 [g]	U-235 [g]	U-238 [g]
1997	564.0	11.98	0.031	4.05	555.6
1998	345.3	4.95	0.039	4.48	678.9
1999	306.8	12.55	0.030	3.57	573.8
2000	329.6	14.65	0.022	2.64	396.0
Total	1545.7	44.13	0.122	14.75	2204.3

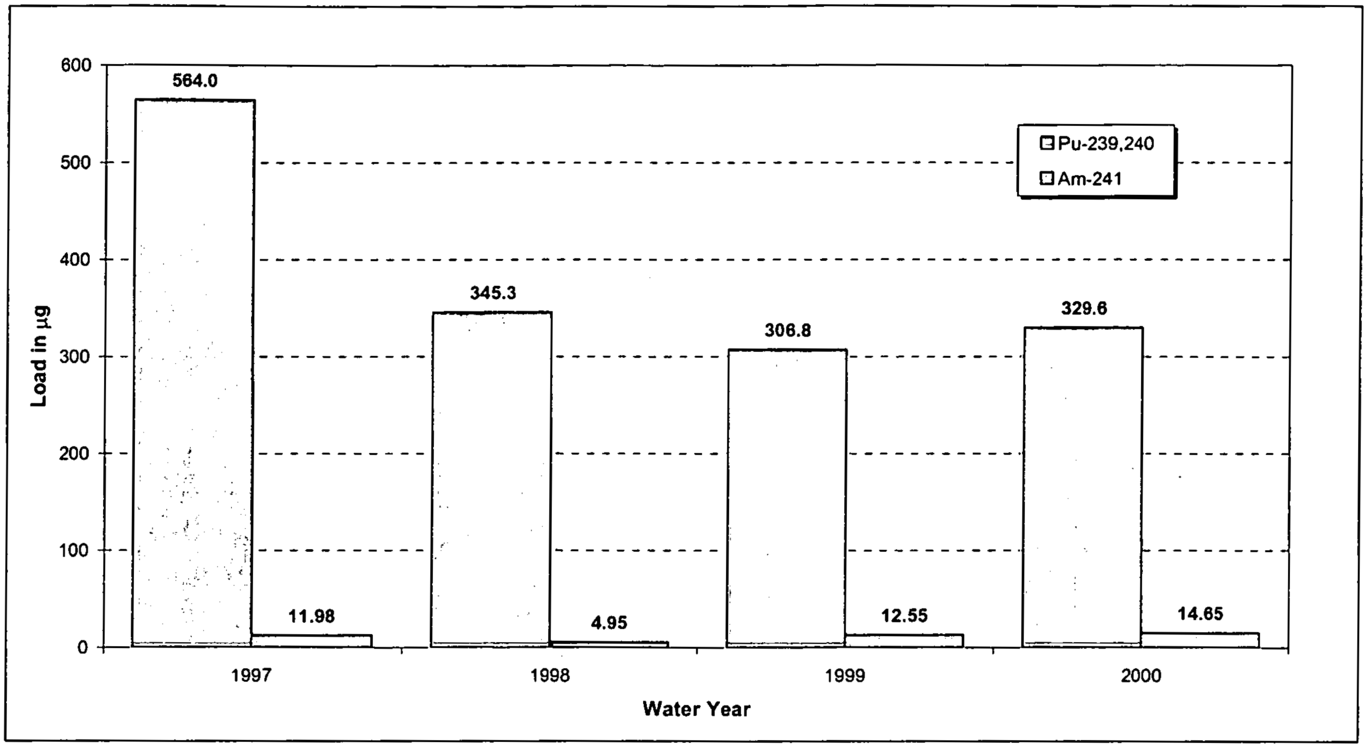

Figure 5-68. Annual Pu and Am Loads at GS10: WY97–00.

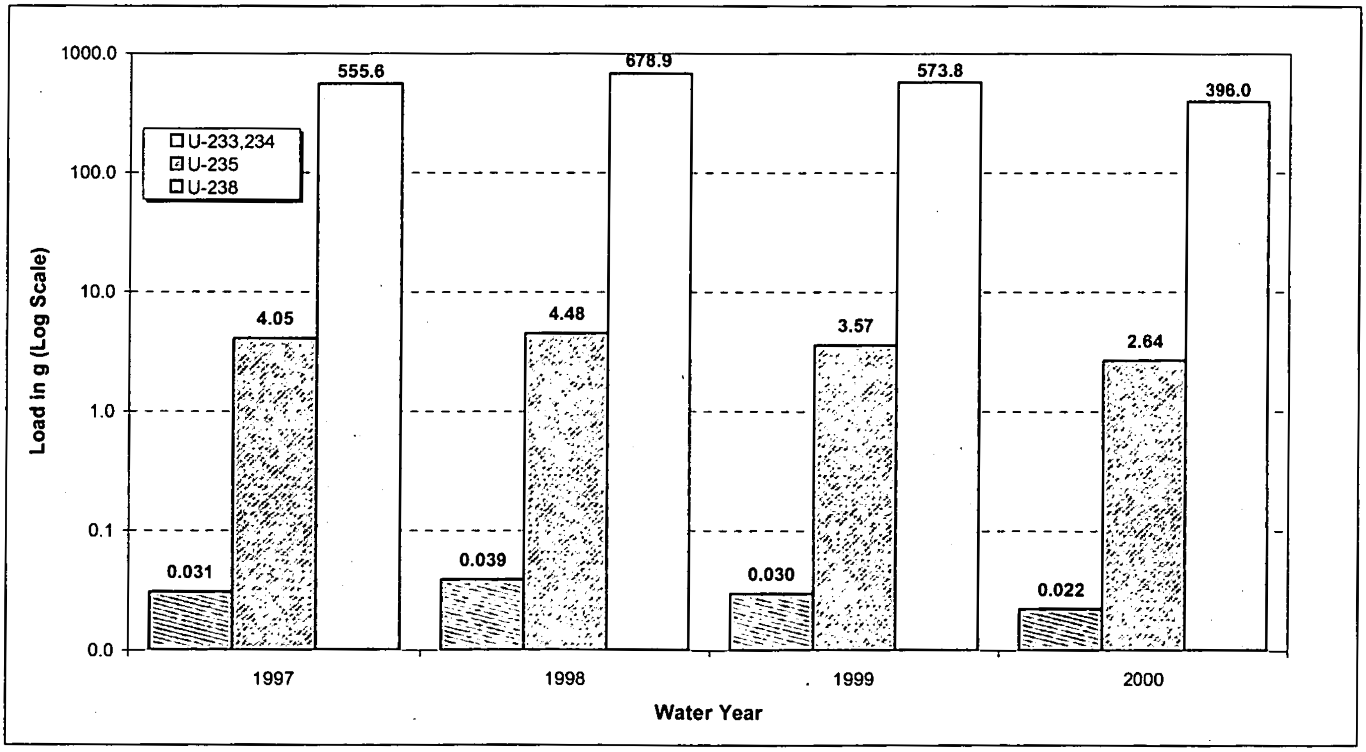

Figure 5-69. Annual Isotopic Uranium Loads at GS10: WY97–00.

5.5.4 South Walnut Creek at the WWTP

This section summarizes the calculated Pu, Am, and isotopic uranium loads for South Walnut Creek at the WWTP. The following points are noted:

- Annual Pu loads at the WWTP vary year-to-year (Figure 5-70).
- Annual Am loads at the WWTP also vary year-to-year (Figure 5-70).
- Annual isotopic uranium loads are also variable year-to-year (Figure 5-71).

Table 5-25. Actinide Loads in S. Walnut Cr. at the WWTP: WY97–00.

Water Year	Pu-239,240 [μg]	Am-241 [μg]	U-233,234 [g]	U-235 [g]	U-238 [g]
1997	13.4	0.44	0.013	2.57	215.3
1998	8.7	0.58	0.023	2.09	514.1
1999	23.2	0.11	0.005	1.21	106.4
2000	18.4	0.33	0.006	0.71	108.9
Total	63.7	1.45	0.047	6.57	944.7

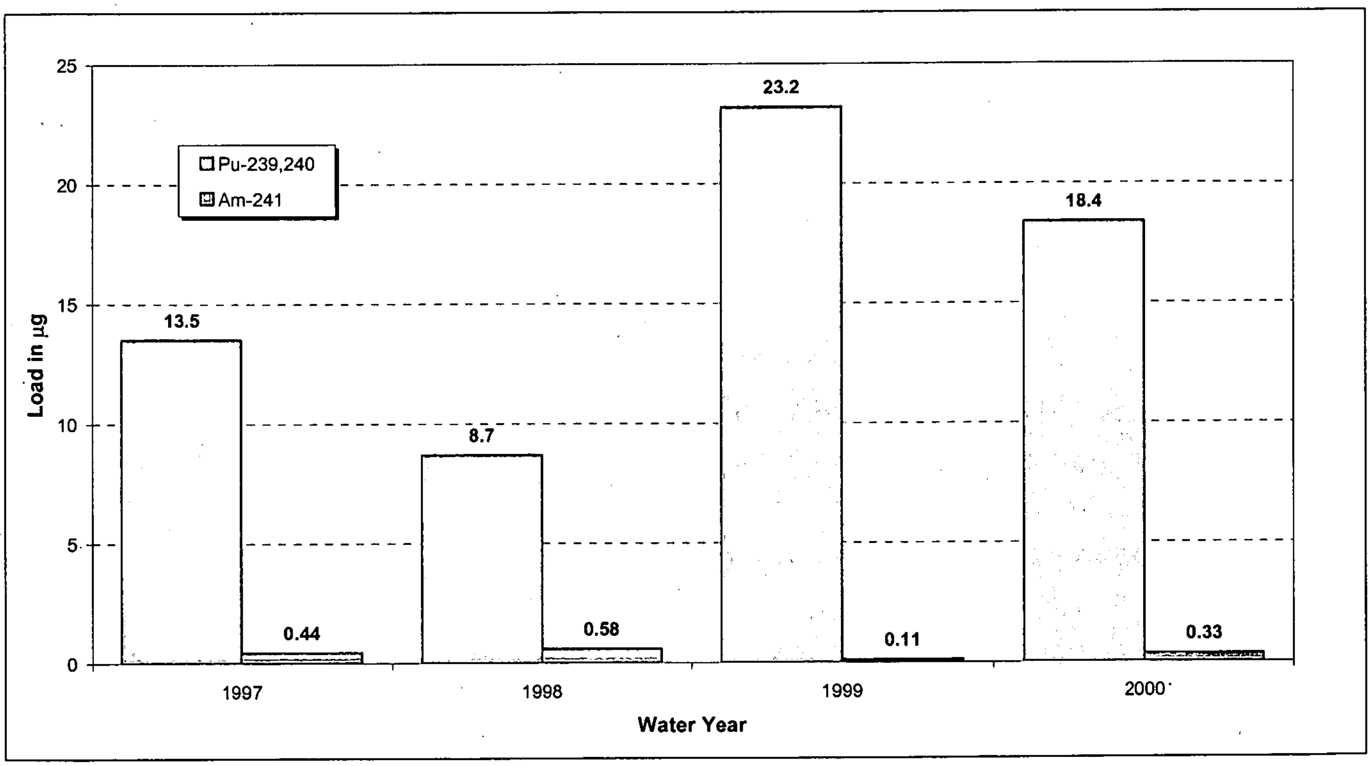

Figure 5-70. Annual Pu and Am Loads at the WWTP: WY97–00.

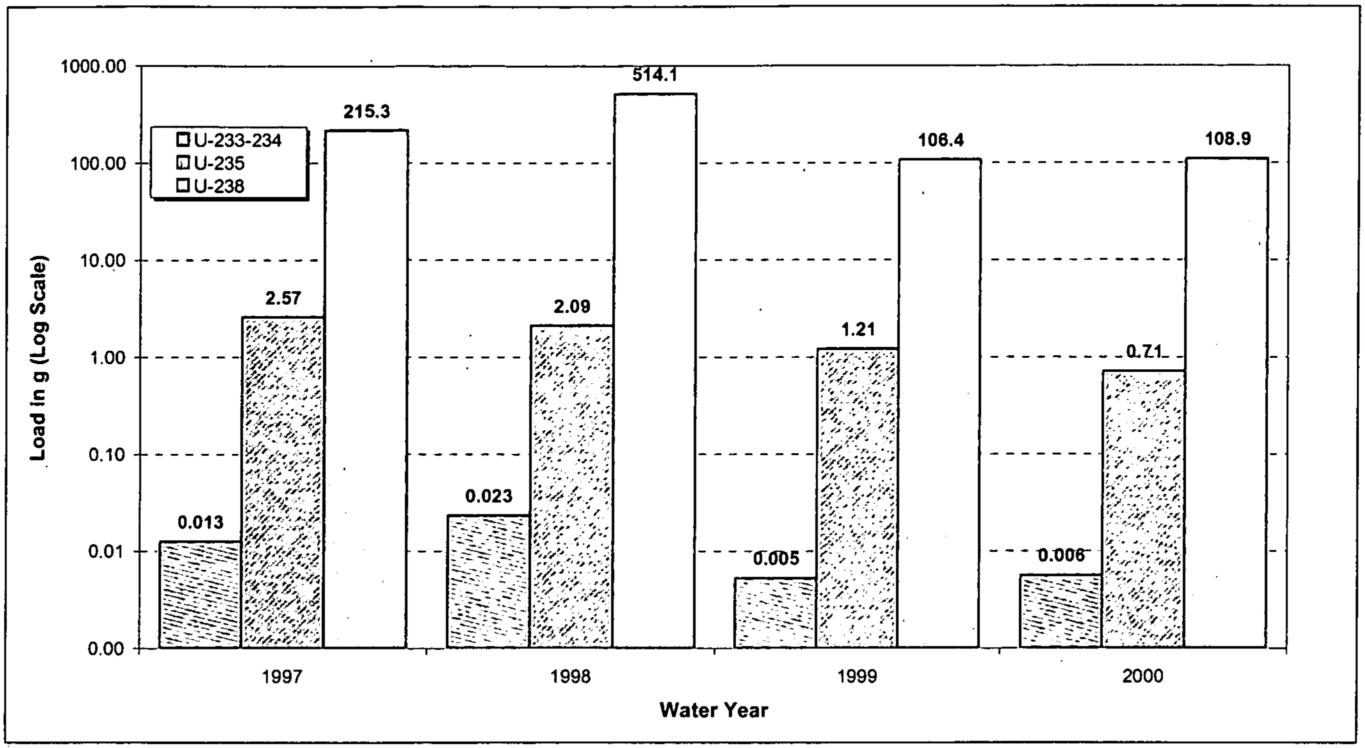

Figure 5-71. Annual Isotopic Uranium Loads at the WWTP: WY97–00.

5.5.5 South Interceptor Ditch at SW027

This section summarizes the calculated Pu, Am, and isotopic uranium loads for the SID at SW027. The following points are noted:

- Annual Pu loads at SW027 vary significantly year-to-year (Figure 5-72).
- Annual Am loads at SW027 also vary year-to-year (Figure 5-72).
- Annual isotopic uranium loads also vary significantly year-to-year (Figure 5-73).

Table 5-26. Actinide Loads in the S. Interceptor Ditch at SW027: WY97–00.

Water Year	Pu-239,240 [μg]	Am-241 [μg]	U-233,234 [g]	U-235 [g]	U-238 [g]
1997	14.2	0.06	0.003	0.43	65.2
1998	90.8	0.28	0.010	1.00	255.0
1999	34.1	0.19	0.005	0.63	112.4
2000	67.5	0.25	0.001	0.18	25.7
Total	206.6	0.78	0.018	2.24	458.3

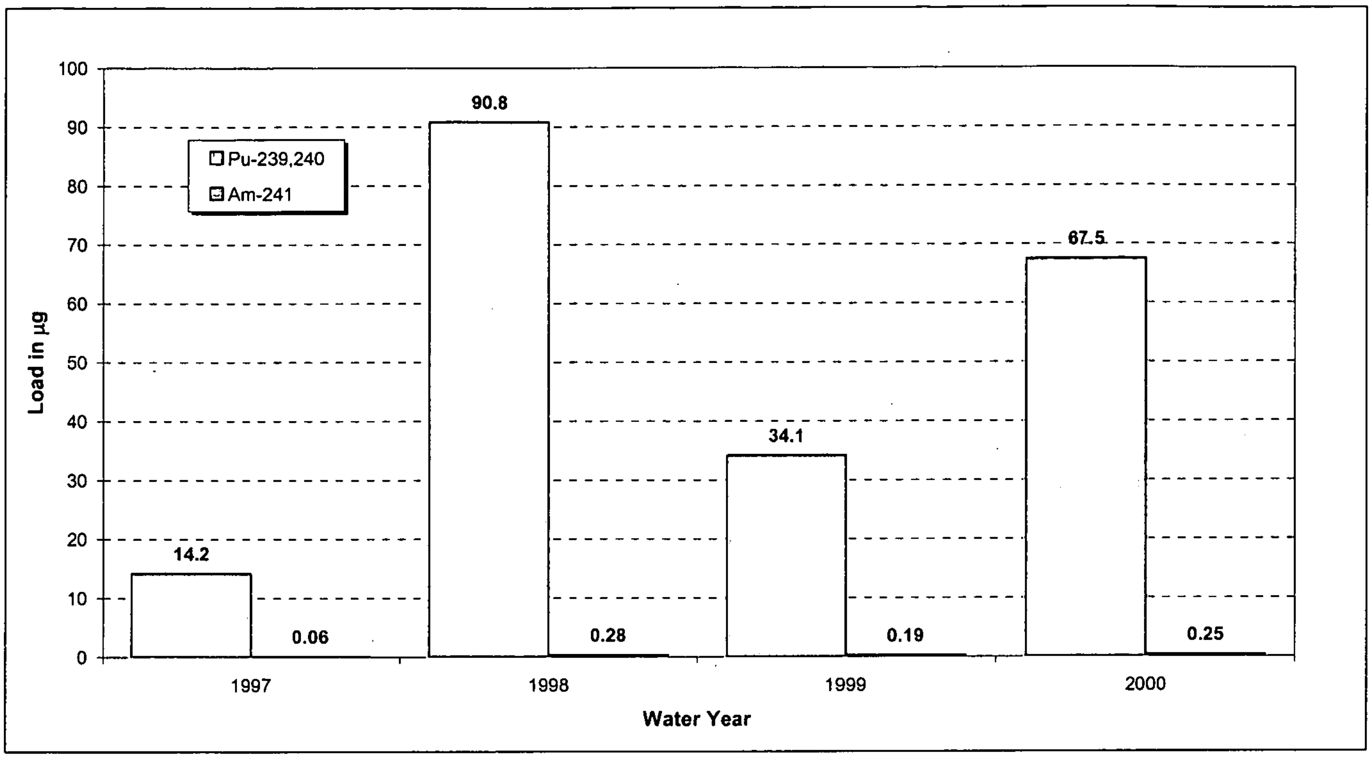

Figure 5-72. Annual Pu and Am Loads at SW027: WY97–00.

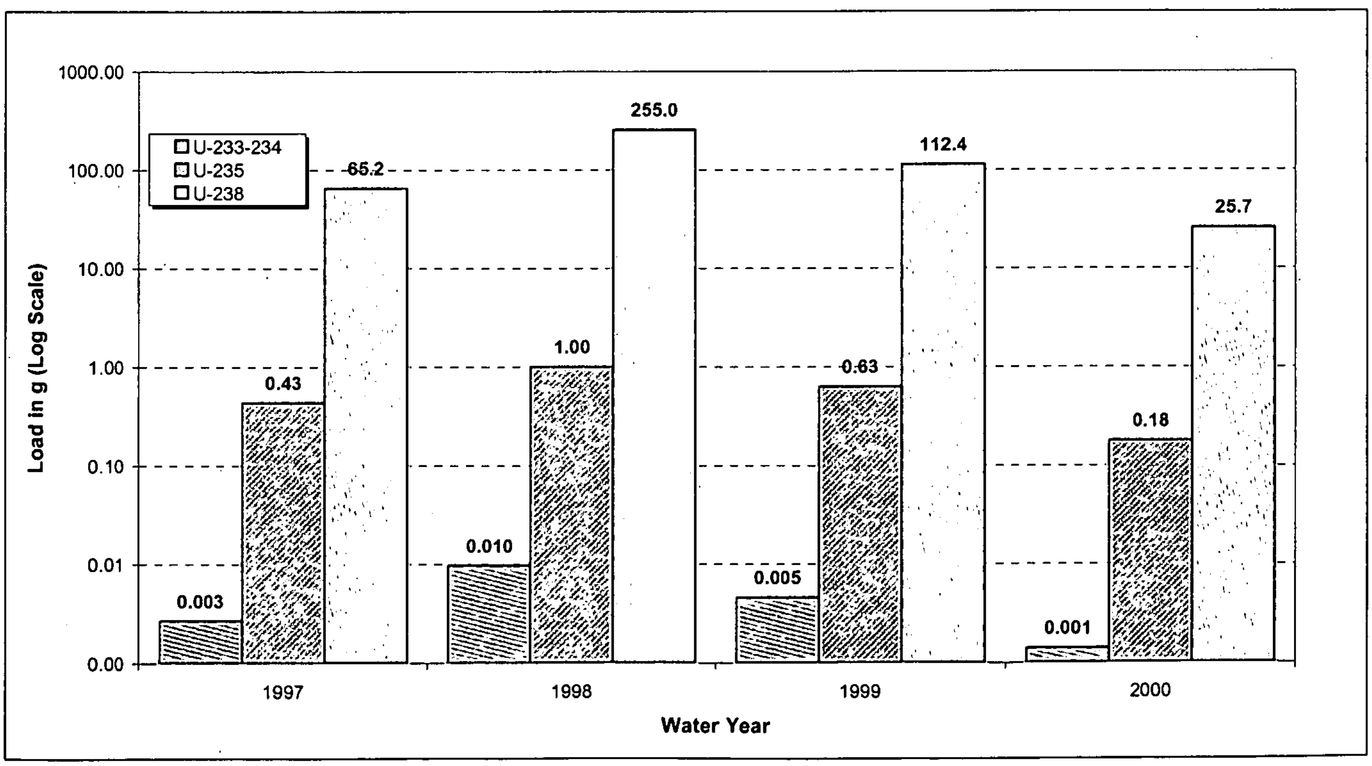

Figure 5-73. Annual Isotopic Uranium Loads at SW027: WY97–00.

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6. SOURCE LOCATION MONITORING

As used in this section a "source" is a contaminant source. The term "new source", as used in this section, means any source that has not previously been located, halted, mitigated, quantified, or corrected.

When new contaminant sources are detected by surface-water monitoring at a New Source Detection location, Point of Evaluation, or Point of Compliance, or in a downstream reservoir, additional monitoring may be required to identify[14] the source and evaluate for corrective actions pursuant to the RFCA Action Level Framework (ALF). The Source Location monitoring objective is intended to locate the source of contamination when a new source of contamination is detected.[15]

The monitoring details in Section 6.1 are based on Source Location monitoring performed in WY97-00.

6.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

Source Location monitoring may be implemented anywhere within a Site surface-water drainage area (including within the IA) where a new contaminant source is detected. The selection of monitoring points is determined by the details of the specific source evaluation to quickly determine source location and to efficiently utilize resources. For example, if monitoring (just outside the IA) through NSD monitoring suggests a new source within the IA, then portable-sampling equipment may be installed within the IA, to locate the source. Similarly, if monitoring for compliance in Segment 4 (POC) suggests a new source, then monitoring to identify the source may begin in Segment 5.

Source Location monitoring should begin as soon as practicable after initial source detection and continue until the source is identified and/or evaluated or is no longer detected. The number of samples will be based on the status of the source evaluation, taking into account, but not limited to, weather conditions, water availability, and process knowledge.

Analyte suites under this monitoring objective are determined based on the detected contaminant of current concern, or related indicators. The information types are entirely dependent on the results of other monitoring objectives under which the source was detected. The analyte suites are limited to parameters that will aid in the identification and evaluation of a contaminant source.

Flow data should be collected, where possible, to provide flow volumes required for contaminant loading analysis. Samples collected should be continuous flow-paced composites to facilitate comparison to POCs and POEs and allow for continuous contaminant loading analysis. Collection of real-time water-quality data may be initiated if such data would facilitate the specific source evaluation.

The specific scope for each source location investigation is detailed in either a sampling and analysis plan (SAP) or included as part of a Letter of Notification from the Site to the regulators.

6.2 WY97-00 MONITORING SCOPE

Table 6-1 lists the Source Location Monitoring locations that were operational during WY97–00. Figure 2-2 shows the location of these monitoring stations.

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

[15] The various monitoring objectives might "detect" a new source through an increase in baseline or exceedance of an action level, standard, permit limitation, etc., depending on the monitoring objective under which the potential new source was detected.

Table 6-1. Source Location Monitoring Locations

ID Code	Location	Flow Measurement Device	Telemetry	Notes
GS27	Small ditch NW of B884	2" Cutthroat Flume	Yes	Supports source eval. for GS10
GS28	Small ditch NW of B865 tributary to Central Avenue Ditch	4" Cutthroat Flume	Yes	Supports source eval. for GS10
GS32	Corrugated metal pipe (cmp; 1.5') north of Solar Ponds in PA draining B779 area	NA[a]	Yes	Supports source eval. for SW093
GS33	No Name Gulch at confluence with Walnut Creek	9.5" Parshall Flume	Yes	Supports source eval. for GS03
GS34	Walnut Creek above confluence with McKay Ditch	1.5' Parshall Flume	Yes	Supports source eval. for GS03
GS35	McKay Ditch at confluence with Walnut Creek	36" Sharp-Crested Rectangular Weir with End Contractions	Yes	Supports source eval. for GS03
GS37	Central Avenue Ditch NW of B443	9.5" Parshall Flume	Yes	Supports source eval. for GS10
GS38	Central Ave. Ditch NW of Building 889	9.5" Parshall Flume	Yes	Supports source eval. for GS10
GS39	Ditch NW of 904 Pad	1' H Flume	Yes	Supports source eval. for GS10
GS40	Drainage Ditch in PA E of Tenth St. (750 Pad) S of Building 997	1' Parshall Flume	Yes	Supports source eval. for GS10
GS41	Subdrainage SW of GS03; drains to Walnut Creek	0.5' H Flume	Yes	Supports source eval. for GS03
GS42	Subdrainage N of SW027; drains to SID	3" Parshall Flume	Yes	Supports source eval. for SW027
GS43	Drainage ditch NE of T886A	0.5' H-Flume	Yes	Supports source eval. for GS10
SW021	Reinforced concrete pipe (rcp) just east of PA draining B991 area	None	No	Synoptic sampling location in support of GS10 source eval.
SW022	Central Avenue Ditch at inner east fence	9.5" Parshall flume	Yes	Dual samplers: both support source eval. for GS10; one is a synoptic sampling point
SW023	S. Walnut Cr. Above B-1 bypass; co-located with GS10	9.5" Parshall flume	Yes	Synoptic sampling location in support of GS10 source eval.
SW060	cmp just east of PA draining Portal 1 parking areas and 500 Area outside PA	None	No	Synoptic sampling location in support of GS10 source eval.
SW118	N. Walnut Creek W of Portal 3	169.5° V-Notch Weir	Yes	Supports source eval. for SW093
SW120	Ditch north of Solar Ponds inside PA	4" Cutthroat flume	Yes	Supports source eval. for SW093
SW132	cmp south of B995 draining area between 750 Pad and B991 (from SW100100)	None	No	Synoptic sampling location in support of GS10 source eval.
SW100100	cmp west of B991 draining area between 750 Pad and B991 (flows to SW132)	None	No	Synoptic sampling location in support of GS10 source eval.

Notes: All locations collect 5- and 15-minute flow data. [a] Due to the current configuration of in-place stormwater culverts, flow measurement at this location is not possible without significant construction modifications.

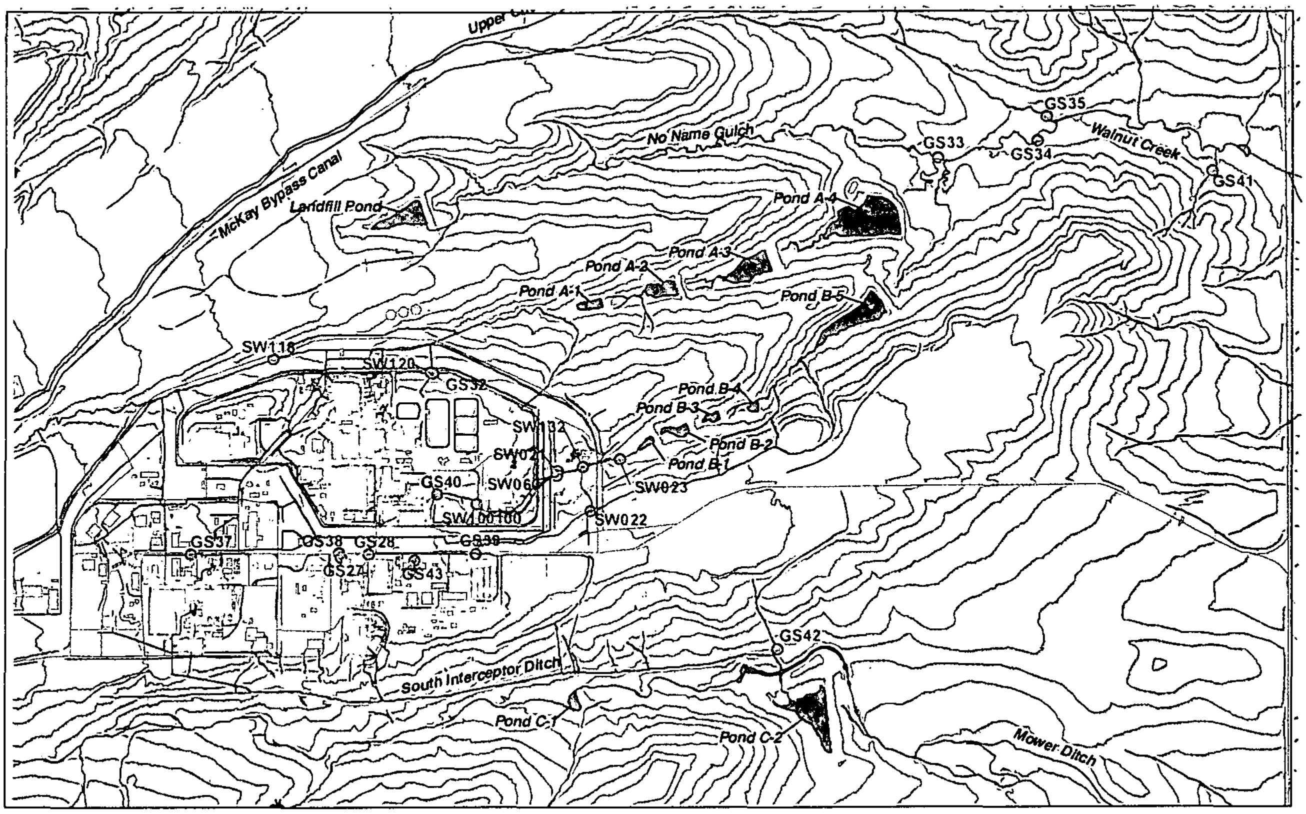

Figure 6-1. Water Year 1997-2000 Source Location Monitoring Locations.

Table 6-2. Source Location Sample Collection Protocols.

ID Code	Frequency	Type[b]
GS27	1 per month	Storm-event rising-limb flow-paced composites[c]
GS28	1 per month	Storm-event rising-limb flow-paced composites[a]
GS32	1 per month	Storm-event rising-limb flow-paced composites[c]
GS33	12 per year[a]	Continuous flow-paced composites
GS34	1 per Pond A-4 or B-5 discharge; 1 per intervening period between discharges	Continuous flow-paced composites
GS35	12 per year[a]	Continuous flow-paced composites
GS37	1 per month	Storm-event rising-limb flow-paced composites[a]
GS38	12 per year[a]	Continuous flow-paced composites
GS39	12 per year[a]	Continuous flow-paced composites
GS40	12 per year[a]	Continuous flow-paced composites
GS41	10-12 as available[a]	Storm-event flow-paced composites
GS42	10-12 as available[a]	Storm-event flow-paced composites
GS43	12 per year[a]	Continuous flow-paced composites
SW021	5 for synoptic sampling project	Storm-event rising-limb time-paced composites
SW022	12 per year[a], plus 5 for synoptic sampling project	Continuous flow-paced composites, storm-event rising-limb flow-paced composites, and storm-event rising-limb time-paced composites[d]
SW023	5 for synoptic sampling project	Storm-event rising-limb time-paced composites
SW060	5 for synoptic sampling project	Storm-event rising-limb time-paced composites
SW118	12 per year[a]	Continuous flow-paced composites
SW120	12 per year[a]	Continuous flow-paced composites

ID Code	Frequency	Type[b]
SW132	5 for synoptic sampling project	Storm-event rising-limb time-paced composites
SW100100	5 for synoptic sampling project	Storm-event rising-limb time-paced composites

Notes: [a] Annual total samples is 12 per year. Frequency of collection is based on expected flow volumes such that each sample collects water representing similar stream discharge volumes; for example, more samples are collected in wet spring months than dry winter months.
[b] Sample types are defined in the Automated Surface-Water Monitoring Work Plan.
[c] Storm-event sampling at locations that are often dry and normally only receive stormwater runoff is opportunistic. Some locations may see flow only during wet months. Every attempt is made to achieve the target sample frequency; however, this is not always possible.
[d] Prior to WY00, SW022 collected storm-event samples. In WY00 SW022 collected continuous flow-paced composites. Synoptic samples are collected as storm-event time-paced composites.

Table 6-3. Source Location Analytical Targets (Analyses per Year).

ID Code	TSS[a]	Pu, Am	Pu, Am, U	CLP Metals[b]	Hardness[b]	Si, TOC, TDS, Maj. Anions[b]
GS27	12	12				
GS28	12	12				
GS32	12	12				
GS33	12	12				
GS34	12	12				
GS35	12	12				
GS37	12	12				
GS38	12	12				
GS39	12	12				
GS40	12	12				
GS41	10-12	10-12				
GS42	10-12	10-12				
GS43	12	12				
SW021	5		5	5	5	5
SW022	12		12 (5 synoptic)	5	5	5
SW023	5		5	5	5	5
SW060	5		5	5	5	5
SW118	12	12				
SW120	12	12				
SW132	5		5	5	5	5
SW100100	5		5	5	5	5

Notes: [a] Ideally, TSS would be analyzed for all samples collected at the above locations. However, continuous flow-paced sampling protocols often result in composite samples which are collected over periods exceeding the 7-day hold time for TSS analyses. Therefore, TSS can not be analyzed for all continuous flow-paced composite samples, but will be analyzed when possible.
[b] Collected for WY00 GS10 Synoptic Sampling Project.

6.3 DATA EVALUATION

Data collected at Source Location monitoring locations are analyzed based on their intent to aid in a specific source evaluation. These analyses include, but are not limited to, loading, fate and transport, correlations and trending, and other statistical evaluation. The WY97 Walnut Creek Source Evaluation Reports (Reports #1, #2, #3, and Final; RMRS 1997a, 1997b, 1997c, and 1998a), the WY98 Source Evaluation Report for Point of Evaluation SW027 (RMRS 1998c), the WY98–99 Source Evaluation Report for Point of Evaluation GS10 (RMRS 1999b), the WY99 Source Evaluation Report for Point of Evaluation SW093 (RMRS 1999c), and the WY00-01 Source Evaluation Report for Point of Evaluation GS10 (RMRS 2001) contain more detailed analysis of the data collected at the above locations. The content of these reports is summarized below.

Summaries for Pu and Am during WY97-00 are given below.[16] The following summaries include all results that were not rejected through the verification/validation process. When a negative radionuclide result (e.g. -0.002 pCi/l) is returned from the laboratory due to blank correction, then a value of 0.0 pCi/l is used for calculation purposes. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' value and the 'duplicate'. When a sample has multiple 'real' analyses (Site requested 're-runs'), the value used in calculations is the arithmetic average of the multiple 'real' analyses. Other data are evaluated in the associated Source Evaluation Reports. All data are presented in Appendix B.2 Analytical Data.

Flow data are summarized in Section 3 Hydrologic Data; more detailed flow data are included in Appendix A.1 Discharge Data.

6.3.1 Location-Specific Summary Statistics

Table 6-4 shows both the volume-weighted average activity and the maximum sample activity for Pu and Am at the WY97-00 Source Location monitoring locations. The method for calculating the volume-weighted activities is given in Appendix B.1 Data Evaluation Methods.

Table 6-4. Selected Summary Statistics for Pu and Am at WY97–00 Source Location Monitoring Locations.

		Volume-Weighted Average Activity (pCi/L)		Maximum Sample Result (pCi/L)	
Location	Period of Data	*Am-241*	*Pu-239,-240*	*Am-241*	*Pu-239,-240*
GS27	10/1/96 – 9/30/00	NA	NA	14.8	64.3
GS28	10/1/96 – 8/26/97	NA	NA	0.240	0.852
GS32	1/31/97 – 9/30/00	NA	NA	4.060	11.5
GS33	9/16/97 - 9/30/00	0.005	0.009	0.033	0.022
GS34	2/5/98 - 9/30/00	0.037	0.057	0.178	0.667
GS35	9/18/97 - 9/30/00	0.004	0.005	0.032	0.011
GS37	10/28/97 – 11/10/98	NA	NA	0.029	0.464
GS38	1/28/98 - 9/30/00	0.023	0.087	0.077	0.307
GS39	1/15/98 - 9/30/00	0.036	0.136	0.160	0.825
GS40	3/4/98 - 9/30/00	0.039	0.020	0.140	0.063
GS41	6/10/98 – 9/30/00	NA	NA	0.016	0.026
GS42	6/23/98 – 9/30/00	NA	NA	0.200	1.150
GS43	6/1/99 – 9/30/00	0.005	0.007	0.018	0.028
SW021	4/10/00 – 10/22/00	NA	NA	0.452	0.305
SW022	10/1/96 – 10/22/00	NA	NA	1.760	9.490
SW023	4/11/00 – 10/22/00	NA	NA	1.240	1.840
SW060	4/10/00 – 10/22/00	NA	NA	0.718	0.350
SW118	11/30/97 - 9/30/00	0.005	0.005	0.024	0.045
SW120	3/14/00 – 9/30/00	0.158	0.420	0.269	0.724
SW132	4/10/00 – 10/22/00	NA	NA	0.336	0.198
SW100100	4/10/00 – 10/22/00	NA	NA	0.376	0.267

Note: NA = Volume-weighted average activities are not calculated for storm-event sampling locations.

[16] For the synoptic locations SW021, SW022, SW023, SW060, SW132, and SW100100 the data is through 10/22/2000 when the synoptic sampling project concluded.

6.3.2 Loading Analysis

Table 6-5 shows the load summary for Pu and Am at the WY97-00 Source Location monitoring locations that exclusively collected continuous flow-paced composites. The method for calculating the loads is given in Appendix B.1 Data Evaluation Methods.

Table 6-5. Load Summary for Pu and Am at WY97–00 Source Location Monitoring Locations.

Location	Period of Data	Load in Micrograms (µg) Am-241	Load in Micrograms (µg) Pu-239,-240
GS33	9/16/97 - 9/30/00	0.15	12.0
GS34	2/5/98 - 9/30/00	18.82	1355.7
GS35	9/18/97 - 9/30/00	0.44	23.5
GS38	1/28/98 - 9/30/00	0.39	68.0
GS39	1/15/98 - 9/30/00	0.12	20.2
GS40	3/4/98 - 9/30/00	1.71	41.0
GS43	6/1/99 – 9/30/00	<0.01	0.2
SW118	11/30/97 - 9/30/00	0.20	8.9
SW120	3/14/00 – 9/30/00	0.10	11.6

6.3.3 WY97 Source Evaluation for Walnut Creek

The WY97 Walnut Creek Source Evaluation Reports (Reports #1, #2, #3, and Final; RMRS 1997a, 1997b, 1997c, and 1998a) included source evaluations for POC GS03 and POEs GS10 and SW093. These reports were completed in response to reportable water-quality levels at these locations during Water Year 1997.

The following text is taken directly from Progress Report #1 to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek, Rev. 0 (RMRS 1997a) describing the contents of that report:

- An evaluation of sampling and analysis QA/QC protocol to verify elevated water-quality results;
- Conclusions and hypotheses for source location(s) with supporting and non-supporting information, including preliminary results on source location;
- Results and analysis of ongoing RFCA monitoring;
- A summary of walk-down activities and observations;
- A statistical assessment of existing monitoring data;
- A summary of current Actinide Migration Study findings with cross-links to source evaluations;
- Details on the new monitoring locations upgradient of GS03 and GS10;
- An initial qualitative evaluation for GS10;
- A discussion of the recent change from rising-limb to continuous flow-paced sampling at RFCA POE and POC locations; and
- A summary of the status for sampling and operational modifications.

The following text is taken directly from Progress Report #2 to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek, Rev. 0 (RMRS 1997b) describing the contents of that report:

- Hypotheses for source location(s) with supporting and non-supporting information, including preliminary results on source location;

- Results and analysis of ongoing RFCA monitoring;
- Updates to the ongoing GS03 evaluation;
- An assessment and incorporation of available new data for GS03;
- A summary of walk-down activities and observations for GS10;
- An assessment of existing monitoring data for GS10;
- A detailed description of new sediment/soil sampling locations for GS10 and SW093;
- A detailed description of proposed new Source Location monitoring stations for GS10 and SW093;
- A summary of current Actinide Migration Study findings with cross-links to source evaluations; and
- A summary of the status for sampling and operational modifications.

The following text is taken directly from Progress Report #3 to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek, Rev. 0 (RMRS 1997c) describing the contents of that report:

- Hypotheses for source location(s) with supporting and non-supporting information, including preliminary results on source location;
- Results and analysis of ongoing RFCA monitoring;
- Updates to the ongoing GS03 and GS10 evaluations;
- An assessment of existing monitoring data for SW093;
- A description of new soil sampling locations in the GS03 drainage;
- Updates for the new Source Location monitoring stations for GS03, GS10, and SW093;
- An evaluation of the effects that watershed improvements may have had on Site water quality;
- A summary of current Actinide Migration Study findings with cross-links to source evaluations; and
- A summary of the status for sampling and operational modifications.

The following text is taken directly from the Final Report to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek, Rev. 0 (RMRS 1998a) describing the contents of that report:

- Updates to the ongoing GS03, GS10, and SW093 evaluations;
- Results and analysis of ongoing RFCA monitoring;
- An assessment and incorporation of available new data for GS03, GS10, and SW093;
- Updates for the new Source Location monitoring stations for GS03, GS10, and SW093;
- Hypotheses for source location(s) with supporting and non-supporting information;
- An identification of data gaps and uncertainties in the source evaluation process with suggested modifications (if any) to the AMS Workscope and the IMP;
- A summary of current AMS findings with cross-links to source evaluations;
- A summary of the status for sampling and operational modifications;

- Results of the source location evaluation;
- A detailed description of identified source areas; and
- A general description of mitigating actions applicable to sources which may be identified in the future.

The Final Report states the following regarding the possible source(s) of the reportable values at GS03:

> To date, a singular source for GS03 has not be identified. Information collected to date does not point to any singular conclusion. In fact, it is entirely possible that multiple sources and transport mechanisms are responsible for the elevated activities at GS03. *To date, no localized areas of radiological contamination have been identified — either historical or resulting from current operations. The Site concludes that the likely source of the exceedance of the 30-day average for Pu and Am at POC GS03, resulted from diffuse radionuclide contamination from past Site operations released to the environment through events and conditions over past years.*

The Final Report further lists the possible GS03 source(s):

- Diffuse soil and sediment contamination in the GS03 drainage
- Tributary surface-water source transporting contamination
- Surface-water activity variability due to the occurrence of small contaminated particles
- Potential issues with laboratory results

The Final Report states the following regarding the possible source(s) of the reportable values at GS10:

> To date, a singular source for GS10 can not be identified. Information collected to date does not point to any singular conclusion. In fact, it is likely that multiple sources and transport mechanisms are responsible for the elevated activities at GS10. *To date, no localized areas of radiological contamination have been identified — either historical or resulting from current operations. The Site concludes that the likely source of the exceedance of the 30-day average for Pu and Am at POE GS10, resulted from diffuse radionuclide contamination from past Site operations released to the environment through events and conditions over past years.*

The Final Report further lists the possible GS10 source(s):

- Diffuse soil and sediment contamination in the GS10 drainage
- Localized contamination near the GS10 sampling location
- Tributary surface-water source transporting contamination

Finally, the Final Report states the following regarding the possible source(s) of the reportable values at SW093:

> To date, a singular source for SW093 can not be identified. Information collected to date does not point to any singular conclusion. In fact, it is likely that multiple sources and transport mechanisms are responsible for the elevated activities at SW093. *To date, no localized areas of radiological contamination have been identified — either historical or resulting from current operations. The Site concludes that the likely source of the exceedance of the 30-day average for Pu at POE SW093, resulted from diffuse radionuclide contamination from past Site operations released to the environment through events and conditions over past years.*

The Final Report further lists the possible SW093 source(s):

- Diffuse soil and sediment contamination in the SW093 drainage
- Tributary surface-water source transporting contamination

6.3.4 WY98 Source Evaluation for POE SW027

The WY98 Source Evaluation Report for Point of Evaluation SW027 (RMRS 1998c) was completed in response to reportable water-quality levels at SW027 during Water Year 1998. The following text is taken directly from that report describing the contents:

- Hypotheses for source location(s) with supporting and non-supporting information, including preliminary results on source location;
- An assessment of existing monitoring data for SW027;
- Results and analysis of ongoing RFCA monitoring;
- A summary of walk-down activities and observations for SW027;
- A description of potential Source Location monitoring stations[17] for SW027; and
- A summary of current AMS findings with cross-links to source evaluations.

This report states the following regarding the possible source(s) of the reportable values at SW027:

> To date, a singular localized source of contamination measured at SW027 can not be identified, although the 903 Pad appears to be the primary source of distributed contamination in the drainage.

This report further lists the possible SW027 source(s):

- Diffuse soil and sediment contamination in the SW027 drainage
- Potential issues with laboratory results

6.3.5 WY98–99 Source Evaluation for POE GS10

The WY98–99 Source Evaluation Report for Point of Evaluation GS10 (RMRS 1999b) was completed in response to reportable water-quality levels at GS10 during Water Years 1998 and 1999. The following text is taken directly from that report describing the contents:

- Results and analysis of ongoing automated surface-water monitoring;
- A brief review of existing soil/sediment data;
- An assessment of Decontamination and Decommissioning (D&D), Environmental Restoration, and Site Closure projects; and
- A summary of current Actinide Migration Evaluation findings.

This following text summarizes the findings, and presents preliminary conclusions based on information presented and analyzed in this report:

- Surface-water and soil/sediment sampling results suggest that one or more low-level distributed actinide source areas exist within the GS10 drainage. Further, surface-water activities have been of similar magnitudes for the last decade, suggesting source areas that originated as legacy contamination.

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[17] Source Location monitoring stations are automated gaging stations installed as part of a source evaluation under RFCA. These locations are installed according to the Integrated Monitoring Plan Source Location decision rule and current Site automated surface-water monitoring practices. Operation of these gages is tailored to meet the requirements of each source evaluation.

- Surface-water sampling results from GS10 show Pu/Am activity ratios that are distinguishable from Pu/Am ratios at other surface-water monitoring location at the Site. This suggests a source relatively 'enriched' in americium may exist in the GS10 drainage.
- Recent surface-water sampling results from Source Location monitoring stations has further refined the estimation of relative plutonium load contributions to GS10 from upstream subdrainage areas. These load estimations suggest that plutonium source terms may exist in the following subdrainage areas:

  1. The Central Avenue Ditch reach between surface-water monitoring locations GS38 and SW022;
  2. Portions of the 800 Area;
  3. A portion of the 500 Area outside the PA; and
  4. The South Walnut Creek reach between surface-water monitoring locations GS40 and GS10.
- Recent surface-water sampling results from Source Location monitoring stations have further refined the estimation of relative americium load contributions to GS10 from upstream subdrainage areas. These load estimations suggest that americium source terms may exist in the following subdrainage areas:

  1. A portion of the 500 Area outside the PA; and
  2. The South Walnut Creek reach between surface-water monitoring locations GS40 and GS10.
- Evaluation of readings from *insitu* water-quality monitoring probes indicates no unusual or unexpected conditions for WY99 to date. WY99 trends for all parameters are similar to those observed in WY98 and WY97.
- A review of current Site activities indicate that no D&D, ER Projects, excavation, nor routine Site operations caused a release of plutonium or americium that resulted in the elevated activities measured at GS10.
- The elevated values observed at GS10 and other monitoring locations in the GS10 drainage are not being observed at the Ponds or downstream POCs.

6.3.6 WY99 Source Evaluation for POE SW093

The WY99 Source Evaluation Report for Point of Evaluation SW093 (RMRS 1999c) was completed in response to reportable water-quality levels at SW093 during Water Year 1999. The following text is taken directly from that report describing the contents:

- Results and analysis of ongoing, automated surface-water monitoring data including trending and correlations, statistical analysis, and loading analysis;
- A review of existing soil/sediment data;
- An assessment of Decontamination and Decommissioning (D&D), Environmental Restoration, and Site Closure projects; and
- A summary of current Actinide Migration Evaluation findings.

This following text summarizes the findings, and presents preliminary conclusions based on information presented and analyzed in this report:

- Surface-water and soil/sediment sampling results suggest that one or more low-level distributed actinide source areas exist within the SW093 drainage. Further, surface-water activities have been of similar magnitudes for the last decade, suggesting source areas that originated as legacy contamination.
- Recent surface-water sampling results from Source Location monitoring stations have further refined the estimation of relative plutonium and americium load contributions to SW093 from upstream subdrainage areas. These load estimations suggest that significant plutonium and americium source terms may exist in the B779 area (GS32 subdrainage). Data indicate that these sources are legacy contamination as a result of past Site operations, and are *not* a result of current D&D activities.
- Load estimations and soil/sediment data also suggest that plutonium and americium source terms may exist in the following subdrainage areas:
  1. North Walnut Creek reach between SW118 and SW093;
  2. A portion of the 700 Area including B771/774 and B776/777;
  3. A portion of the 500 Area including B559;
  4. A portion of the 300 Area including B371/374; and
  5. A portion of the 100 Area.
- Evaluation of readings from *in-situ*, water-quality monitoring probes indicates no unusual or unexpected conditions for WY99 to date. WY99 trends for all parameters are similar to those observed in WY98 and WY97, and real-time water-quality data cannot be linked to discrete upstream source areas.
- A review of current Site activities indicate no reason to suspect that D&D, ER Projects, excavation, or routine Site operations caused a release of plutonium or americium that resulted in the elevated activities measured at SW093.
- The elevated values observed at SW093 and other monitoring locations in the SW093 drainage are not being observed at the Ponds or downstream POCs.

6.3.7 WY00–01 Source Evaluation for POE GS10

The WY00–01 Source Evaluation Report for Point of Evaluation GS10 (RMRS 2001) was completed in response to reportable water-quality levels at GS10 during Water Years 2000 and 2001. The following text is taken directly from that report describing the contents:

- Summary of current applicable Actinide Migration Evaluation findings;
- Evaluation of ongoing automated surface-water monitoring including automated synoptic sampling within the GS10 drainage;
- Estimated actinide loads within the GS10 drainage area;
- Evaluation of Pu/Am ratios within the GS10 drainage area;
- Evaluation of water-quality correlations;
- Evaluation of existing soil/sediment data as well as recent sediment sampling within the GS10 drainage; and,
- Assessment of Decontamination and Decommissioning (D&D), Environmental Restoration, and Site Closure projects.

This following text summarizes the findings, and presents preliminary conclusions based on information presented and analyzed in this report:

The Site concludes that the likely sources of the reportable 30-day moving average values at GS10 are:

1. 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.
2. Actinide contamination enriched in Am that has been incorporated into the stream sediments in South Walnut Creek from past Site operations through events and conditions over past years. This actinide contamination is transported through sediment resuspension by surface-water runoff during precipitation events.

Based on this 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. This source investigation has identified no highly localized source(s) of contamination that warrant targeted remediation based on the available information. The conclusions detailed in this report are summarized below:

- Based on the details regarding recent Site activities outlined in Section 5, it is concluded that neither D&D, construction, environmental remediation, excavation, nor routine operations caused a release that resulted in the reportable Pu and Am values measured at GS10.
- Historical GS10 data suggest that actinides have been available for transport to GS10 for some time and that the recent measurements at GS10 are likely the result of legacy contamination (Section 4.2.1).
- The loading analysis in Section 4.2.2 indicates that the South Walnut Creek reach between GS40 and GS10 is the likely origin of the majority of the Pu and Am load measured at GS10.
- Results in Section 4.2.3 also indicate that the average Pu/Am activity ratio for surface-water samples from GS10 is lower than that generally observed in other drainages and subdrainages across the Site. Results also indicated that the Pu/Am ratios observed at GS10 are significantly lower than those observed at monitoring locations GS27, GS28, GS 38, GS39, and SW022. Although monitoring locations GS40 and GS50 show low Pu/Am ratios, these locations do not contribute significant loads to GS10. These results indicate that a source enriched in Am exists within the GS10 drainage, specifically in the main S. Walnut Cr. reach between GS40 and GS10.
- Extensive evaluation of water-quality correlations indicate that a source term 'enriched' in Am is associated with the sediments in the main S. Walnut Cr. stream reach (Section 4.2.4). This source term appears to affect GS10 water-quality to varying degrees based on streambed erosion/resuspension rates, relative load contributions from distributed sources, and hydrologic conditions. The HRR and soil/sediment data provide information supporting this hypothesis. However, sufficient data do not exist to establish the extent and exact location of this source term.
- Surface-soil and sediment data (Section 4.4) clearly show the existence of distributed Pu and Am source terms throughout the GS10 drainage. The areas near the Solar Ponds and within the S. Walnut Cr. stream reach show lower Pu/Am ratios. However, sufficient data do not exist to establish the extent and exact location of the Am enriched source term in the main S. Walnut Cr. stream reach.

7. AD HOC MONITORING

The Site often monitors surface waters on an *ad hoc* basis for a variety of reasons. This monitoring may be requested by DOE, RFFO, cities, agencies, building managers, and Site facility managers (e.g. the WWTP). It is anticipated that various parties will continue to request such *ad hoc* monitoring in the future, regardless of whether funding is allocated for that purpose. This monitoring will not always require sample analyses. In some cases, only flow or continuously recording water-quality monitoring will be needed. Examples of situations that may warrant *ad hoc* monitoring include:

- Major precipitation events that disrupt routine pond predischarge monitoring and discharge schedules,
- Community assurance monitoring at the request of downstream cities and the DOE RFFO,
- Unanticipated changes in regulatory permits, agreements, or funding,
- Special projects such as Actinide Migration Evaluation and Site-Wide Water Balance,
- Anticipated but unfunded changes in permits or agreements,
- Construction projects,
- Spill events, and
- Operational monitoring (i.e. footing drains, septic lift stations).

The Ad Hoc monitoring details in Section 7.1 are based on Ad Hoc monitoring performed in WY97-00.

7.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

The type of data collected depends exclusively on the predetermined intent of the specific Ad Hoc monitoring location. The collected data can then be processed to provide decision support or input to a technical analysis. In most cases, flow is the primary data collected.

7.2 WY97-00 MONITORING SCOPE

Table 7-1 lists the Source Location Monitoring locations that were operational during WY97–00. Figure 2-2 shows the location of these monitoring stations.

Table 7-1. Ad Hoc Monitoring Locations.

ID Code	Location	Primary Flow Measurement Device	Telemetry	Notes
B371BAS	Building 371 basement footing drain	11.4° V-Notch Weir	Yes	Data collection to confirm proper operation of footing drain systems; funded by Safe Sites
B371SUBBAS	Building 371 sub-basement footing drain	11.4° V-Notch Weir	Yes	Data collection to confirm proper operation of footing drain systems; funded by Safe Sites
B779RD-01	Roof drain on south side of B779 near door 21	No flow measurement at this location	No	Data collection through Actinide Migration Studies; partially funded by CDPHE

ID Code	Location	Primary Flow Measurement Device	Telemetry	Notes
B886RD-01	Roof drain on southeast corner of B886	No flow measurement at this location	No	Data collection through Actinide Migration Studies; partially funded by CDPHE
GS22	Outfall from 400 Area at SID	1.5' H Flume	Yes	Data collection for Site Water Balance
GS41	Subdrainage SW of GS03; drains to Walnut Creek	0.5' H Flume	Yes	Data collection for Actinide Migration Studies; partially funded by EPA
GS42	Subdrainage N of SW027; drains to SID	3" Parshall Flume	Yes	Data collection for Actinide Migration Studies; partially funded by EPA
GS45	Upper Church Ditch east of Site fenceline	9.5" Parshall Flume	No	Data collection for Site Water Balance
GS46	McKay Ditch east of Site fenceline	9.5" Parshall Flume	No	Data collection for Site Water Balance
SW009	McKay Bypass Canal upstream of confluence with West Diversion Ditch	1' Parshall Flume	No	Data collection for Site Water Balance

Note: Only locations specifically installed in support of an Ad Hoc project are shown. All locations providing information (flow and precipitation to Site Water Balance) are shown in Figure 7-1.

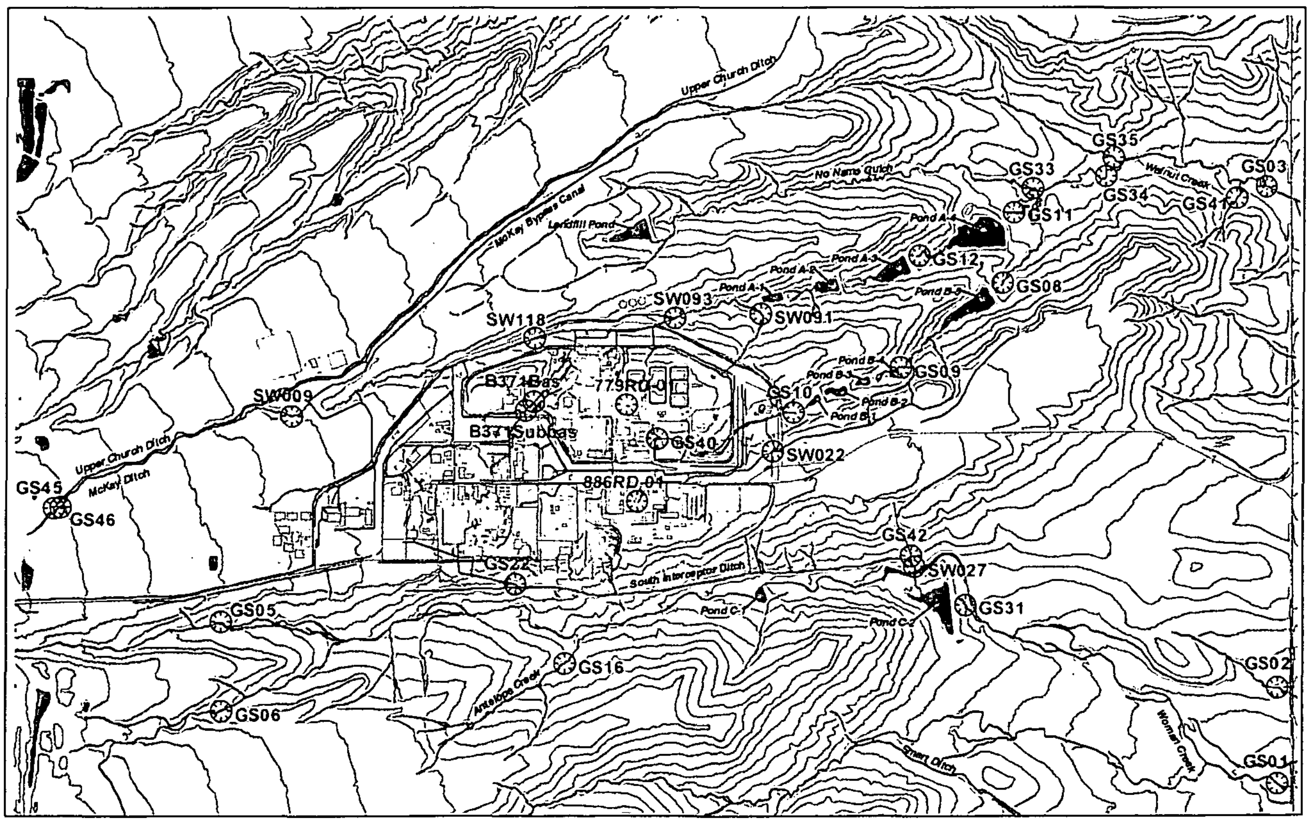

Figure 7-1. Water Year 1997-2000 AdHoc Monitoring Locations.

Table 7-2. Ad Hoc Field Data Collection: Parameters and Frequency.

ID Code	Parameter
	Discharge
B371BAS	hourly averages of 1-min. measurements
B371SUBBAS	hourly averages of 1-min. measurements
B779RD-01	NA
B886RD-01	NA
GS22	15-min continuous
GS41	15-min continuous
GS42	15-min continuous
GS45	15-min continuous
GS46	15-min continuous
SW009	15-min continuous

Note: Only locations specifically installed in support of an Ad Hoc project are shown. All locations providing information (flow and precipitation) are shown in Figure 7-1.

Table 7-3. Ad Hoc Sample Collection Protocols.

ID Code	Frequency	Type[b]
B779RD-01	10-12 as available[a]	Storm-event time-paced composites
B886RD-01	10-12 as available[a]	Storm-event time-paced composites
GS41	10-12 as available[a]	Storm-event flow-paced composites
GS42	10-12 as available[a]	Storm-event flow-paced composites

Notes: [a] Target for the project is 10-12. Frequency of collection is based on opportunistic availability of precipitation runoff; these locations are dry much of the time.
[b] Sample types are defined in the Automated Surface-Water Monitoring Work Plan.
Only locations where sampling occurs in support of an Ad Hoc project are shown.

Table 7-4. Ad Hoc Analytical Targets (Analyses per Year).

ID Code	TSS	Pu, Am
B779RD-01	10-12	10-12
B886RD-01	10-12	10-12
GS41	10-12	10-12
GS42	10-12	10-12

7.3 DATA EVALUATION

7.3.1 Building 371 Footing Drain Monitoring Locations

Operation of B371BAS and B371SUBBAS provides real-time data confirming the proper operation of the B371 footing drain systems. B371 personnel are notified of a no-flow or high-flow condition, which would initiate investigation of those systems. Telemetry has been made available to B371 personnel to allow for direct tracking of footing drain operation and for the monthly building surveillance activity. Flow data are not given in this report. Data can be found in Appendix 1 of the *Building 371 Subsurface Drain System* procedure (4-K14-SDS-371). No sample collection is performed at these locations.

7.3.2 Building 779 and 886 Roof Drain Sampling Locations

Previous source-evaluation work for POEs has not included roof runoff sampling. It is possible that residuals from past fires and other release incidents could be distributed on roofs and may be mobilized during precipitation events. CDPHE requested an examination of loading from roof drains for buildings in the IA to either rule out or quantify their contribution to the loads observed at POEs GS10 and SW093, where RFCA-reportable values for Pu and Am have been measured. Initially, samplers were installed on roof drains at Buildings 779 and 886 (B779RD-01 and B886RD-01 respectively).

If the average Pu or Am activity per gram of suspended solids for three building roof runoff samples (from the same roof drain) exceeded 5 pCi/g, then a sample would be collected from the down spout for ultrafiltration to obtain the particle size distribution of the actinides in the roof runoff. Loadings from one or more building areas would then be estimated and compared to loads calculated at one or more downstream stations, such as SW093 and GS10. An evaluation would also be made to determine if a basis exists for the use of applied controls to reduce the transport of actinides from building roofs.

This effort was intended to support the ongoing scientific research as part of the AMS and the applied science and engineering for actinide source evaluation and control strategies implemented by RFETS. The goal of this effort is to explain the origin, mechanisms of transport, pertinent transformations, and fate of actinides at RFETS and the environs. As the actinide investigation efforts proceed, using the DQO process, the iterative nature of the investigation may raise additional questions needing short-term sampling and analysis.

Summary information for B779RD-01 and B886RD-01 is presented in Table 7-5 and Table 7-6, respectively. All data are presented in Appendix B.2 Analytical Data.

Table 7-5. Sample Information for Location B779RD-01.

Sample Date	Pu-239,240 [pCi/L]	Pu-239,240 LLD or MDA [pCi/L]	Am-241 [pCi/L]	Am-241 LLD or MDA [pCi/L]	TSS [mg/L]	TSS MDL [mg/L]	Pu-239,240 [pCi/g]	Am-241 [pCi/g]
12/14/98	0.030	0.20	0.000	0.10	Undetect[a]	10	6.0	0.0
4/5/99	0.060	0.10	0.200	0.10	Undetect[a]	10	12.0	40.0
4/21/99	0.060	0.07	0.500	0.10	51	10	1.2	9.8
7/24/99	-0.110	0.30	0.270	0.50	53	10	0.0	5.1

Notes: For actinides, LLD is the Lower Level of Detection and MDA is the Minimum Detectable Activity. For TSS, MDL in the Minimum Detectable Level.
[a] Half the detection limit used for calculation purposes.

Table 7-6. Sample Information for Location B886RD-01.

Sample Date	Pu-239,240 [pCi/L]	Pu-239,240 LLD or MDA [pCi/L]	Am-241 [pCi/L]	Am-241 LLD or MDA [pCi/L]	TSS [mg/L]	TSS MDL [mg/L]	Pu-239,240 [pCi/g]	Am-241 [pCi/g]
1/23/99	0.008	0.20	0.100	0.10	Undetect[a]	10	1.6	20.0
4/13/99	0.003	0.10	-0.001	0.10	21	10	0.1	0.0
4/21/99	-0.070	0.10	-0.200	0.10	24	10	0.0	0.0
7/24/99	-0.190	0.40	-0.170	0.50	27	10	0.0	0.0

Notes: For actinides, LLD is the Lower Level of Detection and MDA is the Minimum Detectable Activity. For TSS, MDL in the Minimum Detectable Level.
[a] Half the detection limit used for calculation purposes.

Although both locations show locations show Pu and Am activity per gram of suspended solid in excess of 5 pCi/g, the high detection limits do not allow for accurate calculation of the suspended solids activity. The selected analytical procedures, as determined by CDPHE, were not sensitive enough to satisfy the calculations as specified by the DQOs. Therefore, ultrafiltration was not performed for samples at these locations. However, the low Pu and Am activities (significantly lower than the POE actions levels of 0.15 pCi/L), coupled with the small runoff volumes from these locations, suggest that roofdrain runoff may not be a significant contributor of Pu and Am at the POEs.

7.3.3 Sitewide Water Balance Flow Measurement Locations

Monitoring locations GS22, GS45, GS46, and SW009 were installed to specifically collect flow data in support of collected the Site-Wide Water Balance Modeling Project. Flow data from these locations will be applied to configuration and calibration of the model. Flow and precipitation data from existing monitoring locations at the Site are also used by this project (see Section 7.2). These locations are described under the other decision rules included in this report. Flow data are summarized in Section 3 Hydrologic Data; more detailed flow data are included in Appendix A.1 Discharge Data.

7.3.4 Erosion and Actinide Transport Monitoring Locations

Data collected at GS41 and GS42 will be used for Actinide Migration Evaluation (AME) projects. Specifically, evaluation will include determination of sediment yield and associated actinide content on the suspended solids. These estimates will be calculated based on the analytical results obtained from TSS, Pu, Am, and U analyses at these locations. Two AME reports, the *Actinide Migration Evaluation Pathway Analysis Report* and the *Soil Erosion and Sediment Transport Modeling of Hydrologic Scenarios for the Actinide Migration Evaluations at the Rocky Flats Environmental Technology Site* report will include data from these locations. Data analysis is not included in this report.

Flow data are summarized in Section 3 Hydrologic Data; more detailed flow data are included in Appendix A.1 Discharge Data.

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8. INDICATOR PARAMETER MONITORING FOR ASSESSMENT OF ANALYTICAL WATER-QUALITY DATA

This objective provides the justification for the collection of general water-quality and quantity information to be used for various data assessments. Specifically, this objective outlines the current and expected uses of parameters such as TSS, turbidity, and flow rate.

This monitoring objective is intended to establish relationships between analytical measurements of constituents such as actinides and metals with selected indicator parameters, such as TSS, turbidity, precipitation, and flow rate. The determination of these relationships will support evaluation of erosion control measures, design of final Site land configuration options, future pond operations, investigations into actinide transport, assessment of statistically significant changes in water quality, and management decision making. Table 8-3 provides a listing of data uses for this monitoring objective.

8.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

To evaluate the relationship between TSS and analytical constituents[18], TSS would ideally be analyzed for all samples collected at the locations covered by the other decision rules in this report. However, sampling protocols (continuous flow paced) often result in composite samples that are collected over periods exceeding the 7-day hold time for TSS analyses. Therefore, TSS cannot be analyzed for all composite samples but will be analyzed whenever hold time requirements are met.

To evaluate the relationship between turbidity and analytical constituents, turbidity will be monitored at the locations where required by the other applicable decision rules. These locations include POEs [GS10, SW093, and SW027] and terminal pond POCs [GS08, GS11, and GS31]. Each of these stations is equipped with a real-time, water-quality probe to continuously monitor turbidity.

To evaluate the relationship between precipitation and analytical constituents, precipitation is currently monitored at 11 locations across the Site. The location of precipitation gages allows for the calculation of areal precipitation for any drainage area tributary to each monitoring location. Each of these locations is equipped with a continuously recording precipitation gage.

To evaluate the relationship between flow rate and analytical constituents, flow is currently monitored at almost all monitoring locations across the Site. Each of these locations is equipped with continuously-recording flow-measurement instrumentation. Some locations do not collect flow data due to specific water routing configuration limitations. However, flow can be estimated for these locations using flow from comparable locations, runoff coefficients, and subdrainage area.

This decision rule does not limit the data uses to those given in Table 8-3. Relationships can be determined for any data combinations as required. For example, relationships between flow and precipitation, turbidity and TSS, precipitation and TSS, etc. may be useful depending on the specific data evaluation.

8.2 WY97-00 MONITORING SCOPE

The following tables detail the Indicator Parameter monitoring scope for WY97-00. Figure 8-1 shown the locations evaluated in this section.

[18] The term 'analytical constituents' is used here to refer to constituents measured for samples collected as defined by the other decision rules in this report.

Table 8-1. Indicator Parameter Data Collection: Parameters and Frequency.

Parameter	Frequency	Monitoring Location(s)
Turbidity[a]	15-min continuous	GS08, GS10, GS11, GS31, SW027, and SW093
Flow rate	5-min continuous	All locations where feasible
Precipitation	5-min continuous	11 locations sitewide
Flow volume	Derived from flow rate for any selected time period	All locations where feasible

Notes: [a] Turbidity is collected using real-time water-quality probes. These probes can not handle winter icing conditions without being damaged. Therefore, these probes collect data whenever possible, and data collection may not be possible for significant periods during the winter.

Table 8-2. Analytical Data Collection: Analytes and Frequency.

Analyte	Frequency	Monitoring Location(s)
Radionuclides	Determined by applicable monitoring objective	All locations as applicable
Total Suspended Solids (TSS)	Determined by applicable monitoring objective; all samples that meet TSS hold time limits	All locations as applicable

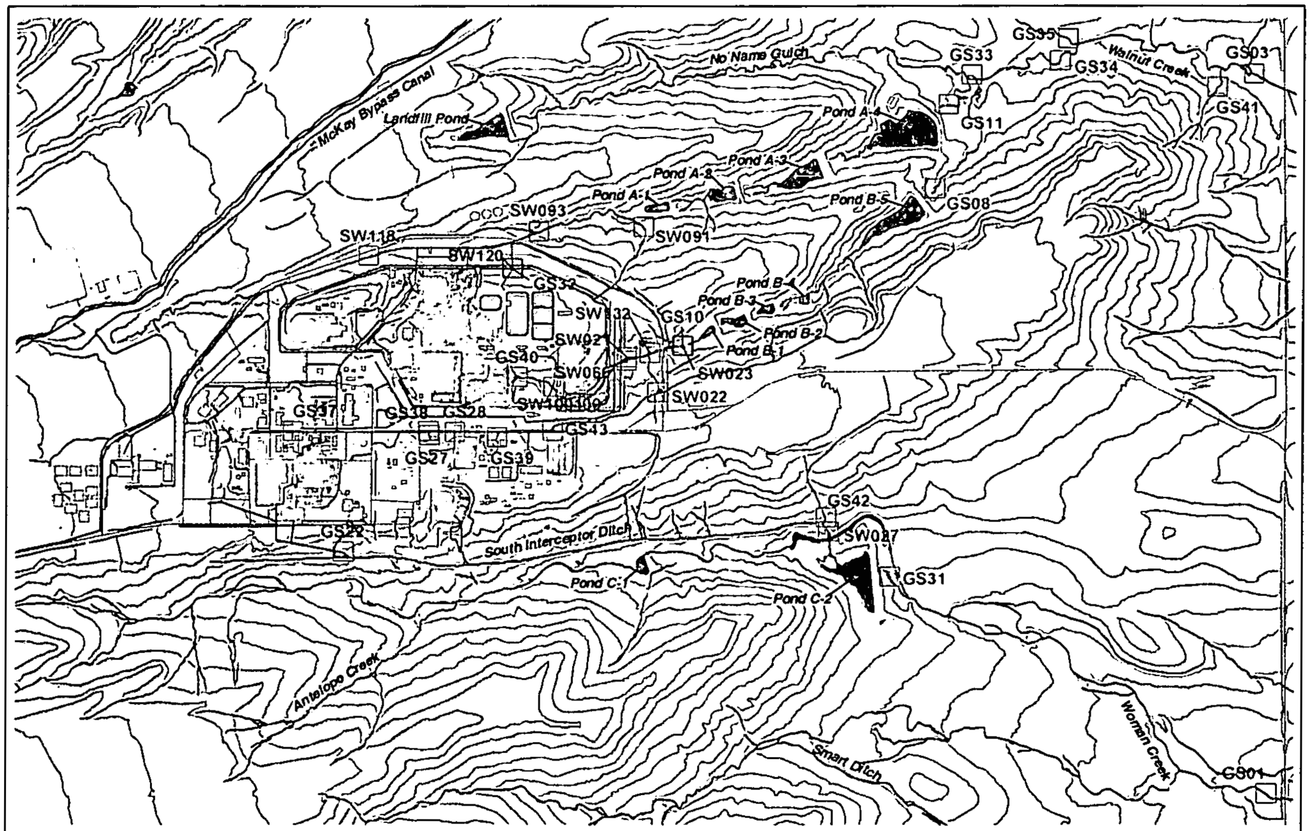


Figure 8-1. Water Year 1997-2000 Indicator Parameter Monitoring Locations.

8.3 DATA EVALUATION

Table 8-3 outlines the anticipated or past data uses associated with this decision rule. This list provides examples of data uses; future data uses are expected to be developed as needs arise. The data uses listed in **bold** are included in this section. Other data uses are included in Source Evaluation reports (see Section 6) or in reports from other Site projects.

The following evaluations include all results that were not rejected through the verification/validation process. When a negative radionuclide result (e.g. -0.002 pCi/l) is returned from the laboratory due to blank correction, then a value of 0.0 pCi/l is used for calculation purposes. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' value and the 'duplicate'. When a sample has multiple 'real' analyses (Site requested 're-runs'), the value used in calculations is the arithmetic average of the multiple 'real' analyses. Total uranium is calculated by summing the activities for the analyzed isotopes (U-233,234 + U-235 + U-238).

Linear, logarithmic, 2nd-order polynomial, power, and exponential curve fits were tested for each of the data sets. The curve fit with the highest R^2 value was then selected for plotting. In general, but not exclusively, data sets with R^2 values of less than 0.4 were plotted without a trendline. The R^2 values were then used to qualitatively assess the plotted fits. Generally, $0.4<R^2<0.5$ is considered weak, $0.5<R^2<0.7$ is considered fair, $0.7<R^2<0.9$ is considered good, and $R^2>0.9$ is considered strong.

Table 8-3. Selected Data Uses of Indicator Parameter Monitoring for Analytical Water-Quality Assessment.

Data Use	Required Parameters	Description
Correlation of Actinides with TSS	**Actinides, TSS**	**Use of TSS measurements to predict actinide concentrations**
Correlation of Actinides with Turbidity	**Actinides, turbidity**	**Use of turbidity measurements to predict actinide concentrations**
Correlation of Radionuclides with Flow Rate	**Radionuclides, flow rate**	**Use of flow rate measurements to predict radionuclides concentrations**
Rainfall-Runoff Relationships	Precipitation, flow rate, flow volume	Determination of hydrologic characteristics for specific drainage areas
Correlation of TSS with Turbidity	**TSS, turbidity**	**Use of turbidity measurements to predict TSS concentrations**
Correlation of TSS and Turbidity with Flow Rate	**TSS, turbidity, flow rate**	**Use of flow rate measurements to predict TSS concentrations and turbidity**
Assessment of Actinide Measurements	Actinides, TSS, turbidity, flow rate	Determine if cause of elevated actinide measurement is likely due to Site activity (i.e. D&D work) or unusual hydrologic conditions
Assessment of Closure Activities	Actinides, TSS, turbidity, flow rate	Determine effects of closure activities on water quality and drainage characteristics
Erosion Modeling	TSS, flow rate, actinides	Model design, calibration, and verification
Water Balance Modeling	Flow rate, flow volume	Model design, calibration, and verification
BMP Assessment	TSS, turbidity, flow rate	Determine effectiveness of various erosion control measures
Land Configuration Design	Flow rate, flow volume, TSS	Design land configuration options: determine flow routing, size hydraulic components, assess sedimentation rates, design maintenance and operation protocols
Long-Term Stewardship	Flow rate, flow volume, TSS, turbidity	Assess post-closure conditions

8.3.1 Correlation of Actinides with TSS

Since Pu and Am tend to be transported in surface water in association with particulate matter (measured as TSS), a relationship between activity and TSS could be used as an indicator of Pu and Am transport. This section evaluates the variation of composite sample Pu and Am activity with the corresponding TSS concentration. Plots are presented for all locations where both Pu and Am data are collected with TSS.

The sample Pu and Am activities are the values obtained through laboratory analysis given in pCi/L. Only Pu and Am values greater than the MDA (generally 0.015 pCi/L) are included.

The sample TSS is the value obtained through laboratory analysis given in mg/L. TSS analysis is only performed for composite samples that are collected over a period of less than the TSS hold time (7 days). Consequently, not all samples collected at the locations below were analyzed for TSS. Only TSS values greater than the detection limit (generally 5 mg/L) are included.

Plots are also included to assess the variability of composite-sample suspended solids activity (as pCi/g Pu or Am) with the corresponding TSS. The suspended solids activity is calculated by dividing the activity by the TSS concentration and converting for units.

Only locations that had greater than two data pairs are plotted. As such, locations GS01, GS31, GS33, GS34, GS35, GS40, GS42, GS43, SW060, SW118, SW120, B779RD-01, and B886RD-01 are not presented.

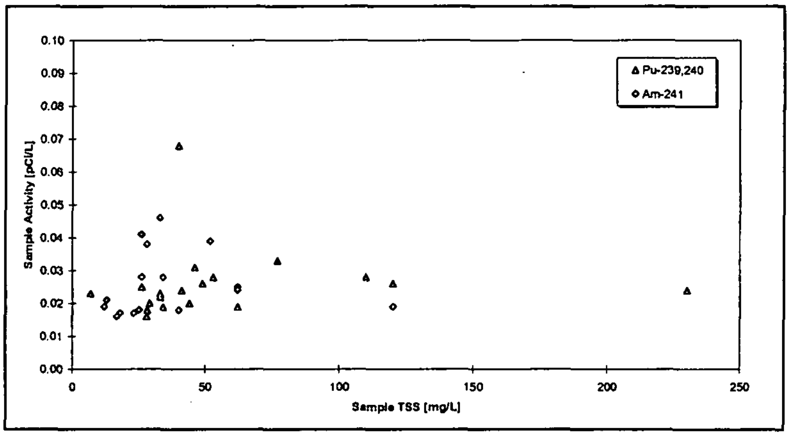


Figure 8-2. Variation of Pu and Am with TSS at GS03.

Location GS03

GS03 shows no statistically significant correlation between activity and TSS.

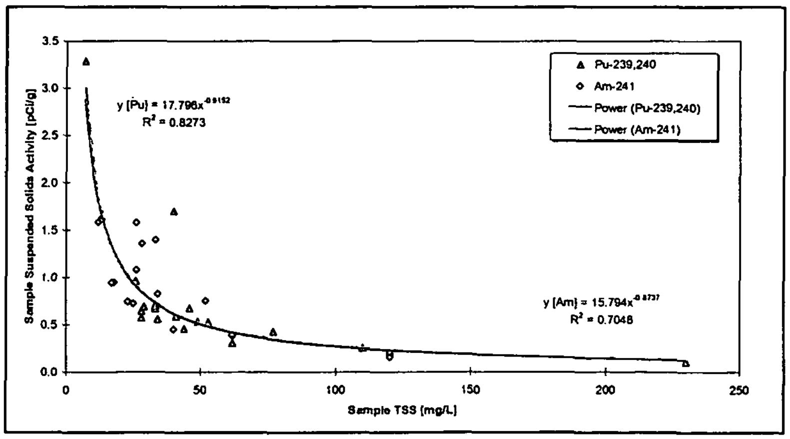


Figure 8-3. Variation of Suspended Solids Activity with TSS at GS03.

Good correlations exist at GS03 for decreasing solids activity with increasing TSS. If all TSS particles were of similar activity, then suspended solids activity would not vary with TSS concentration. Since TSS generally increases with increasing flow rate at GS03 (Figure 8-91), the data suggest that the more easily mobilized particles (possibly based on density) are of a higher activity per unit mass than the heavier particles that are more likely to move at higher flow rates.

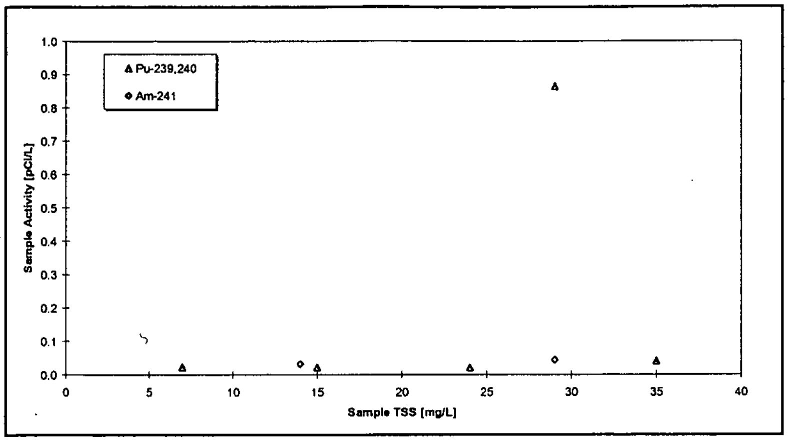


Figure 8-4. Variation of Pu and Am with TSS at GS08.

Location GS08

GS08 shows no statistically significant correlation between activity and TSS.

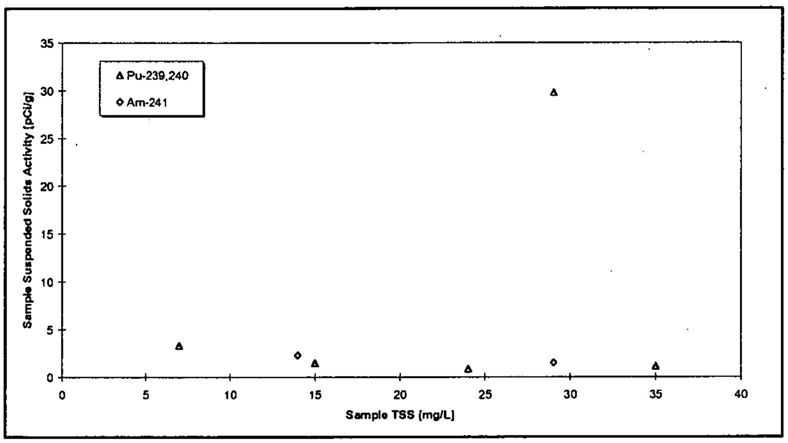


Figure 8-5. Variation of Suspended Solids Activity with TSS at GS08.

GS08 also shows no statistically significant correlation between suspended solids activity and TSS.

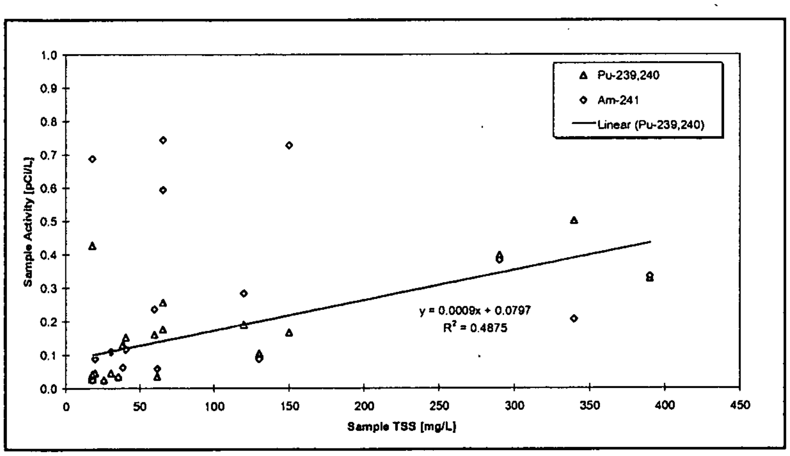
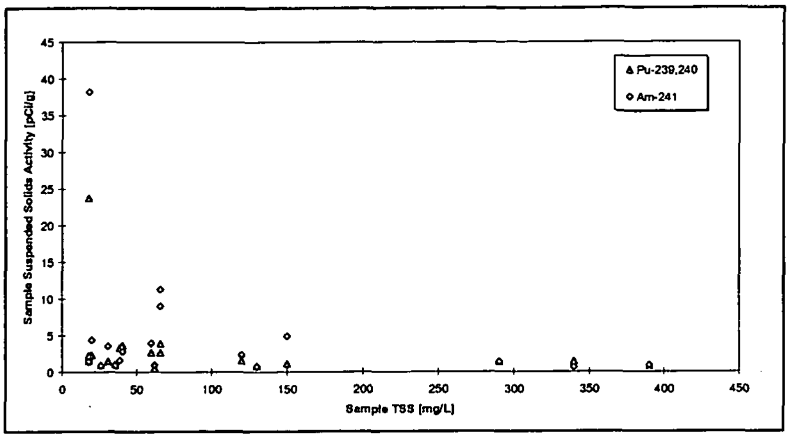


Figure 8-6. Variation of Pu and Am with TSS at GS10.

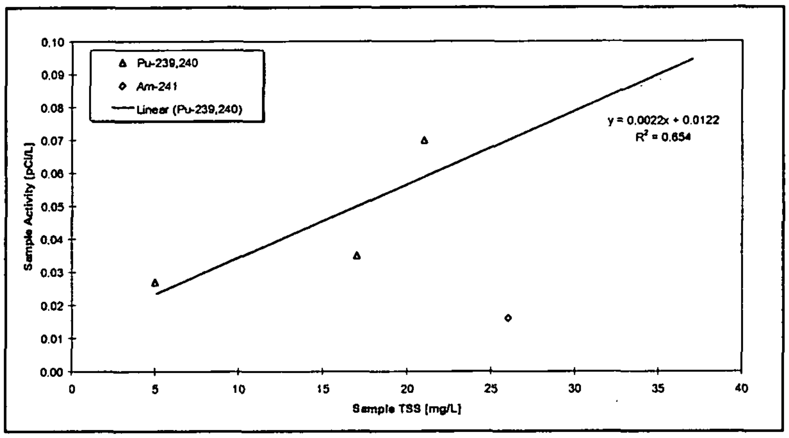
Location GS10

GS10 shows a weak correlation between increasing Pu and increasing TSS. However, no statistically significant correlation is evident between Am and TSS. This lack of correlation may be caused by the variability of contamination levels throughout the drainage and the possible existence of localized Am source areas (see Section 6.3.7).



GS10 shows no statistically significant correlation between suspended solids activity and TSS. This lack of correlation may also be caused by the variability of contamination levels throughout the drainage and the possible existence of localized Am source areas (see Section 6.3.7).

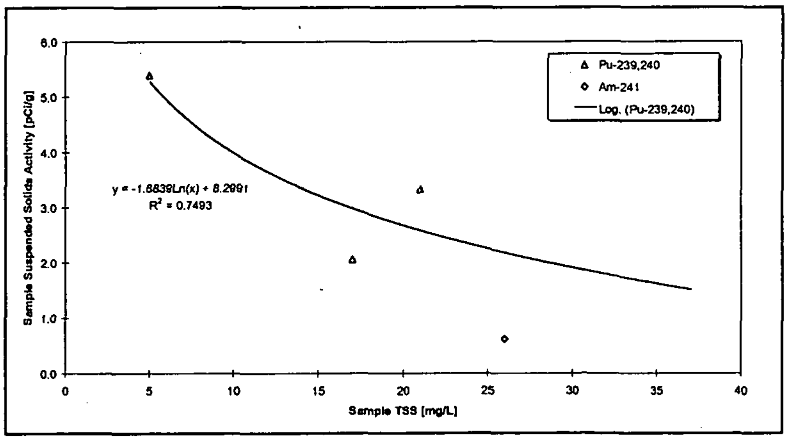
Figure 8-7. Variation of Suspended Solids Activity with TSS at GS10.



Location GS11

GS11 shows a fair correlation between increasing Pu and increasing TSS for the few data points available. Only one Am-TSS point was available.

Figure 8-8. Variation of Pu and Am with TSS at GS11.



GS11 shows a good correlation between *decreasing* Pu and increasing TSS for the few data points available. This may be caused by the preferential association of Pu with smaller/lighter particles.

Only one Am-TSS point was available.

Figure 8-9. Variation of Suspended Solids Activity with TSS at GS11.

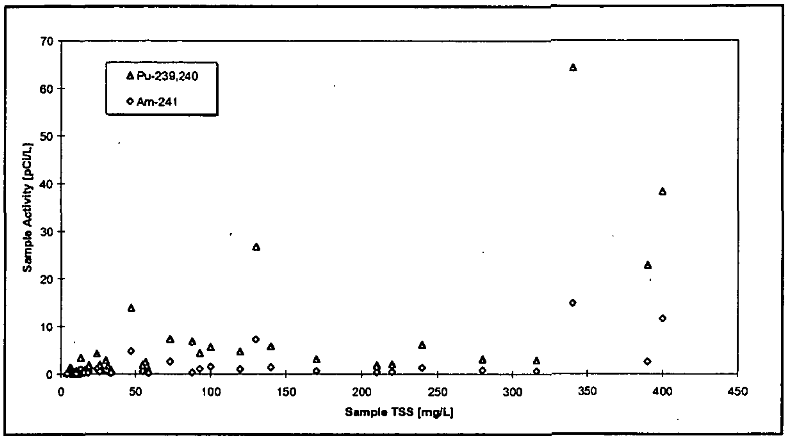


Figure 8-10. Variation of Pu and Am with TSS at GS27.

Location GS27

GS27 shows that the highest Pu and Am activities are associated with higher TSS, although the correlation is poor.

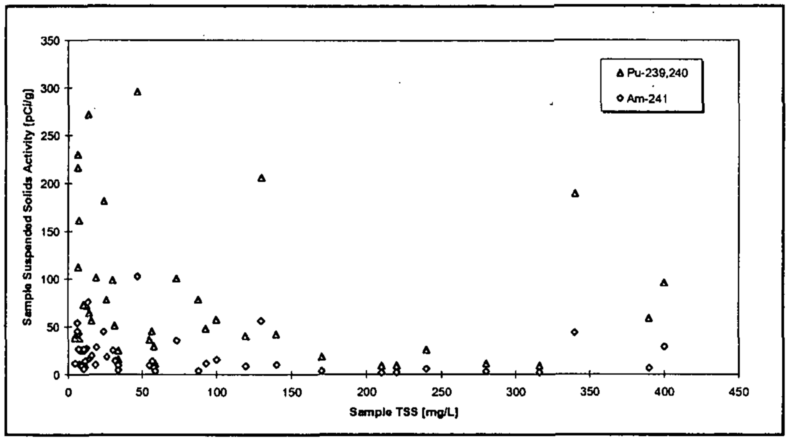


Figure 8-11. Variation of Suspended Solids Activity with TSS at GS27.

GS27 shows no statistically significant correlation between suspended solids activity and TSS.

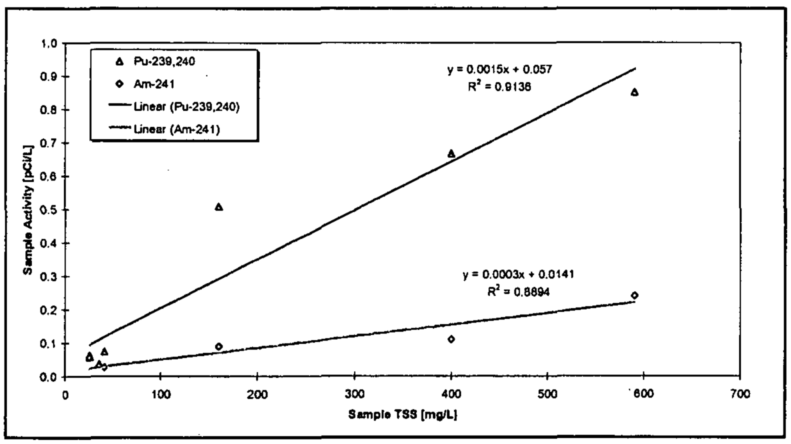
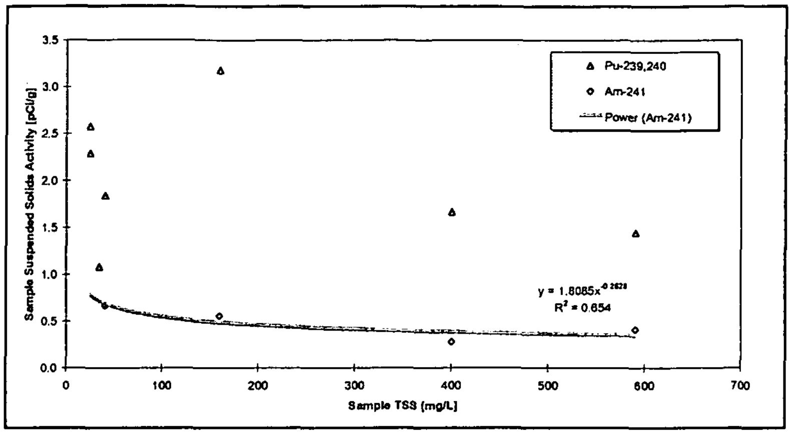


Figure 8-12. Variation of Pu and Am with TSS at GS28.

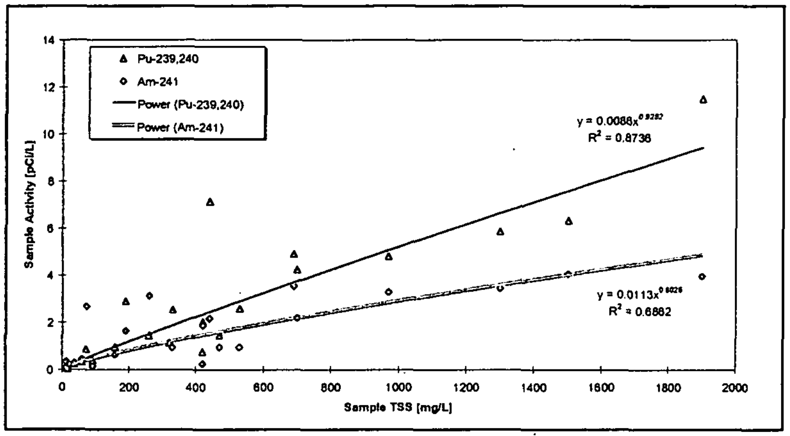
Location GS28

GS28 shows strong correlations between increasing Pu and Am with increasing TSS for the few data points available.



GS28 shows a fair correlation between suspended solids Am activity and TSS concentration. No statistically significant correlation between suspended solids Pu activity and TSS concentration is noted.

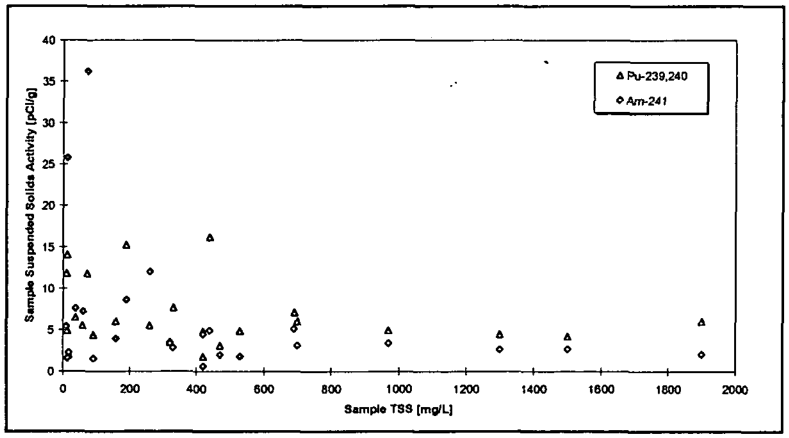
Figure 8-13. Variation of Suspended Solids Activity with TSS at GS28.



Location GS32

GS32 shows a good correlation between increasing Pu activity and increasing TSS. Similarly, a fair correlation exists between increasing Am activity and increasing TSS.

Figure 8-14. Variation of Pu and Am with TSS at GS32.



GS32 shows no statistically significant correlation between suspended solids activity and TSS.

Figure 8-15. Variation of Suspended Solids Activity with TSS at GS32.

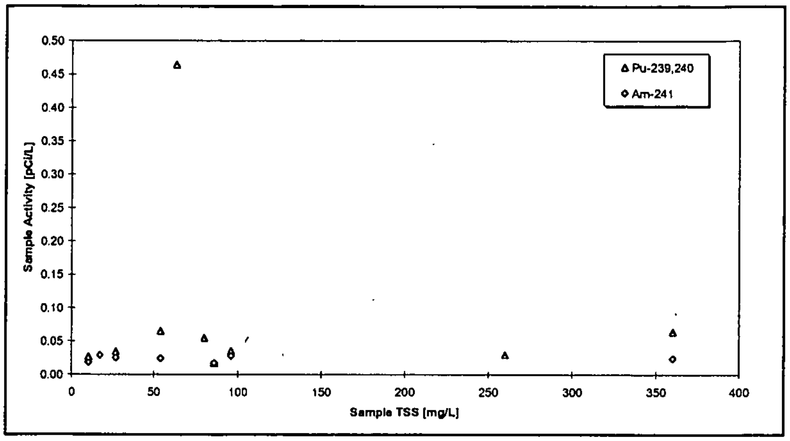


Figure 8-16. Variation of Pu and Am with TSS at GS37.

Location GS37

GS37 shows no statistically significant correlation between activity and TSS.

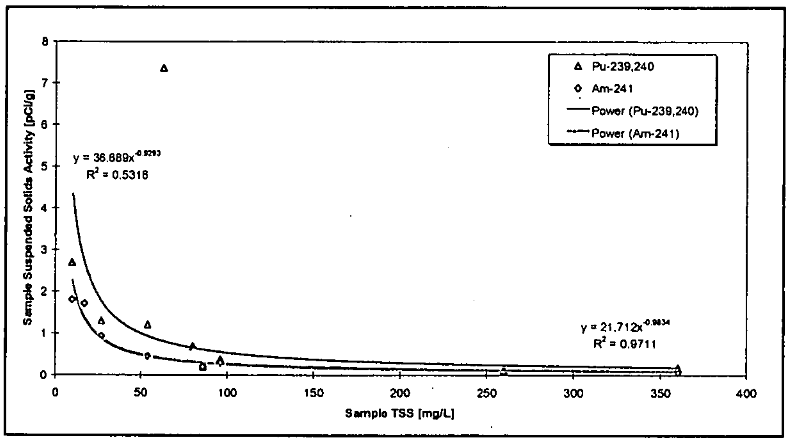


Figure 8-17. Variation of Suspended Solids Activity with TSS at GS37.

GS37 shows correlations between *decreasing* Pu and Am with increasing TSS for the relatively few data points available. This may be caused by the preferential association of Pu with smaller/lighter particles.

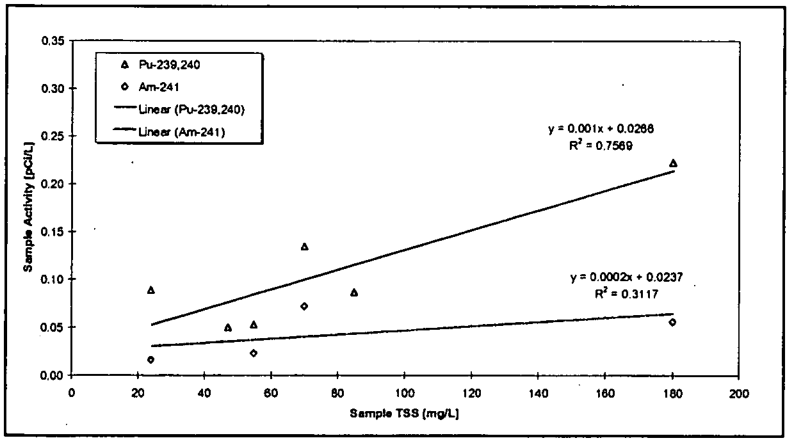
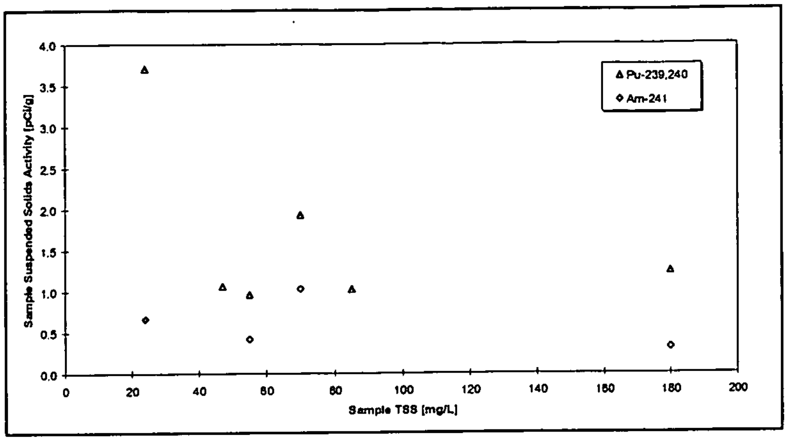


Figure 8-18. Variation of Pu and Am with TSS at GS38.

Location GS38

GS38 shows a good correlation between increasing Pu activity and increasing TSS for the few points available. Similarly, a weak correlation exists between increasing Am activity and increasing TSS.



GS38 shows no statistically significant correlation between suspended solids activity and TSS.

Figure 8-19. Variation of Suspended Solids Activity with TSS at GS38.

Location GS39

GS39 shows strong correlations between increasing Pu and Am activity with increasing TSS for the few points available.

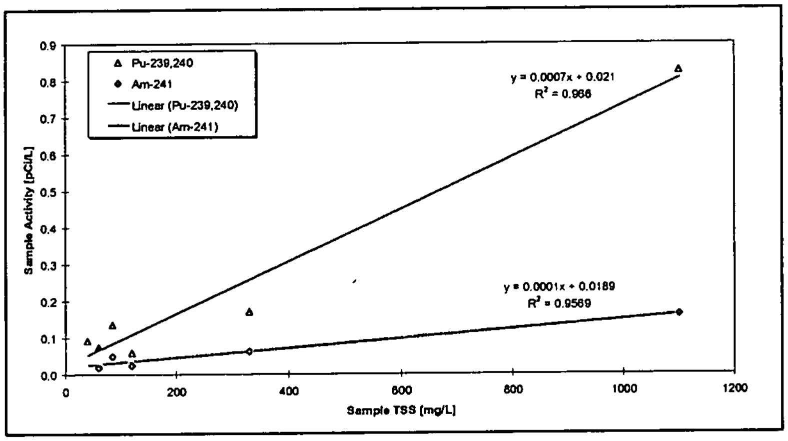


Figure 8-20. Variation of Pu and Am with TSS at GS39.

GS39 shows weak correlations between *decreasing* Pu and Am with increasing TSS for the relatively few data points available. This may be caused by the preferential association of Pu with smaller/lighter particles.

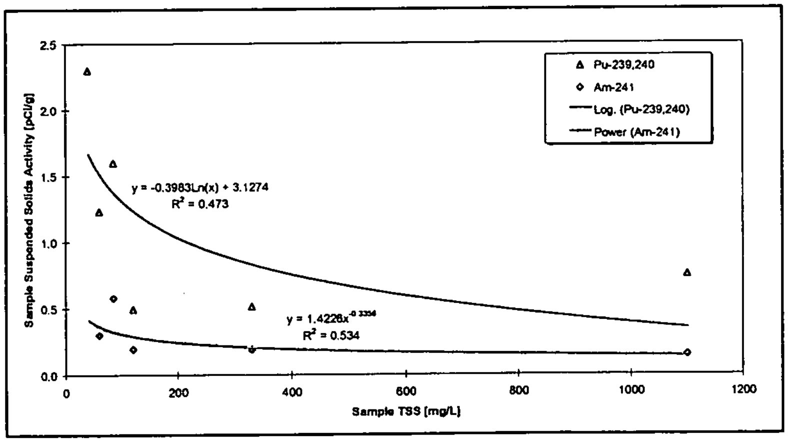


Figure 8-21. Variation of Suspended Solids Activity with TSS at GS39.

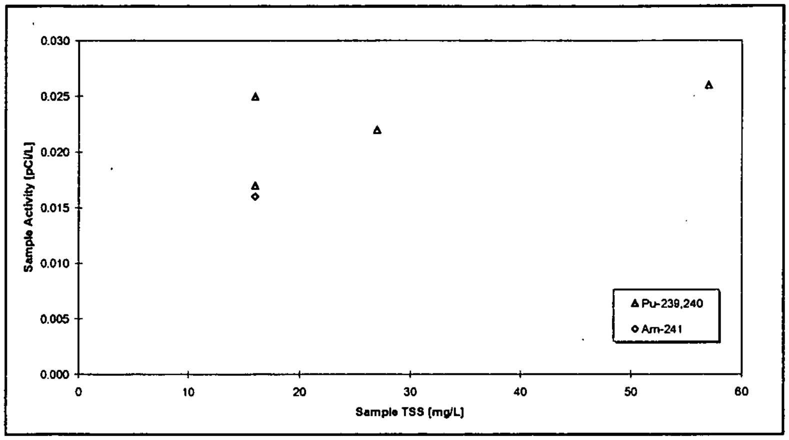


Figure 8-22. Variation of Pu and Am with TSS at GS41.

Location GS41

GS41 shows no statistically significant correlation between activity and TSS.

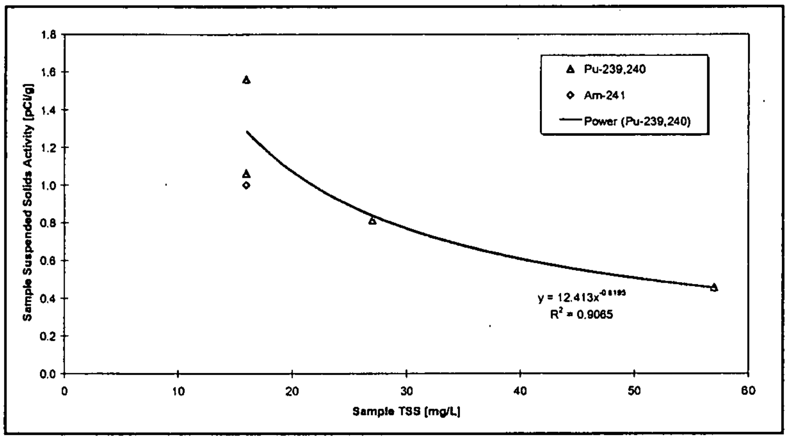


Figure 8-23. Variation of Suspended Solids Activity with TSS at GS41.

GS41 shows a strong correlation between *decreasing* Pu activity with increasing TSS for the relatively few data points available. Only one suspended solids Am point was available.

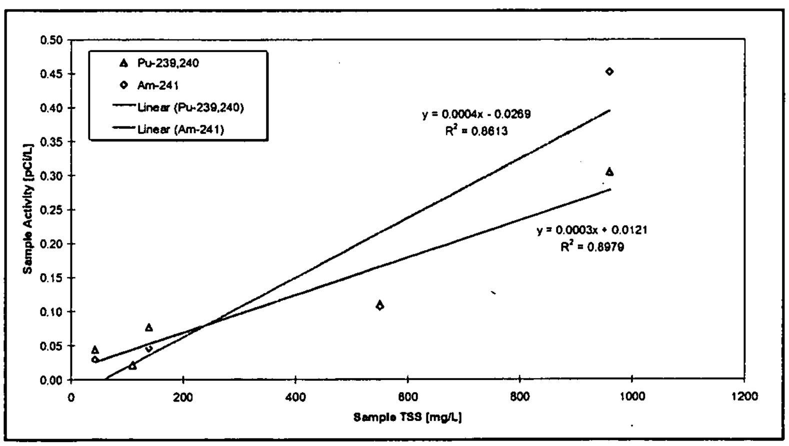
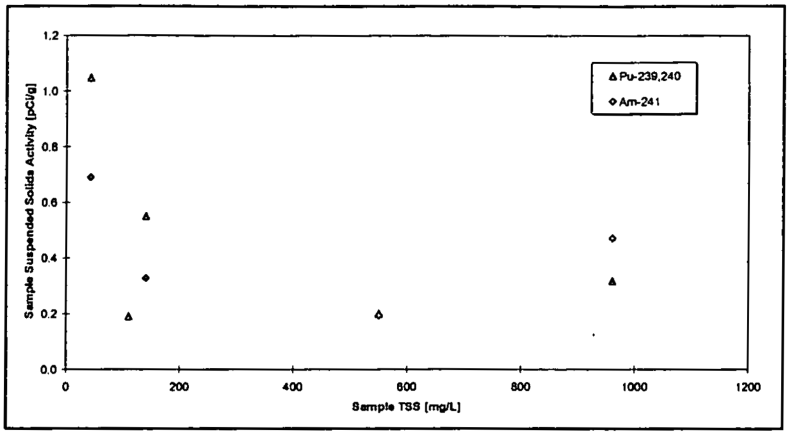


Figure 8-24. Variation of Pu and Am with TSS at SW021.

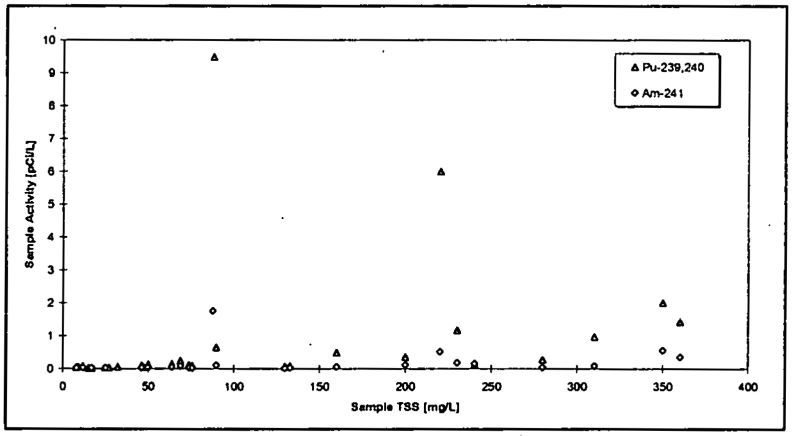
Location SW021

SW021 shows good correlations between increasing Pu and Am activity with increasing TSS for the few points available. The Pu correlation is highly influenced by a single point.



SW021 shows no statistically significant correlation between suspended solids activity and TSS.

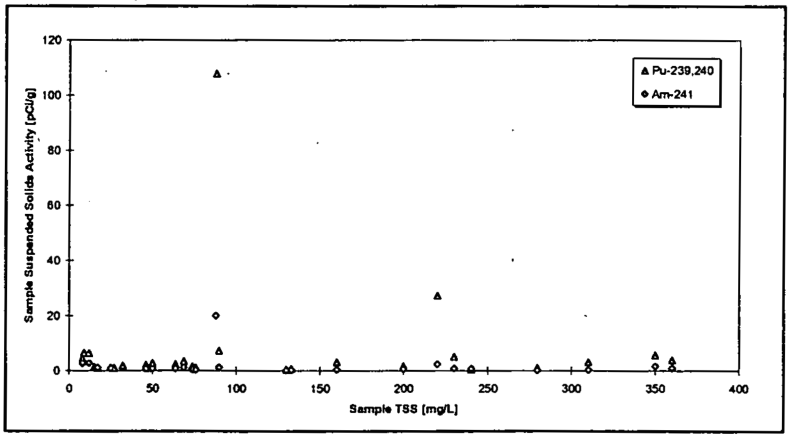
Figure 8-25. Variation of Suspended Solids Activity with TSS at SW021.



Location SW022

SW022 shows no statistically significant correlation between activity and TSS.

Figure 8-26. Variation of Pu and Am with TSS at SW022.



SW022 shows no statistically significant correlation between suspended solids activity and TSS.

Figure 8-27. Variation of Suspended Solids Activity with TSS at SW022.

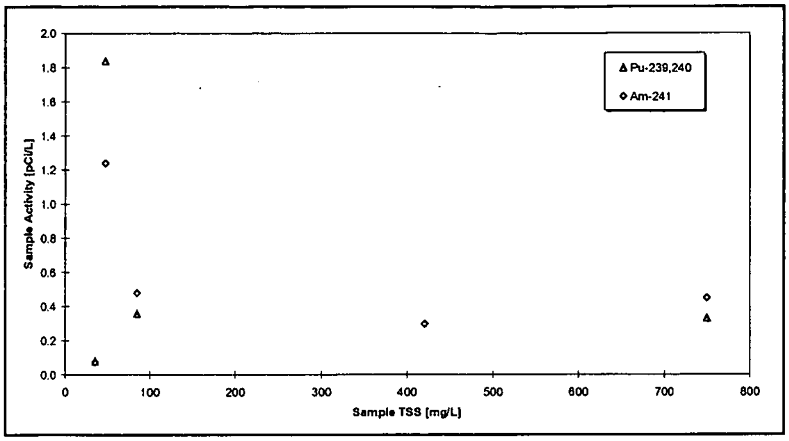


Figure 8-28. Variation of Pu and Am with TSS at SW023.

Location SW023

SW023 shows no statistically significant correlation between activity and TSS.

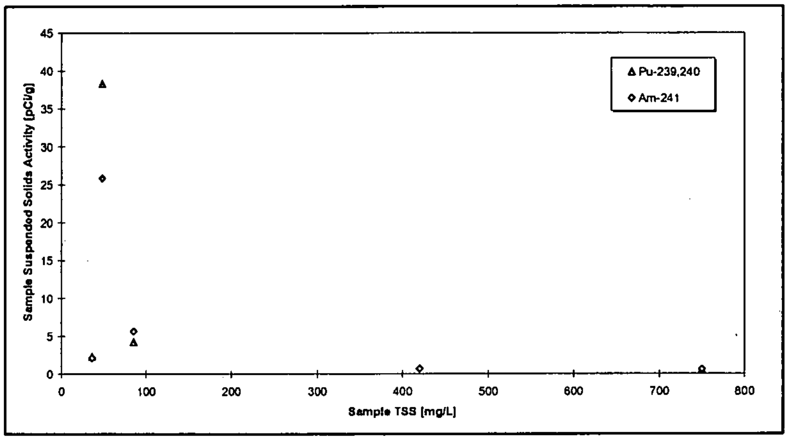


Figure 8-29. Variation of Suspended Solids Activity with TSS at SW023.

SW023 shows no statistically significant correlation between suspended solids activity and TSS.

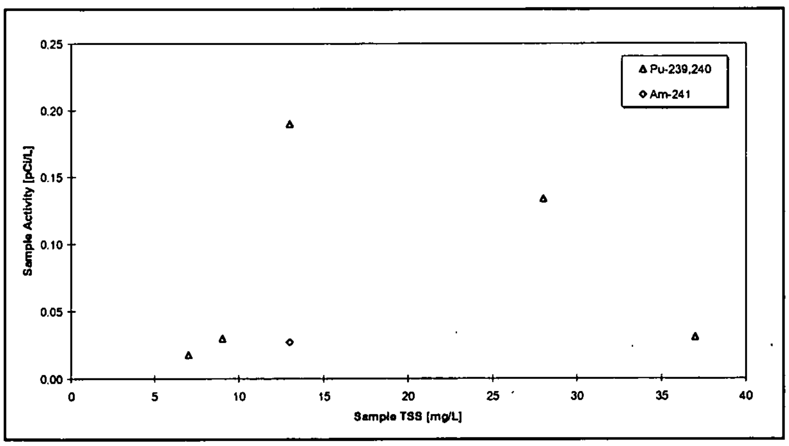
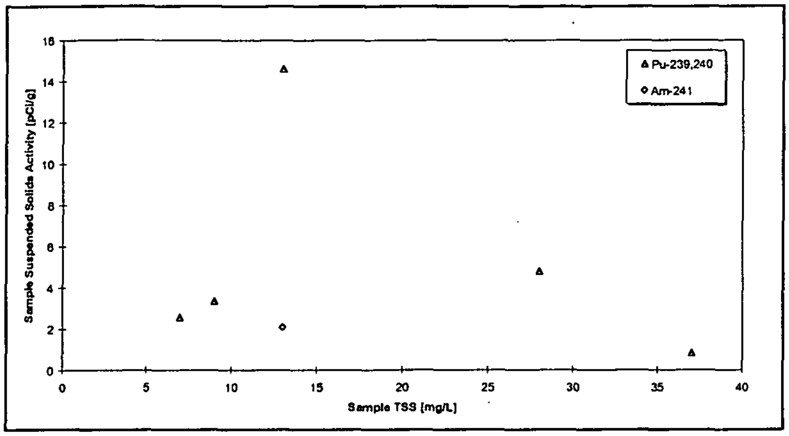


Figure 8-30. Variation of Pu and Am with TSS at SW027.

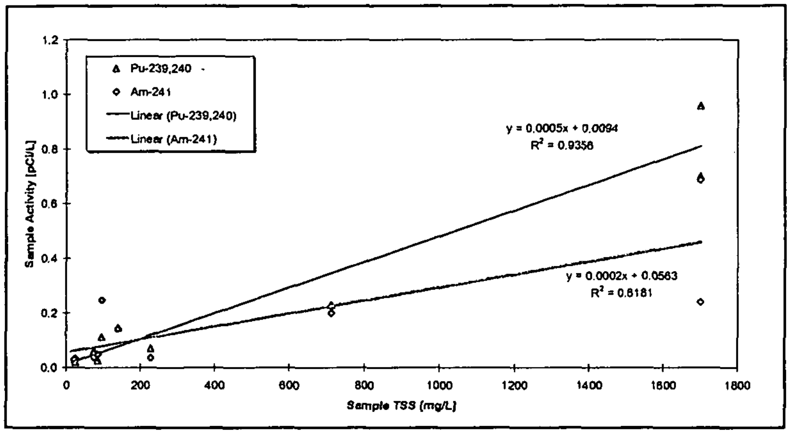
Location SW027

SW027 shows no statistically significant correlation between activity and TSS.



SW027 shows no statistically significant correlation between suspended solids activity and TSS.

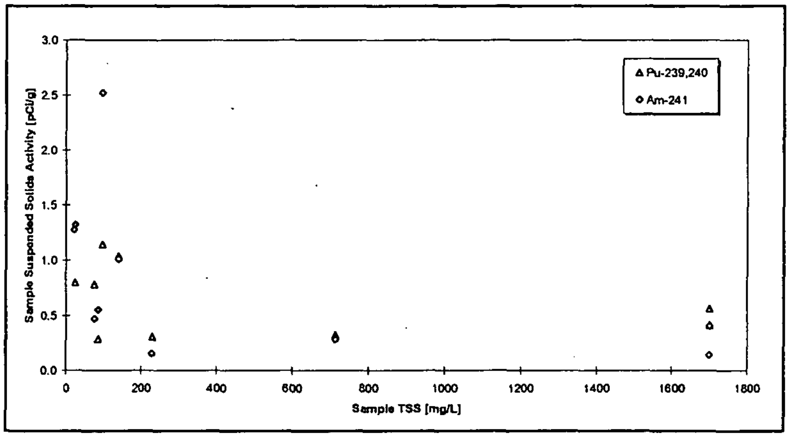
Figure 8-31. Variation of Suspended Solids Activity with TSS at SW027.



Location SW091

SW091 shows a strong correlation between increasing Pu activity and increasing TSS for the few points available. Similarly, a fair correlation exists between increasing Am activity and increasing TSS.

Figure 8-32. Variation of Pu and Am with TSS at SW091.



SW091 shows no statistically significant correlation between suspended solids activity and TSS.

Figure 8-33. Variation of Suspended Solids Activity with TSS at SW091.

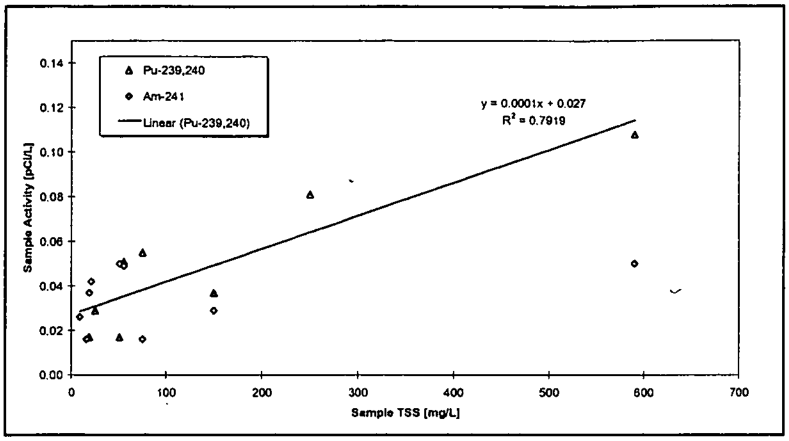


Figure 8-34. Variation of Pu and Am with TSS at SW093.

Location SW093

SW093 shows a good correlation between increasing Pu activity and increasing TSS for the few points available. However, no statistically significant correlation exists between Am activity and TSS.

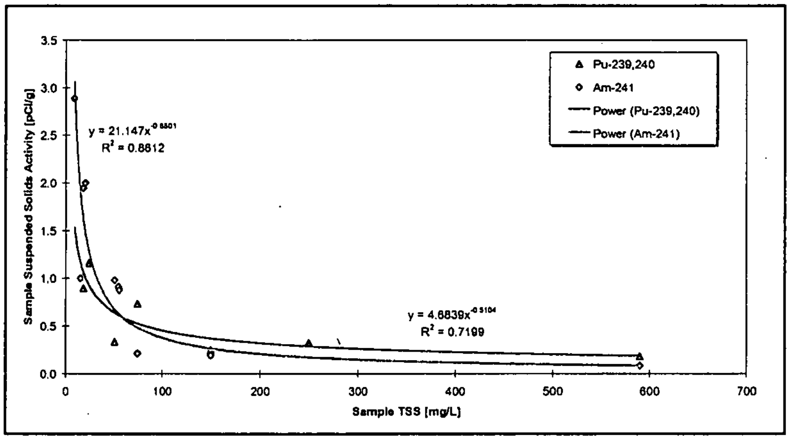


Figure 8-35. Variation of Suspended Solids Activity with TSS at SW093.

SW093 shows good correlations between *decreasing* Pu and Am with increasing TSS. This may be caused by the preferential association of Pu with smaller/lighter particles.

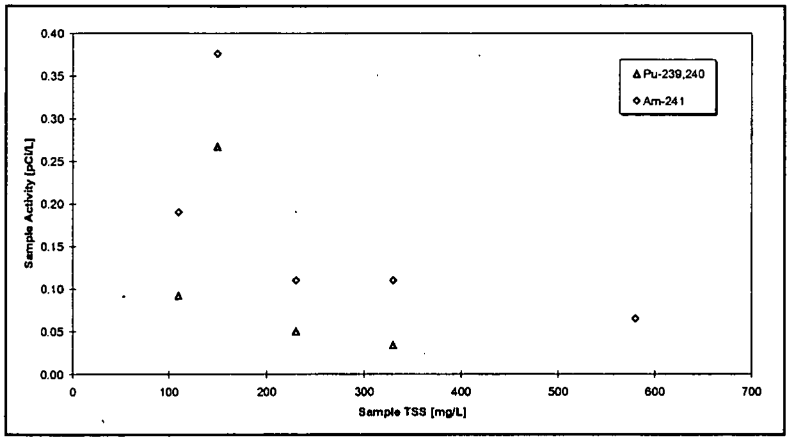


Figure 8-36. Variation of Pu and Am with TSS at SW100100.

Location SW100100

SW100100 shows no statistically significant correlation between activity and TSS.

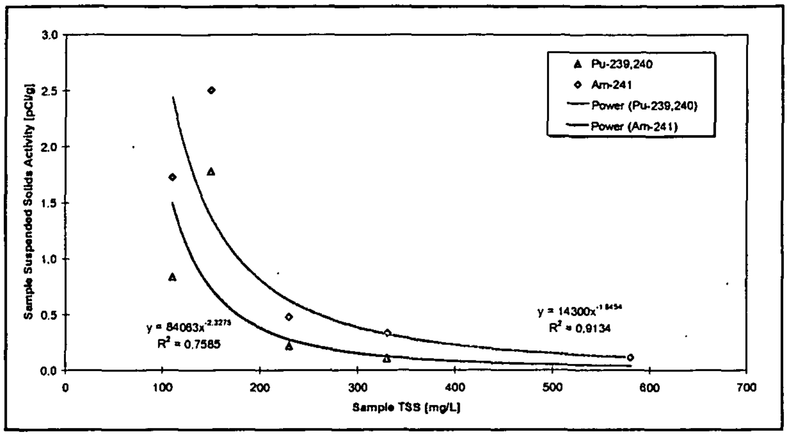


Figure 8-37. Variation of Suspended Solids Activity with TSS at SW100100.

SW100100 shows good correlations between *decreasing* Pu and Am with increasing TSS. This may be caused by the preferential association of Pu with smaller/lighter particles.

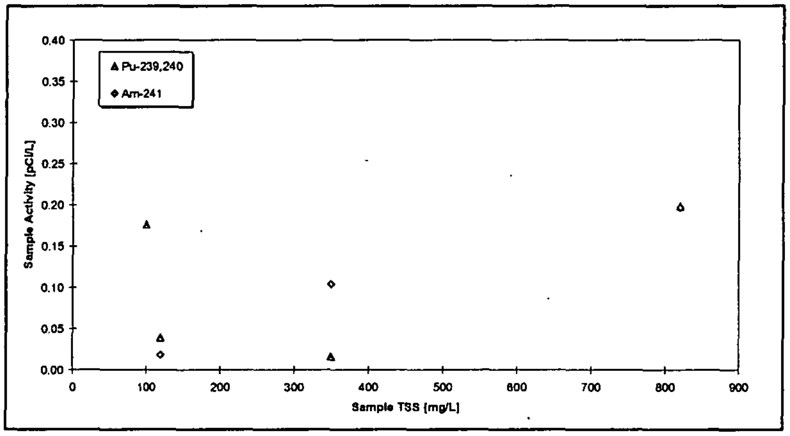


Figure 8-38. Variation of Pu and Am with TSS at SW132.

Location SW132

SW132 shows no statistically significant correlation between activity and TSS.

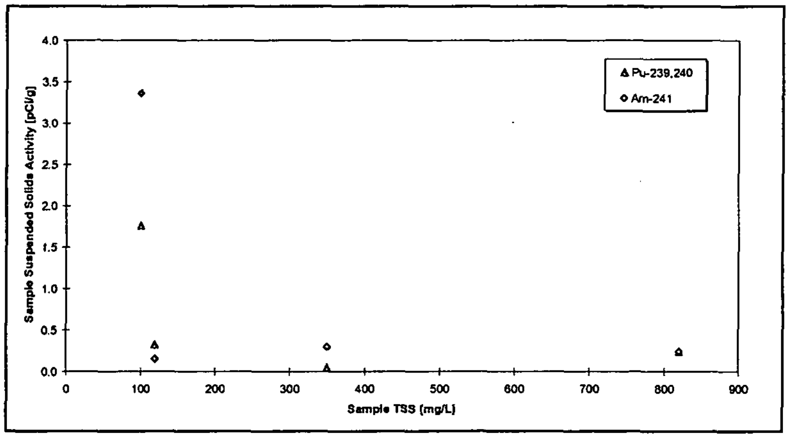


Figure 8-39. Variation of Suspended Solids Activity with TSS at SW132.

SW132 shows no statistically significant correlation between suspended solids activity and TSS.

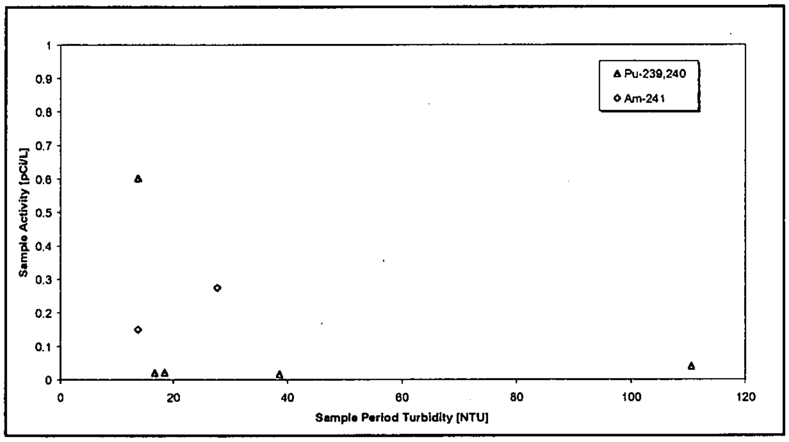
8.3.2 Correlation of Actinides with Turbidity

Since Pu and Am tend to be transported in surface water in association with particulate matter (measured as TSS), a relationship between activity and turbidity could be used as an indicator of Pu and Am transport. This section evaluates the variation of composite sample Pu and Am activity with the corresponding average real-time turbidity data. Plots are presented for all locations where turbidity data are collected. These locations are GS08, GS10, GS11, GS31, SW027, and SW093.

The sample Pu and Am activities are the values obtained through laboratory analysis given in pCi/L. Only Pu and Am values greater than the MDA (generally 0.015 pCi/L) are included.

The average composite-sample period turbidity (NTU) is calculated as follows:

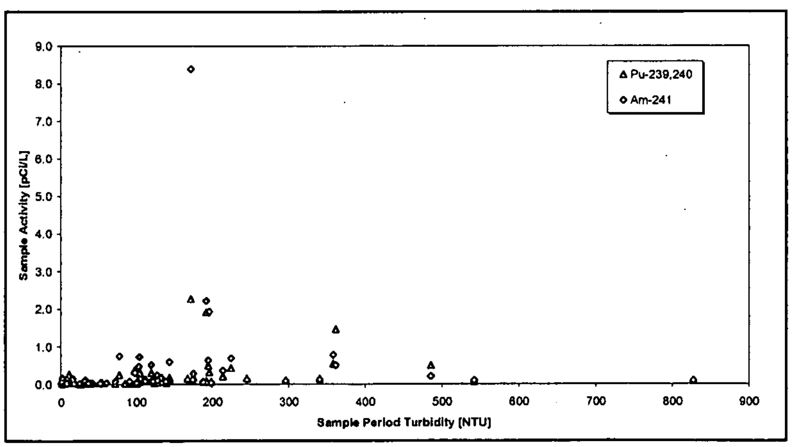
1. The date and time of each grab sample comprising the composite is obtained from the monitoring instrumentation.
2. The corresponding turbidity value for each grab sample is interpolated from the 15-minute interval turbidity data. Some samples may not have turbidity values due to equipment failures and periodic equipment removal for winter icing conditions.
3. Since each grab sample is of the same volume (200 ml), the interpolated turbidity values are arithmetically averaged to obtain the applicable turbidity for the entire composite sampling period.



Location GS08

GS08 shows no statistically significant correlation between increasing activity and increasing turbidity.

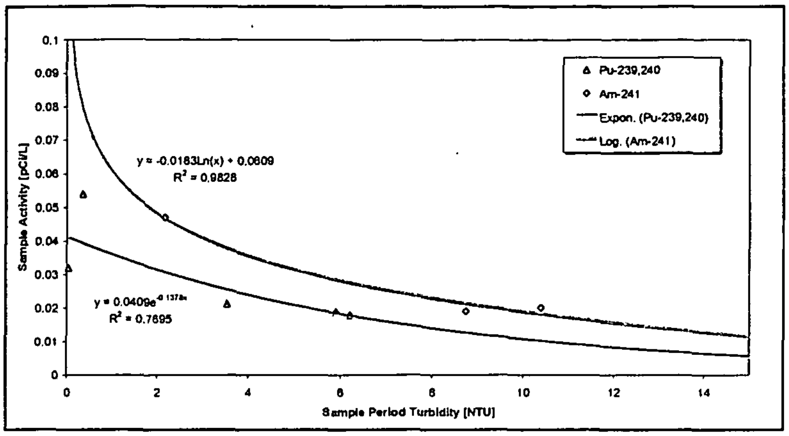
Figure 8-40. Variation of Pu and Am Activity with Turbidity at GS08.



Location GS10

GS10 also shows no statistically significant correlation between increasing activity and increasing turbidity.

Figure 8-41. Variation of Pu and Am Activity with Turbidity at GS10.



Location GS11

GS11 shows good to strong correlations between *decreasing* activity and increasing turbidity for the limited number of data points available. The possible cause of this phenomena is not clear, though the correlations could be serendipitous due to the small number of data points.

Figure 8-42. Variation of Pu and Am Activity with Turbidity at GS11.

Location GS31

GS31 shows correlations between increasing activity and increasing turbidity for the limited number of data points available. It should be noted that the two high points most influencing the correlations are associated with a sample collected during pond dewatering to allow for video surveillance of the outlet works. To achieve dewatering, the outlet works valve on the bottom (essentially in the pond bottom sediments) of the pond is used to drain the pond. At these low pond levels, higher turbidity values are expected. The other values are for samples collected during normal pump discharge operations where water is taken from the pond surface.

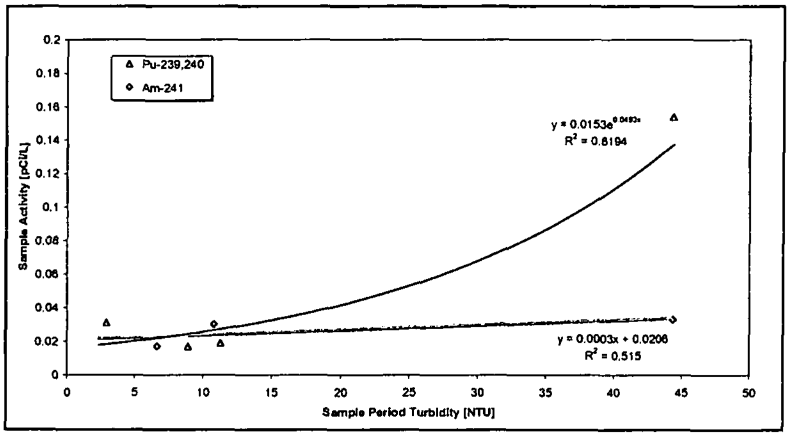
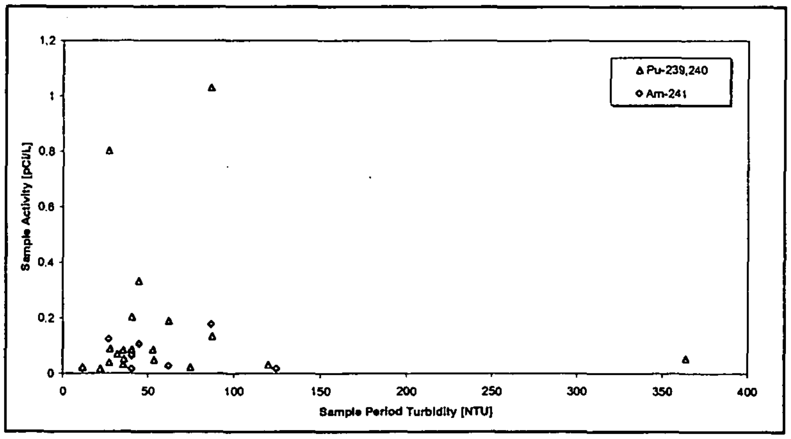


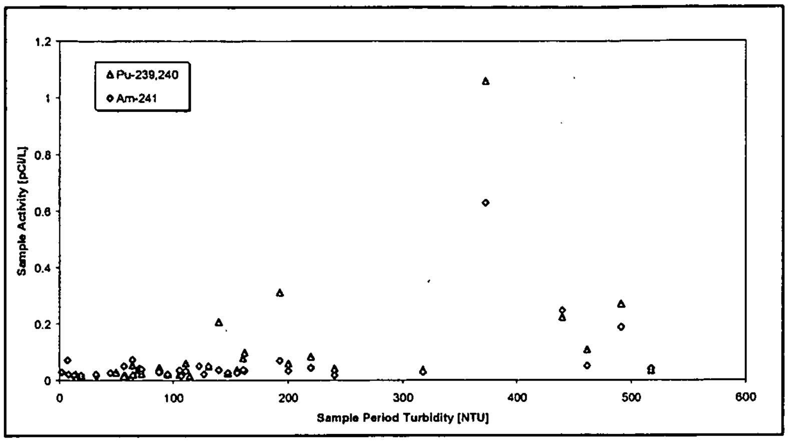
Figure 8-43. Variation of Pu and Am Activity with Turbidity at GS31.



Location SW027

SW027 also shows no statistically significant correlation between increasing activity and increasing turbidity.

Figure 8-44. Variation of Pu and Am Activity with Turbidity at SW027.



Location SW093

SW093 also shows no statistically significant correlation between increasing activity and increasing turbidity. However, the higher activities are generally associated with higher turbidities.

Figure 8-45. Variation of Pu and Am Activity with Turbidity at SW093.

8.3.3 Correlation of Radionuclides with Flow Rate

Since Pu and Am tend to be transported in surface water in association with particulate matter, and assuming that higher flow rates tend to transport more sediment, a relationship between activity and flow rate could be used as an indicator of Pu and Am transport. This section evaluates the variation of composite sample Pu and Am activity with the corresponding average flow rate. Plots are presented for all locations where both Pu and Am data are collected with flow measurement.

The sample Pu and Am activities are the values obtained through laboratory analysis given in pCi/L. Only Pu and Am values greater than the MDA (generally 0.015 pCi/L) are included.

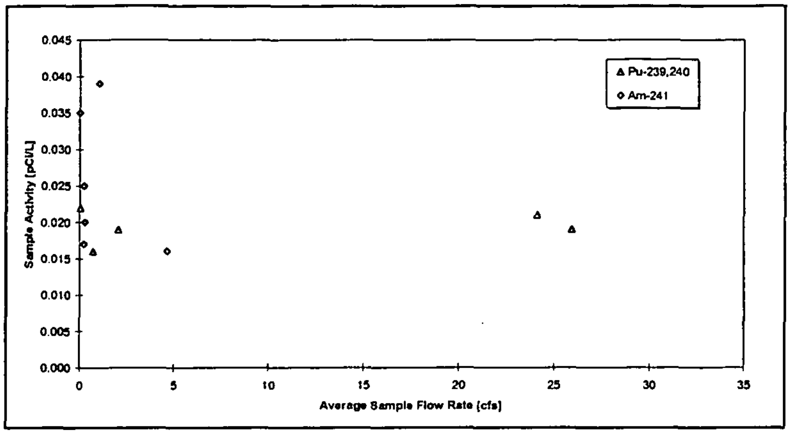
Plots are also presented showing the variability of total uranium with flow rate. Plots are presented for all locations where uranium data are collected with flow measurement.

The sample total uranium activity is the sum of the isotopic values obtained through laboratory analysis given in pCi/L (U-233,234 + U-235 + U-238).

The average composite-sample period flow rate (CFS) is calculated as follows:

1. The date and time of each grab sample comprising the composite is obtained from the monitoring instrumentation.
2. The corresponding flow value for each grab sample is interpolated from the 15-minute interval flow data. Some samples may not have flow values due to equipment failures and periodic winter icing conditions.
3. Since each grab sample is of the same volume (200 ml), the interpolated flow values are arithmetically averaged to obtain the applicable flow for the entire composite sampling period.

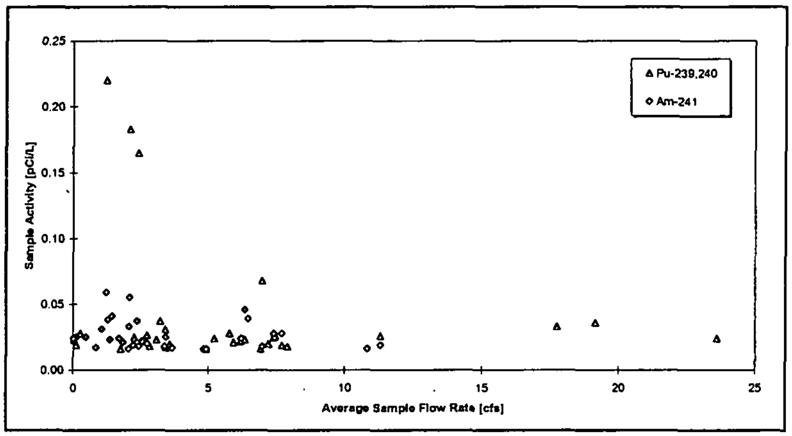
Only locations that had greater than two data pairs are plotted. As such, Pu and Am plots are not presented for locations GS35, GS42, and GS43. Similarly, uranium plots are not presented for locations GS35, GS41, and GS42.



Location GS01

GS01 shows no statistically significant correlation between Pu and Am activity with flow rate.

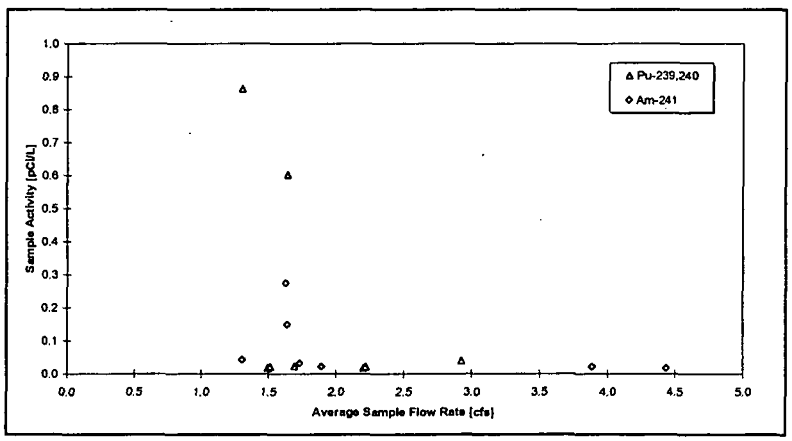
Figure 8-46. Variation of Pu and Am with Flow Rate at GS01.



Location GS03

GS03 shows no statistically significant correlation between Pu and Am activity with flow rate.

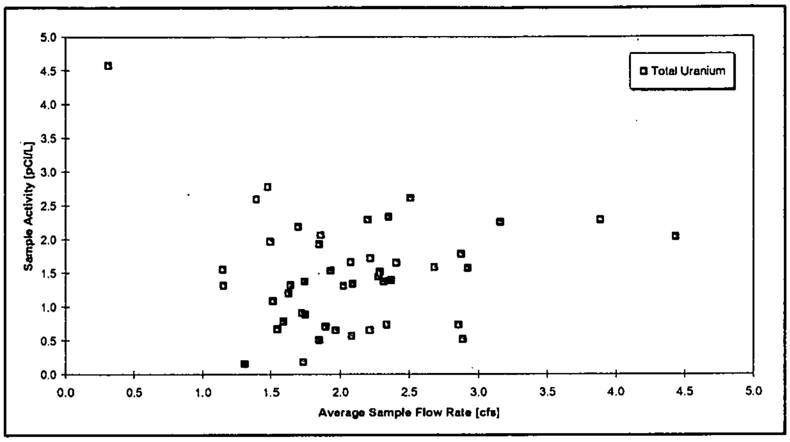
Figure 8-47. Variation of Pu and Am with Flow Rate at GS03.



Location GS08

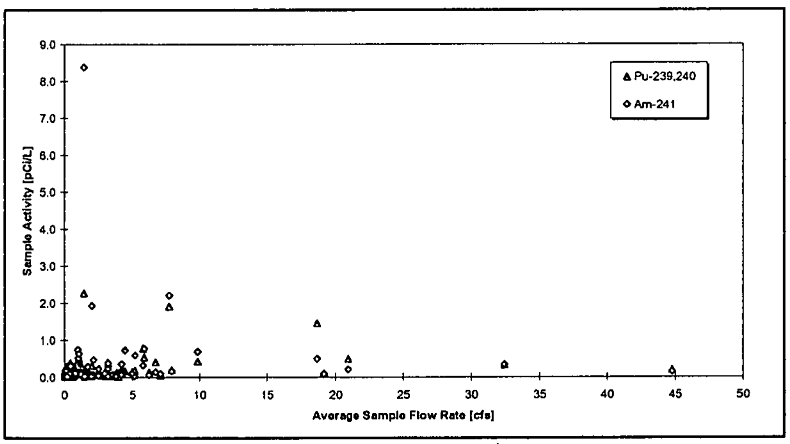
GS08 shows no statistically significant correlation between Pu and Am activity with flow rate.

Figure 8-48. Variation of Pu and Am with Flow Rate at GS08.



GS08 shows no statistically significant correlation between uranium activity and flow rate.

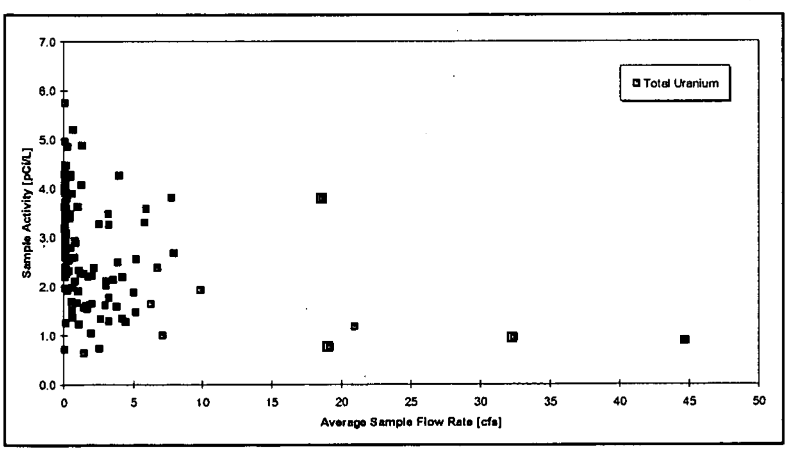
Figure 8-49. Variation of Total Uranium with Flow Rate at GS08.



Location GS10

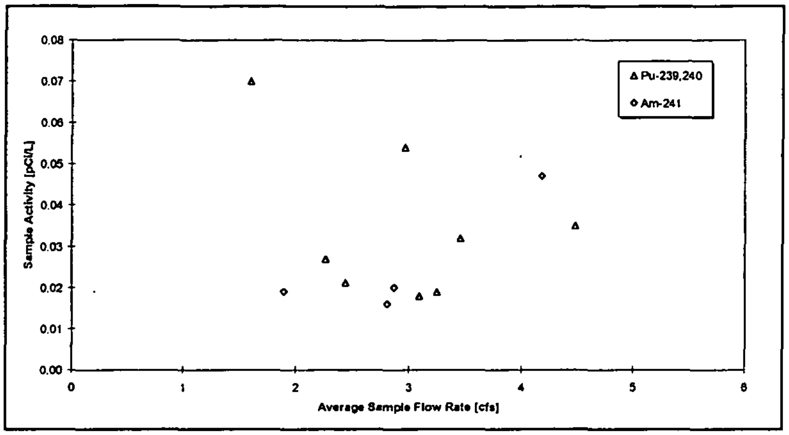
GS10 shows no statistically significant correlation between Pu and Am activity with flow rate.

Figure 8-50. Variation of Pu and Am with Flow Rate at GS10.



GS10 shows no statistically significant correlation between uranium and flow rate.

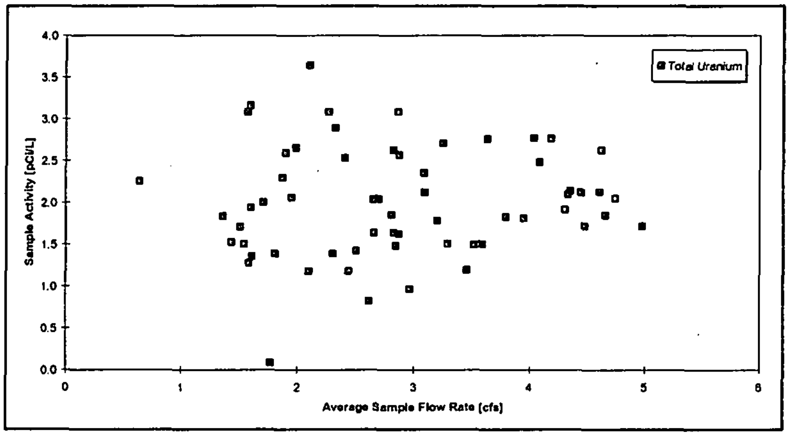
Figure 8-51. Variation of Total Uranium with Flow Rate at GS10.



Location GS11

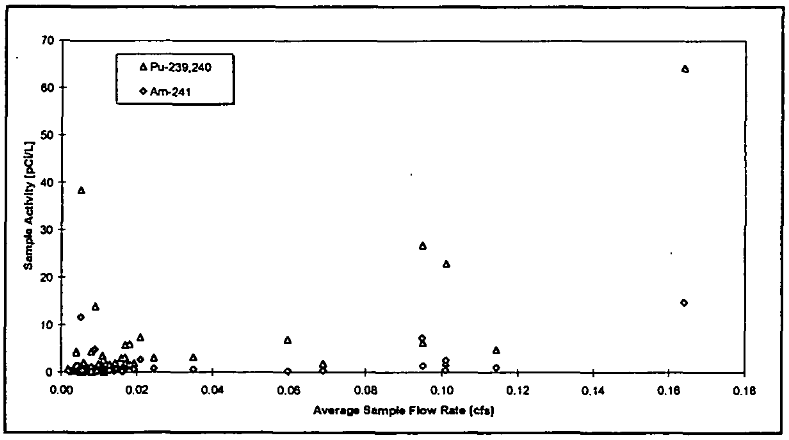
GS11 shows no statistically significant correlation between Pu and Am activity with flow rate.

Figure 8-52. Variation of Pu and Am with Flow Rate at GS11.



GS11 shows no statistically significant correlation between uranium and flow rate.

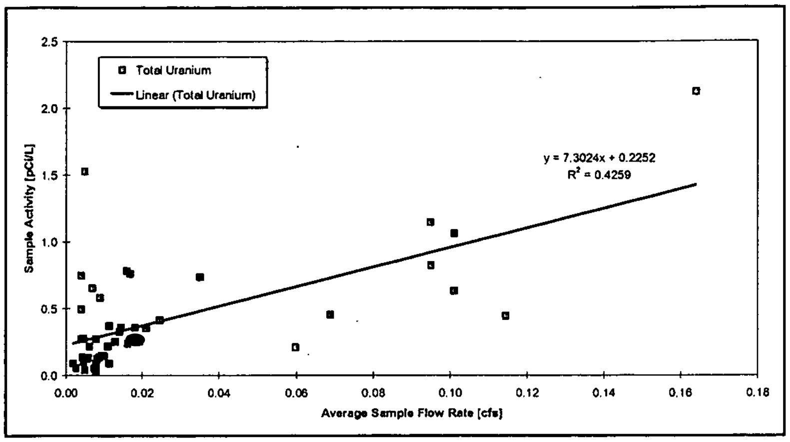
Figure 8-53. Variation of Total Uranium with Flow Rate at GS11.



Location GS27

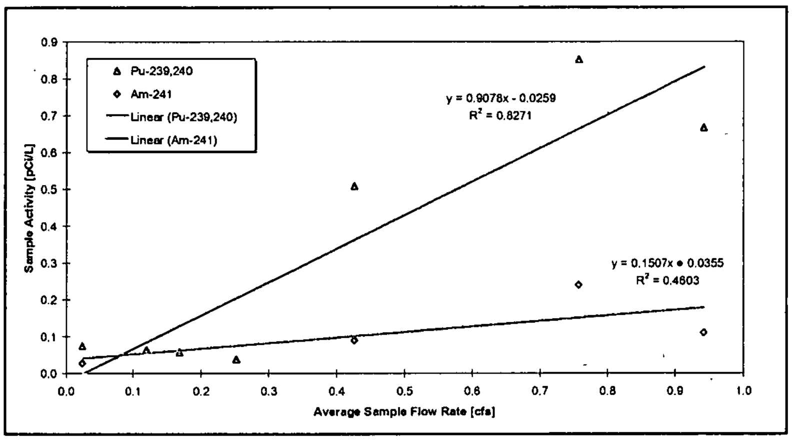
GS27 shows no statistically significant correlation between Pu and Am activity with flow rate. However, most of the higher activities occurred with higher flow rates.

Figure 8-54. Variation of Pu and Am with Flow Rate at GS27.



GS27 shows a weak correlation between increasing uranium activity and increasing flow rate.

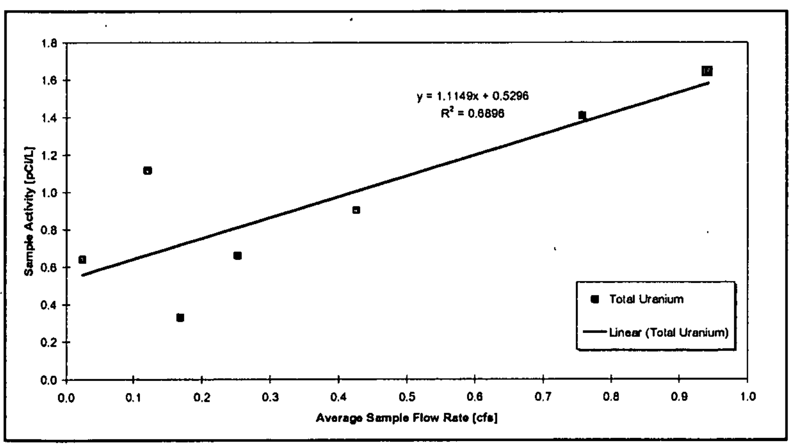
Figure 8-55. Variation of Total Uranium with Flow Rate at GS27.



Location GS28

GS28 shows a good correlation between increasing Pu activity and increasing flow rate. A weak correlation between increasing Am activity and increasing flow rate is apparent for the few data points available.

Figure 8-56. Variation of Pu and Am with Flow Rate at GS28.



GS28 shows a fair correlation between increasing uranium activity and increasing flow rate.

Figure 8-57. Variation of Total Uranium with Flow Rate at GS28.

Location GS31

GS31 shows good correlations between *decreasing* activity and increasing flow rate for the limited number of data points available. It should be noted that the four high activity points most influencing the correlations are associated with samples collected during pond dewatering to allow for video surveillance of the outlet works. To achieve dewatering, the outlet works valve on the bottom (essentially in the pond bottom sediments) of the pond is used to drain the pond. At these low pond levels, higher turbidity values are expected (Figure 8-43). Since Pu and Am tend to be transported in association with particulate matter, the higher activities are expected. The other values are for samples collected during normal pump discharge operations where water is taken from the pond surface.

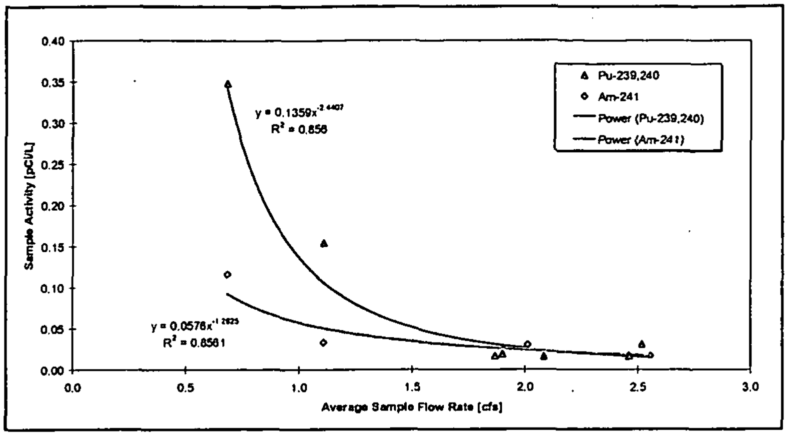


Figure 8-58. Variation of Pu and Am with Flow Rate at GS31.

GS31 shows no statistically significant correlation between uranium and flow rate. It should be noted that the two highest uranium results are associated with the valve tests.

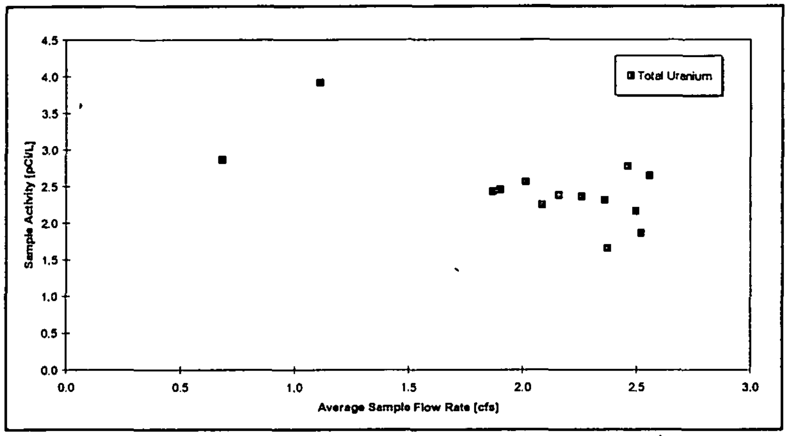


Figure 8-59. Variation of Total Uranium with Flow Rate at GS31.

Location GS33

GS33 shows that Pu activity does not change significantly with flow rate for the few data points available. Only one Am point was available for the analysis.

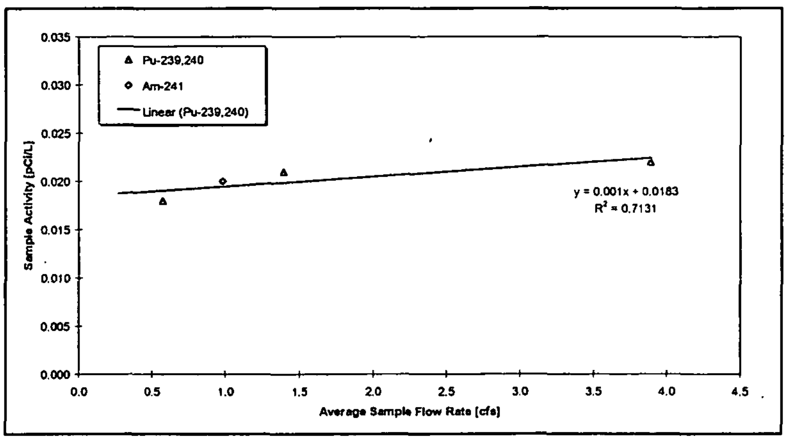
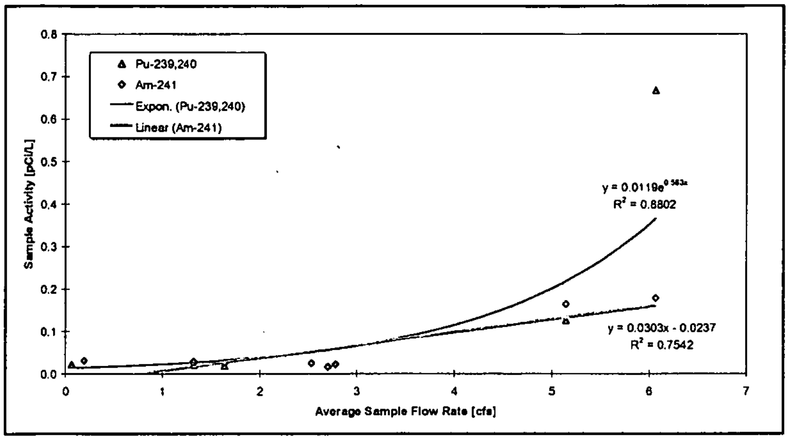


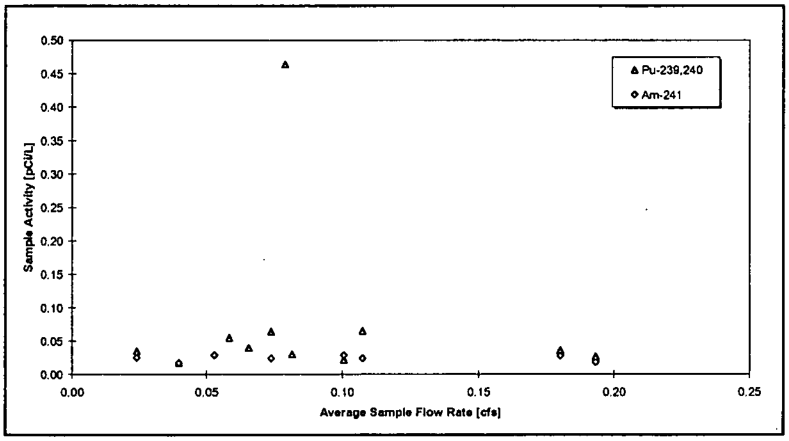
Figure 8-60. Variation of Pu and Am with Flow Rate at GS33.



Location GS34

GS34 shows good correlations between increasing Pu and Am activity with increasing flow rate.

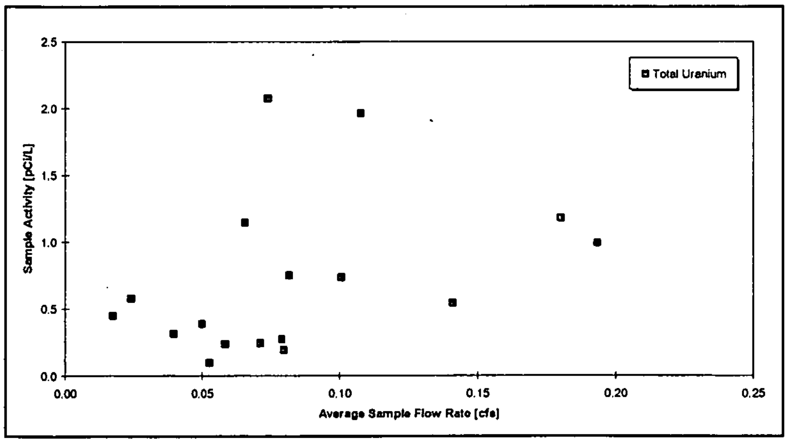
Figure 8-61. Variation of Pu and Am with Flow Rate at GS34.



Location GS37

GS37 shows no statistically significant correlation between Pu and Am activity with flow rate.

Figure 8-62. Variation of Pu and Am with Flow Rate at GS37.



GS37 shows no statistically significant correlation between uranium and flow rate.

Figure 8-63. Variation of Total Uranium with Flow Rate at GS37.

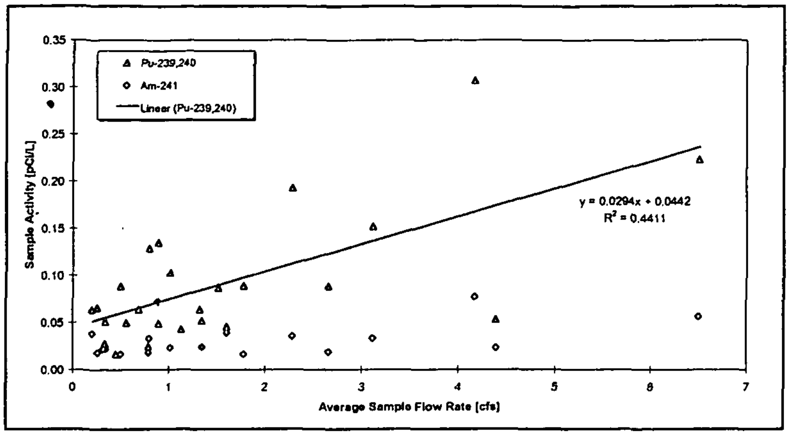


Figure 8-64. Variation of Pu and Am with Flow Rate at GS38.

Location GS38

GS38 shows a weak correlation between increasing Pu activity and increasing flow rate. Am activity appears to not vary with flow rate.

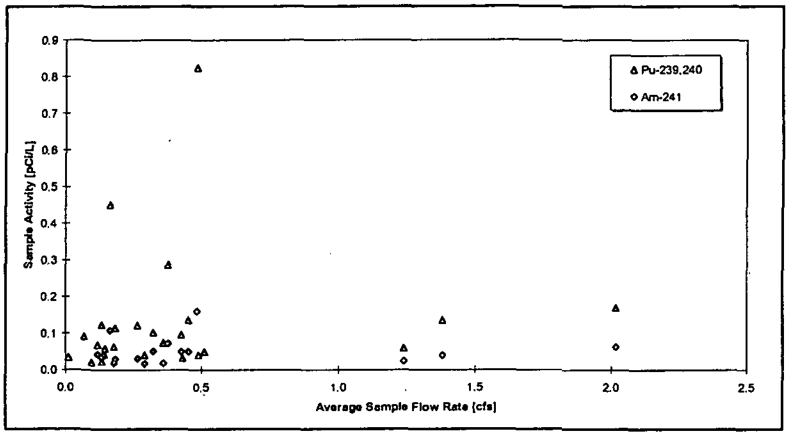


Figure 8-65. Variation of Pu and Am with Flow Rate at GS39.

Location GS39

GS39 shows no statistically significant correlation between Pu and Am activity with flow rate.

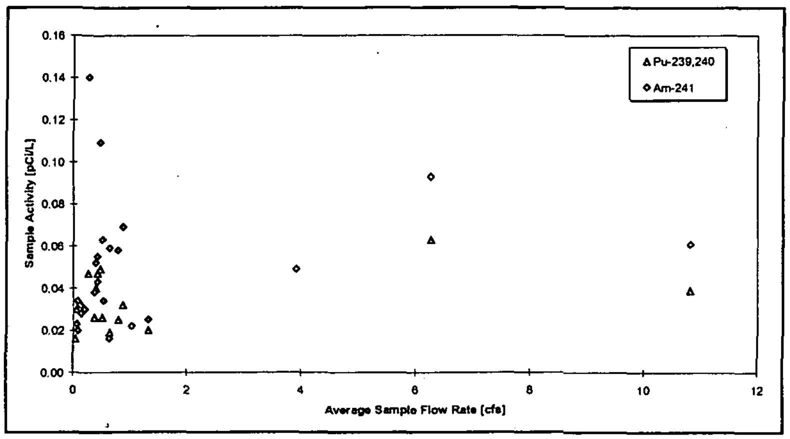
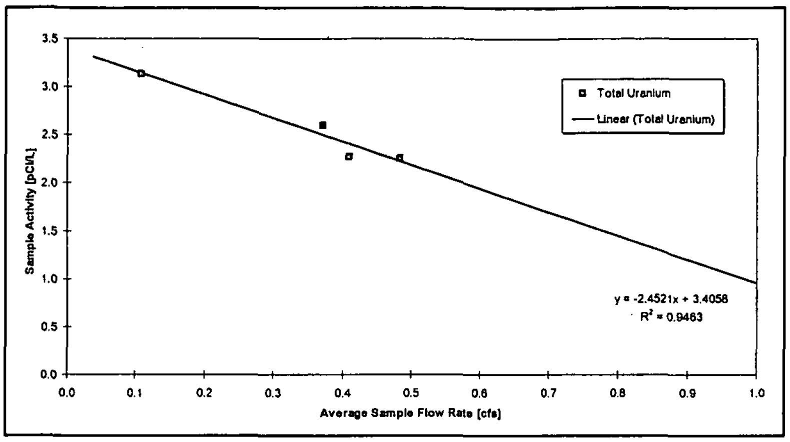


Figure 8-66. Variation of Pu and Am with Flow Rate at GS40.

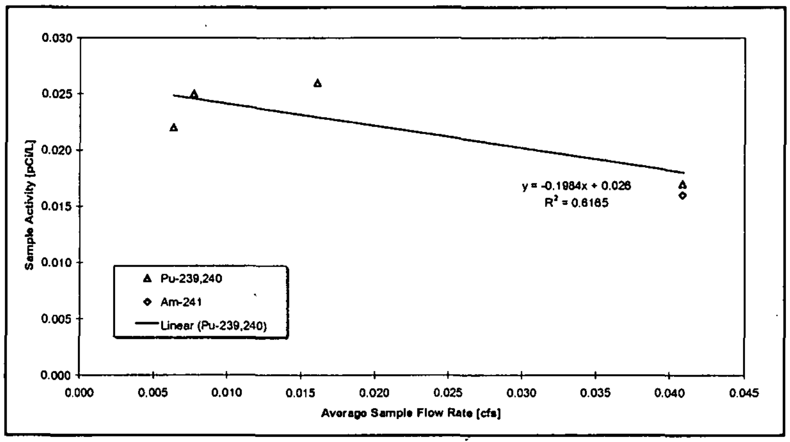
Location GS40

GS40 shows no statistically significant correlation between Pu and Am activity with flow rate.



GS40 shows a strong correlation between *decreasing* uranium activity and increasing flow rate for the few points available. Baseflow (low flow rates) at GS40 is sustained by footing drain flows (B707) and possibly intercepted groundwater. If naturally occurring (or possibly anthropogenic) uranium is associated with these flows, then the decrease in uranium activity at higher flow rates could be caused by dilution from stormwater runoff.

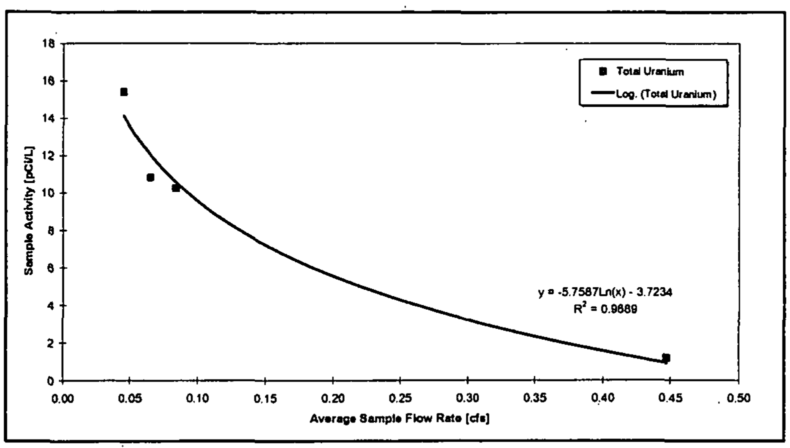
Figure 8-67. Variation of Total Uranium with Flow Rate at GS40.



Location GS41

GS41 shows little change in Pu activity depending on flow rate. Only one Am point was available for the evaluation.

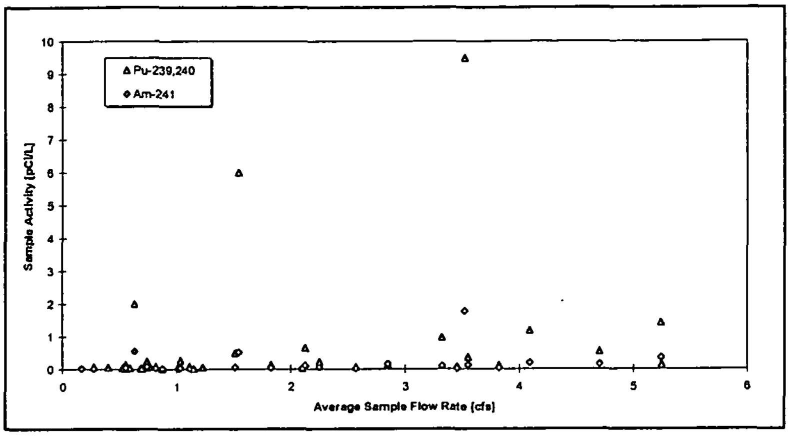
Figure 8-68. Variation of Pu and Am with Flow Rate at GS41.



Location GS43

GS43 shows a strong correlation between *decreasing* uranium activity and increasing flow rate for the few points available. GS43 receives pumped footing drain flows from the 886 and 865 building cluster. At least two of the higher uranium samples are from footing drain discharges. If naturally occurring (or possibly anthropogenic) uranium is associated with these flows, then the decrease in uranium activity at higher flow rates could be caused by dilution from stormwater runoff.

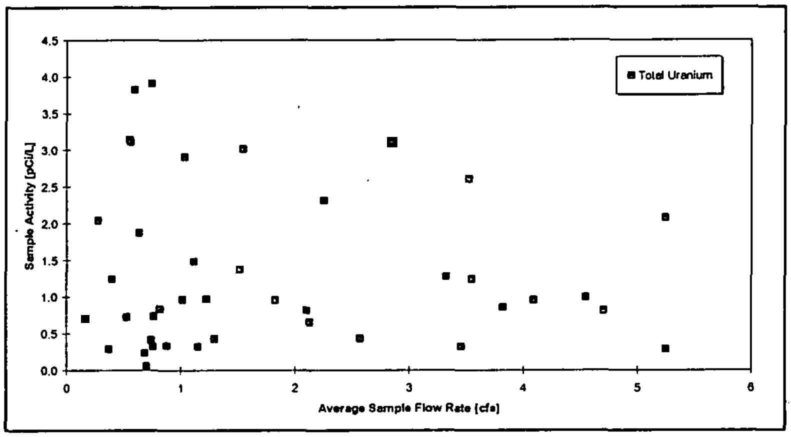
Figure 8-69. Variation of Total Uranium with Flow Rate at GS43.



Location SW022

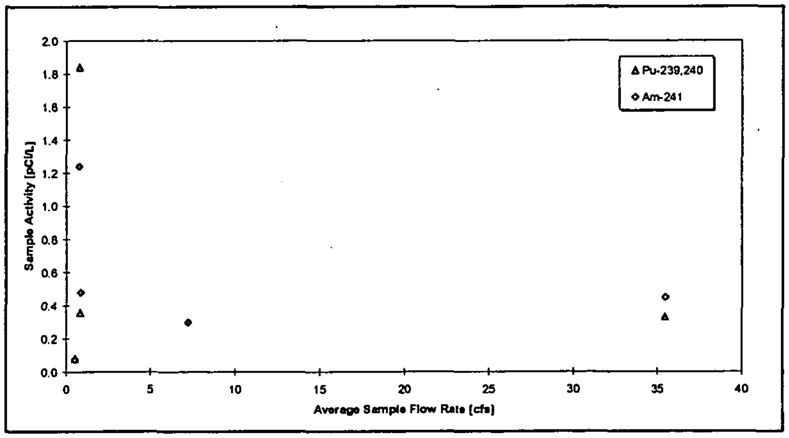
SW022 shows no statistically significant correlation between Pu and Am activity with flow rate.

Figure 8-70. Variation of Pu and Am with Flow Rate at SW022.



SW022 shows no statistically significant correlation between uranium and flow rate.

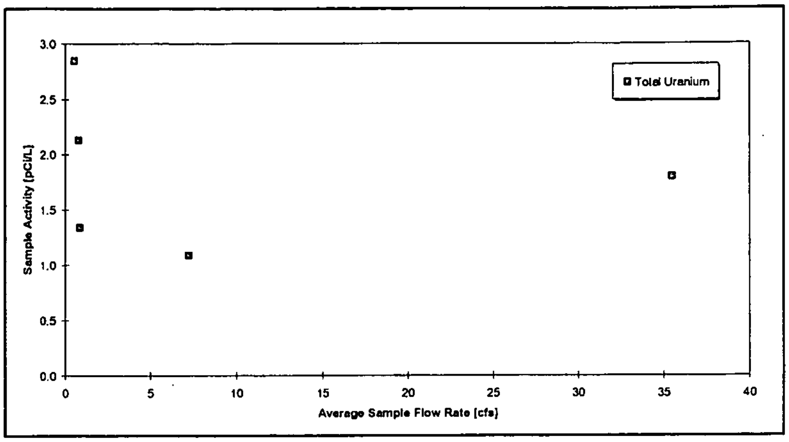
Figure 8-71. Variation of Total Uranium with Flow Rate at SW022.



Location SW023

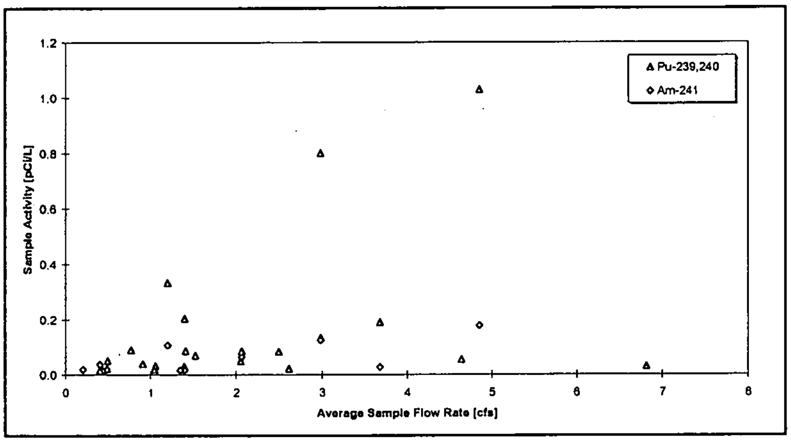
SW023 shows no statistically significant correlation between Pu and Am activity with flow rate.

Figure 8-72. Variation of Pu and Am with Flow Rate at SW023.



SW023 shows no statistically significant correlation between uranium and flow rate.

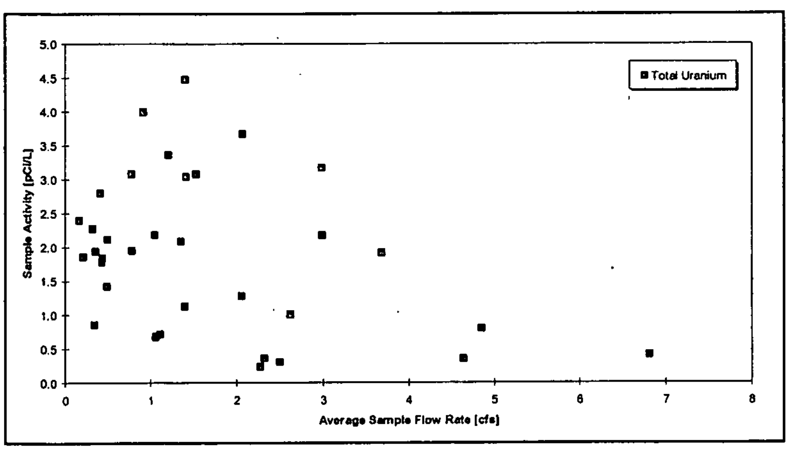
Figure 8-73. Variation of Total Uranium with Flow Rate at SW023.



Location SW027

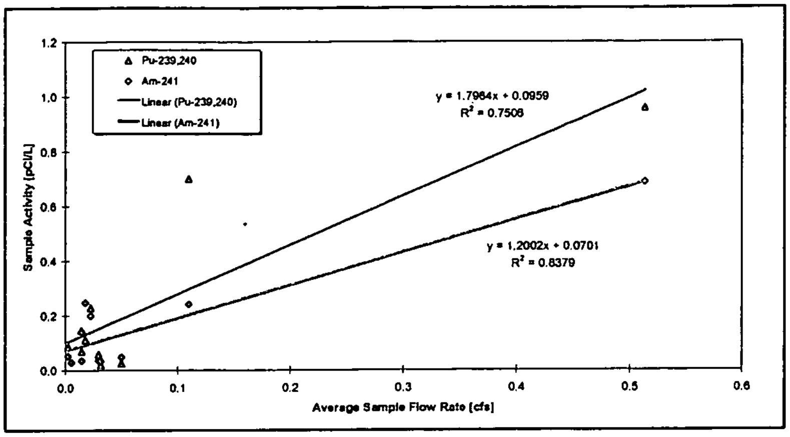
SW027 shows no statistically significant correlation between Pu and Am activity with flow rate.

Figure 8-74. Variation of Pu and Am with Flow Rate at SW027.



SW027 shows a weak trend between *decreasing* uranium activity and increasing flow rate. Baseflow (low flow rates) at SW027 is sustained in the Spring by footing drain flows (400 Area) and possibly intercepted groundwater. If naturally occurring (or possibly anthropogenic) uranium is associated with these flows, then the decrease in uranium activity at higher flow rates could be caused by dilution from stormwater runoff.

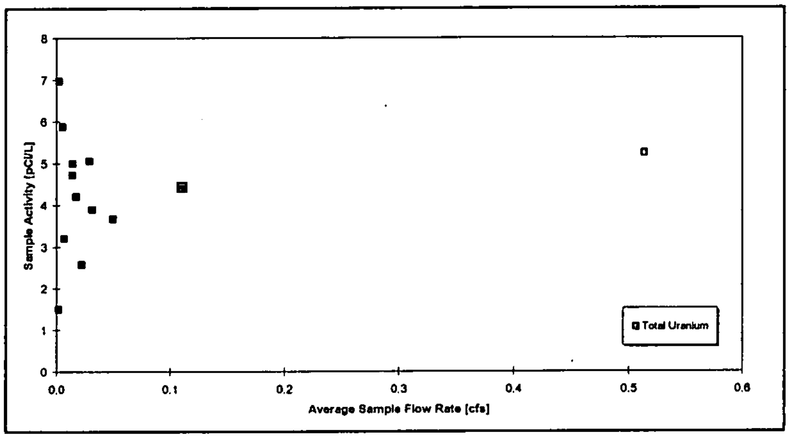
Figure 8-75. Variation of Total Uranium with Flow Rate at SW027.



Location SW091

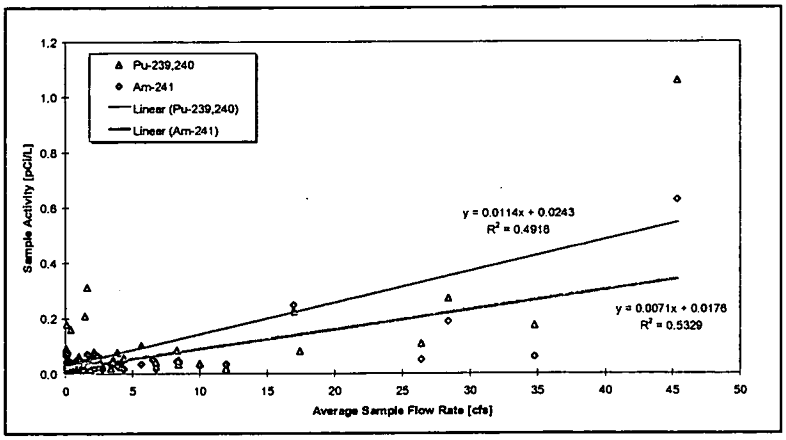
SW091 shows good correlation between increasing Pu and Am activities with increasing flow rates. However, the trends are strongly influenced by a single sample.

Figure 8-76. Variation of Pu and Am with Flow Rate at SW091.



SW091 shows no statistically significant correlation between uranium and flow rate.

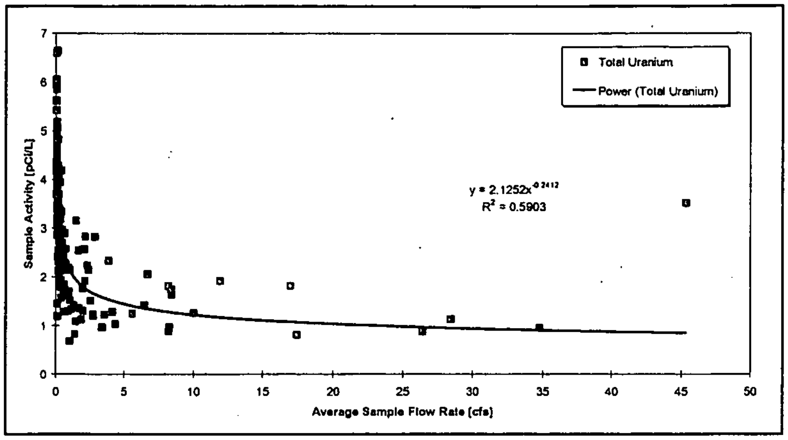
Figure 8-77. Variation of Total Uranium with Flow Rate at SW091.



Location SW093

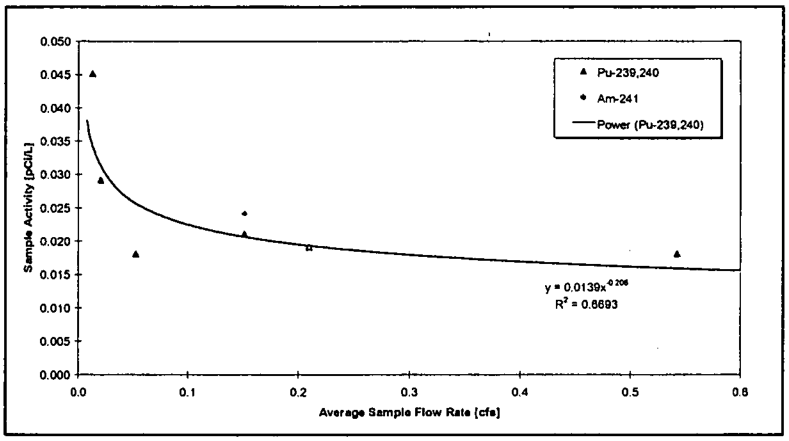
SW093 shows weak correlations between increasing Pu and Am activity with increasing flow rate.

Figure 8-78. Variation of Pu and Am with Flow Rate at SW093.



SW093 shows a fair trend between *decreasing* uranium activity and increasing flow rate. Baseflow (low flow rates) at SW093 is sustained by footing drain flows (northern IA) and possibly intercepted groundwater. If naturally occurring (or possibly anthropogenic) uranium is associated with these flows, then the decrease in uranium activity at higher flow rates could be caused by dilution from stormwater runoff. The highest activities are associated with the lowest flows.

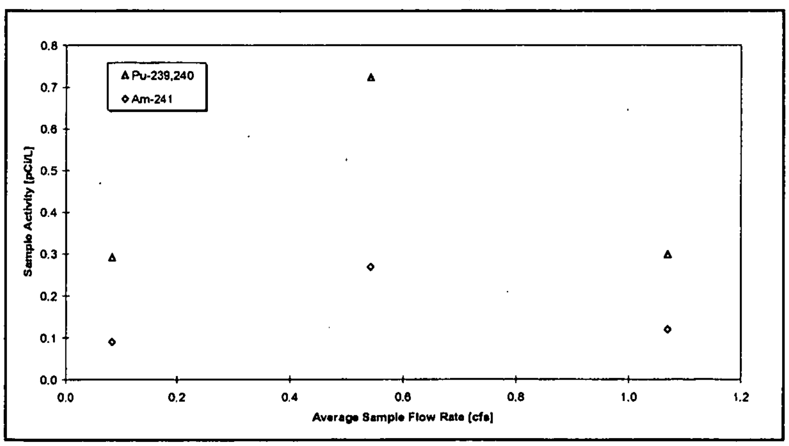
Figure 8-79. Variation of Total Uranium with Flow Rate at SW093.



Location SW118

SW118 shows a fair correlation between *decreasing* Pu activity and increasing flow rate. For smaller storm events runoff may originate from marginally more contaminated areas, or re-suspended creek sediments from N. Walnut may be contributing activity. However, for larger events, relatively less contaminated runoff from less contaminated areas may be diluting the overall activity.

Figure 8-80. Variation of Pu and Am with Flow Rate at SW118.



Location SW120

SW120 shows no statistically significant correlation between Pu and Am activity with flow rate.

Figure 8-81. Variation of Pu and Am with Flow Rate at SW120.

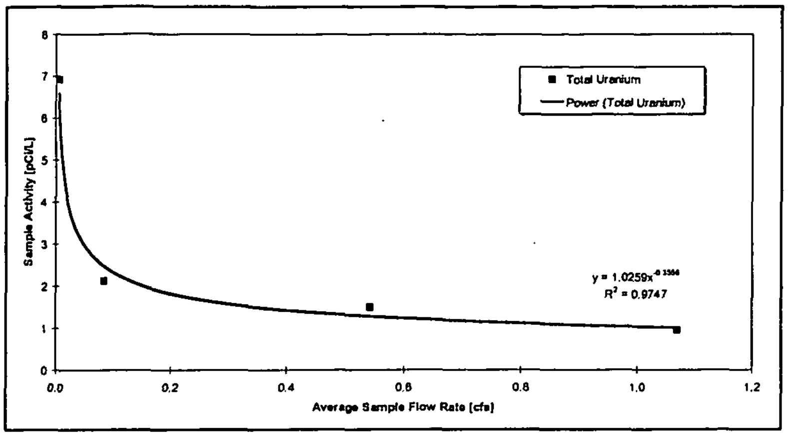


Figure 8-82. Variation of Total Uranium with Flow Rate at SW120.

SW120 shows a strong correlation between *decreasing* uranium activity and increasing flow rate for the few points available. Baseflow (low flow rates) at SW120 is mostly made up of flows passing through Bowman's Pond which is sustained by footing drain flows (771/774 area) and possibly intercepted groundwater. If naturally occurring (or possibly anthropogenic) uranium is associated with these flows, then the decrease in uranium activity at higher flow rates could be caused by dilution from stormwater runoff.

8.3.4 Correlation of TSS with Turbidity

Since many contaminants tend to be transported in surface water in association with particulate matter (measured as TSS) and turbidity is an indicator of TSS, a relationship between TSS and turbidity could be used as an indicator of contaminant transport. This section evaluates the variation of composite sample TSS with the corresponding average real-time turbidity data. Plots are presented for all locations where turbidity data are collected. These locations are GS08, GS10, GS11, GS31, SW027, and SW093.

The sample TSS is the value obtained through laboratory analysis given in mg/L. TSS analysis is only performed for composite samples that are collected over a period of less than the TSS hold time (7 days). Consequently, not all samples collected at the above locations were analyzed for TSS. Only TSS values greater than the detection limit (generally 5 mg/L) are included.

The average composite sample period turbidity (NTU) is calculated as follows:

1. The date and time of each grab sample comprising the composite is obtained from the monitoring instrumentation.
2. The corresponding turbidity value for each grab sample is interpolated from the 15-minute interval turbidity data. Some TSS samples may not have turbidity values due to equipment failures and periodic equipment removal for winter icing conditions.
3. Since each grab sample is of the same volume (200 ml), the interpolated turbidity values are arithmetically averaged to obtain the applicable turbidity for the entire composite sampling period.

GS31 is not presented below, as there was only one TSS-turbidity data point.

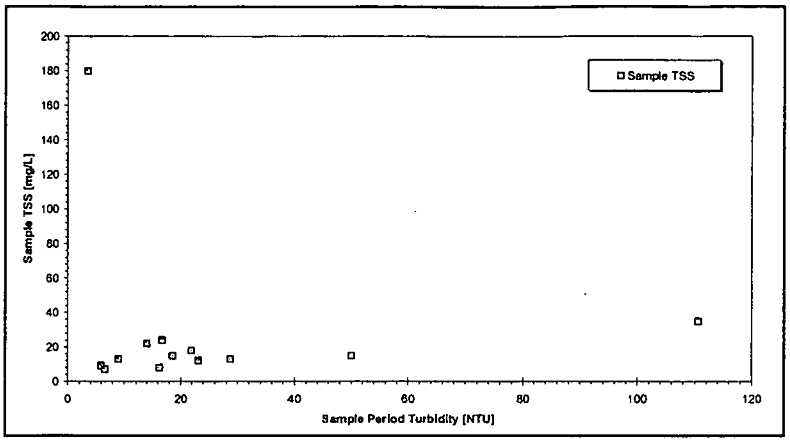


Figure 8-83. Variation of TSS with Turbidity at GS08.

Location GS08

GS08 does not show a strong relationship due to a single point with high TSS and low turbidity (Figure 8-83). This may have been caused by the sample intake temporarily sucking streambed sediments while the corresponding turbidity was measured higher in the water column.

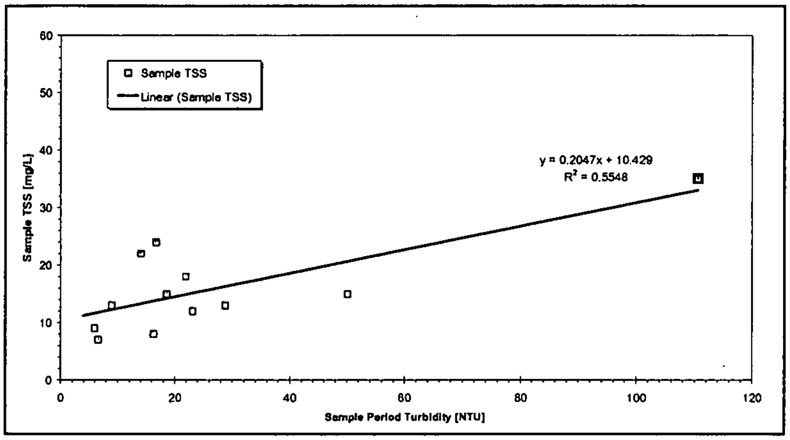


Figure 8-84. Variation of TSS with Turbidity at GS08: Data Subset.

Figure 8-84 shows the GS08 data with the point noted above removed from the evaluation. Although the linear fit is influenced by a single high value, the relationship reflects the expected increasing TSS with increasing turbidity.

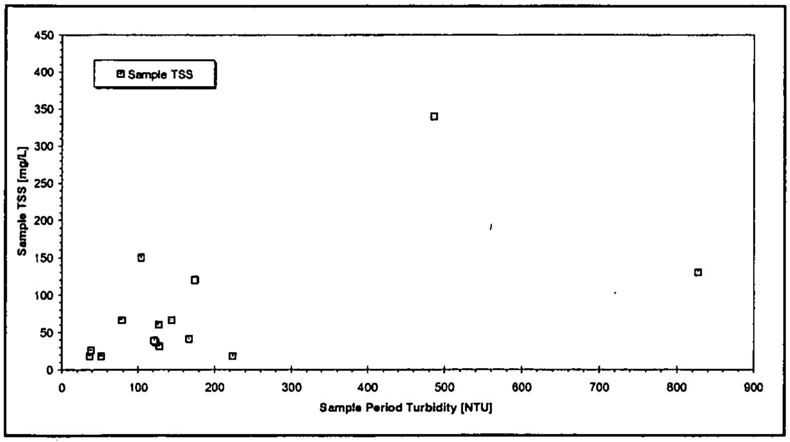


Figure 8-85. Variation of TSS with Turbidity at GS10.

Location GS10

GS10 shows a general increase in TSS with increasing turbidity, although the correlation is weak.

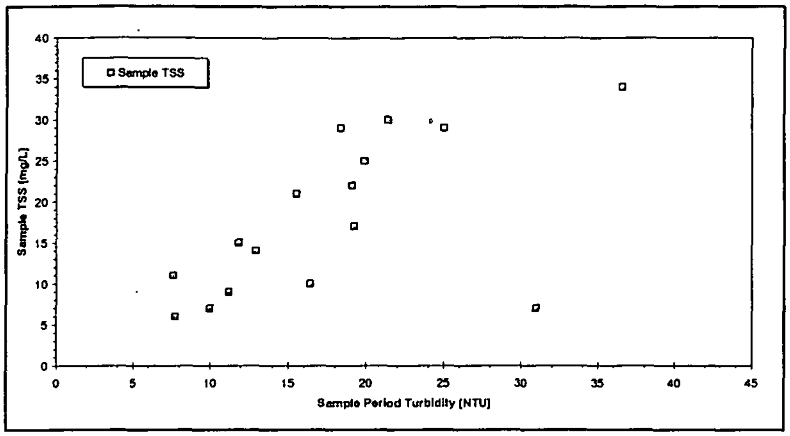


Figure 8-86. Variation of TSS with Turbidity at GS11.

Location GS11

GS11 also shows a general increase in TSS with increasing turbidity, although the correlation is weak.

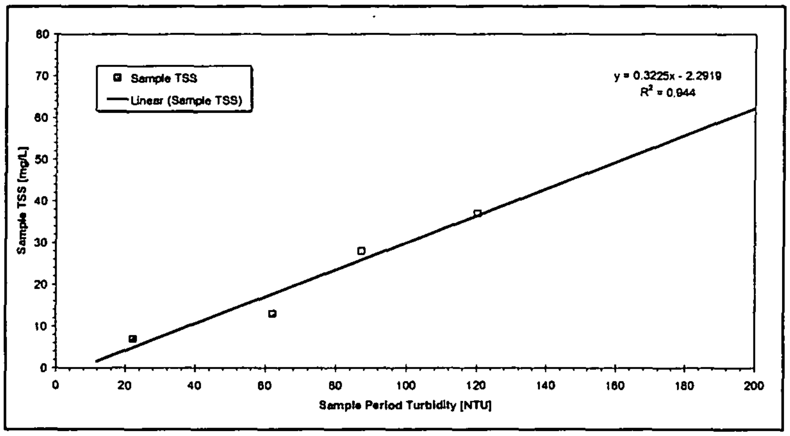


Figure 8-87. Variation of TSS with Turbidity at SW027.

Location SW027

SW027 shows a strong correlation between increasing turbidity and increasing TSS for the relatively few samples available.

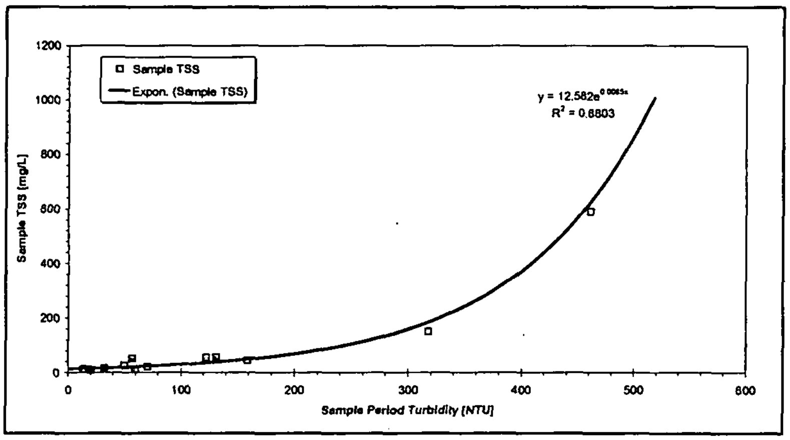


Figure 8-88. Variation of TSS with Turbidity at SW093.

Location SW093

SW093 also shows a good correlation between increasing turbidity and increasing TSS, although the relationship is influenced by a few higher points.

8.3.5 Correlation of TSS with Flow Rate

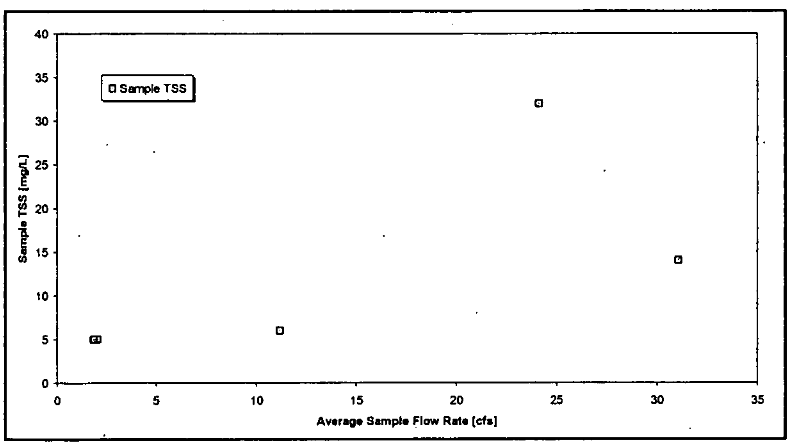
Since many contaminants tend to be transported in surface water in association with particulate matter (measured as TSS), if a relationship between TSS and flow rate could be established, then flow could be used as an indicator of contaminant transport. This section evaluates the variation of composite sample TSS with the corresponding average flow rate. Plots are presented for all locations where both flow and TSS data are collected.

The sample TSS is the value obtained through laboratory analysis given in mg/L. TSS analysis is only performed for composite samples that are collected over a period of less than the TSS hold time (7 days). Consequently, not all samples collected at the locations evaluated were analyzed for TSS. Only TSS values greater than the detection limit (generally 5 mg/L) are included.

The average composite sample period flow rate (CFS) is calculated as follows:

1. The date and time of each grab sample comprising the composite is obtained from the monitoring instrumentation.
2. The corresponding flow value for each grab sample is interpolated from the 15-minute interval flow data. Some TSS samples may not have flow values due to equipment failures and poor flow data due to winter icing conditions.
3. Since each grab sample is of the same volume (200 ml for flow-paced composites and generally 1L for storm-event composites), the interpolated flow values are arithmetically averaged to obtain the applicable flow for the entire composite sampling period.

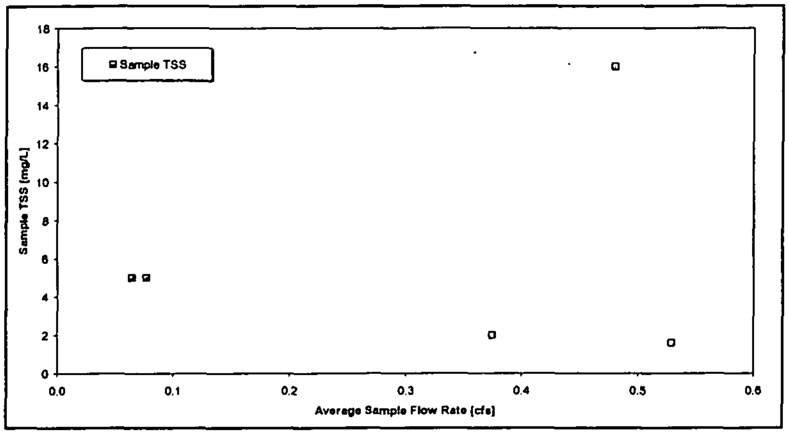
GS31, GS40, GS42, GS43, SW118, and SW120 are not presented below, as there were less than two TSS-flow data points at these locations.



Location GS01

GS01 shows a general increase in TSS with increasing flow rate, although the correlation is weak and there are few data points.

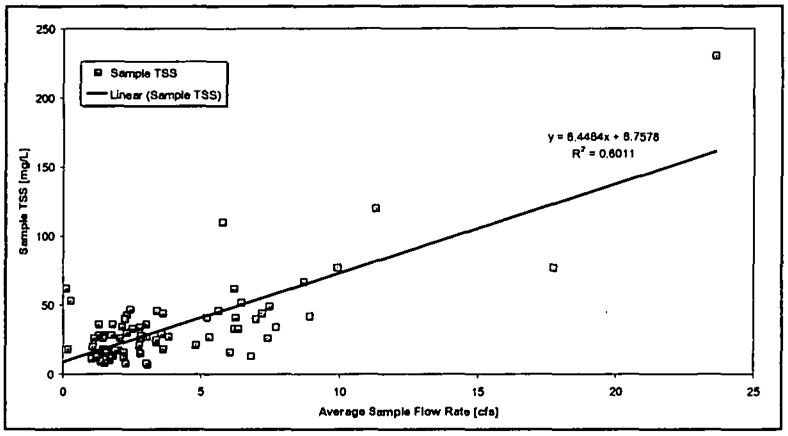
Figure 8-89. Variation of TSS with Flow Rate at GS01.



Location GS02

GS02 shows no statistically significant correlation between TSS and increasing flow rate.

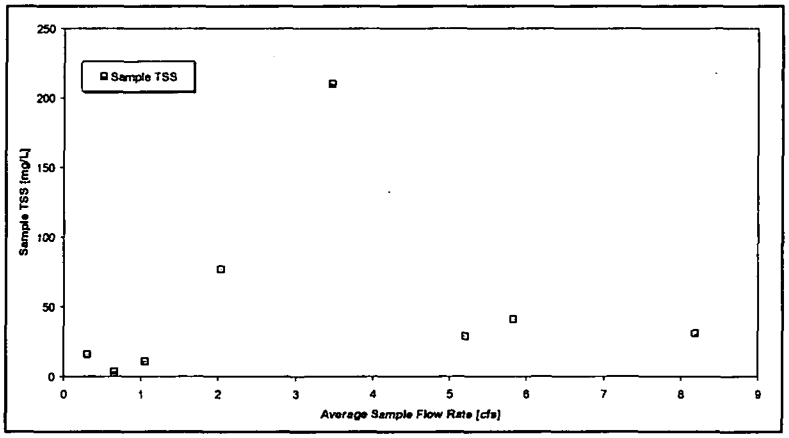
Figure 8-90. Variation of TSS with Flow Rate at GS02.



Location GS03

GS03 shows a fair correlation between increasing TSS and increasing flow rate.

Figure 8-91. Variation of TSS with Flow Rate at GS03.



Location GS04

GS04 shows no statistically significant correlation between TSS and increasing flow rate.

Figure 8-92. Variation of TSS with Flow Rate at GS04.

Location GS05

GS05 shows no statistically significant correlation between TSS and increasing flow rate, although the higher TSS values are associated with the higher flow rates.

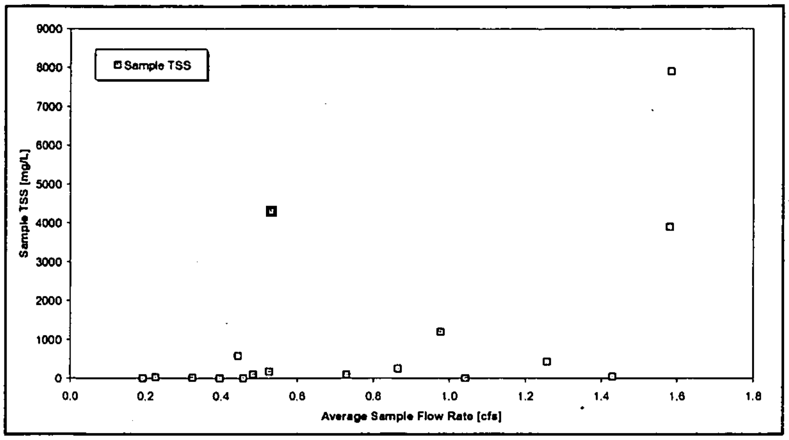


Figure 8-93. Variation of TSS with Flow Rate at GS05.

Location GS06

GS06 shows no statistically significant correlation between TSS and increasing flow rate.

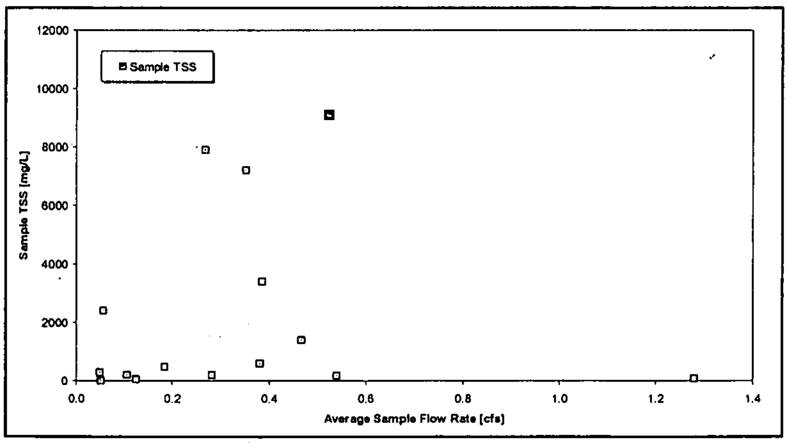


Figure 8-94. Variation of TSS with Flow Rate at GS06.

Location GS08

GS08 does not show a strong relationship due to a single point with high TSS (Figure 8-95). This may have been caused by the sample intake temporarily sucking streambed sediments.

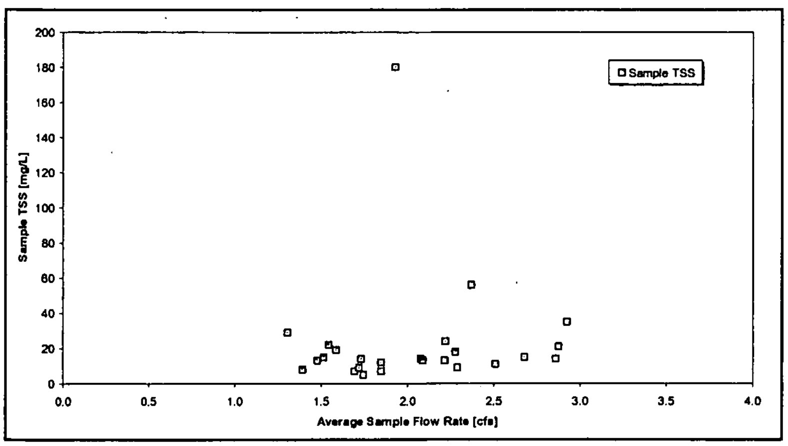


Figure 8-95. Variation of TSS with Flow Rate at GS08.

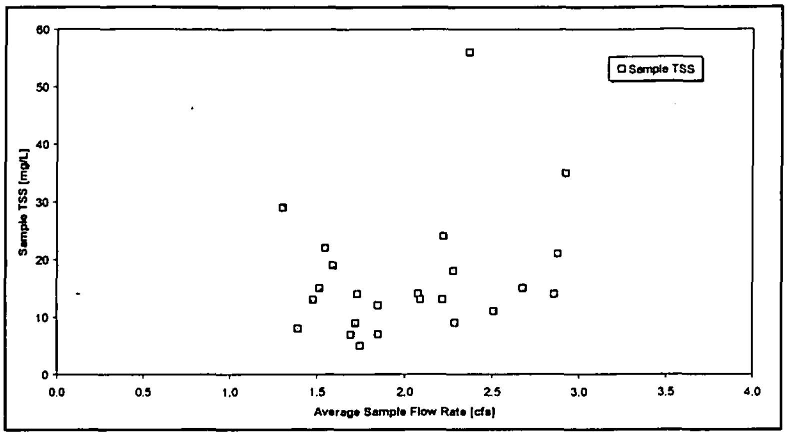
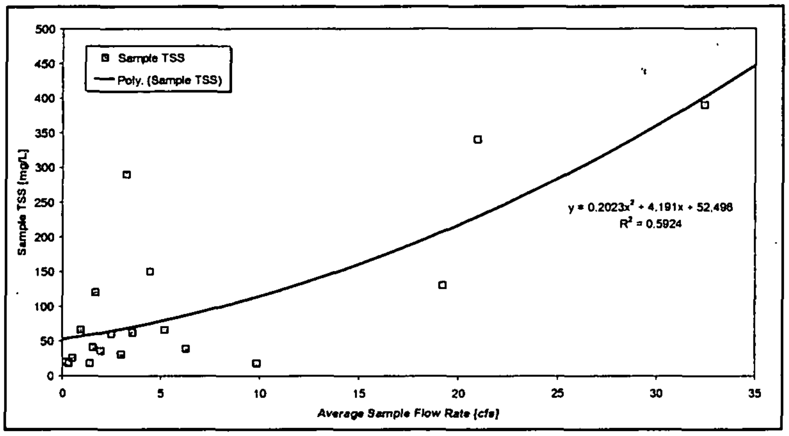


Figure 8-96 shows the GS08 data with the point noted above removed from the evaluation. With this data subset no statistically significant correlation is noted between TSS and flow rate.

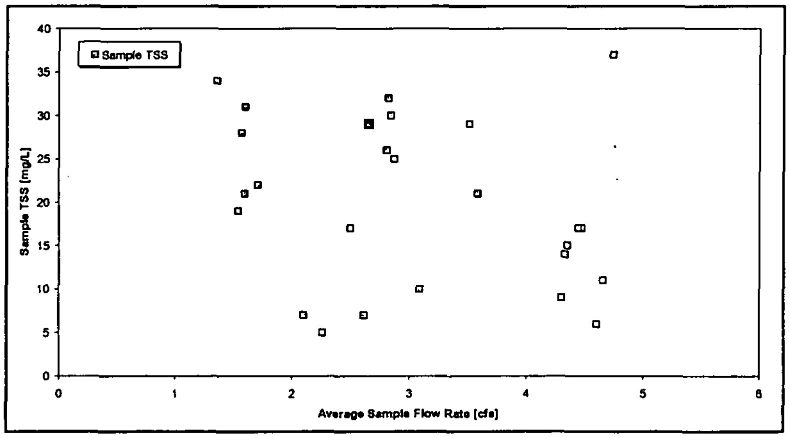
Figure 8-96. Variation of TSS with Flow Rate at GS08: Data Subset.



Location GS10

GS10 shows a fair correlation between increasing TSS and increasing flow rate.

Figure 8-97. Variation of TSS with Flow Rate at GS10.



Location GS11

GS11 shows no statistically significant correlation between TSS and increasing flow rate.

Figure 8-98. Variation of TSS with Flow Rate at GS11.

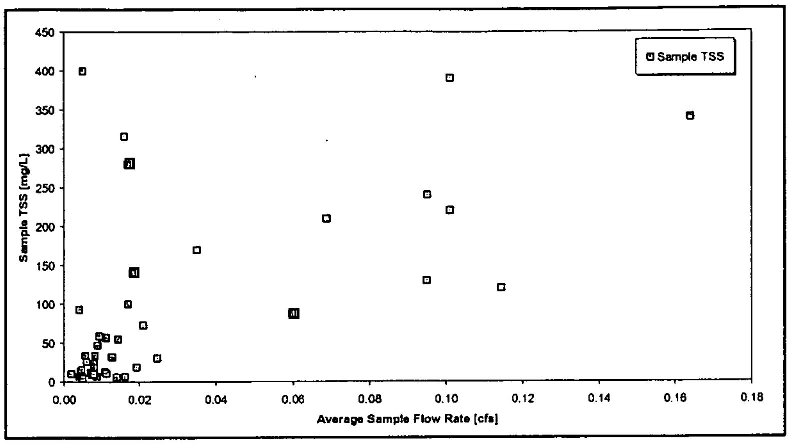


Figure 8-99. Variation of TSS with Flow Rate at GS27.

Location GS27

GS27 shows no statistically significant correlation between TSS and increasing flow rate. The high TSS values for low flow rates may be the result of intense low-volume precipitation events (possibly with hail) that pulverize local soils to yield high TSS with lower peak flow rates.

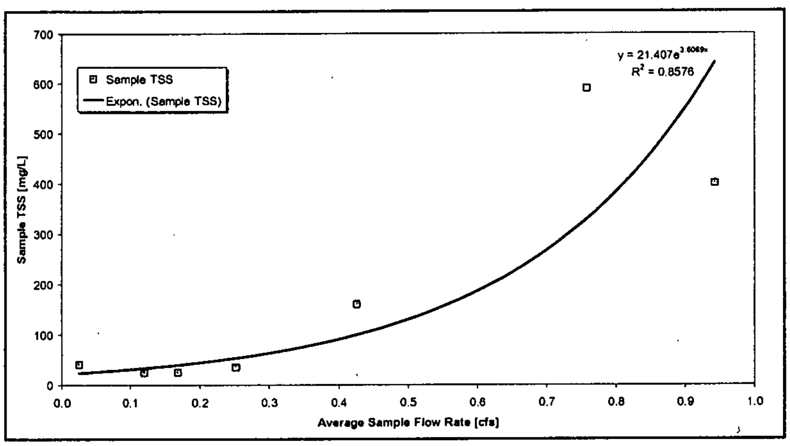


Figure 8-100. Variation of TSS with Flow Rate at GS28.

Location GS28

GS28 shows a good correlation between increasing TSS and increasing flow rate.

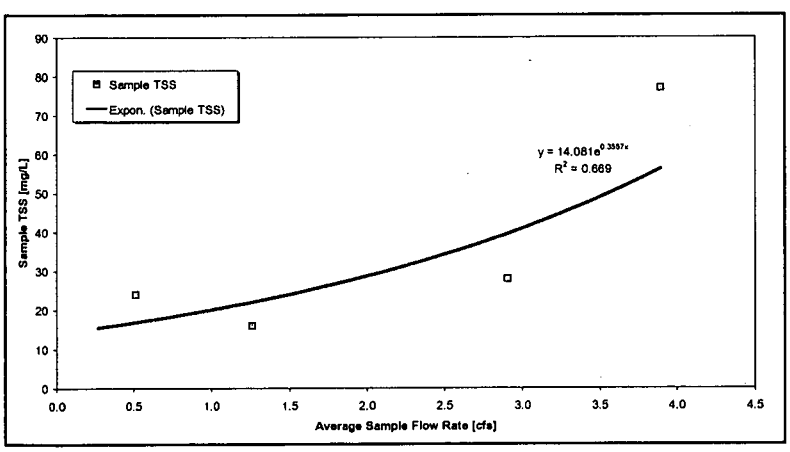


Figure 8-101. Variation of TSS with Flow Rate at GS33.

Location GS33

GS33 shows a fair correlation between increasing TSS and increasing flow rate for the relatively few samples available.

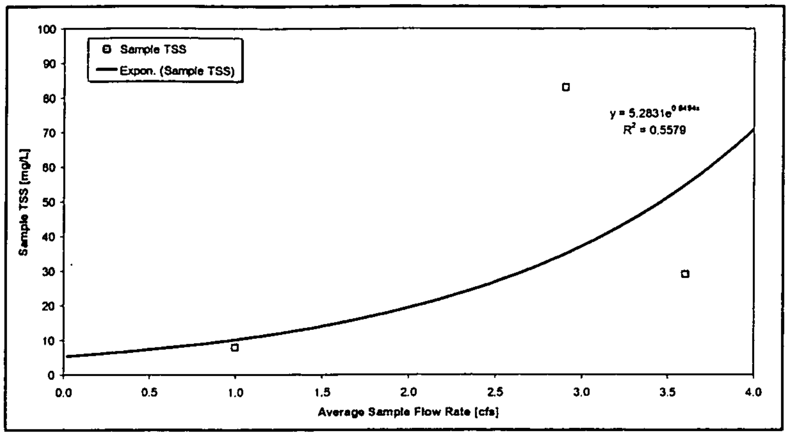


Figure 8-102. Variation of TSS with Flow Rate at GS34.

Location GS34

GS34 shows a fair correlation between increasing TSS and increasing flow rate for the relatively few samples available.

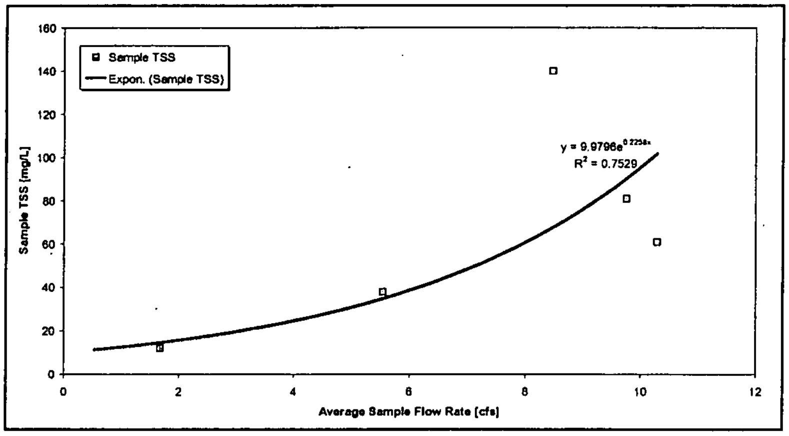


Figure 8-103. Variation of TSS with Flow Rate at GS35.

Location GS35

GS35 shows a good correlation between increasing TSS and increasing flow rate for the relatively few samples available.

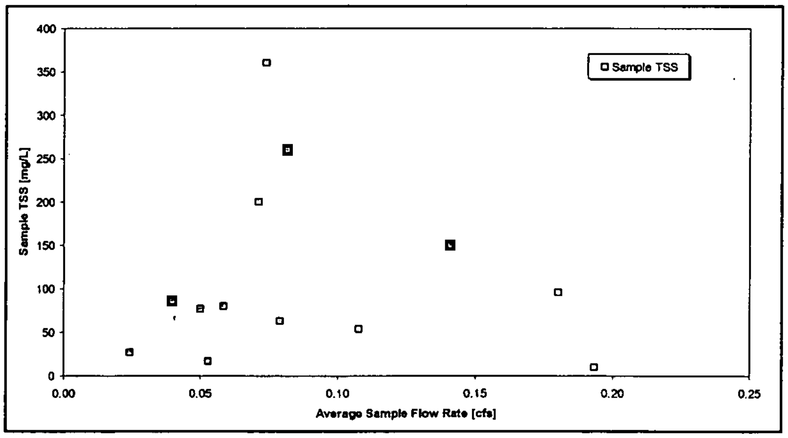


Figure 8-104. Variation of TSS with Flow Rate at GS37.

Location GS37

GS37 shows no statistically significant correlation between TSS and increasing flow rate.

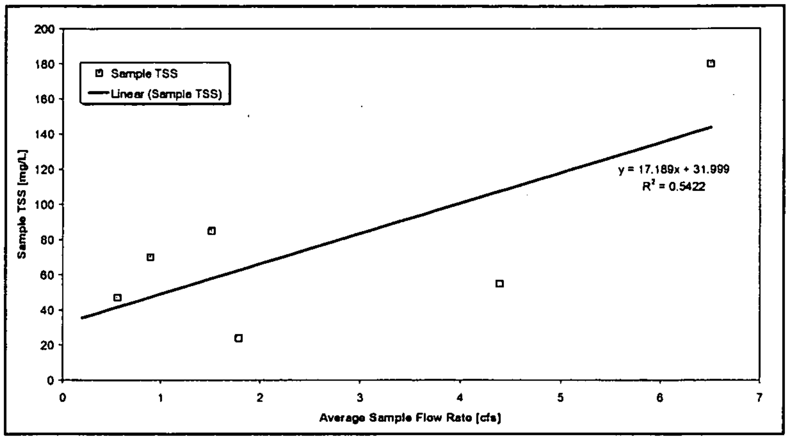


Figure 8-105. Variation of TSS with Flow Rate at GS38.

Location GS38

GS38 shows a fair correlation between increasing TSS and increasing flow rate for the relatively few samples available.

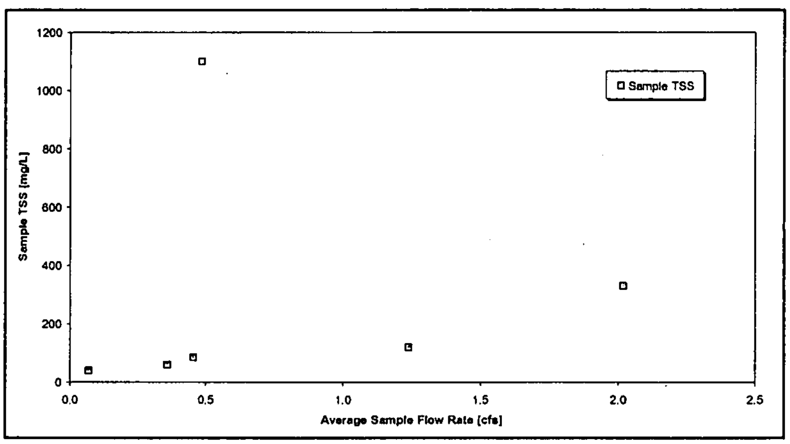


Figure 8-106. Variation of TSS with Flow Rate at GS39.

Location GS39

GS39 does not show a strong relationship due to a single point with high TSS (Figure 8-106). This location is located near a high-traffic dirt road that accesses the Contractor Yard. During runoff events, especially snowmelts, traffic on this road results in runoff with visibly high TSS. Since this sample was collected in March 1998, the high TSS may have been a result of vehicle traffic.

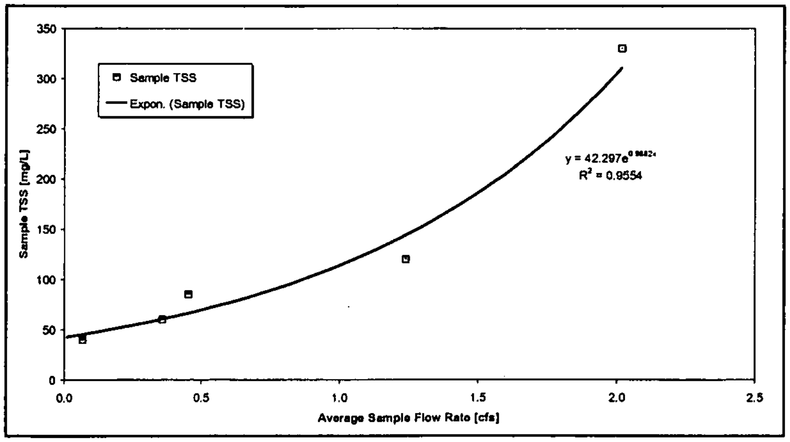


Figure 8-107. Variation of TSS with Flow Rate at GS39: Data Subset.

Figure 8-107 shows the GS39 data with the point noted above removed from the evaluation. The plot shows a strong relationship between increasing TSS and increasing flow rate for the few points available.

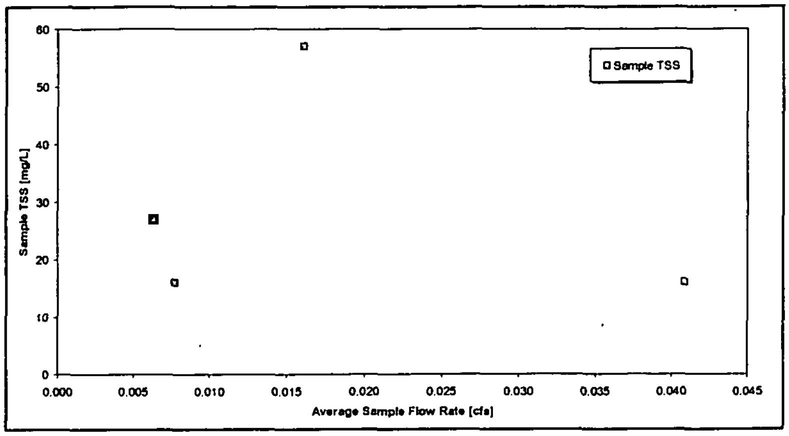


Figure 8-108. Variation of TSS with Flow Rate at GS41.

Location GS41

GS41 shows no statistically significant correlation between TSS and increasing flow rate.

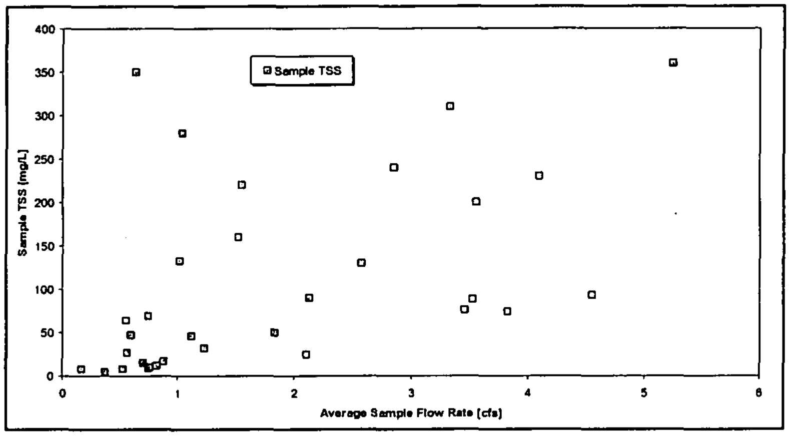


Figure 8-109. Variation of TSS with Flow Rate at SW022.

Location SW022

SW022 shows no statistically significant correlation between TSS and increasing flow rate.

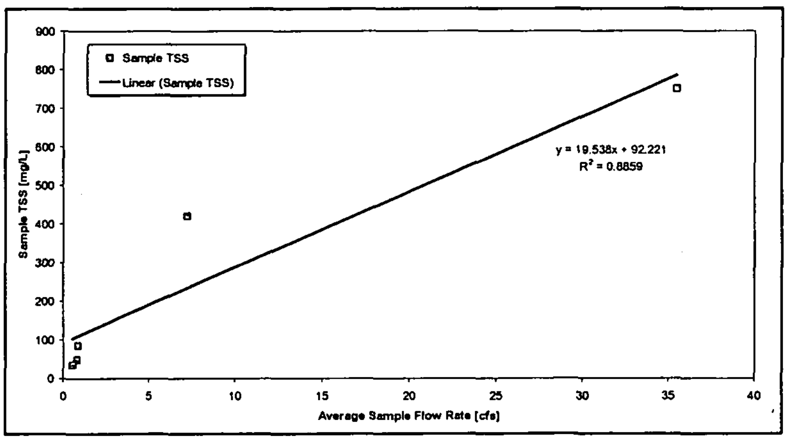


Figure 8-110. Variation of TSS with Flow Rate at SW023.

Location SW023

SW023 shows a good correlation between increasing TSS and increasing flow rate for the relatively few samples available. However, the correlation is strongly influenced by a couple of high points.

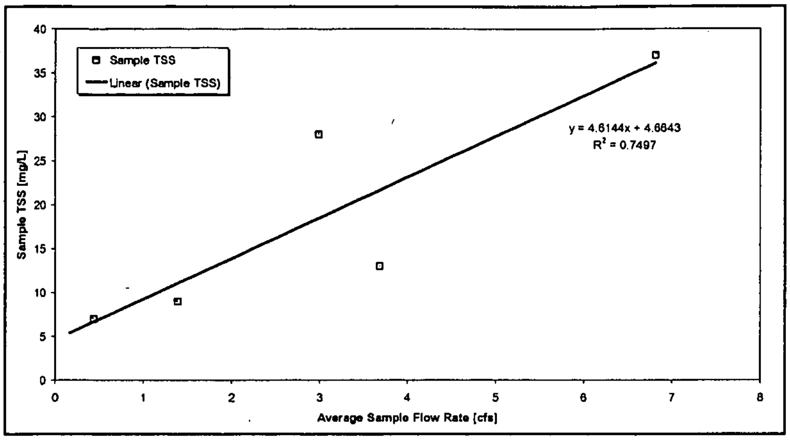


Figure 8-111. Variation of TSS with Flow Rate at SW027.

Location SW027

SW027 shows a good correlation between increasing TSS and increasing flow rate for the relatively few samples available.

Location SW091

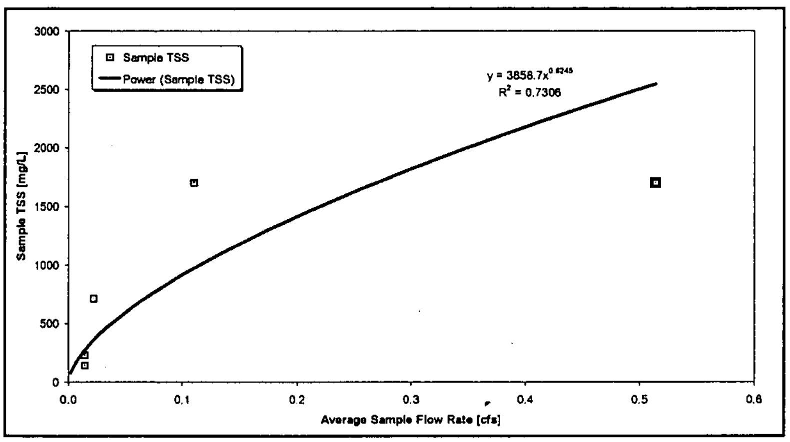


Figure 8-112. Variation of TSS with Flow Rate at SW091: Original Location.

SW091 shows a good correlation between increasing TSS and increasing flow rate for the relatively few samples available.

Due to high channel erosion rates and frequent winter icing conditions, SW091 was moved 500' downstream on 5/4/98. Since the new location is below a small depression where flows are temporarily detained, water quality is expected to vary between the two locations. Therefore, data from the original location are presented in Figure 8-112 and data from the current location are presented in Figure 8-113.

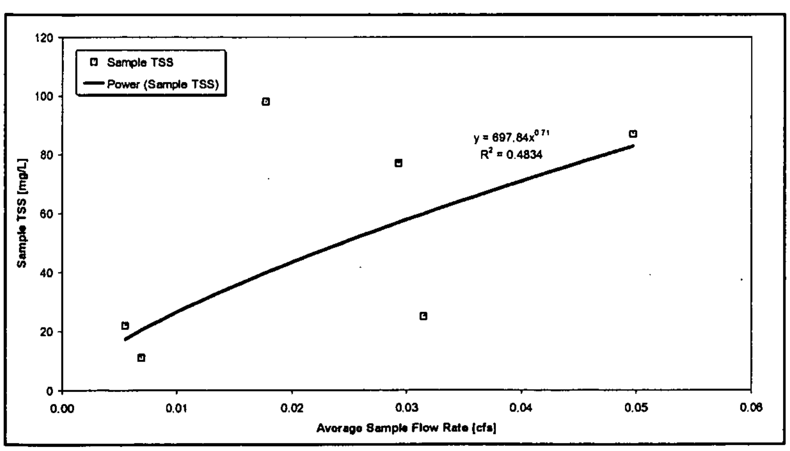


Figure 8-113. Variation of TSS with Flow Rate at SW091: Current Location.

SW091 (current location) shows a weak correlation between increasing TSS and increasing flow rate for the relatively few samples available.

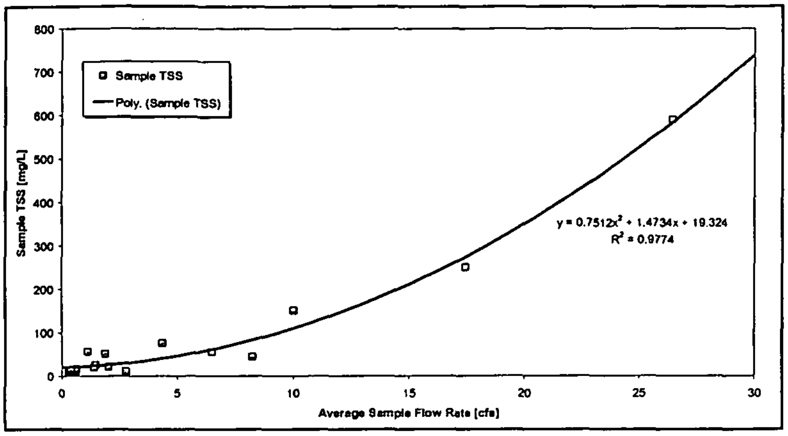


Figure 8-114. Variation of TSS with Flow Rate at SW093.

Location SW093

SW093 shows a strong correlation between increasing TSS and increasing flow rate.

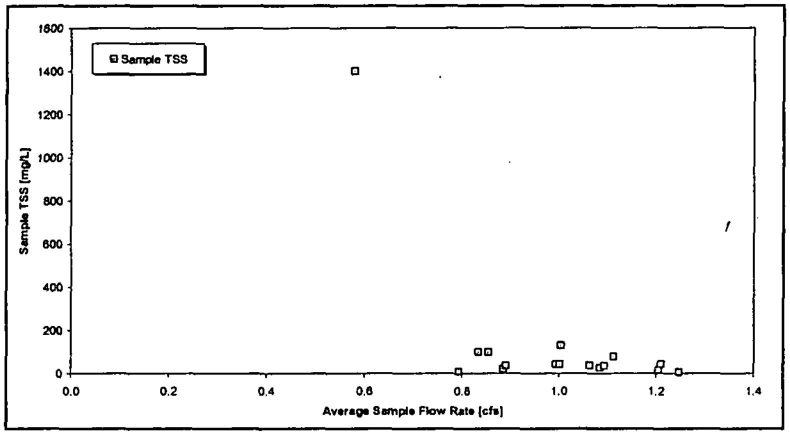


Figure 8-115. Variation of TSS with Flow Rate at SW134.

Location SW134

SW134 shows no statistically significant correlation between TSS and increasing flow rate. Since SW134 generally monitors pumped discharges from a series of active gravel pits, the origin of the pumped water could be expected to result in varying water quality.

8.3.6 Correlation of Turbidity with Flow Rate

This section evaluates the variation of mean daily turbidity with the corresponding average flow rate. Plots are presented for all locations where both flow and real-time turbidity data are collected. These locations are GS08, GS10, GS11, GS31, SW027, and SW093.

The mean daily turbidity is the arithmetic average of the 15-minute interval turbidity data during periods of greater than zero streamflow for any given date. The corresponding average flow rate is the arithmetic average of the 15-minute interval flow data during periods of greater than zero streamflow for the same date. Only days where complete record (no missing data) for both turbidity and flow rate are included.

Location GS08

GS08 shows no statistically significant correlation between turbidity and increasing flow rate.

Since GS08 is on the outfall of Pond B-5, the flow rates are valve controlled and not dependent on runoff conditions. In order to maintain a 1-foot per day drawdown rate in the pond (to prevent sloughing due to excessive soil dewatering rates), the lowest flow rates tend to occur at the lowest pond levels. At low pond levels, the residence time (for passive settling) of runoff inflows (from GS10) is shorter and less water is available to dilute the associated turbidity. Consequently, low-flow and high-turbidity points could be for discharge days at the end of a batch discharge period.

Additionally, at these lower pond levels, biologic growth rates may be enhanced resulting in higher turbidity measurements.

Finally, higher discharge rates can be maintained when runoff inflow rates (from GS10) are higher. Consequently, high-flow and high-turbidity points could be for discharge days when significant runoff (with higher expected turbidity; see Figure 8-117) is entering Pond B-5.

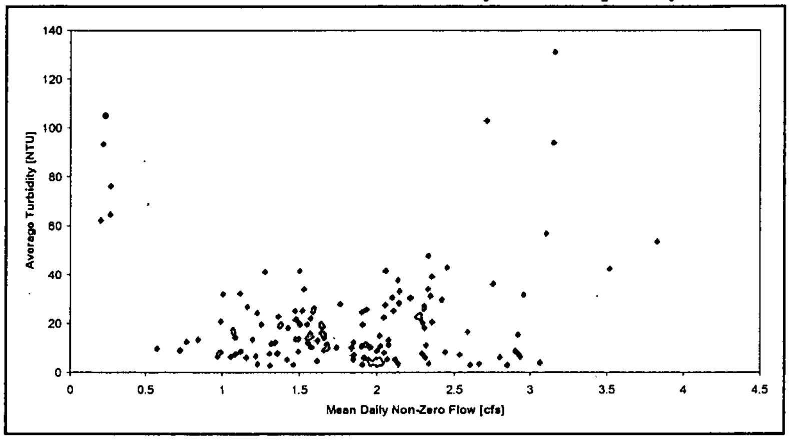


Figure 8-116. Variation of Turbidity with Flow Rate at GS08.

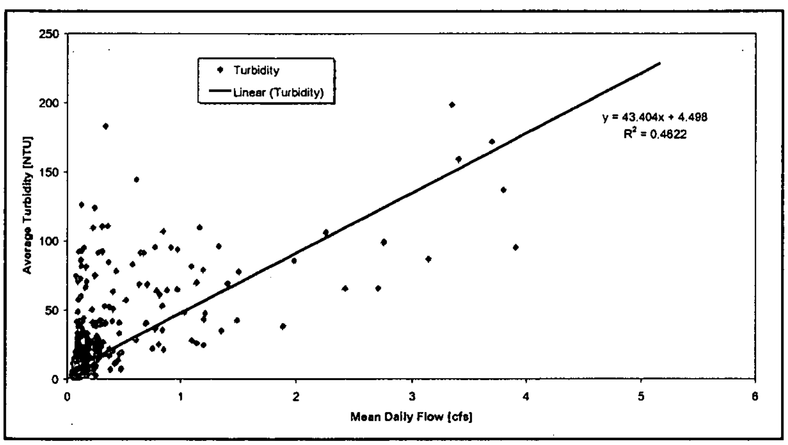


Figure 8-117. Variation of Turbidity with Flow Rate at GS10.

Location GS10

GS10 shows a weak correlation between increasing turbidity and increasing flow rate. This is expected since TSS (as indicated by turbidity) generally increases with increasing flow rate at GS10 (Figure 8-97).

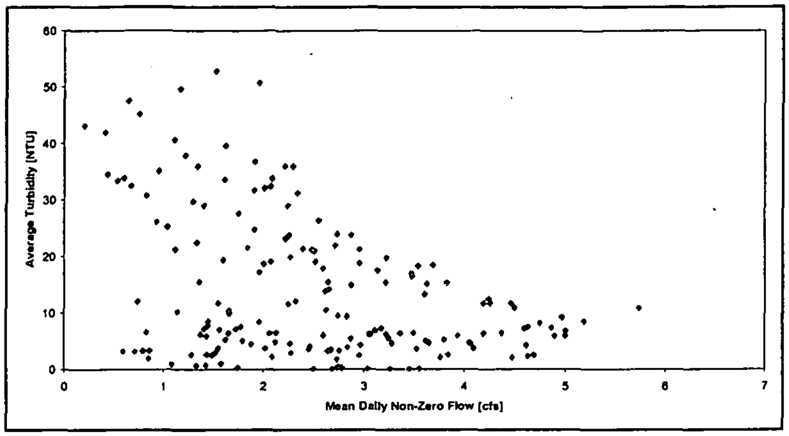


Figure 8-118. Variation of Turbidity with Flow Rate at GS11.

Location GS11

GS11 shows a general trend between decreasing turbidity and increasing flow rate. Since GS11 is on the outfall of Pond A-4, the flow rates are valve controlled and not dependent on runoff conditions. In order to maintain a 1-foot per day drawdown rate in the pond, the lowest flow rates tend to occur at the lowest pond levels. At these lower pond levels, biologic growth rates may be enhanced resulting in higher turbidity measurements.

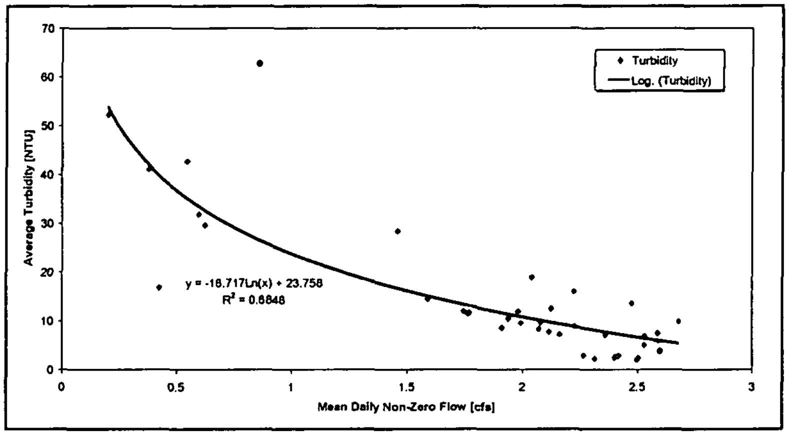


Figure 8-119. Variation of Turbidity with Flow Rate at GS31.

Location GS31

GS31 shows a good correlation between decreasing turbidity and increasing flow rate. Since GS31 is on the outfall of Pond C-2, the flow rates are controlled by pumping rates and not dependent on runoff conditions. In order to maintain a 1-foot per day drawdown rate in the pond, the lowest flow rates tend to occur at the lowest pond levels. At these lower pond levels, biologic growth rates may be enhanced resulting in higher turbidity measurements.

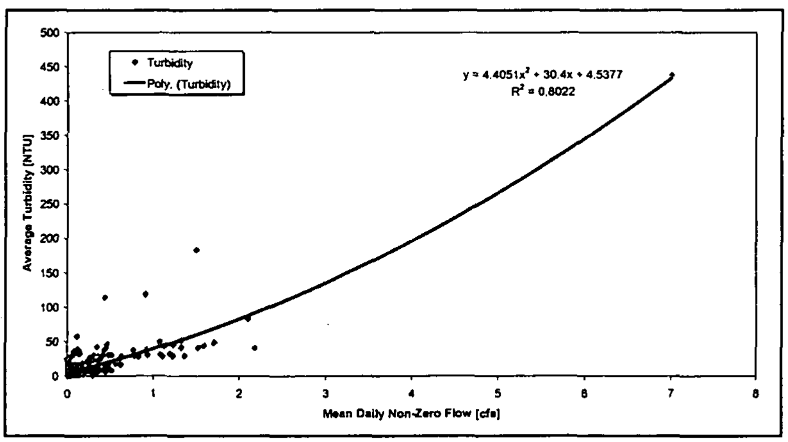


Figure 8-120. Variation of Turbidity with Flow Rate at SW027.

Location SW027

SW027 shows a good correlation between increasing turbidity and increasing flow rate, although the fit is strongly influenced by a single data point. This is expected since TSS (as indicated by turbidity) generally increases with increasing flow rate at SW027 (Figure 8-111).

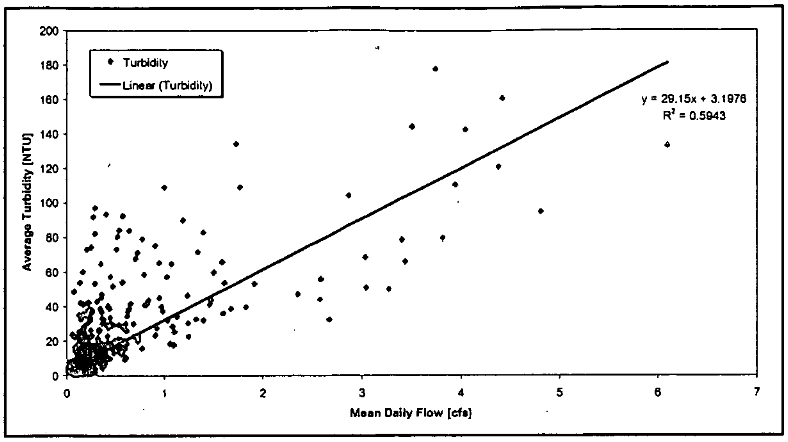


Figure 8-121. Variation of Turbidity with Flow Rate at SW093.

Location SW093

SW093 shows a fair correlation between increasing turbidity and increasing flow rate. This is expected since TSS (as indicated by turbidity) generally increases with increasing flow rate at SW093 (Figure 8-114).

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9. NPDES DISCHARGE MONITORING

9.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

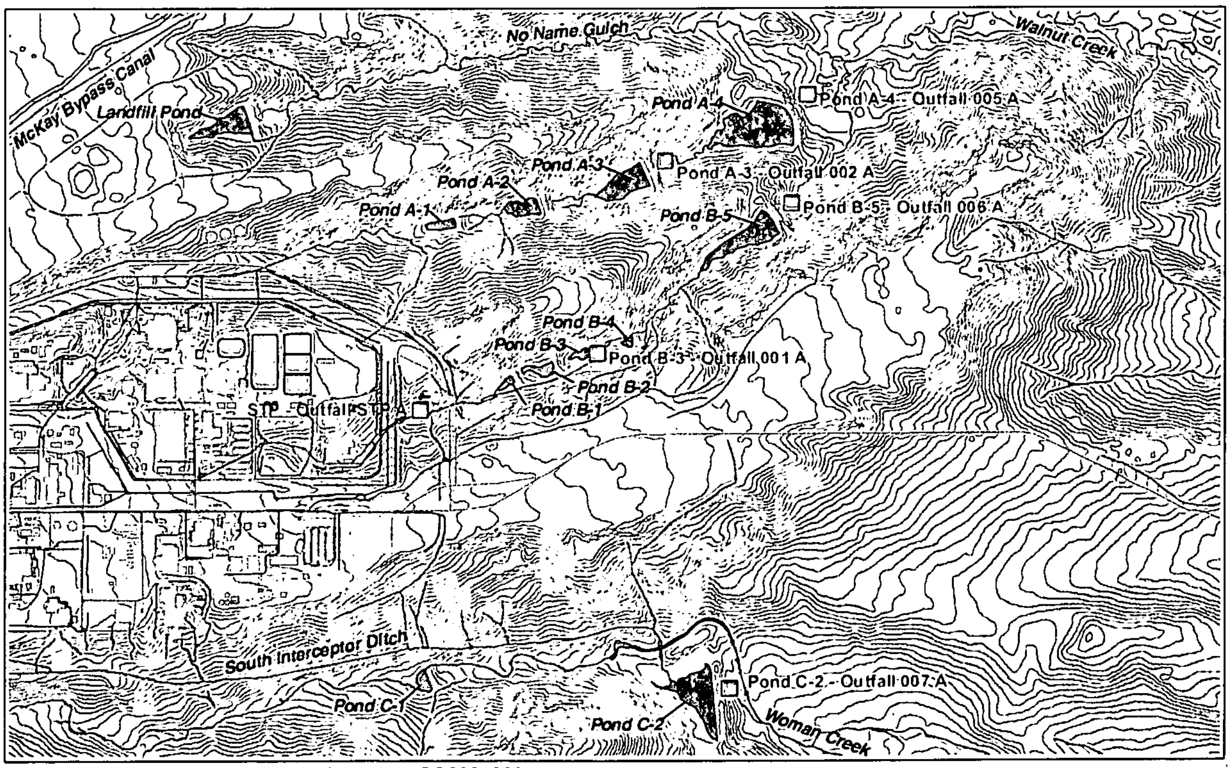
The National Pollutant Discharge Elimination System (NPDES) permit program controls the release of pollutants into the waters of the United States and requires routine monitoring of point source discharges and reporting of results. The Site's first NPDES permit, CO-0001333, was issued by EPA in 1974. The permit in force during the reporting period covered in this document was originally reissued by EPA in 1984, expired in 1989, was administratively extended, and again renewed in late October of 2000.

Six discharge locations were included in the NPDES permit in force and are identified in Table 9-1. All monitoring for NPDES compliance is prescriptively required by EPA in the permit. Table 9-2 details the specific analytes, collection frequencies, and parameter limitations, as applicable, for each monitoring location. Table 9-3 provides summary data for each of the permitted locations. Finally, Table 9-4 details measurements that were reported to EPA in the monthly Discharge Monitoring Report as being greater than the permitted limitations for specific location and analyte.

9.2 WY97-00 MONITORING SCOPE

Table 9-1. NPDES Monitoring Locations.

Outfall Code	Location Description
Outfall STP A	Discharge from the Sewage Treatment Plant, Bldg. 995
Outfall 001 A	Discharge from Pond B-3
Outfall 002 A	Discharge from Pond A-3
Outfall 005 A	Discharge from Pond A-4
Outfall 006 A	Discharge from Pond B-5
Outfall 007 A	Discharge from Pond C-2



Note: Locations are for RFETS NPDES permit number CO0001333.

Figure 9-1. Water Year 1997-2000 NPDES Monitoring Locations.

Table 9-2. NPDES Sample Collection Requirements.

Outfall Code	Analyte	Frequency	Type	Limitation(s)
STP A	pH	daily	grab	6.0 – 9.0 S.U.
	Total Suspended Solids	2 X week	composite	30 mg/l, 30 day average; 45 mg/l, 7 day average
	Oil and Grease, visual	daily	visual observation	no sheen
	Oil and Grease, gravimetric method	collected if sheen observed	grab	10 mg/l, daily maximum
	Total Phosphorous (as P)	2 X week	composite	8 mg/l, 30 day average; 12 mg/l, daily maximum
	Flow	continuous recorder	contiguous recorder	report only, no limitation
	Total Residual Chlorine	daily	grab	report only, no limitation
	Fecal Coliform	2 X week	grab	200 colonies/100 ml, 30 day geometric mean; 400 colonies/100 ml, 7 day geometric mean
	Carbonaceous Biochemical Oxygen Demand, 5 day test	2 X week	composite	10 mg/l, 30 day average; 25 mg/l, daily maximum
	Whole Effluent Toxicity, acute test	quarterly	composite	report only, no limitation
001 A	Biochemical Oxygen Demand, 5 day test	weekly	grab	report only, no limitation
	Total Suspended Solids	weekly	grab	report only, no limitation
	Total Nitrogen, Nitrate (as N)	weekly	grab	10 mg/l, 30 day average; 20 mg/l, maximum 7 day average
	Total Residual Chlorine	daily	grab	0.5 mg/l, daily maximum
	Carbonaceous Biochemical Oxygen Demand, 5 day test	weekly	grab	report only, no limitation
002 A	pH	Daily during discharge	grab	6.0 – 9.0 S.U.
	Total Nitrogen, Nitrate (as N)	Daily during discharge	grab	10 mg/l, 30 day average; 20 mg/l, daily maximum
	Flow	Daily during discharge	Instantaneous	report only, no limitation
005 A	Flow	Daily during discharge	Instantaneous	report only, no limitation
	Non-volatile Suspended Solids	Daily during discharge	grab	report only, no limitation
	Total Chromium (as Cr)	monthly during discharge	grab	50 µg/l, daily maximum
	Whole Effluent Toxicity, acute test	quarterly, if discharge occurs	grab	report only, no limitation

Outfall Code	Analyte	Frequency	Type	Limitation(s)
006 A	Flow	daily during discharge	Instantaneous	Report only, no limitation
	Non-volatile Suspended Solids	daily during discharge	grab	Report only, no limitation
	Total Chromium (as Cr)	monthly during discharge	grab	50 µg/l, daily maximum
	Whole Effluent Toxicity, acute test	quarterly, if discharge occurs	grab	report only, no limitation
007 A	Flow	daily during discharge	Instantaneous	report only, no limitation
	Non-volatile Suspended Solids	daily during discharge	grab	report only, no limitation
	Total Chromium (as Cr)	monthly during discharge	grab	50 µg/l, daily maximum
	Whole Effluent Toxicity, acute test	quarterly, if discharge occurs	grab	report only, no limitation

9.3 DATA EVALUATION

Table 9-3. NPDES Monitoring Analytical Data Summary.

Outfall Code	Analyte	Analyses Performed During Reporting Period	Minimum	Maximum	Average
STP A	pH	1460	6.2 S.U.	8.7 S.U.	N/A
	Total Suspended Solids	468	1.5 mg/l	12.0 mg/l	5.0 mg/l
	Oil and Grease, visual	1460	N/A	N/A	N/A
	Oil and Grease, gravimetric method	0	N/A	N/A	N/A
	Total Phosphorous (as P)	468	0.1 mg/l	17.0 mg/l	1.9 mg/l
	Total Residual Chlorine	1460	< 0.01 mg/l	0.5 mg/l	0.02 mg/l
	Fecal Coliform	446	< 2 colonies/100 ml	1600 colonies/100 ml	N/A
	Carbonaceous Biochemical Oxygen Demand, 5 day test	475	1.2 mg/l	36.8 mg/l	3.0 mg/l
	Whole Effluent Toxicity, acute test	16	N/A	N/A	N/A
	Flow	1460	6,000 gallons	546,000 gallons	178,000 gallons
001 A	Biochemical Oxygen Demand, 5 day test	265	2.0 mg/l	38.0 mg/l	7.6 mg/l
	Total Suspended Solids	265	< 2 mg/l	380 mg/l	11 mg/l
	Total Nitrogen, Nitrate (as N)	264	0.4 mg/l	12.0 mg/l	4.5 mg/l
	Total Residual Chlorine	1397	< 0.01 mg/l	0.13 mg/l	0.03 mg/l
	Carbonaceous Biochemical Oxygen Demand, 5 day test	266	0.9 mg/l	33.2 mg/l	3.6 mg/l

Outfall Code	Analyte	Analyses Performed During Reporting Period	Minimum	Maximum	Average
002 A	pH	227	6.9 S.U.	9.3 S.U.	N/A
	Total Nitrogen, Nitrate (as N)	227	0.1 mg/l	20.0 mg/l	2.2 mg/l
	Flow	228	88,000 gallons	3,059,000 gallons	948,000 gallons
005 A	Flow	215	500 gallons	3,231,000 gallons	N/A
	Non-Volatile Suspended Solids	215	< 5 mg/l	84	14
	Total Chromium (as Cr)	20	< 1 µg/l	< 1 µg/l	< 1 µg/l
	Whole Effluent Toxicity, acute test	6	no toxicity measured	no toxicity measured	N/A
006 A	Flow	255	3,000 gallons	2,589,000 gallons	N/A
	Total Chromium (as Cr)	23	< 1µg/l	< 1 µg/l	< 1 µg/l
	Whole Effluent Toxicity, acute test	9	no toxicity measured	no toxicity measured	N/A
007 A	Flow	41	12,000 gallons	1,670,000 gallons	N/A
	Total Chromium (as Cr)	4	< 1 µg/l	< 1 µg/l	< 1 µg/l
	Whole Effluent Toxicity, acute test	2	no toxicity measured	no toxicity measured	N/A

Table 9-4. Summary of NPDES Measurements Greater than Permit Limitations

Outfall Code	Date(s)	Parameter/Limitation	Measurements Greater than Permit Limitation
STP A	2/11/97	Carbonaceous Biochemical Oxygen Demand, 5 Day Test/Daily maximum 25 mg/l	36.8 mg/l
STP A	Week of 7/20/97 – 7/26/97	Fecal Coliform/ 7 day geometric mean, 400 colonies/100 ml	1058 colonies/100 ml
STP A	9/1/98	Total Phosphorus (as P)/ Daily maximum 12 mg/l	15.6 mg/l
002 A	1/00	Total Nitrogen, Nitrate (as N)/ 30 day average, 10 mg/l	15.6 mg/l
STP A	2/10/00	Total Phosphorus (as P)/ Daily maximum 12 mg/l	17.0 mg/l
002 A	7/24/00	pH/Daily maximum 9.0 S.U.	9.3 S.U.

10. PERFORMANCE MONITORING

This section addresses monitoring the performance of specific actions[19] on Site for the release of contaminants to the environment. Project-specific Performance monitoring (PM) may be specified in the project plan through the review and approval process for those projects which pose a concern for a contaminant release, especially for a contaminant that may not be adequately monitored by other monitoring objectives downstream. Each PM location will target contaminants of the greatest concern for the specific action being monitored. For example, PM for specific analytes may be needed for the evaluation of the following:

- Specific D&D Actions: The review and approval process for a D&D action may identify the need for Performance monitoring specific to that action.
- Specific Remedial Actions: There are monitoring requirements associated with specific Operable Unit (OU) activities. For example, the existing consolidated treatment plant for OU1 and OU2 has a surface water discharge. Performance monitoring specific to this discharge is specified in the work plans.
- Transition Actions: For example, DOE, RFFO has proposed changes to the operation protocols of the ITS. Specific Performance monitoring may be needed in light of this change if other monitoring in the IMP fails to provide adequate assurance of protecting the environment and public health.
- Best Management Practices (BMPs) for the Control of Plutonium Transport in Surface Water Runoff: For example, when a BMP (barrier, trap, filter, or other watershed improvement) is installed to control a potential source of Pu-contaminated runoff, the Site would like to determine the effectiveness of the BMP so that future resources may be allocated where they are most effective.

Monitoring of activities within the IA is achieved, in general, through New Source Detection (NSD) and Point of Evaluation (POE) monitoring (see Sections 11 and 12 for details) at the IA boundary. Project-specific PM stations monitor specific high-risk Site activities, such as D&D of a particular building or building cluster. These mobile, temporary stations will be placed upstream from the routine monitoring stations (POE and NSD), closer to specific projects/activities to monitor a specific subdrainage for releases of contaminants associated with the activity in the subdrainage.

10.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

Data quality objectives must be specified in the project plan. Analyte suites (data types for collection) are generally determined by the contaminants of concern associated with a specific activity. Generally, automated samples are continuous flow-paced composites. However, protocols may be modified depending on the specific conditions for a monitoring location or drainage basin. Regardless, the sampling protocols are designed to accurately characterize existing flows, and confidently monitor for changes during the project activities.

Generally, monitoring is initiated prior to the start of project activities such that 10 - 15 samples over varying flow rates can be collected (preferably 18 months prior to project initiation[20]). Results from these samples are used to establish a baseline for the subdrainage. Monitoring continues during the activity, attempting to collect one sample per month. After project completion, monitoring continues long enough (approximately 3 months) to determine any impacts (both positive and negative) to surface-water quality.

PM can occur anywhere within the Site surface-water drainage area (especially within the IA), downstream from a BMP, remediation, or high-risk activity.

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[19] This is project-specific, versus the global monitoring (NSD and POE) of the IA discussed in Sections 11 and 12.

[20] Due to the dynamic nature of Site Cleanup, initiation of Performance monitoring 18 months prior to an activity is rarely achieved. However, additional samples are often collected at an increased rate to establish baseline prior to initiation of project activities.

10.2 WY97-00 MONITORING SCOPE

Table 10-1. Performance Monitoring Locations.

ID Code	Location	Primary Flow Measurement Device	Telemetry	Project [Project Contact]
GS27	Small ditch NW of B884 tributary to Central Avenue Ditch	2" Cutthroat Flume	Yes	D&D of B889; Watershed Improvements evaluation; [Contact: NA]
GS28	Small ditch NW of B865 tributary to Central Avenue Ditch	4" Cutthroat Flume	Yes	D&D of B889 (location currently not operating); to be re-installed for B883 and B865 D&D activities; [Contact: M. Shafer, x4375]
GS32	Corrugated metal pipe (1.5') north of Solar Ponds in PA draining B779 area	18" cmp[a]	Yes	D&D of B779 and B776/777; [Contacts: J. Stevens, x5797, B779; R. Lesser, x2298, B776/777]
GS37	Central Avenue Ditch NW of B443	9.5" Parshall Flume	Yes	D&D of B123; location discontinued
GS39	Corrugated metal pipe (1.0') north of 904 Pad draining 903/904 Pads and Contractor Yard areas	1' H Flume	Yes	Remediation activities for 903 Pad; [Contact: T. Spence, x4322]
GS40	Drainage Ditch in PA E of Tenth St. (750 Pad) S of Building 997	1' Parshall Flume	Yes	B707 Area D&D activities; [Contact: R. Lesser, x2298]
GS43	Drainage ditch northeast of T886A	0.5' H-Flume	Yes	D&D of B886; [Contact: M. Shafer, x4375]
SW022	East end of Central Avenue Ditch	9.5" Parshall Flume	Yes	ER projects for Trench T-1
SW120	Drainage ditch north of Solar Ponds along PA perimeter road	4" Cutthroat Flume	Yes	B771/774 D&D and Solar Ponds activities; [Contact: T. Lindsay, x5705, Solar Ponds; C. Gilbreath, x7355, B771/774]

Notes: [a] Due to the current configuration of in place stormwater culverts, flow measurement at this location is not possible without significant construction modifications. All other locations collect 5- and 15-minute flow data.

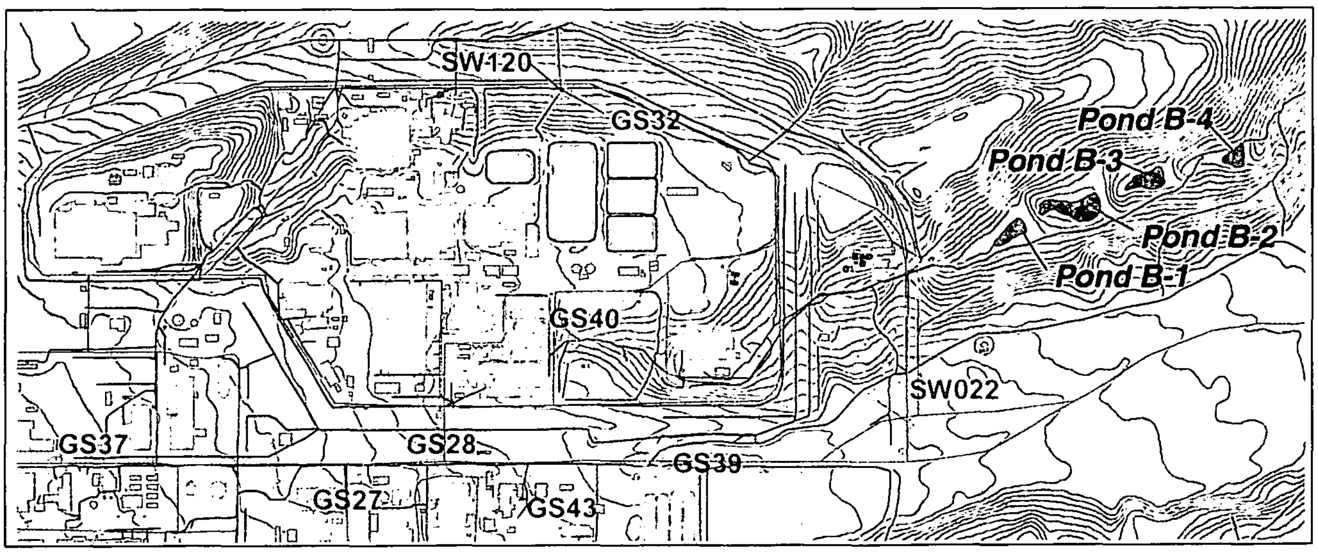

Figure 10-1. Water Year 1997-2000 Performance Monitoring Locations.

Table 10-2. Performance Sample Collection Protocols.

ID Code	Frequency	Type[b]
GS27	1 per month	Storm-event rising-limb flow-paced composites[a]
GS28	1 per month	Storm-event rising-limb flow-paced composites[a]
GS32	1 per month	Storm-event rising-limb time-paced composites[a]
GS37	1 per month	Storm-event rising-limb flow-paced composites[a]
GS39	12 per year[c]	Continuous flow-paced composites
GS40	12 per year[c]	Continuous flow-paced composites
GS43	12 per year[c]	Continuous flow-paced composites
SW022	1 per month	Storm-event rising-limb time-paced composites[a] and Continuous flow-paced composites (after 10/1/99)
SW120	12 per year[c]	Continuous flow-paced composites

Notes: [a] Storm-event sampling at locations which are often dry, and normally only receive direct runoff, is opportunistic. Some locations may see flow only during wet months. Every attempt is made to achieve the target sample frequency; however, this is not always possible.
[b] Sample types are defined in the Automated Surface-Water Monitoring Work Plan.
[c] Annual total samples is 12 per year. Frequency of collection is based on expected flow volumes such that each sample collects water representing similar stream discharge volumes; for example, more samples are collected in wet spring months than dry winter months.

Table 10-3 Performance Analytical Targets (Analyses per Year).

ID Code	TSS[a]	Pu, Am	Pu, U, Am	Tritium	CLP Metals
GS27	12		12		
GS28	12		12		
GS32	12		12		12
GS37	12		12	12	
GS39	12	12			
GS40	12		12 (U added 8/00)	12 (added 8/00)	12 (added 8/00)
GS43	12		12		12
SW022	12		12		12 (added 3/98; discontinued 10/00)
SW120	12		12	12	12

Notes: [a] Ideally, TSS would be analyzed for all samples collected at the above locations. However, continuous flow-paced sampling protocols often result in composite samples which are collected over periods exceeding the 7-day hold time for TSS analyses. Therefore, TSS can not be analyzed for all continuous flow-paced composite samples, but will be analyzed when possible.

10.3 DATA EVALUATION

Data evaluation will be specified for individual projects. A project-specific indicator might be a single monitoring result, a 30-day average for a specific analyte, or an indicator for the analyte of concern. An example decision rule is shown below. Generally, evaluation is performed as data become available, especially if an initial qualitative screening based on process knowledge indicates that an analytical result is higher than normal for a particular location.

IF — The project-specific indicator is greater than the 95% upper tolerance limit (UTL) of baseline,

THEN — The Site will evaluate the specific activity to improve performance. The appropriate project contacts will be notified

IF — The project-specific indicator is less than the 95% lower tolerance level (LTL),

THEN — The Site will conclude that the project has reduced environmental releases of the specific contaminant.

Generally, UTLs are calculated on a semi-monthly basis. While this is the only routine data evaluation performed for PM locations, project-specific evaluations may also be detailed in the applicable project plans.

The following sections present the performance monitoring data evaluations on a project-specific basis. Each section includes a table of summary statistics for the location-specific analytes of interest, 95% UTL plots, box-whisker plots, and plots of the temporal variation of suspended solids Pu and Am activity.

The following evaluations include all results that were not rejected through the verification/validation process. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' value and the 'duplicate'. When a sample has multiple 'real' analyses (Site requested 're-runs'), the value used in calculations is the arithmetic average of the multiple 'real' analyses. Total uranium is calculated by summing the activities for the analyzed isotopes (U-233,234 + U-235 + U-238).

For the summary tables, when a negative radionuclide result (e.g. -0.002 pCi/l) is returned from the laboratory due to blank correction, then a value of 0.0 pCi/l is used for calculation purposes. When metals and TSS results are returned from the laboratory as 'undetect', ½ of the detection limit is used for calculation purposes.

The method for calculating UTLs is given in Appendix B.1: Data Evaluation Methods. For this report, the four year period of WY97–00 was used to calculate the UTL values. UTL lines are shown on the plots only for the determined distribution. When the data may satisfy either distribution, both UTL lines are plotted; when no distribution is determined, no UTL line is plotted.

Box-whisker plots were prepared using S-Plus statistical evaluation software. For these plots, when a negative radionuclide result (e.g. -0.002 pCi/l) is returned from the laboratory due to blank correction, then a value of 0.0 pCi/l is used for calculation purposes. When metals and TSS results are returned from the laboratory as 'undetect', ½ of the detection limit is used for calculation purposes. Pu/Am ratios are calculated only for samples where both the Pu and Am results were greater than 0.015 pCi/L to avoid ratios for samples with activities near the MDA. A key describing the components of the box-whisker plots is given in Appendix B.1: Data Evaluation Methods.

The temporal variation of suspended solids activity plots are included as an indication of changes in the contamination characteristics of a particular drainage basin. A suspended solids activity that decreases over time may indicate that contaminant sources have been removed from the drainage, clean solids have become more available to runoff, or contaminant sources have been naturally attenuated over time. Similarly, a suspended solids activity that increases over time may indicate that new contaminant sources have become available for transport in the drainage. TSS analysis is only performed for composite samples that are collected over a period of less than the TSS hold time (7 days). Consequently, not all samples collected at the locations below were analyzed for TSS. Only values greater than the detection limit (generally 5 mg/L for TSS, 0.015 pCi/L for Pu and Am) are included.

10.3.1 Building 889 D&D

Monitoring locations GS27 and GS28 were originally installed under the IA IM/IRA in support of the D&D of Building 889. GS27 was installed on 3/9/95, and GS28 was installed on 5/9/95. Monitoring at GS28 was discontinued on 8/26/97 after completion of the B889 demolition at the end of WY96.[21]

Figure 3-34 and 3-36 show the drainage areas for GS27 and GS28, respectively. Other major buildings within these drainages include 883 and 865.

Monitoring data collected at GS27 have shown the highest Pu and Am activities for automated monitoring locations (Table 10-4). The high activities prompted the Site to initiate an investigation, with the intent being the mitigation of contaminated soils and/or the removal of 'hot spots'. However, surface-soil and sediment sampling, in addition to FIDLER surveys, in the GS27 subdrainage have shown only moderate activities in the single pCi/g

[21] GS28 was reinstalled on 2/18/02 in support of 800 Area D&D activities.

range. The fact that suspended solids activities are frequently 1 to 2 orders of magnitude higher than the surface-soil/sediment activities (Figure 10-7) suggests that preferential suspension in runoff of more contaminated particles may be occurring at this location.

In an attempt to mitigate the movement of contaminated soils, some sediment was removed from the drainage ditch immediately upstream of GS27, and exposed soils were treated with a soil stabilizer called Topseal® in September 1996. Although lower activities were measured during WY97, higher activities were again measured in WY98 (Figure 10-2 and Figure 10-3). It is not clear if the Topseal, the completion of the B889 D&D, or natural variability are the cause of these temporarily lower activities. However, Figure 10-7 shows a general reduction in suspended solids activity over time.

Figure 10-2 and Figure 10-3 show the UTL plots for Pu and Am, respectively. During WY97–00, no Pu results exceeded the calculated UTL. For Am, although two results were greater than the UTL, these values did not persist and were associated with high TSS measurements. Similarly, the suspended solids activities for these samples were not unusual. Figure 10-4 shows that a single total uranium result was greater than the UTL.

Table 10-4. Summary Statistics for Radionuclide Results from GS27 in WY97-00.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
TSS [mg/L]	45	34	214	400	NA
Pu-239,240	46	1.945	6.368	64.3	67.0[a]
Am-241	45	0.458	1.478	14.8	7.61[a]
U-233,234	46	0.150	0.358	1.070	
U-235	46	0.009	0.032	0.116	1.54[a]
U-238	46	0.142	0.366	1.050	

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.
TSS is given in mg/L.
Uranium UTL given for total uranium.

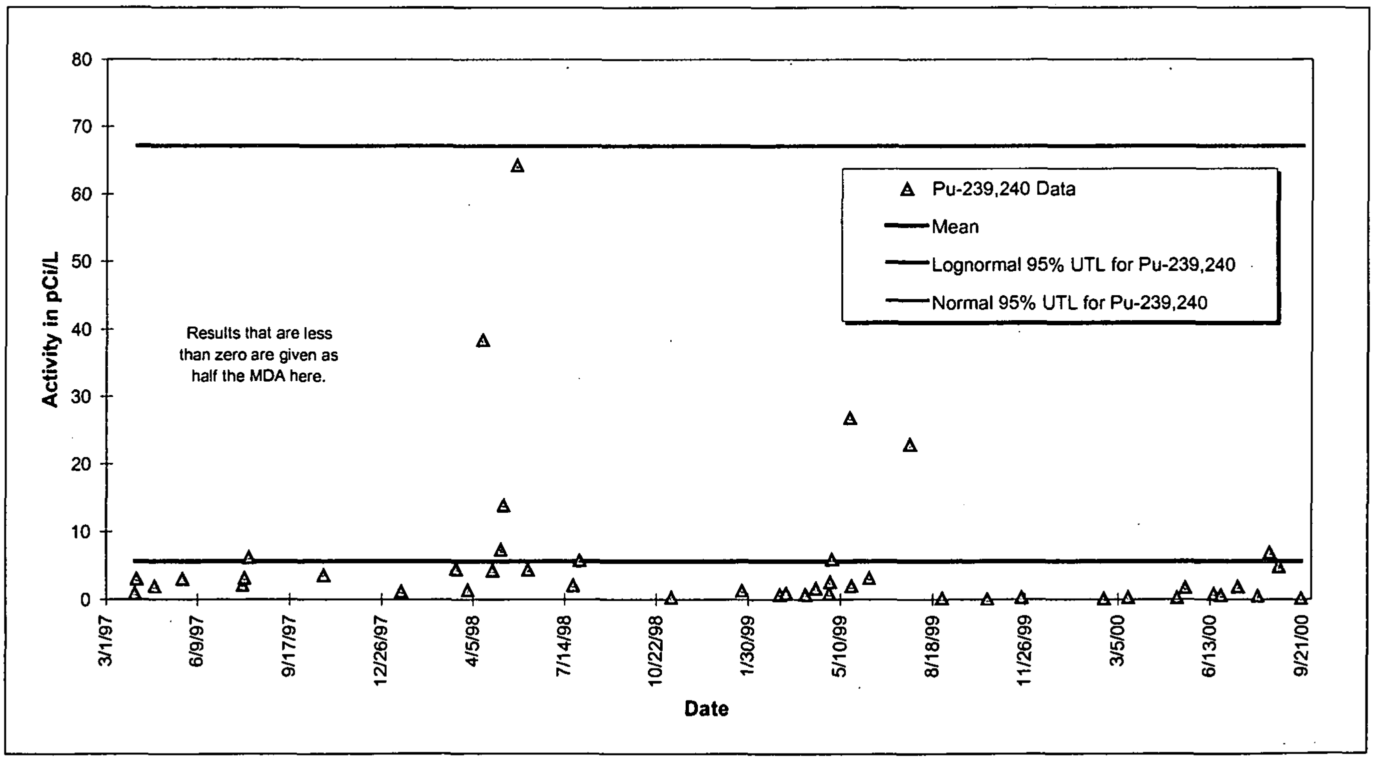

Figure 10-2. 95% UTL for Pu-239,240 at GS27: WY97-00.

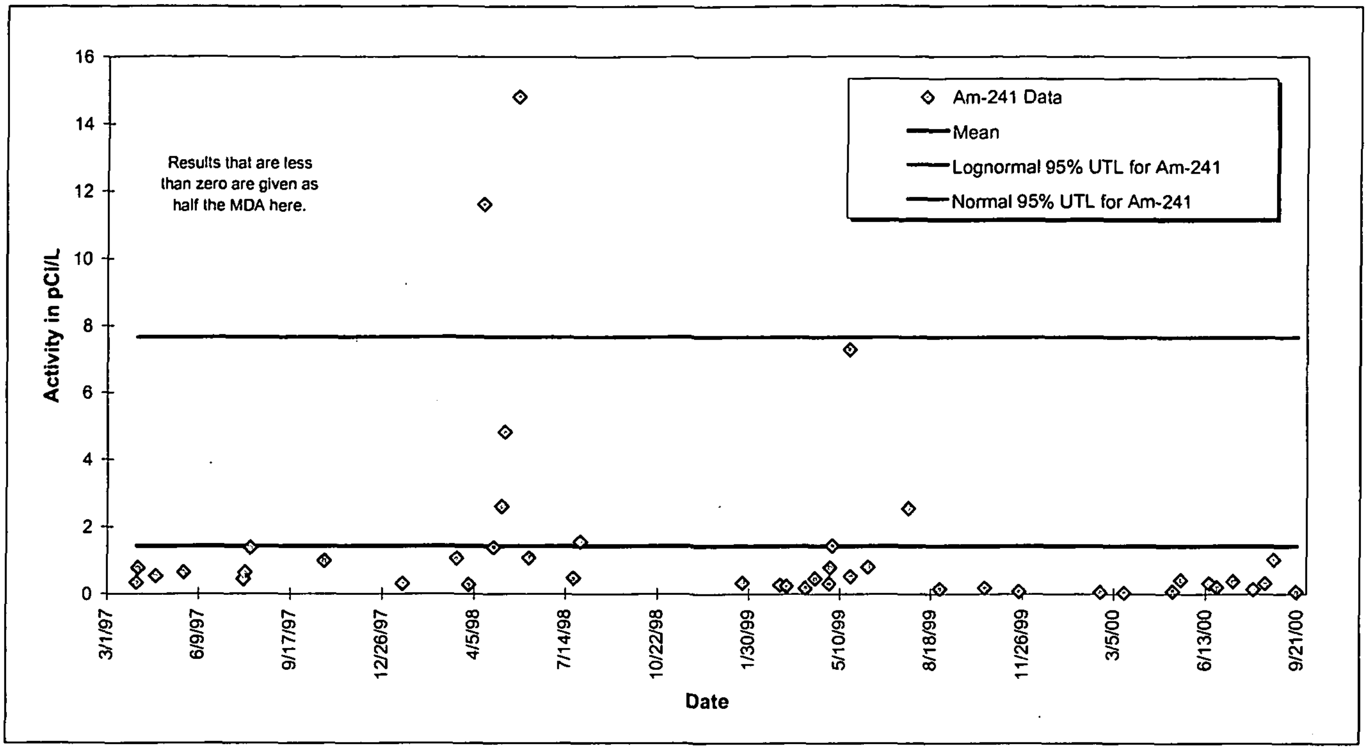

Figure 10-3. 95% UTL Plot for Am-241 at GS27: WY97-00.

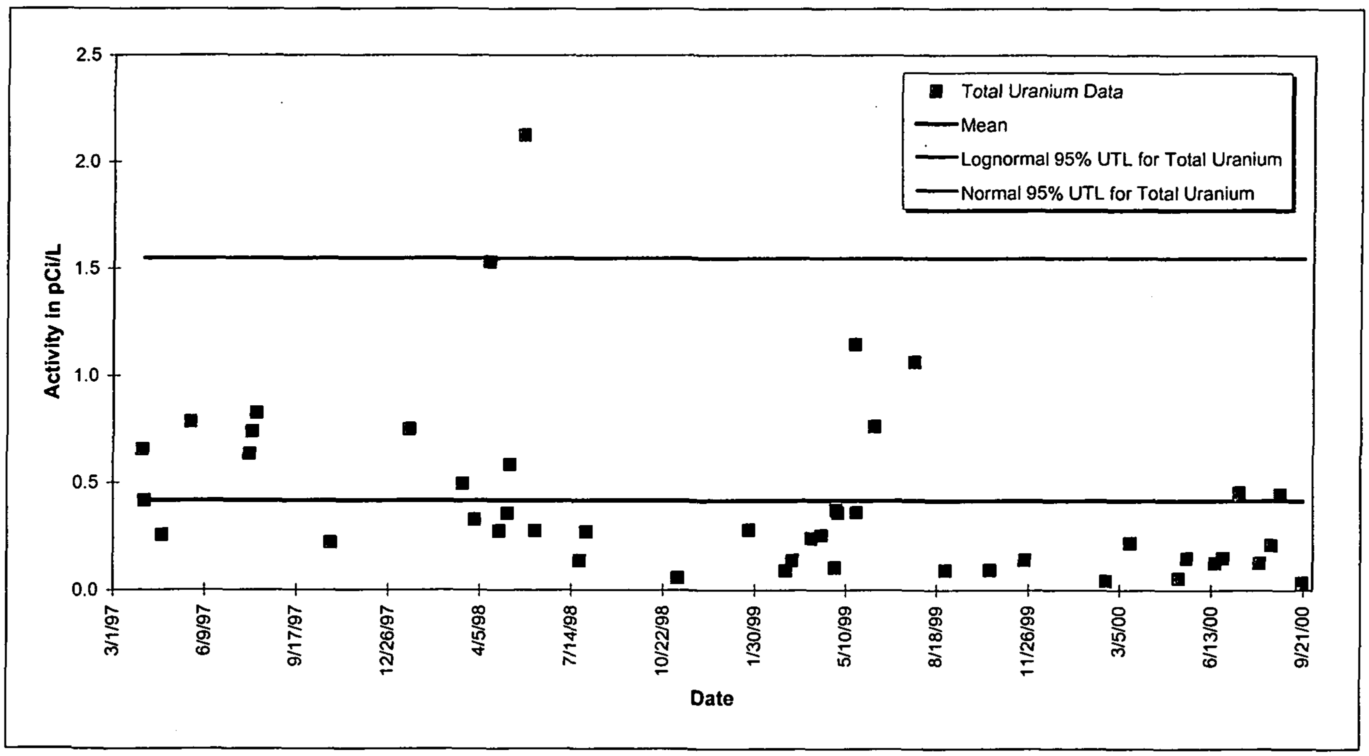

Figure 10-4. 95% UTL Plot for Total Uranium at GS27: WY97-00.

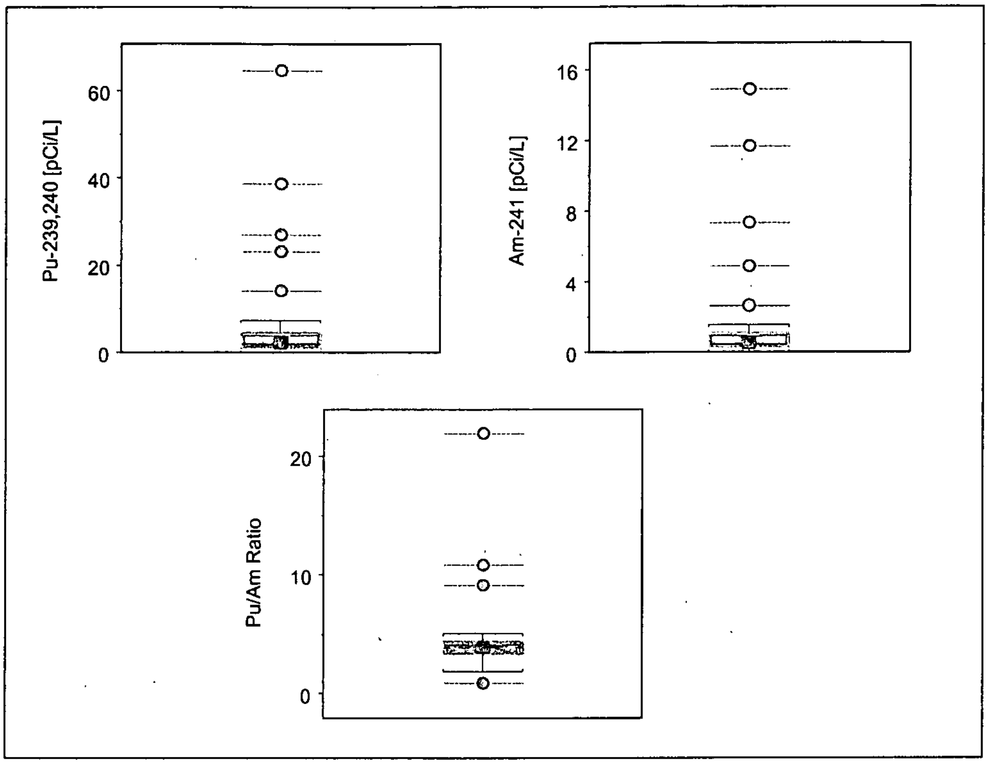

Figure 10-5. Pu and Am Box Plots for GS27: WY97–00.

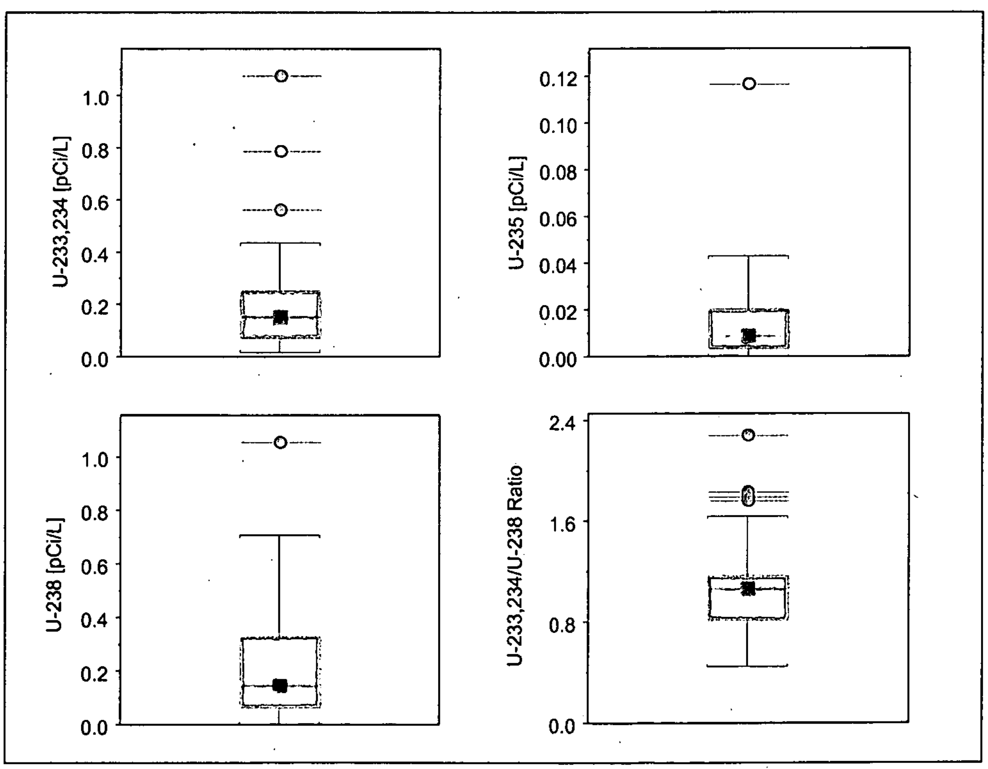

Figure 10-6. Uranium Box Plots for GS27: WY97–00.

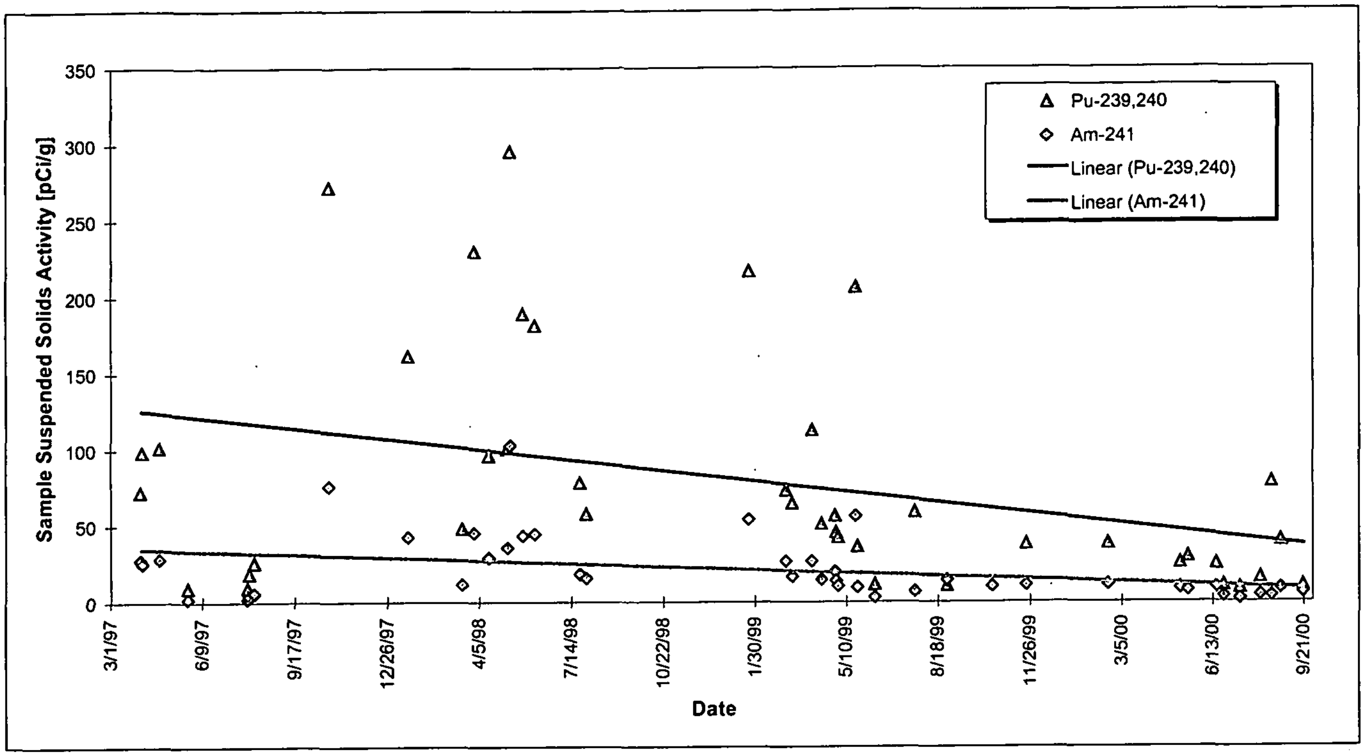

Figure 10-7. Temporal Variation of Suspended Solids Activity at GS27: WY97–00.

Monitoring data collected at GS28 show moderate median Pu and Am activities (Table 10-5). Figure 10-8 and Figure 10-9 show the UTL plots for Pu and Am, respectively. During WY97–00, no Pu or Am results exceeded the calculated UTL. Figure 10-10 shows that no total uranium results were greater than the UTL. Figure 10-13 shows that suspended solids activity has not changed over time.

Table 10-5. Summary Statistics for Radionuclide Results from GS28 in WY97-00.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
TSS [mg/L]	7	41	419	590	NA
Pu-239,240	7	0.075	0.686	0.852	3.39[a]
Am-241	7	0.027	0.123	0.240	0.60[a]
U-233,234	7	0.370	0.530	0.627	
U-235	7	0.045	0.068	0.173	2.99[a] / 2.53[b]
U-238	7	0.437	0.744	0.993	

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.
TSS is given in mg/L.
Uranium UTL given for total uranium.

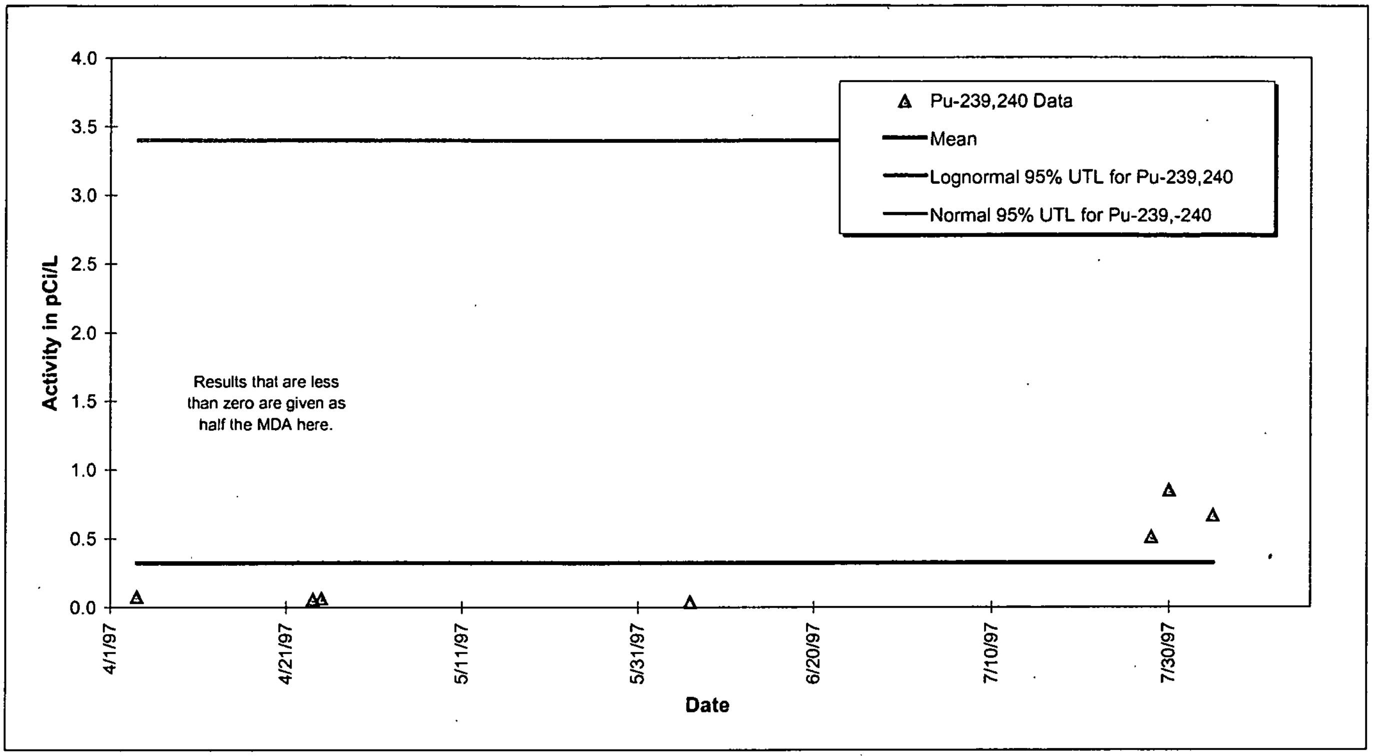

Figure 10-8. 95% UTL Plot for Pu-239,240 at GS28: WY97-00.

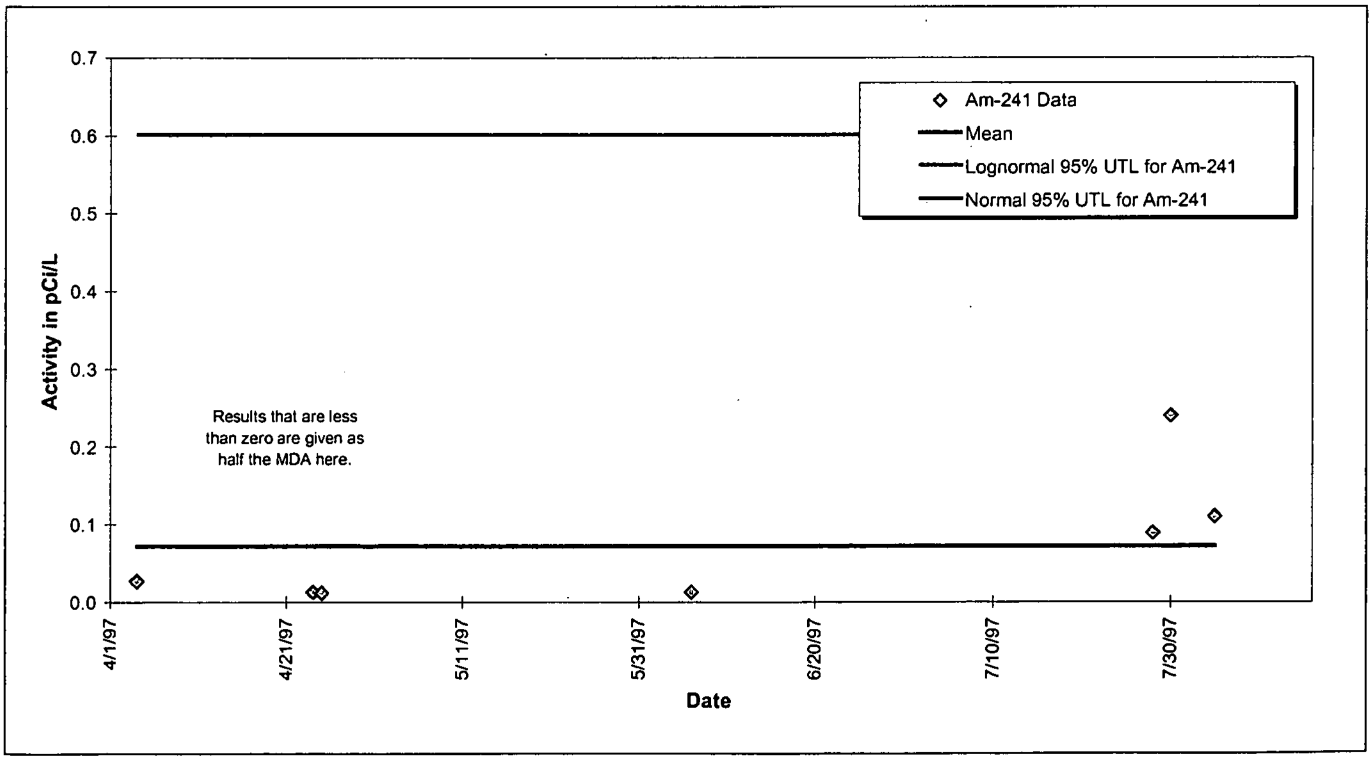

Figure 10-9. 95% UTL Plot for Am-241 at GS28: WY97-00.

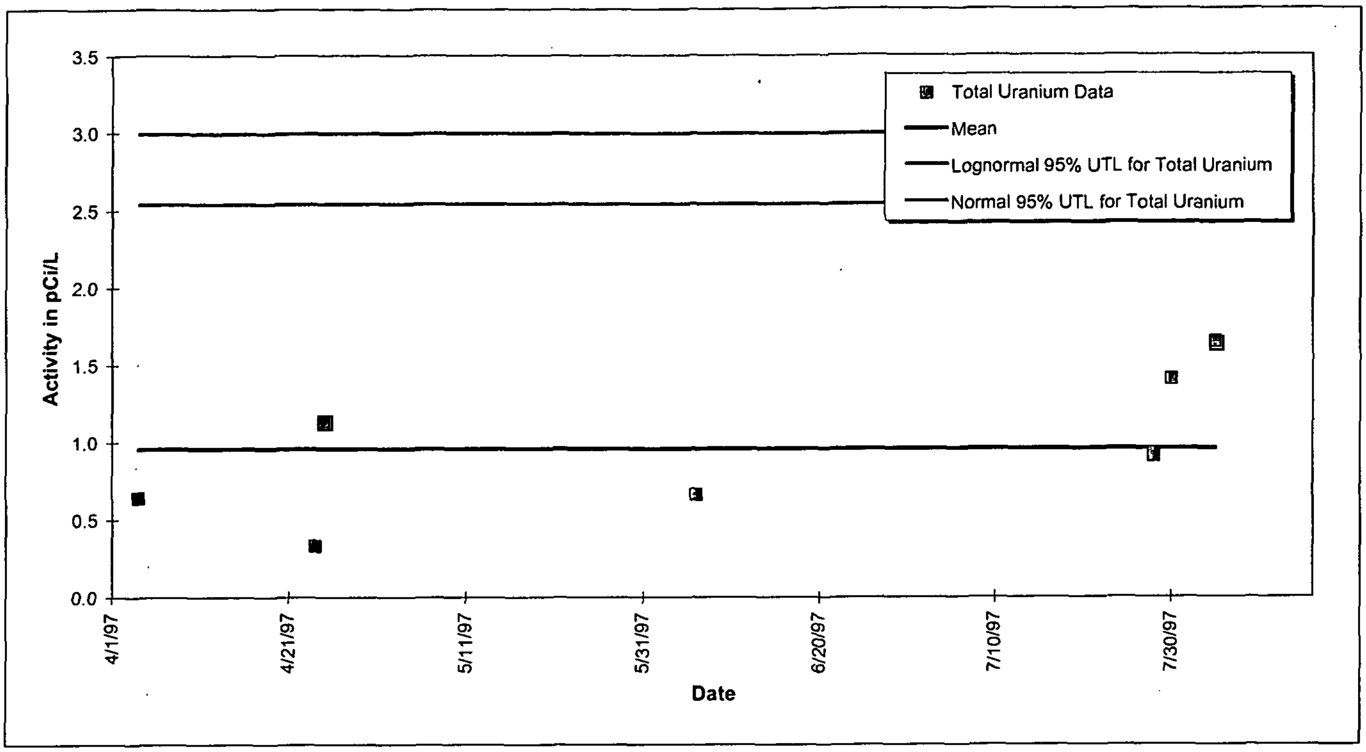

Figure 10-10. 95% UTL Plot for Total Uranium at GS28: WY97-00.

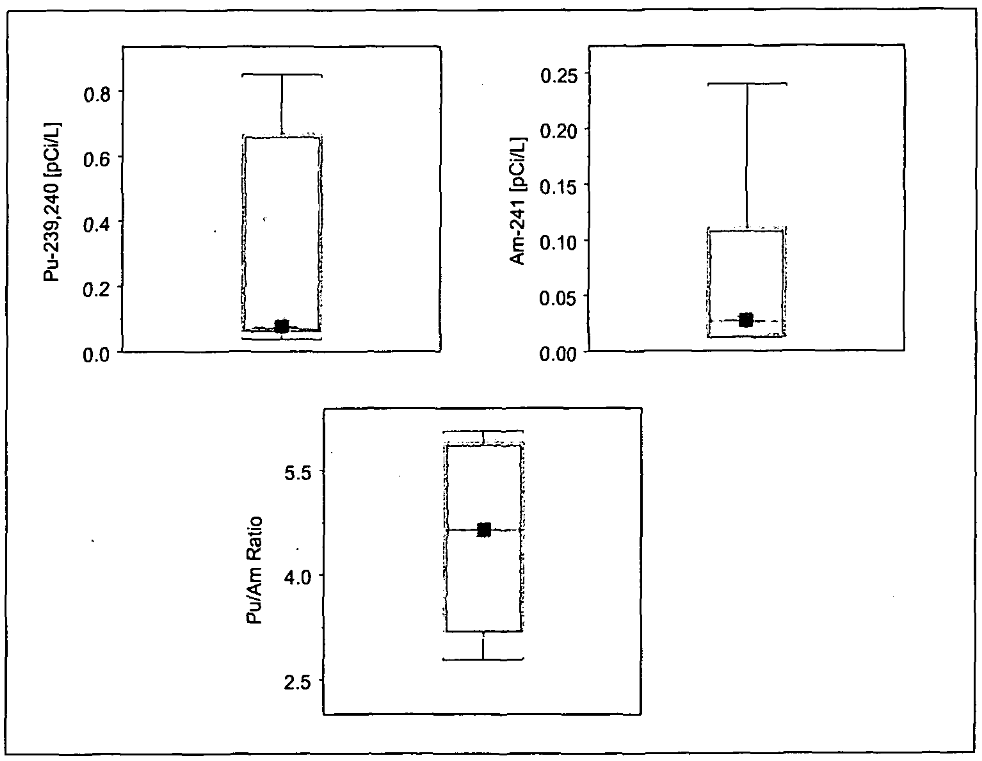

Figure 10-11. Pu and Am Box Plots for GS28: WY97–00.

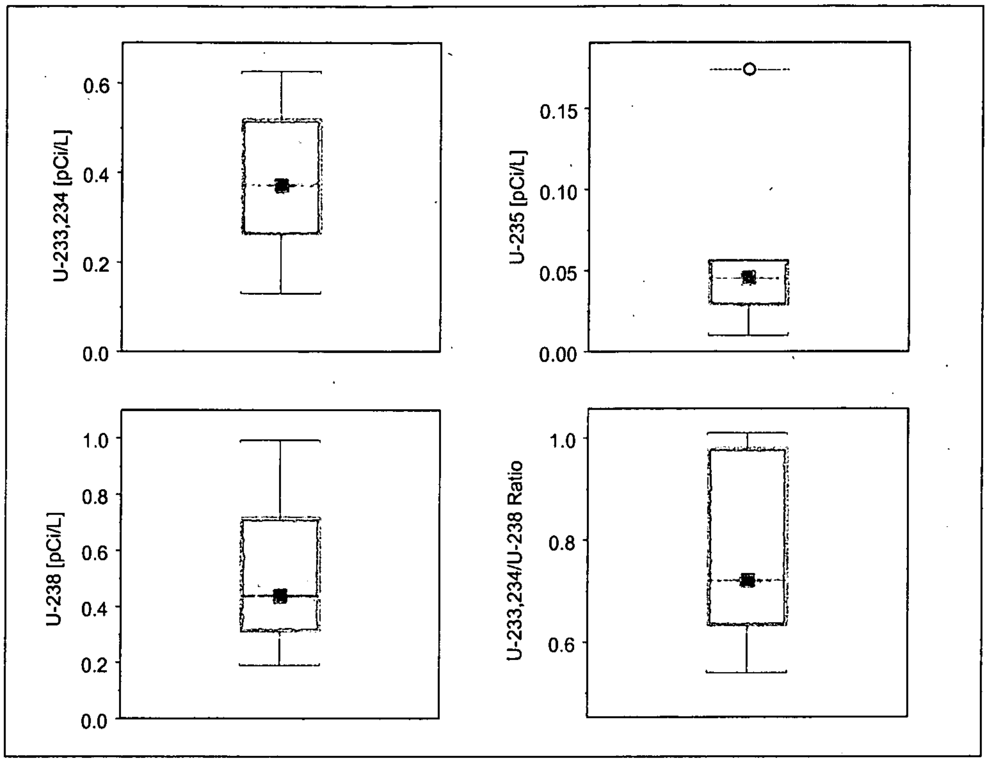

Figure 10-12. Uranium Box Plots for GS28: WY97–00.

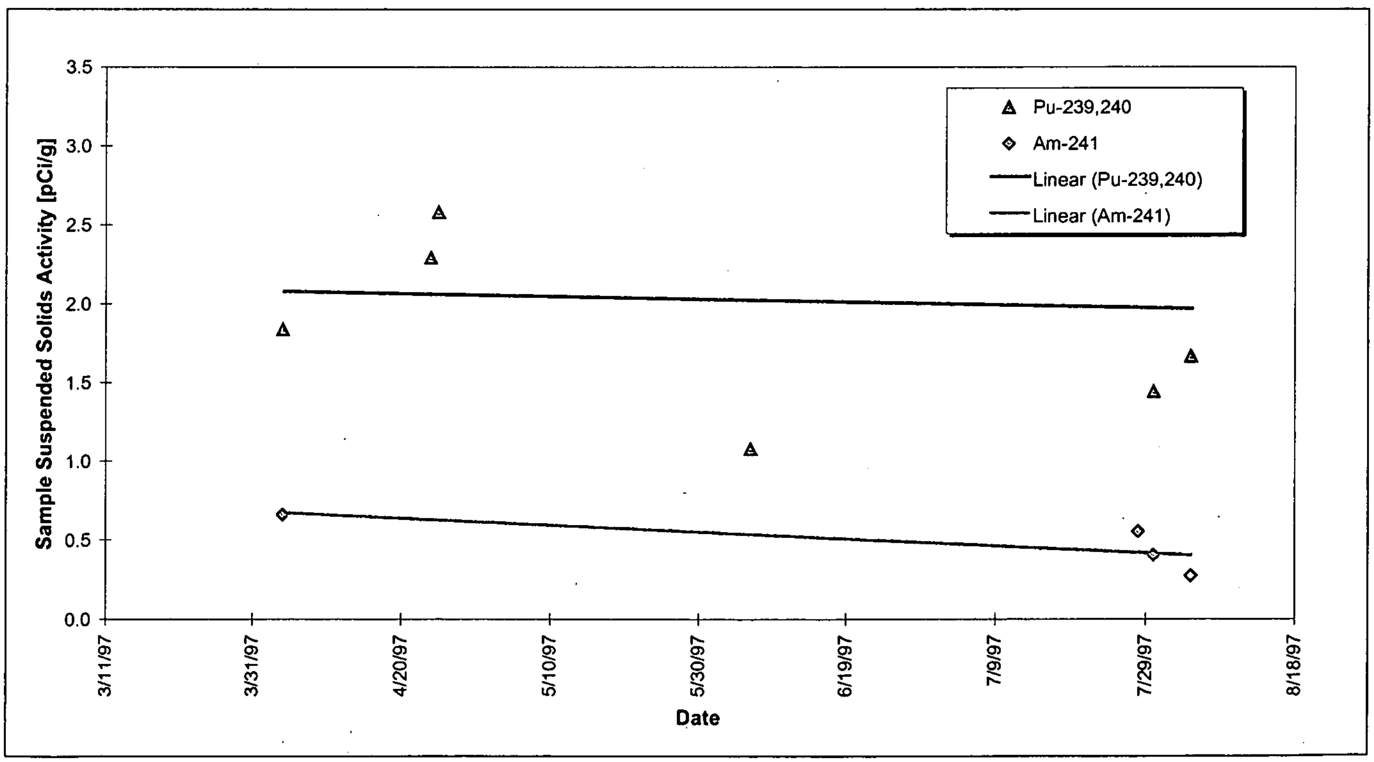

Figure 10-13. Temporal Variation of Suspended Solids Activity at GS28: WY97–00.

10.3.2 Building 779 D&D

Monitoring location GS32 was installed on 1/31/97 in support of the D&D of Building 779. This location also supports D&D activities for Building 776/777 and activities for the Solar Ponds. In support of the B776/777 D&D, tritium was added to the analyte suite in WY01. Figure 3-40 shows the drainage area for GS32. Other buildings within this drainage include 778, 705 and 706.

Monitoring data collected at GS32 have somewhat higher Pu and Am activities than for other automated monitoring locations (Table 10-6). Figure 10-14 and Figure 10-15 show the UTL plots for Pu and Am, respectively. During WY97–00, no Pu results exceeded the calculated UTL. For Am, the data distribution could not be determined, but Figure 10-17 indicates that none of the data can be considered 'suspect'.

Figure 10-16 shows a significant short-term increase in total uranium activities, two which are greater than the UTL. These samples were collected soon after completion of the demolition of B779. Building personnel were notified of the results and a field investigation ensued. The investigation looked into the possible existence of sumps or drains that may be flowing to GS32. No causes could be determined, and subsequent sample results reverted to normal levels.

Figure 10-19 shows that suspended solids activity has not changed significantly over time.

Table 10-6. Summary Statistics for Radionuclide Results from GS32 in WY97-00.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
TSS [mg/L]	26	290	768	1900	NA
Pu-239,240	34	1.070	4.968	11.5	39.5[a]
Am-241	34	0.625	3.262	4.060	[c]
U-233,234	34	0.771	1.592	10.800	9.38[a]
U-235	34	0.043	0.085	0.319	
U-238	34	0.572	0.974	6.410	

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.
TSS is given in mg/L.
Uranium UTL given for total uranium..

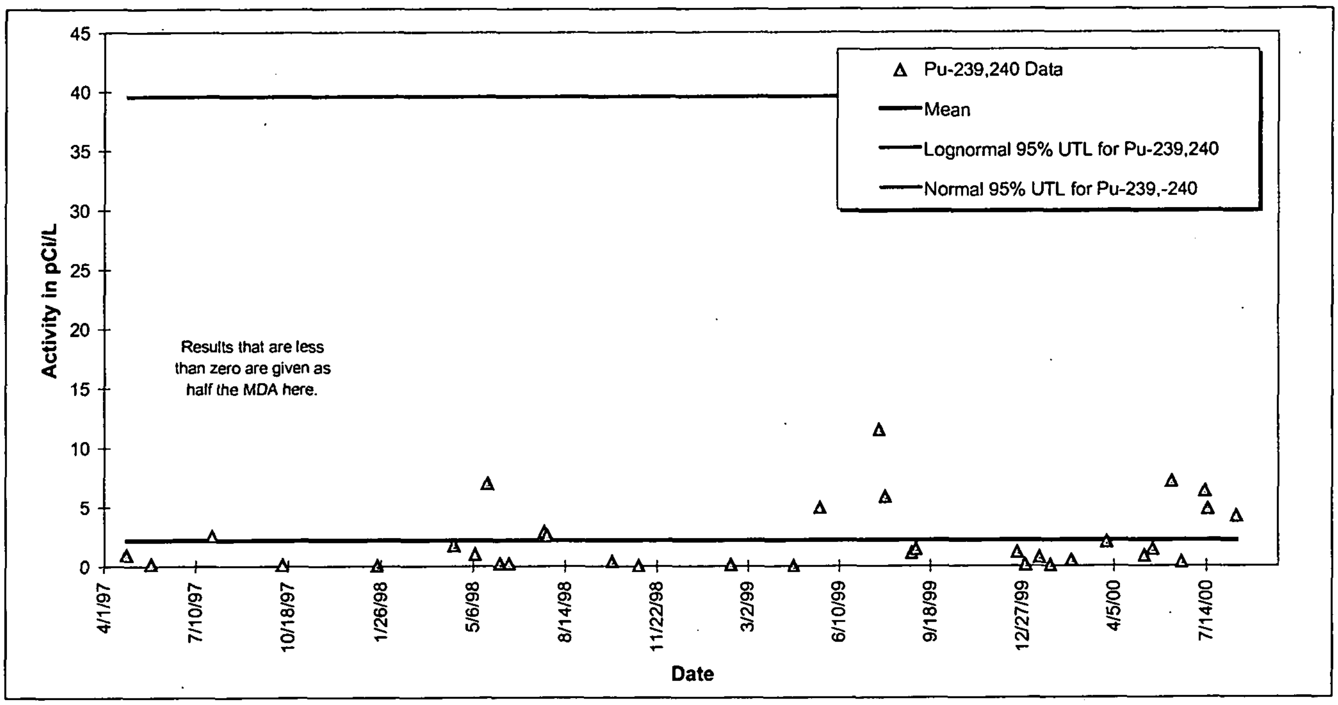

Figure 10-14. 95% UTL Plot for Pu-239,240 at GS32: WY97-00.

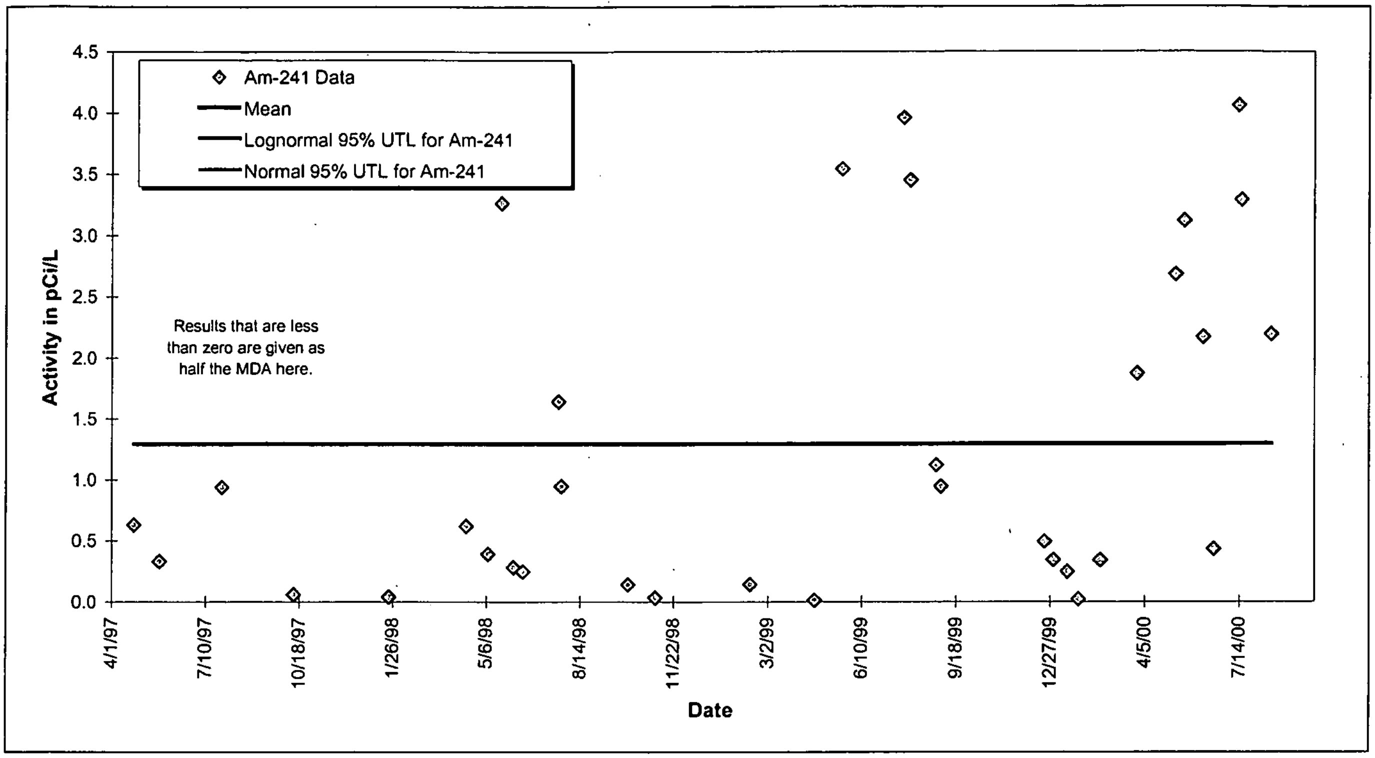

Figure 10-15. 95% UTL Plot for Am-241 at GS32: WY97-00.

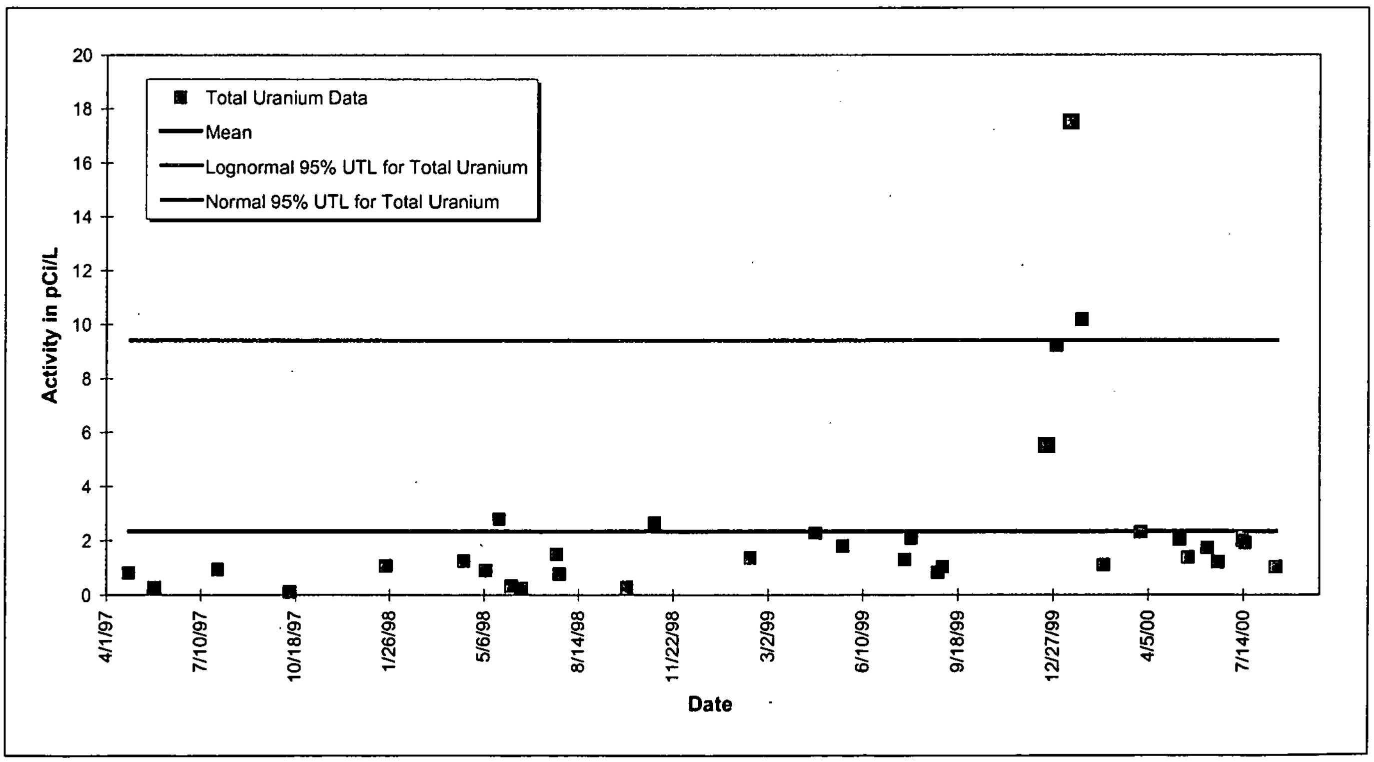

Figure 10-16. 95% UTL Plot for Total Uranium at GS32: WY97-00.

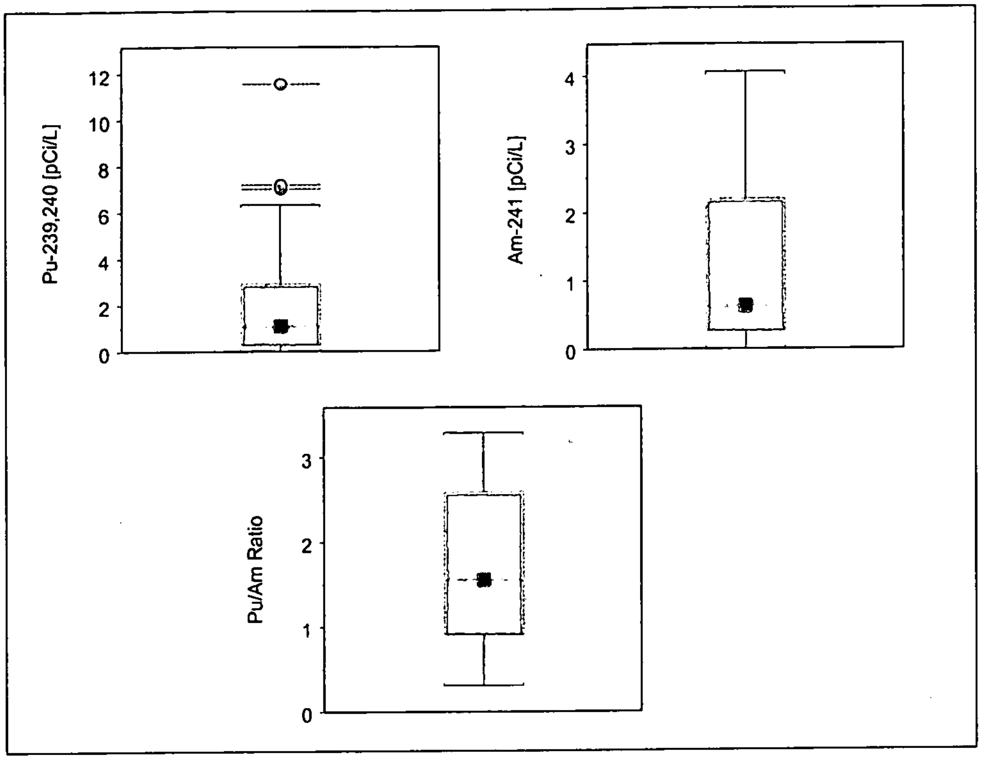

Figure 10-17. Pu and Am Box Plots for GS32: WY97–00.

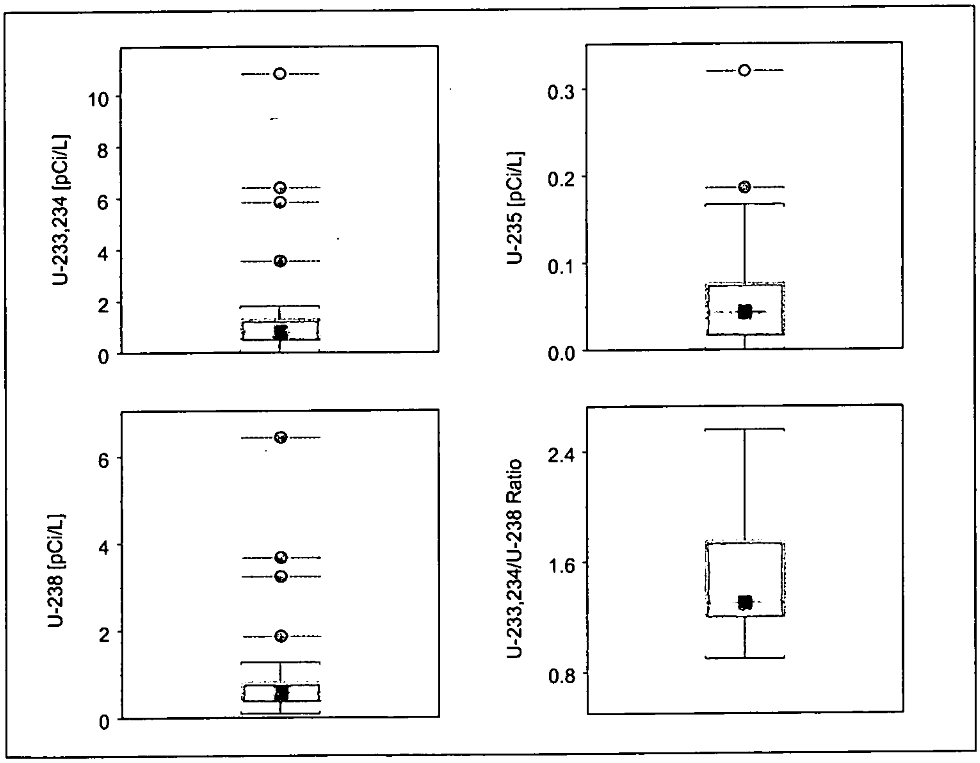

Figure 10-18. Uranium Box Plots for GS32: WY97–00.

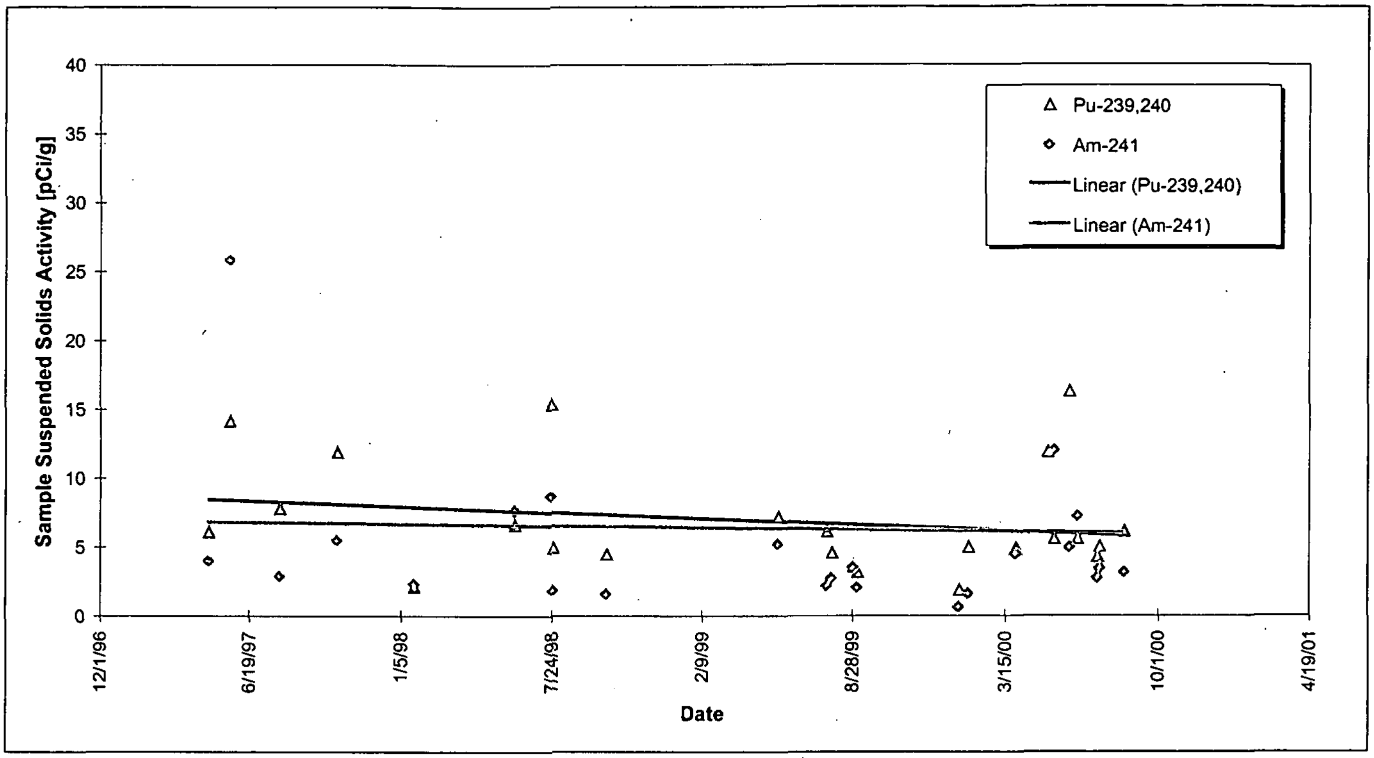

Figure 10-19. Temporal Variation of Suspended Solids Activity at GS32: WY97–00.

Table 10-7 shows the total metals results for samples collected at GS32. Figure 10-20 through Figure 10-24 show the UTL plots for the metals. For the metals with a determined distribution, most results did not exceed the calculated UTL. Only Li, Mo, Ag, Sr, and Zn showed results greater than the UTL. Many of the higher metals values are associated with the elevated uranium activities noted above, coinciding with the completion of the B779 demolition. The increased deconstruction activities may have resulted in the higher concentrations. In addition, heavy winter road/walkway salting has been noted to cause water-quality impacts at the Site (a correlation between Na and Sr has been noted for some locations). Expected increases in K and Na can clearly be seen below. Trace constituents in these products could also be causing elevated concentrations for other metals. In all cases, subsequent samples showed normal metals concentrations.

For the metals with undetermined distributions, only Hg, K, Na, Tl, and Sn show 'suspect' values as indicated by the boxplots. The K and Na values are likely associated with salting operations. For Hg, one of the results is an 'undetect' with a high detection limit (0.5 μg/L); the cause of the other results is unknown. For Tl, three of the results are associated with a high detection limit (10 μg/L); the other result is only 148% of the detection limit. For Sn, the highest result is an 'undetect' with a high detection limit (15.2 μg/L); the cause of the other results in unknown.

Table 10-7. Summary Statistics for Metals Results from GS32 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median [µg/L]	85th Percentile [µg/L]	Maximum [µg/L]	95% UTL [µg/L]
ALUMINUM	35	0.0%	3820	16550	43000	62764[a]
ANTIMONY	35	22.9%	5.30	11.7	21.2	[c]
ARSENIC	35	14.3%	3.70	8.45	13.0	[c]
BARIUM	35	0.0%	93.6	229	340	535[a]
BERYLLIUM	34	20.6%	0.50	1.21	1.90	[c]
CADMIUM	35	8.6%	1.30	2.49	4.80	[c]
CALCIUM	35	0.0%	40100	73850	164000	193169[a]
CHROMIUM	35	5.7%	12.50	26.0	46.9	75.7[a]
COBALT	35	17.1%	3.50	7.86	16.4	24.6[a]
COPPER	35	0.0%	38.3	86.2	114	185[a]
IRON	35	0.0%	7380	18750	48900	76905[a]
LEAD	35	5.7%	20.5	47.2	69.8	[c]
LITHIUM	32	3.1%	19.0	40.4	143	141[a]
MAGNESIUM	35	0.0%	4490	8738	18200	21743[a]
MANGANESE	35	0.0%	204	464	915	[c]
MERCURY	34	79.4%	0.05	0.12	0.27	[c]
MOLYBDENUM	32	18.8%	2.38	6.09	28.5	19.8[a]
NICKEL	35	11.4%	9.20	18.3	45.6	45.6[a]
POTASSIUM	35	0.0%	6900	17410	674000	[c]
SELENIUM	35	68.6%	0.55	1.96	2.40	[c]
SILVER	35	65.7%	0.18	0.55	2.10	1.55[a]
SODIUM	35	0.0%	18400	286100	2930000	[c]
STRONTIUM	32	0.0%	169	268	2050	1089[a]
THALLIUM	35	77.1%	0.48	0.92	7.50	[c]
TIN	32	50.0%	0.85	2.74	7.60	[c]
VANADIUM	35	0.0%	20.4	44.4	104	134[a]
ZINC	35	0.0%	580	1288	5130	4304[a]

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

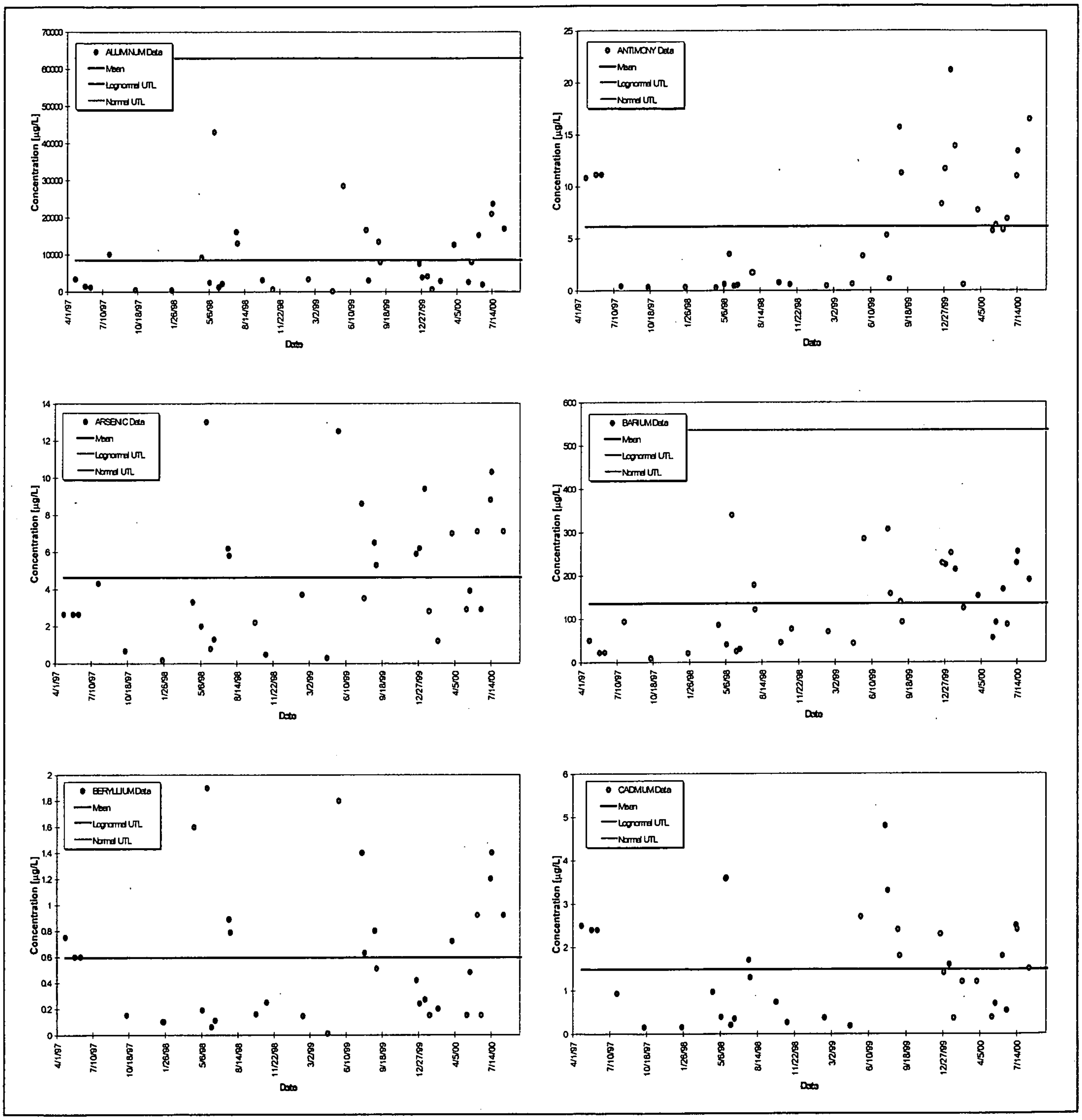

Figure 10-20. Total Metals UTL Plots for GS32: Aluminum through Cadmium.

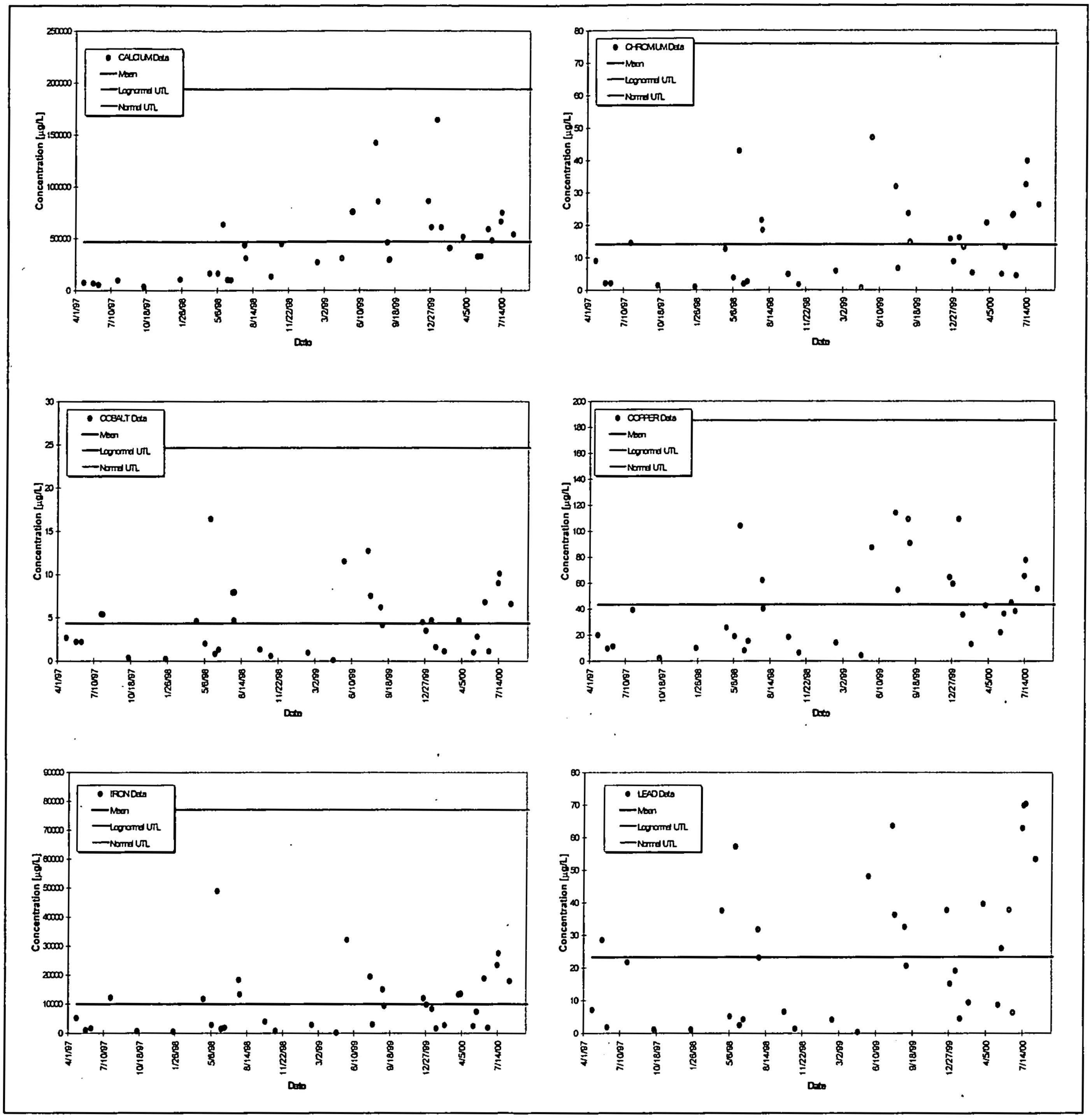

Figure 10-21. Total Metals UTL Plots for GS32: Calcium through Lead.

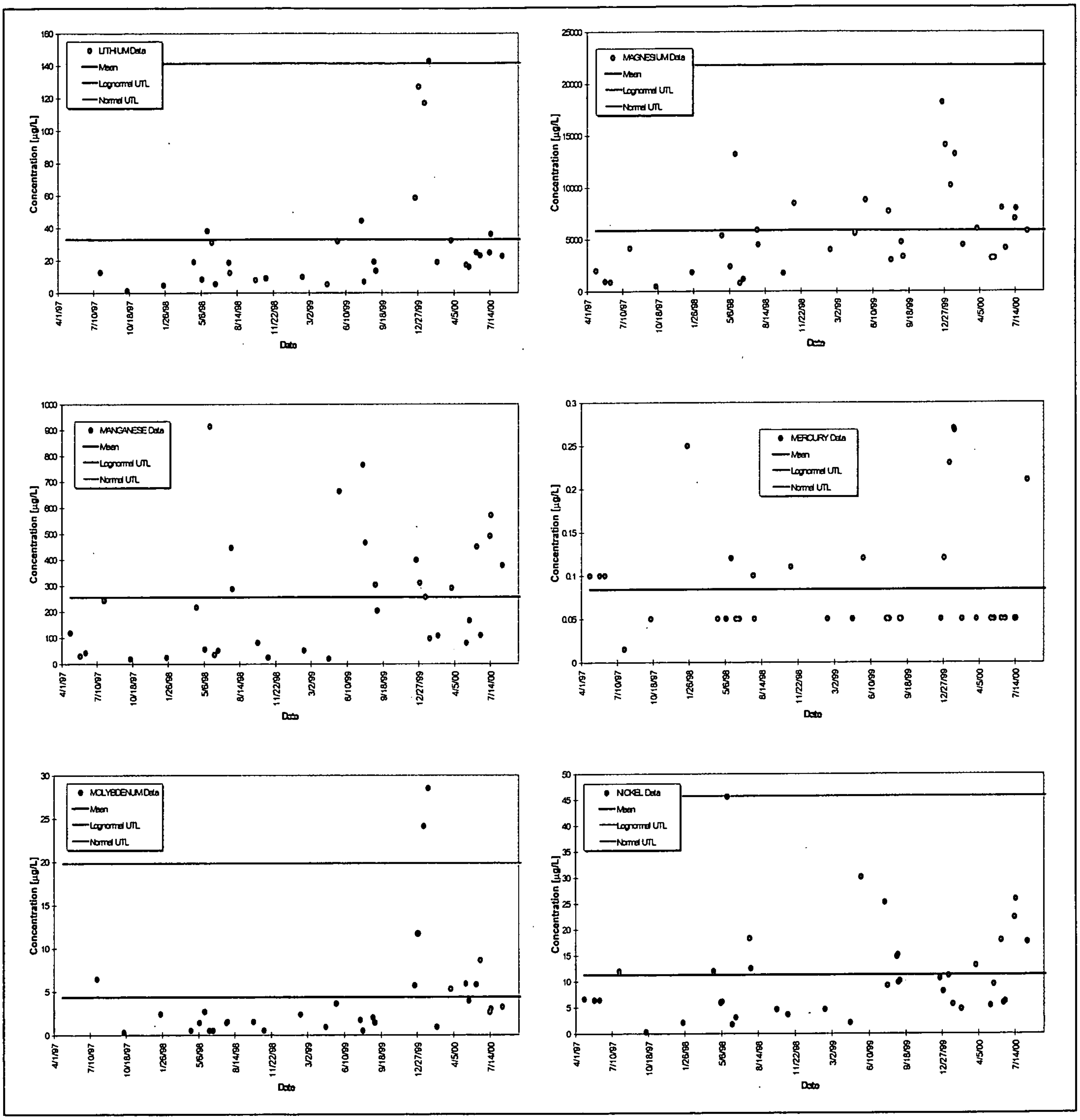

Figure 10-22. Total Metals UTL Plots for GS32: Lithium through Nickel.

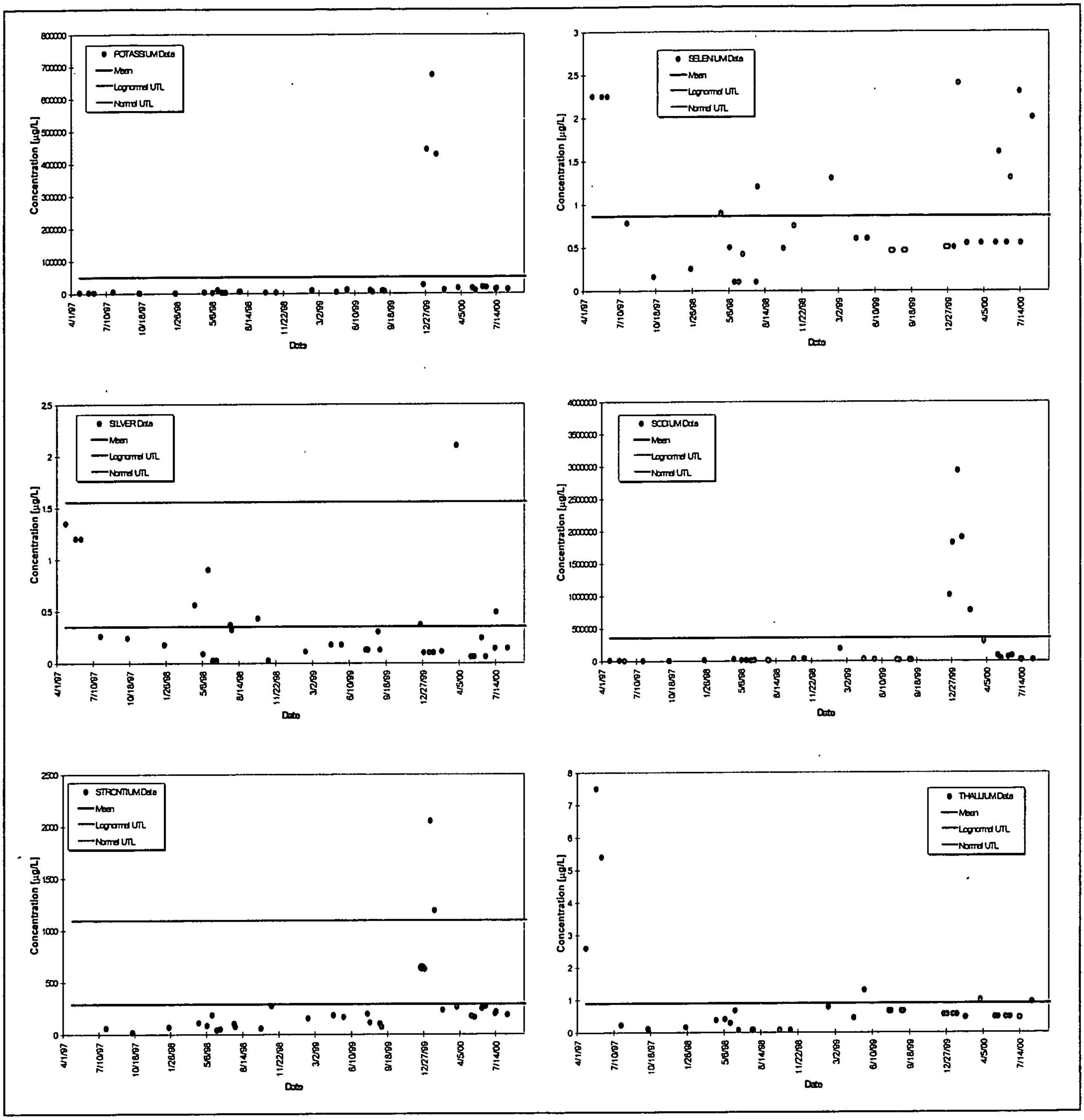

Figure 10-23. Total Metals UTL Plots for GS32: Potassium through Thallium.

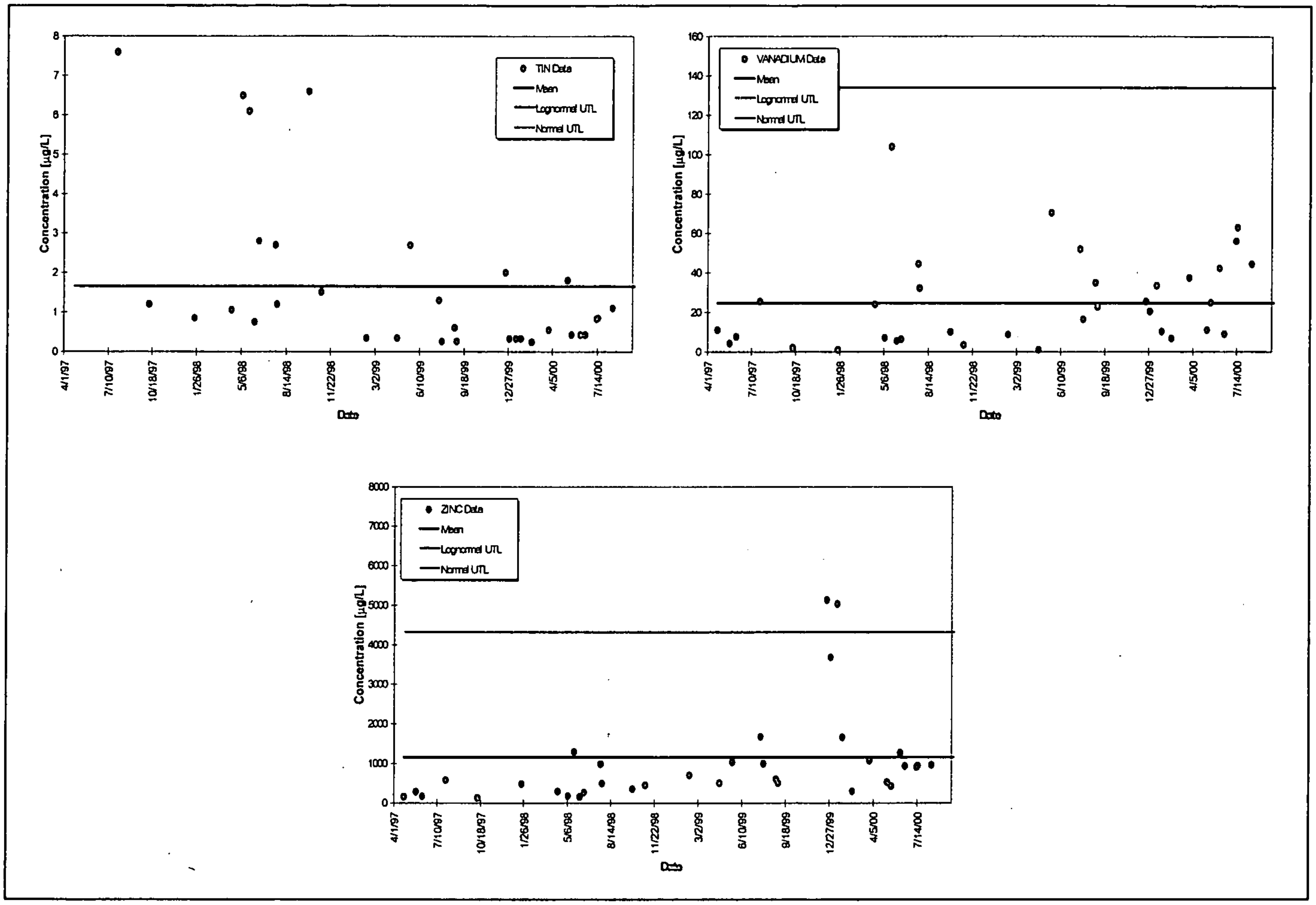

Figure 10-24. Total Metals UTL Plots for GS32: Tin through Zinc.

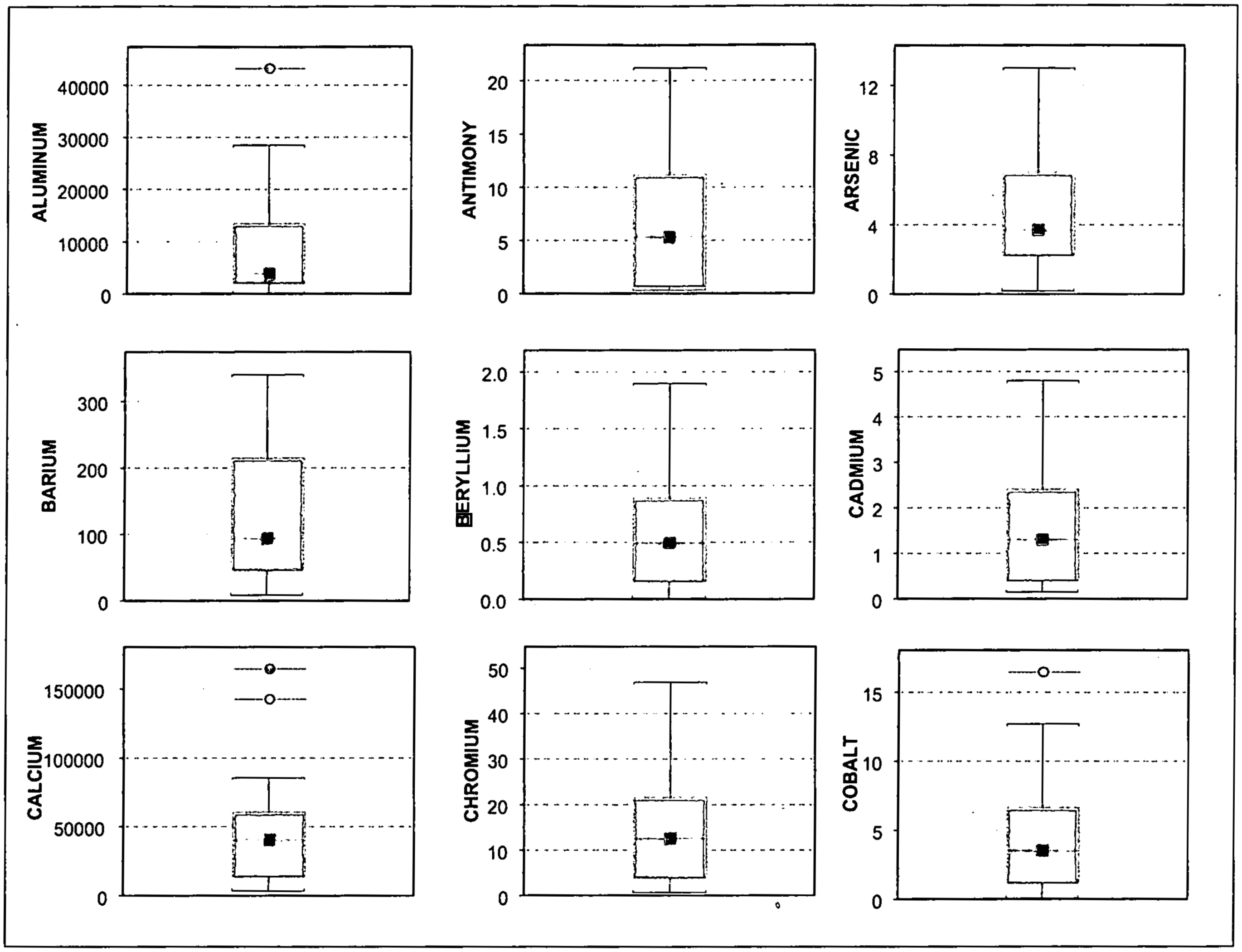

Figure 10-25. Total Metals Box Plots for GS32: Aluminum through Cobalt.

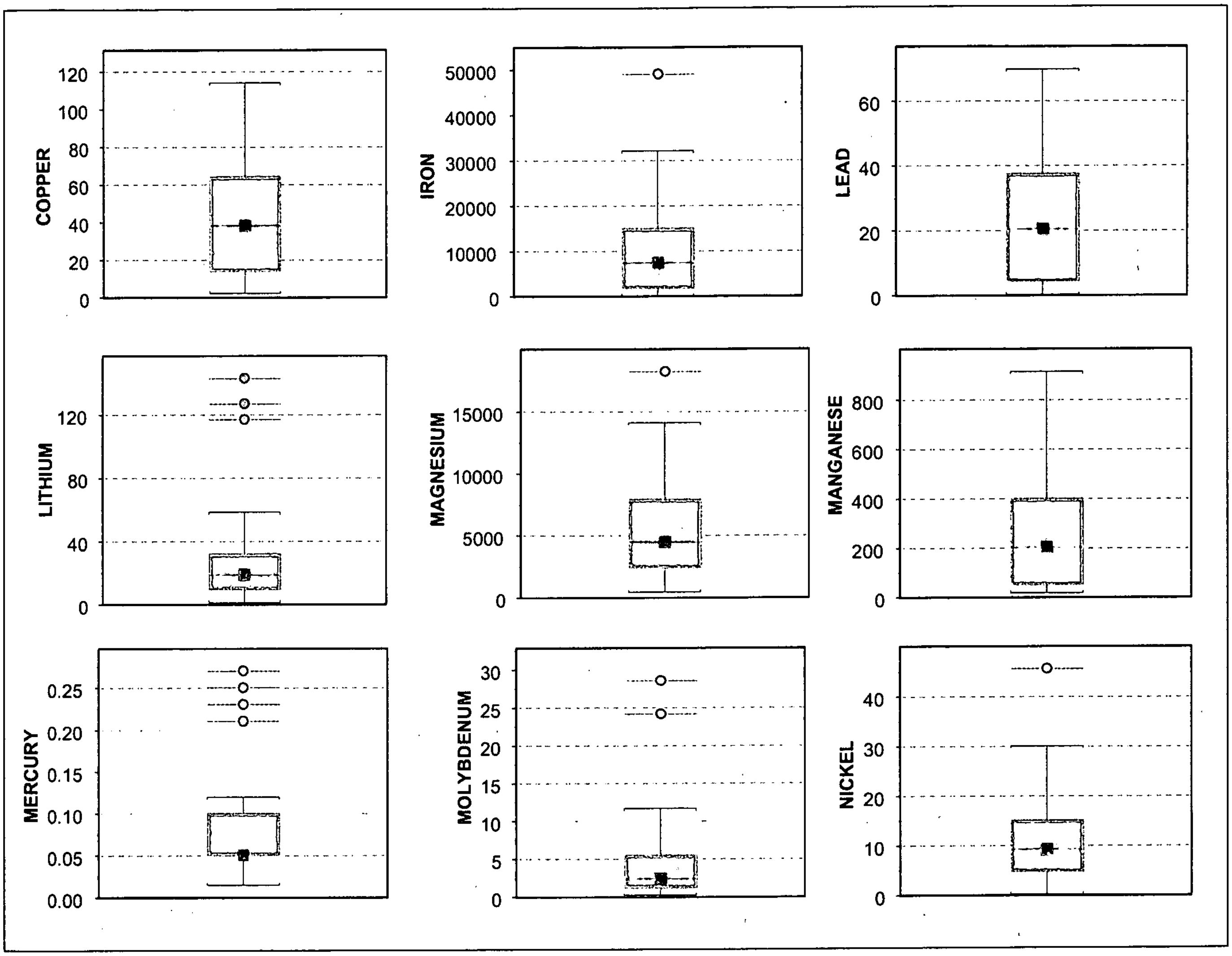

Figure 10-26. Total Metals Box Plots for GS32: Copper through Nickel.

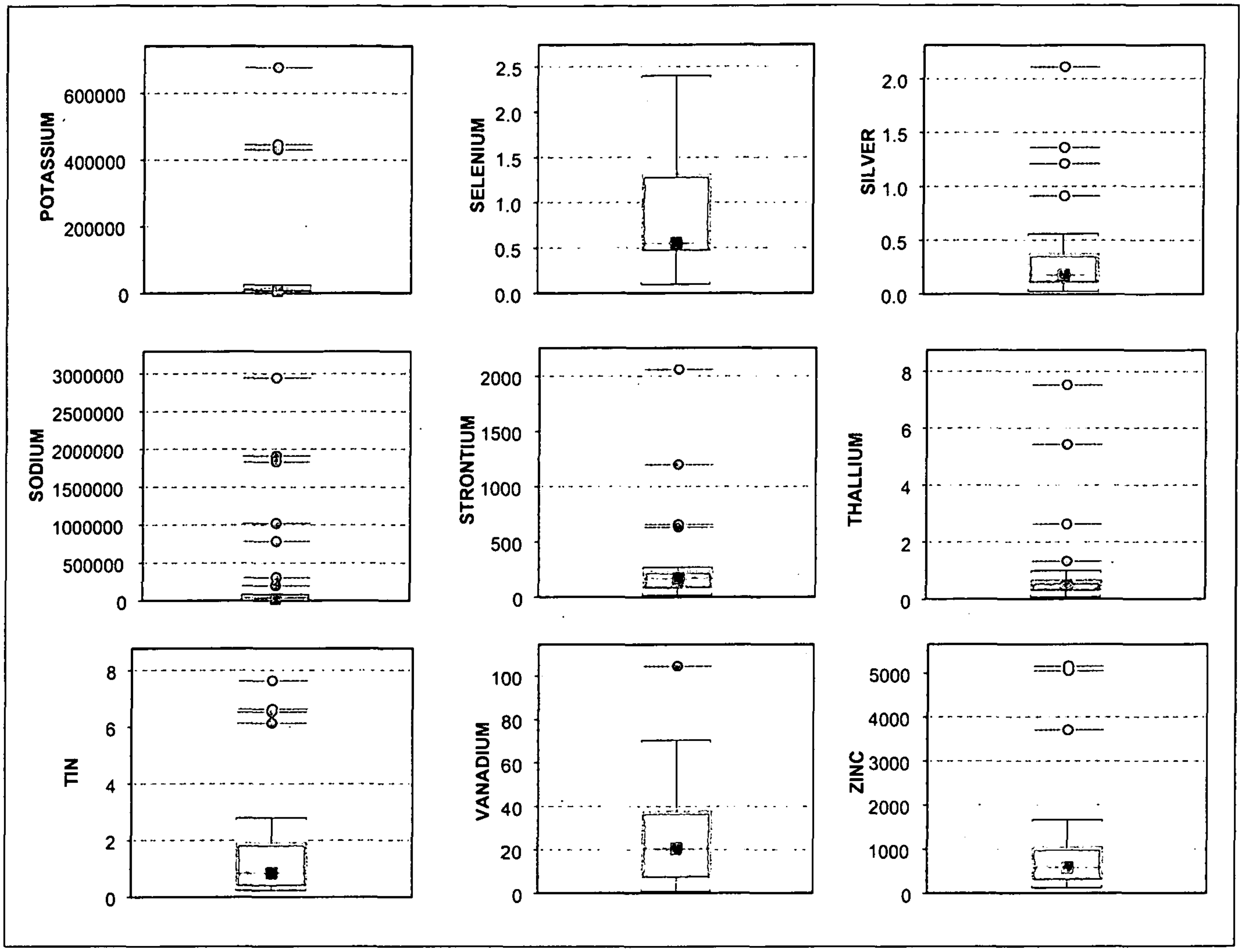

Figure 10-27. Total Metals Box Plots for GS32: Potassium through Zinc.

10.3.3 Building 123 D&D

Monitoring location GS37 was installed on 10/28/97 in support of the D&D of Building 123. Monitoring at GS37 was discontinued on 11/10/98 after completion of the B123 demolition at the end of WY98.

Figure 3-47 shows the drainage area for GS37. Other buildings within this drainage include 121, 122, 125 and 441.

Monitoring data collected at GS37 show moderate median Pu and Am activities (Table 10-8). Figure 10-28 and Figure 10-29 show the UTL plots for Pu and Am, respectively. During WY97–00, no Am results exceeded the calculated UTL. For Pu, although a single result was greater than the UTL, these values did not persist.

Figure 10-30 shows that no total uranium results were greater than the UTL. Figure 10-33 shows that suspended solids activity did not change during the monitoring period.

Table 10-8. Summary Statistics for Radionuclide Results from GS37 in WY97-00.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
TSS [mg/L]	14	79	203	360	NA
Pu-239,240	17	0.027	0.060	0.464	0.245[a]
Am-241	17	0.015	0.027	0.029	0.039[b]
Tritium	16	175	288	320	468[a] / 389[b]
U-233,234	17	0.253	0.586	1.070	2.64[a]
U-235	17	0.016	0.035	0.062	
U-238	17	0.314	0.574	1.150	

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.
TSS is given in mg/L.
Uranium UTL given for total uranium.

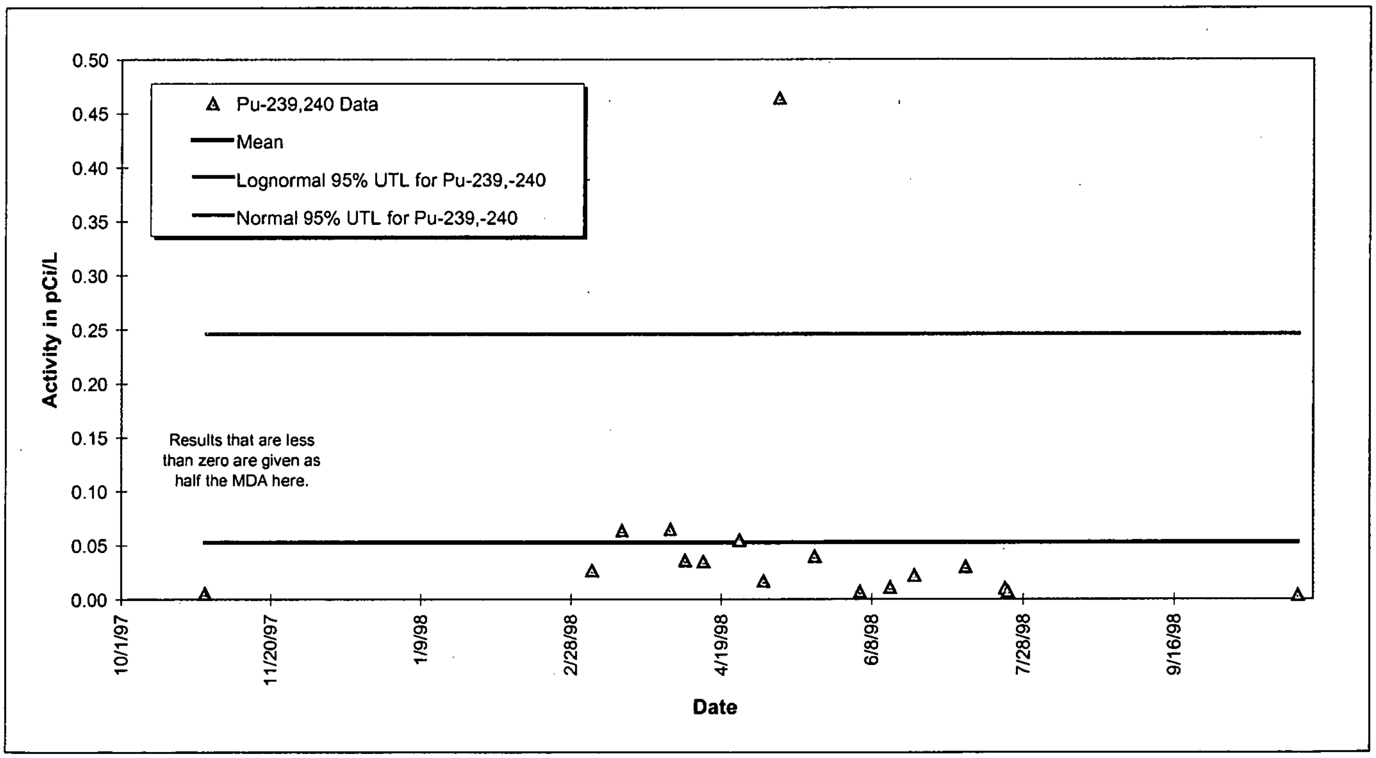

Figure 10-28. 95% UTL Plot for Pu-239,240 at GS37: WY97-00.

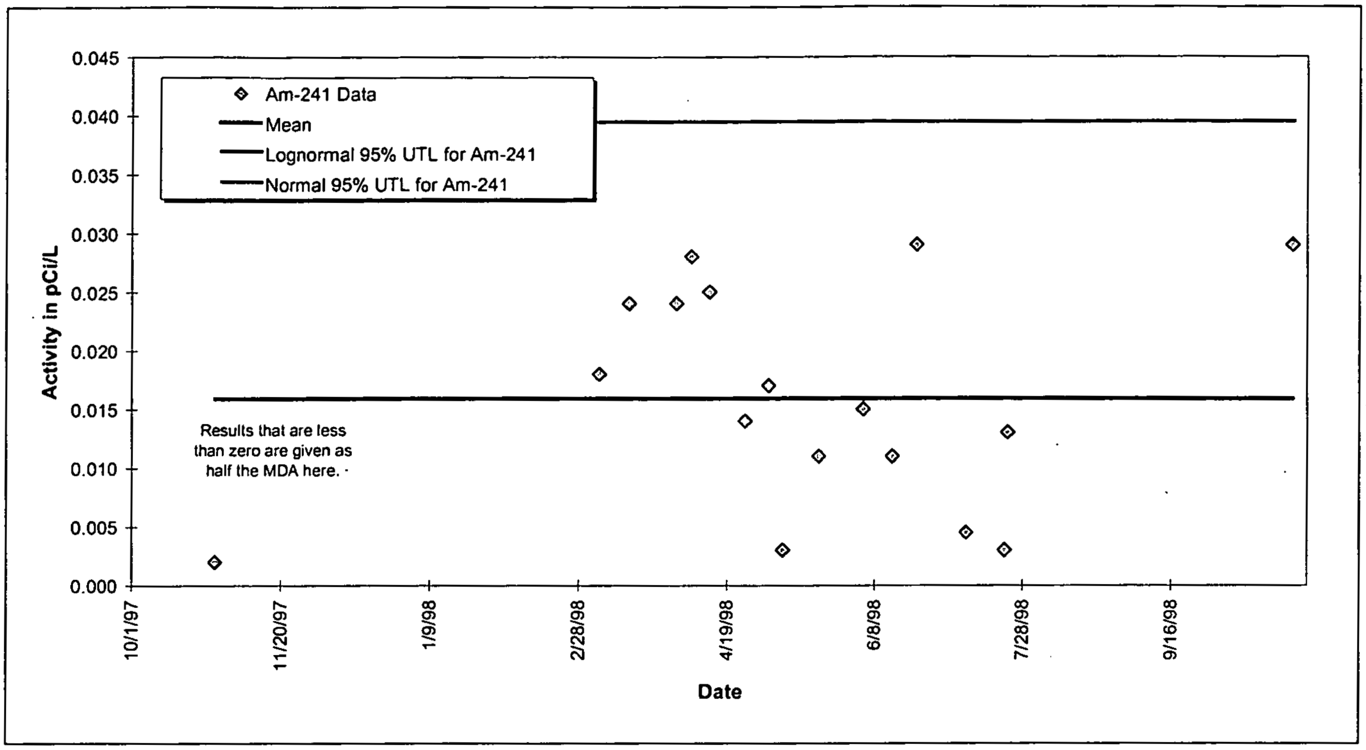

Figure 10-29. 95% UTL Plot for Am-241 at GS37: WY97-00.

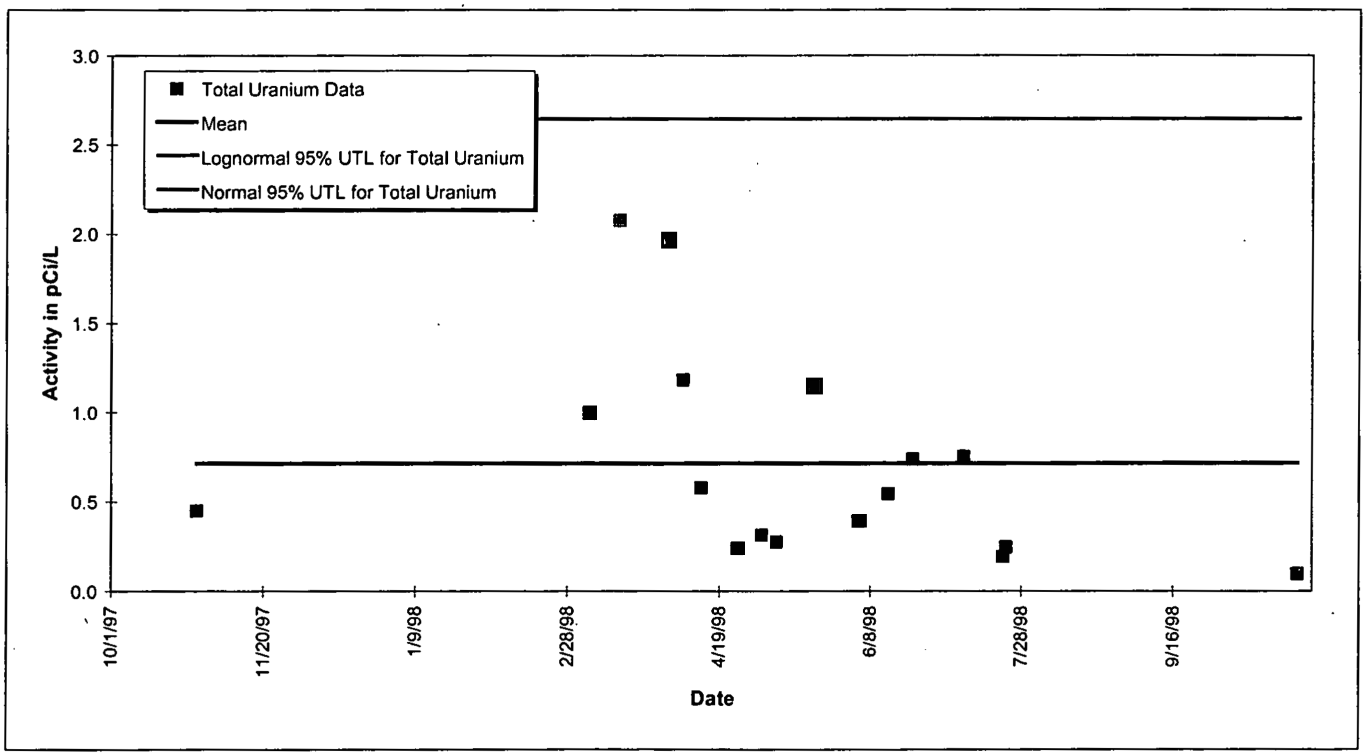

Figure 10-30. 95% UTL Plot for Total Uranium at GS37: WY97-00.

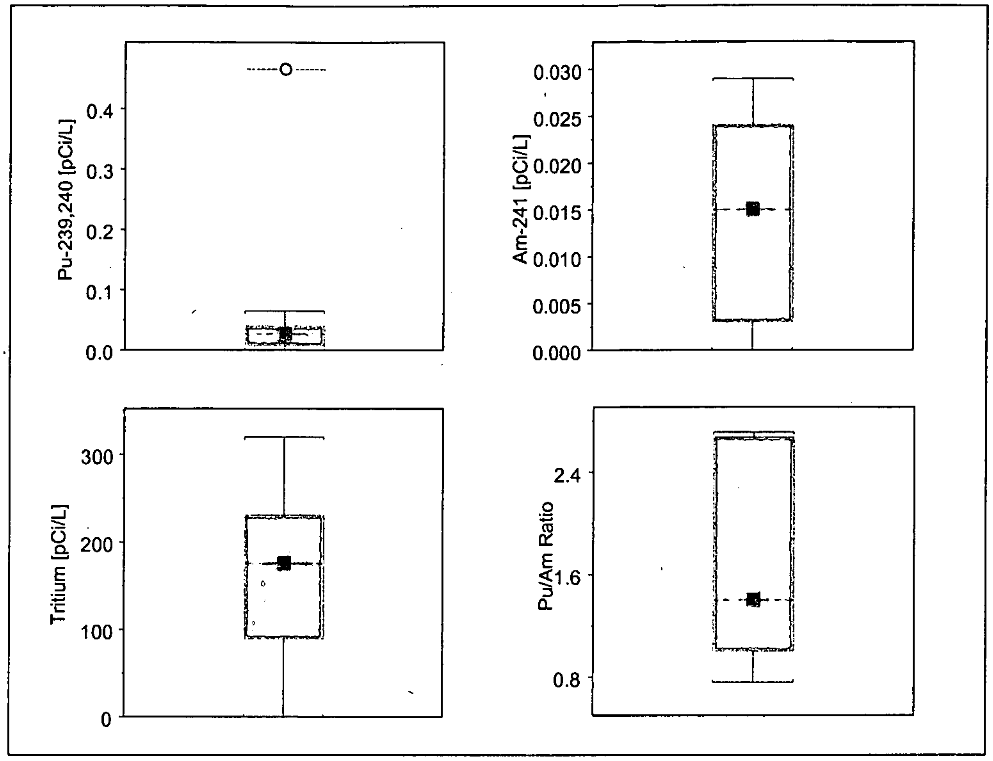

Figure 10-31. Pu and Am Box Plots for GS37: WY97–00.

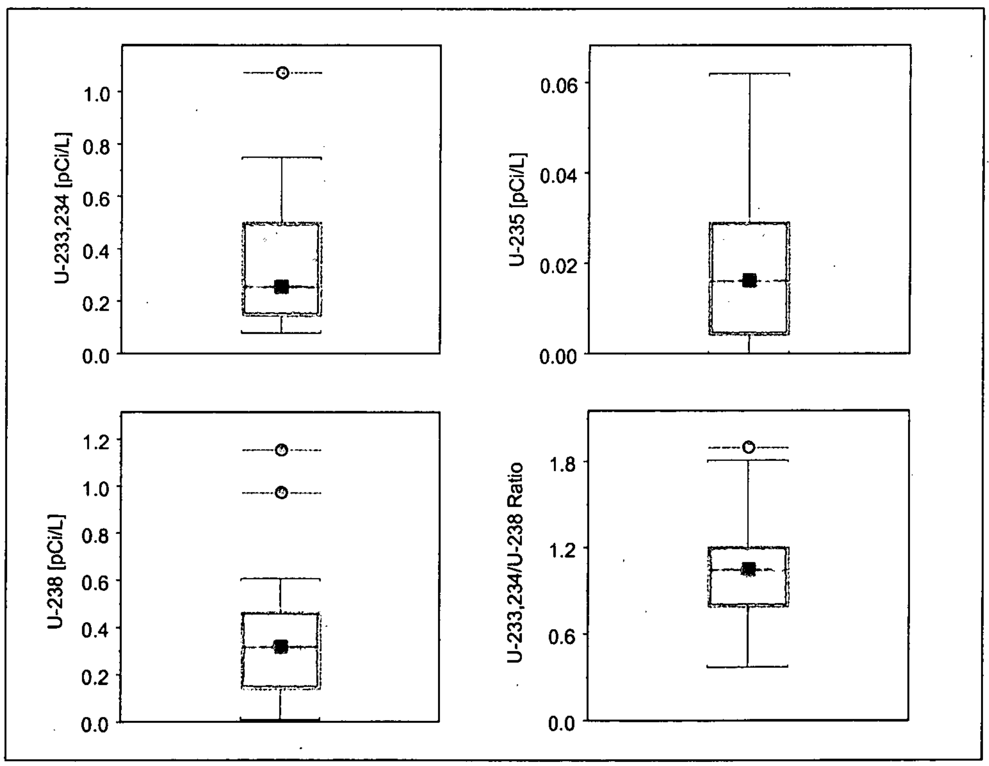

Figure 10-32. Uranium Box Plots for GS37: WY97–00.

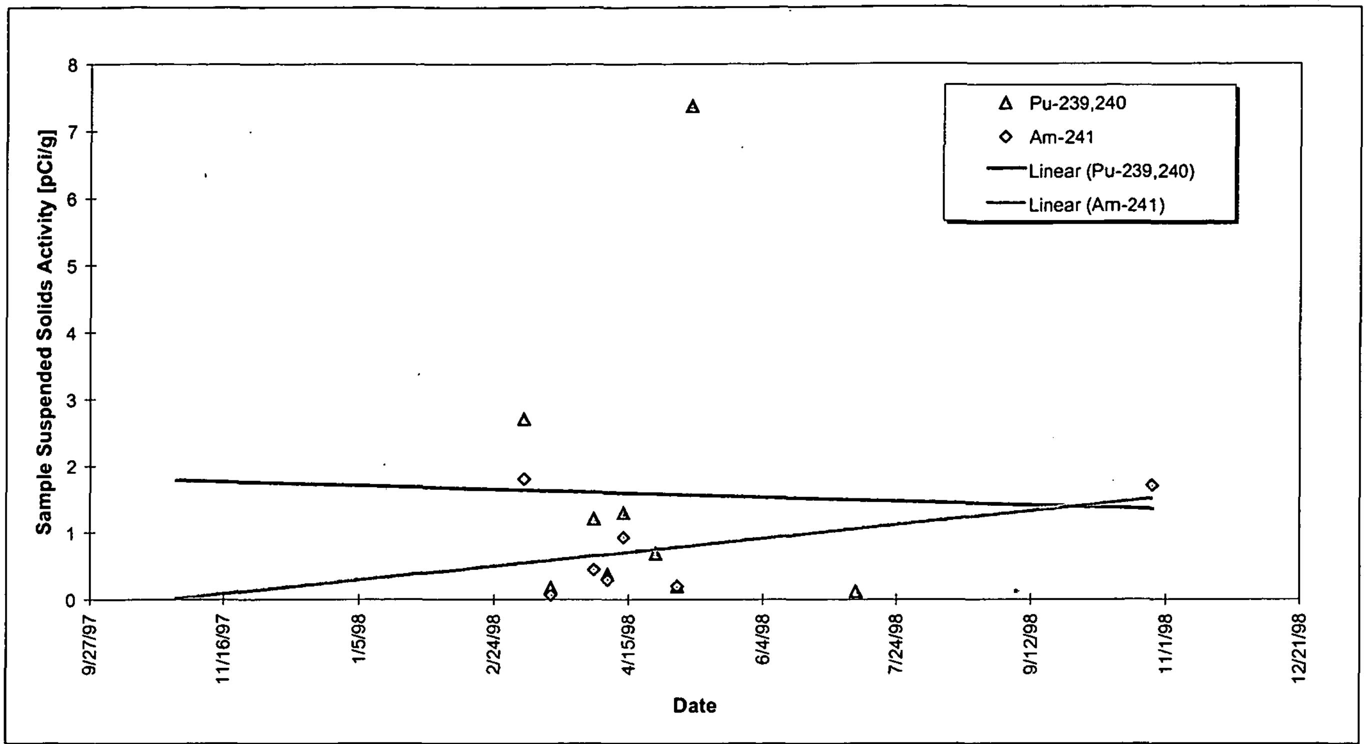

Figure 10-33. Temporal Variation of Suspended Solids Activity at GS37: WY97–00.

10.3.4 903 Pad and Lip Area Activities

Monitoring location GS39 was installed on 1/15/98 in support of the source evaluation efforts related to GS10. GS39 also supports activities associated with the 903 Pad and Lip Area. Several other locations were installed or upgraded to support 903 Pad activities in WY01; as such these locations are not included in this report. These new/upgraded locations (GS42, GS51, GS52, GS53, GS54, and SW055) will be included in future reports.

Figure 3-51 shows the drainage area for GS39. Other structures within this drainage include B906 and the 904 Pad tents.

Monitoring data collected at GS39 show moderate median Pu and Am activities (Table 10-9). Figure 10-34 and Figure 10-35 show the UTL plots for Pu and Am, respectively. During WY97–00, no Am results exceeded the calculated UTL. For Pu, although a single result was greater than the UTL, these values did not persist.

Figure 10-37 shows that too few suspended solids samples have been collected to draw conclusions regarding the temporal variation of suspended solids activity.

Table 10-9. Summary Statistics for Radionuclide Results from GS39 in WY97-00.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
TSS [mg/L]	6	103	523	1100	NA
Pu-239,240	27	0.068	0.139	0.825	0.547[a]
Am-241	27	0.018	0.051	0.160	0.180[a]

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.
TSS is given in mg/L.

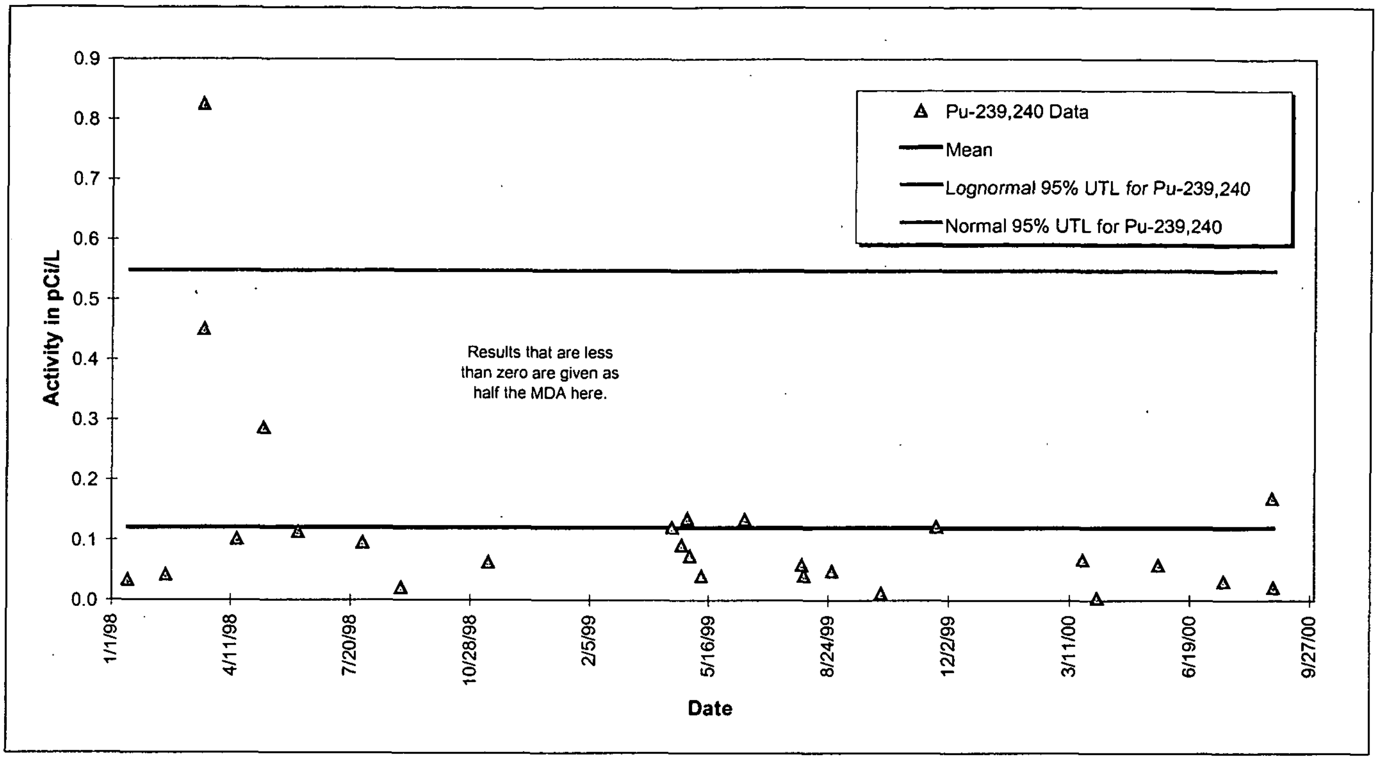

Figure 10-34. 95% UTL Plot for Pu-239,240 at GS39: WY97-00.

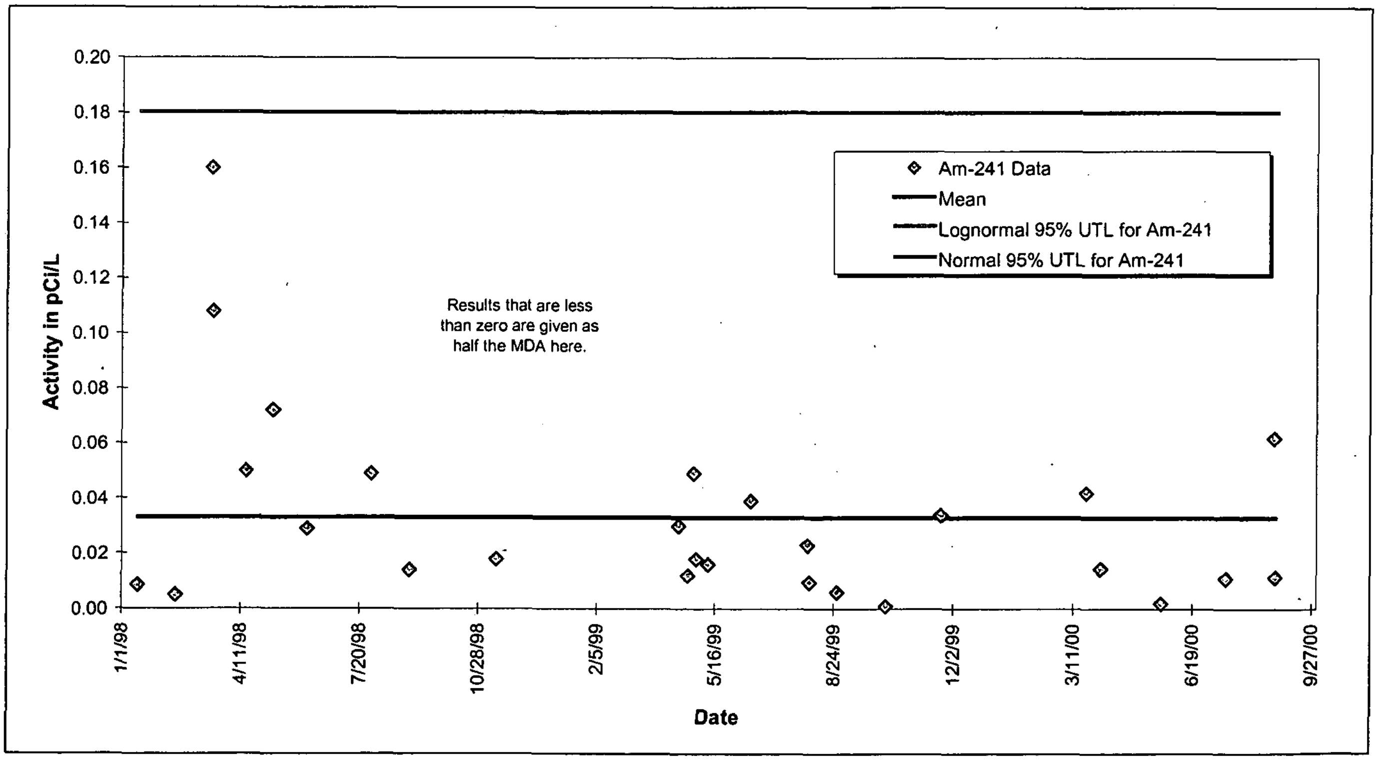

Figure 10-35. 95% UTL Plot for Am-241 at GS39: WY97-00.

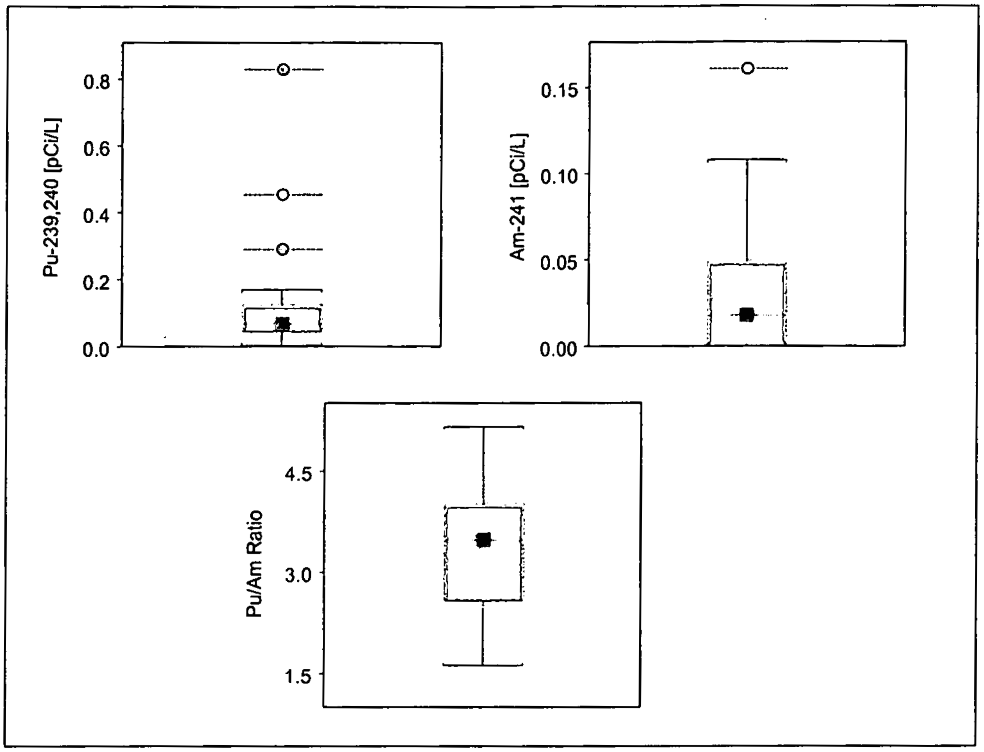

Figure 10-36. Pu and Am Box Plots for GS39: WY97–00.

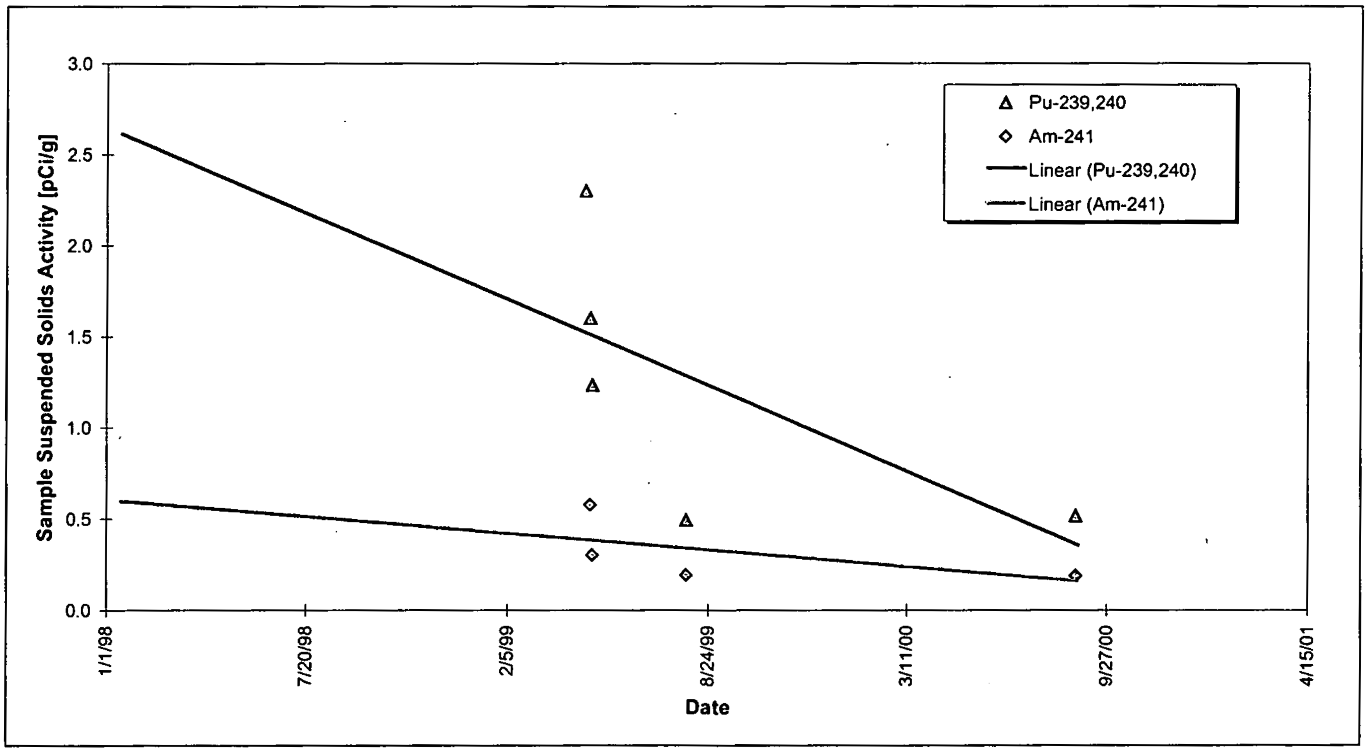

Figure 10-37. Temporal Variation of Suspended Solids Activity at GS39: WY97–00.

10.3.5 700 Area [B707] D&D

Monitoring location GS40 was installed on 3/4/98 in support of the source evaluation efforts related to GS10. GS40 also monitors D&D activities in the 700 Area around B707.

Figure 3-53 shows the drainage area for GS40. Other buildings within this drainage include 559, 561, 564, 559, 711, 708, 709, 778, 750, and the 750 Pad tents.

Monitoring data collected at GS40 show moderate median Pu and Am activities (Table 10-10). Figure 10-38 and Figure 10-39 show the UTL plots for Pu and Am, respectively. During WY97–00, no Pu or Am results exceeded the calculated UTL. Total uranium was added to the analyte suite during WY00, so few results are available[22], therefore uranium box plots are nor presented. Figure 10-40 shows that none of the few total uranium results available were greater than the calculated UTL.

Tritium was added to the analyte suite in the end of WY00 and only two results are available for this report. Therefore, UTL and box plots are not included.

Total metals analysis was also added to the analyte suite at the end of WY00. Since only two metals results were available for the WY97-00 period, evaluation is not included in this report.

Only one TSS result was available during the WY97-00 period. Therefore, temporal variation of suspended solids activity is not included herein.

Table 10-10. Summary Statistics for Radionuclide Results from GS40 in WY97-00.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
TSS [mg/L]	NA	NA	NA	NA	NA
Pu-239,240	32	0.014	0.039	0.063	0.074[a]
Am-241	32	0.031	0.062	0.140	0.174[a]
Tritium	2	95	126	140	NA
U-233,234	4	1.064	1.228	1.300	4.627[a]/4.685[b]
U-235	4	0.052	0.082	0.094	
U-238	4	1.320	1.602	1.800	

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.
TSS is given in mg/L.
Uranium UTL given for total uranium.

[22] A single total uranium analysis was performed for the 3/23/98 sample.

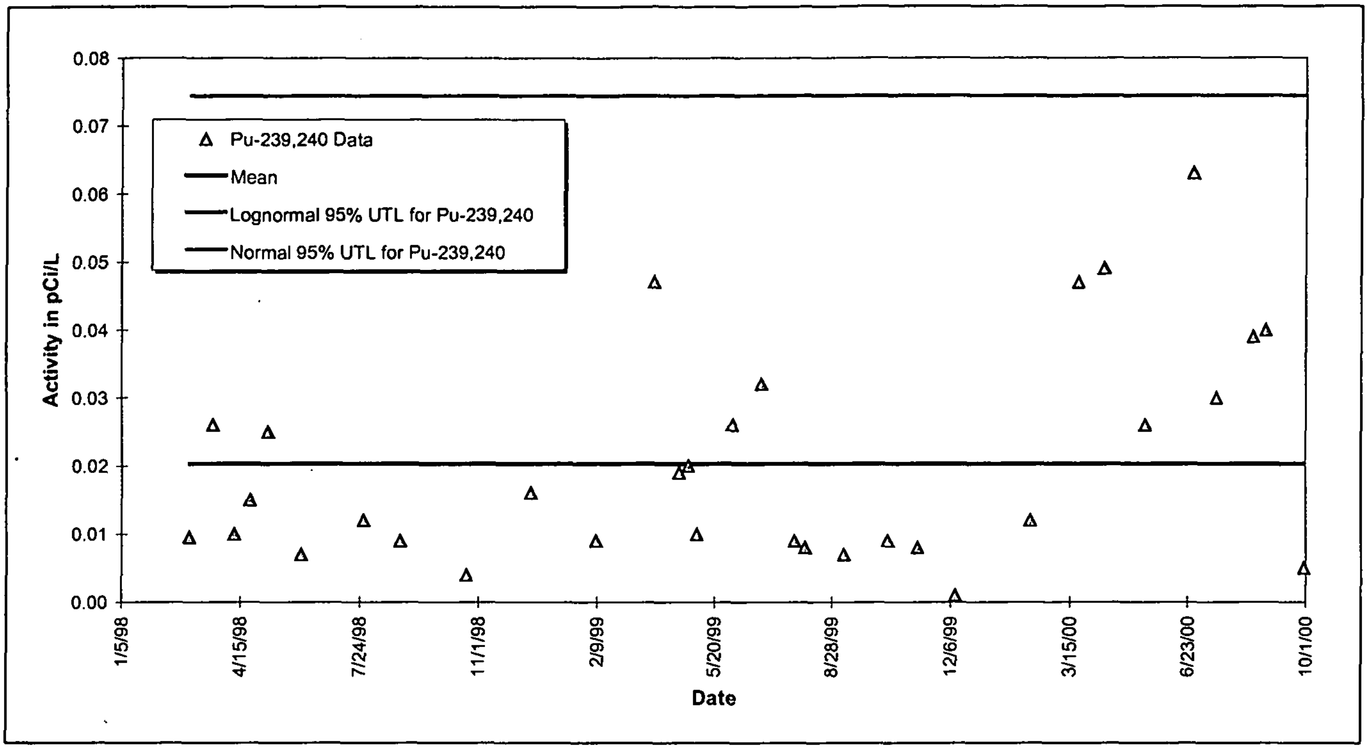

Figure 10-38. 95% UTL Plot for Pu-239,240 at GS40: WY97-00.

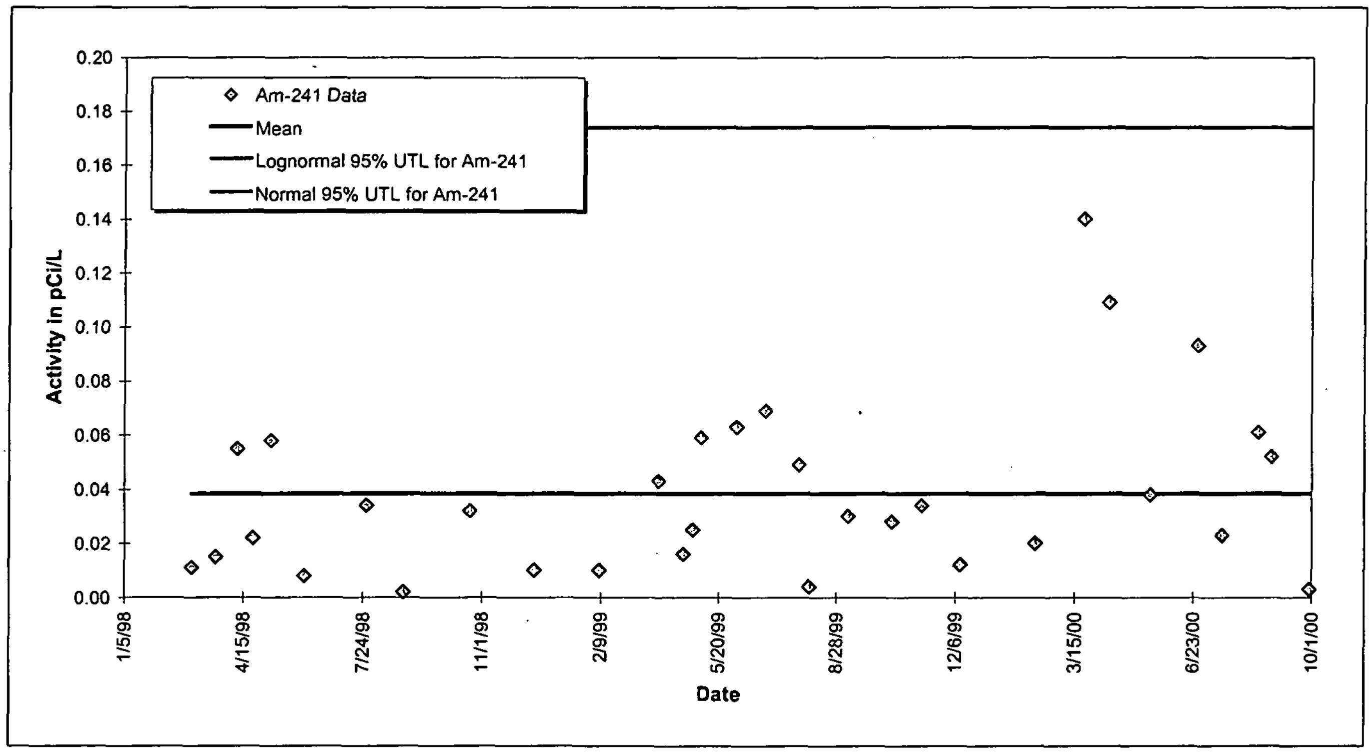

Figure 10-39. 95% UTL Plot for Am-241 at GS40: WY97-00.

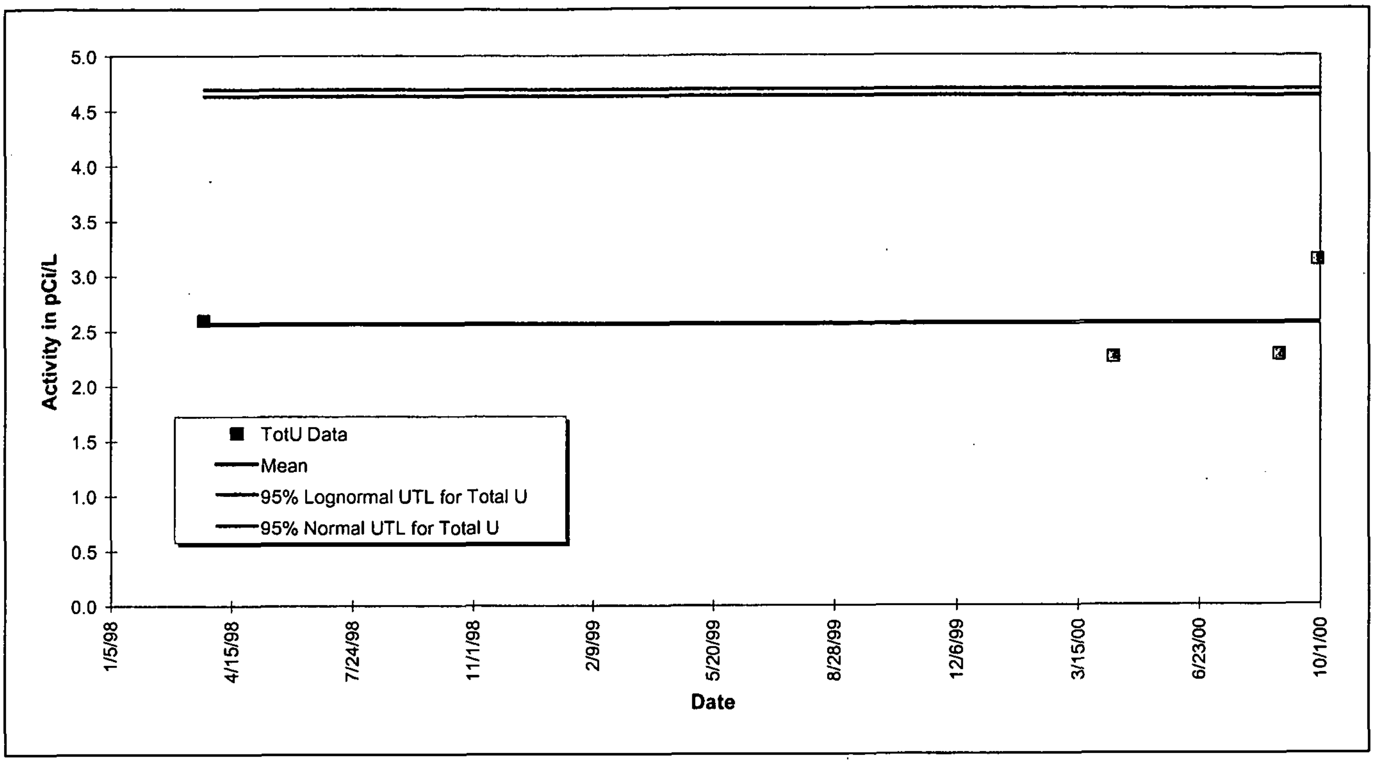

Figure 10-40. 95% UTL Plot for Total Uranium at GS40: WY97-00.

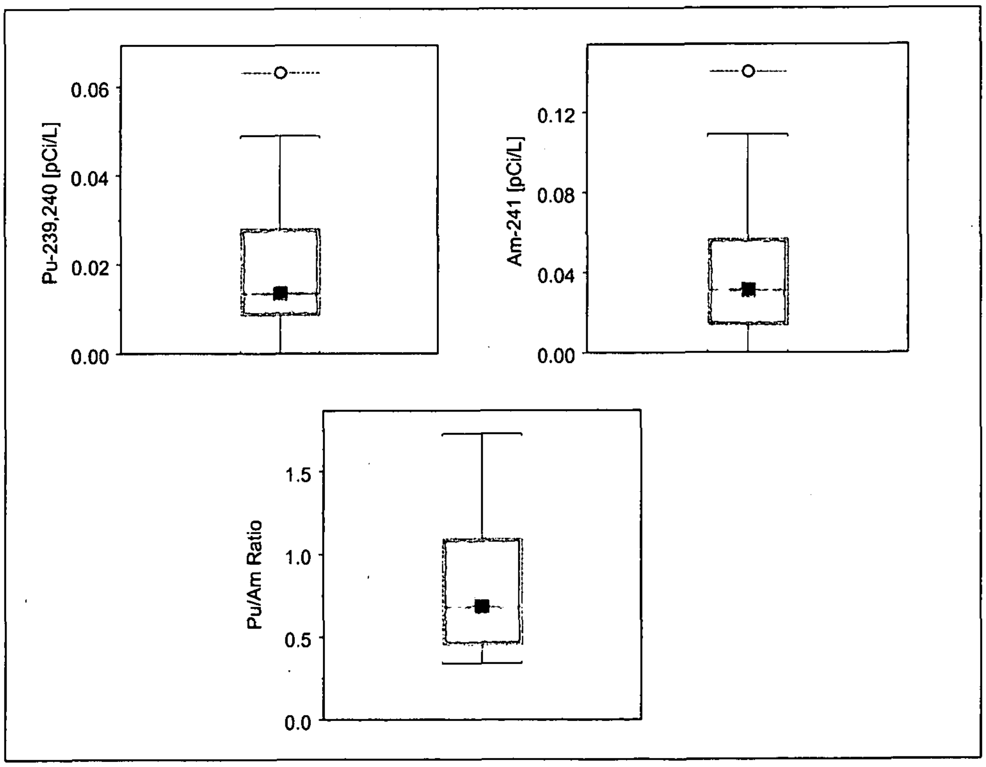

Figure 10-41. Pu and Am Box Plots for GS40: WY97–00.

10.3.6 Trench T-1 Remediation

The analyte suite at monitoring location SW022 was temporarily expanded to include total metals analyses starting in WY98 in support of the Trench T-1 remediation activities.[23]

Figure 3-68 shows the drainage area for SW022. Many other buildings within the IA and south of Central Avenue are included within this drainage.

Prior to WY00, SW022 collected storm-event rising-limb flow-paced composite samples.[24] Starting in WY00, SW022 began collecting more representative continuous flow-paced composite samples. Therefore, radionuclide evaluation below is performed separately for each sample type. All metals analyses were performed for storm-event samples only.

Monitoring data collected at SW022 show moderate median Pu and Am activities (Table 10-11 and Table 10-12), although several higher results have been obtained (Figure 10-45 and Figure 10-50). Figure 10-42 and Figure 10-47 show the Pu UTL plots for storm-event and continuous flow-paced samples, respectively. Figure 10-43 and Figure 10-48 show the Am UTL plots for storm-event and continuous flow-paced samples, respectively. During WY97–00, a single Pu and Am result exceeded the calculated UTL, and several higher results were noted. Although this sample was collected prior to excavation at T-1[25], staging of structures and equipment occurred during this time with disturbance of the surrounding soils taking place. Runoff was noted from the area surrounding the tent showing significant amounts of TSS. Although the measured TSS concentrations at SW022 were not unusually high for these samples, this area includes some of the higher surface-soil activities in the SW022 drainage. It is possible that this disturbed area resulted in runoff with unusually high activities. After completion of the project and revegetation[26], activities returned to more normal levels.

Monitoring data collected at SW022 show moderate median total uranium activities (Table 10-11 and Table 10-12), although several higher U-235 results have been obtained (Figure 10-46). Figure 10-44 and Figure 10-49 show that none of the total uranium results were greater than the calculated UTL.

The temporal variation of suspended solids activity (Figure 10-52) shows a slight trend downward, though the correlation is weak.

Table 10-11. Summary Statistics for Storm-Event Radionuclide Results from SW022 in WY97-00.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
TSS [mg/L]	33	69	232	360	NA
Pu-239,240	35	0.089	0.936	9.490	7.267[a]
Am-241	36	0.028	0.144	1.760	0.701[a]
U-233,234	36	0.415	1.165	1.750	5.729[a]
U-235	36	0.021	0.073	0.187	
U-238	36	0.511	1.500	2.601	

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.
Uranium UTL given for total uranium.
Includes the last synoptic sample collected 10/22/00.

[23] Radionuclides are routinely monitored at SW022 as part of the NSD objective (Section 11).

[24] Sample types are defined in the Automated Surface-Water Monitoring Work Plan.

[25] Excavation began in June 1998.

[26] Revegetation occurred early in FY99.

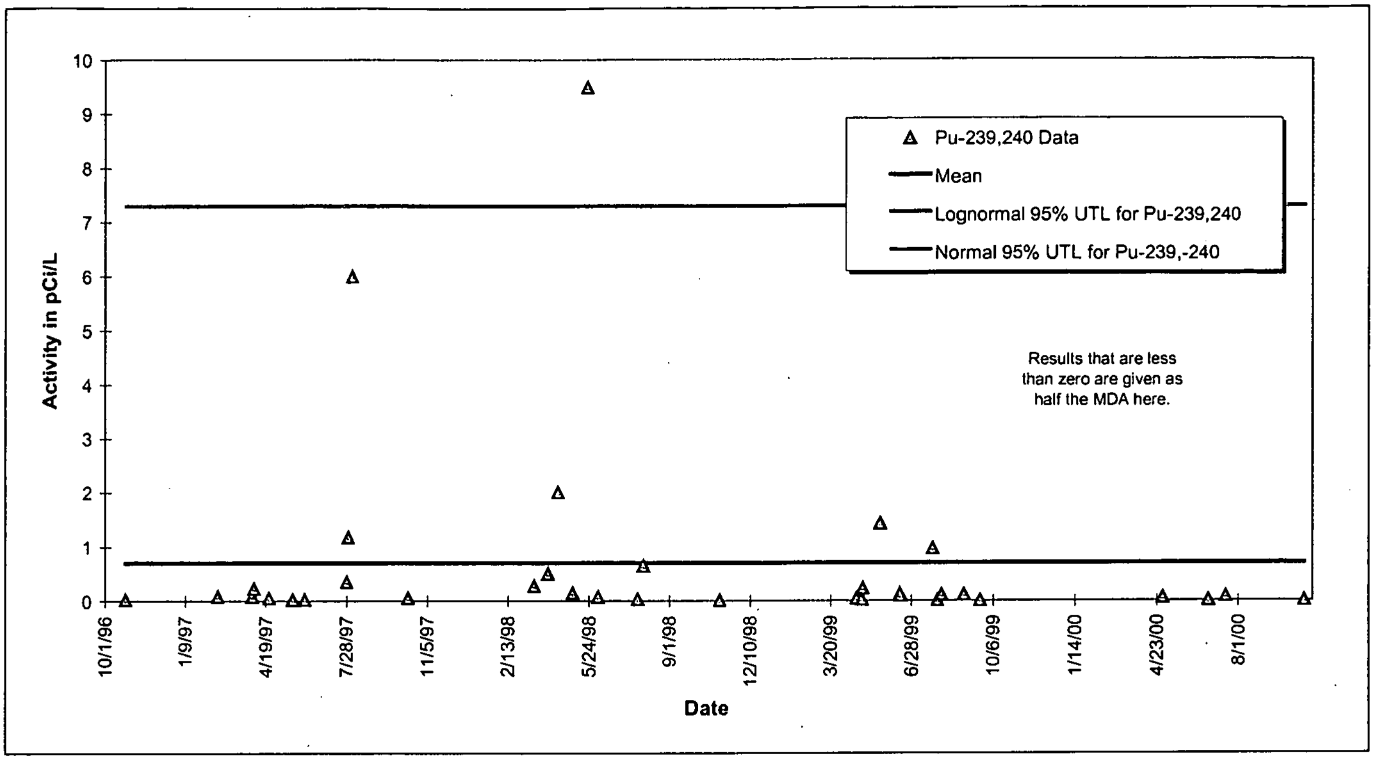

Figure 10-42. Storm-Event 95% UTL Plot for Pu-239,240 at SW022: WY97-00.

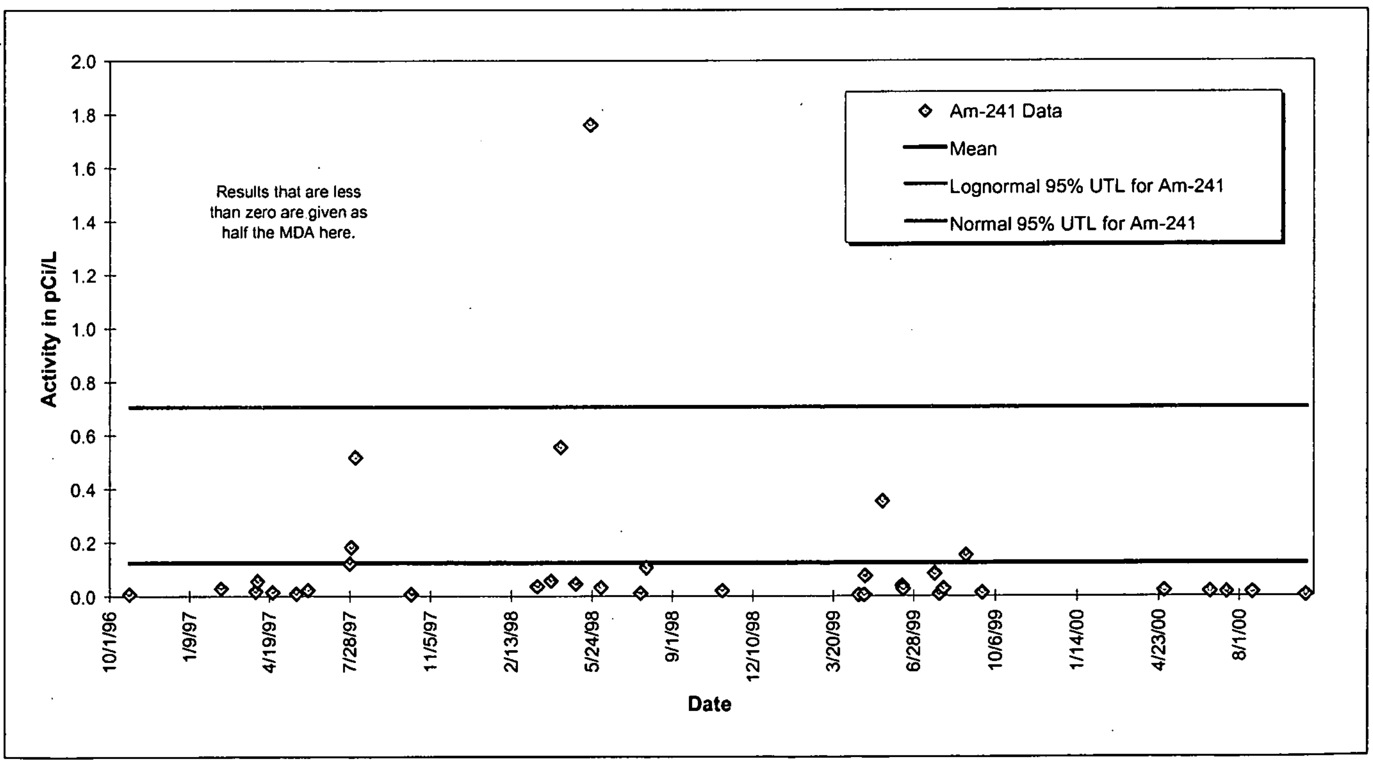

Figure 10-43. Storm-Event 95% UTL Plot for Am-241 at SW022: WY97-00.

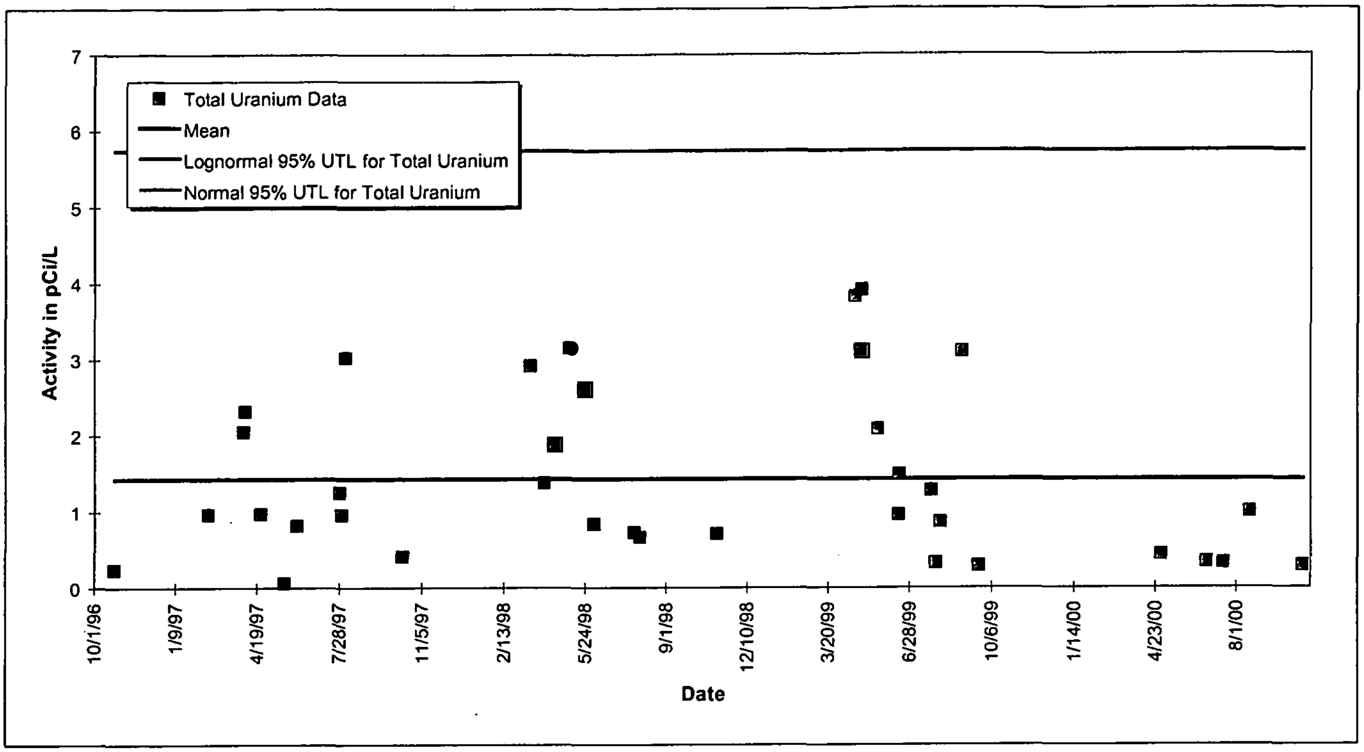

Figure 10-44. Storm-Event 95% UTL Plot for Total Uranium at SW022: WY97-00.

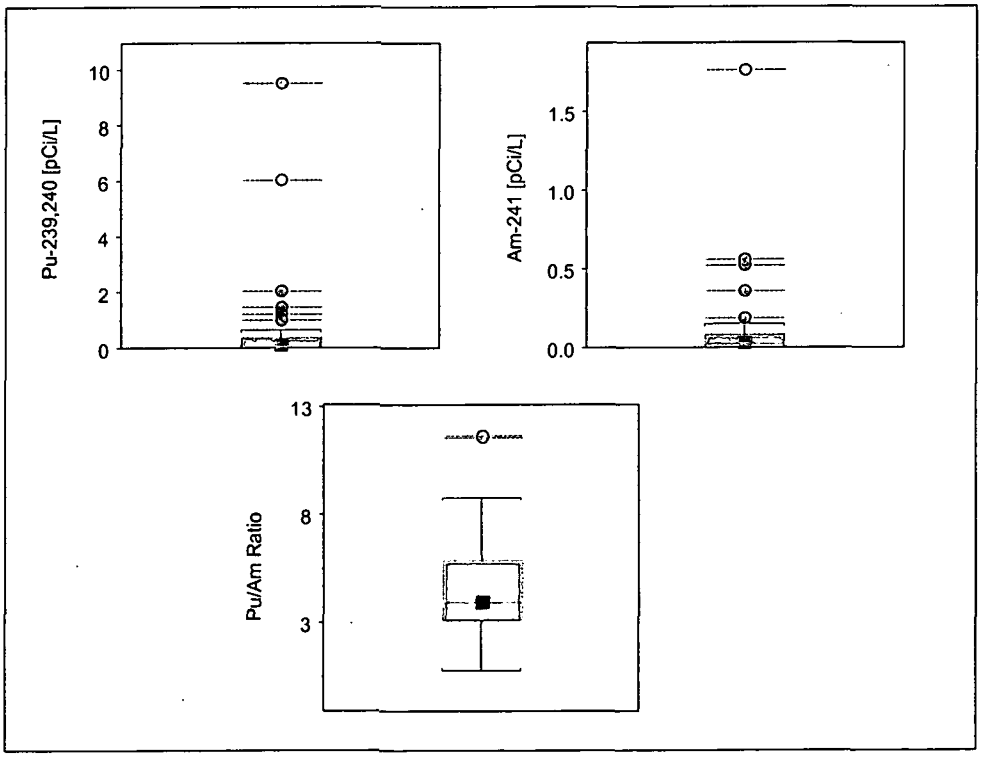

Figure 10-45. Storm-Event Pu and Am Box Plots for SW022: WY97–00.

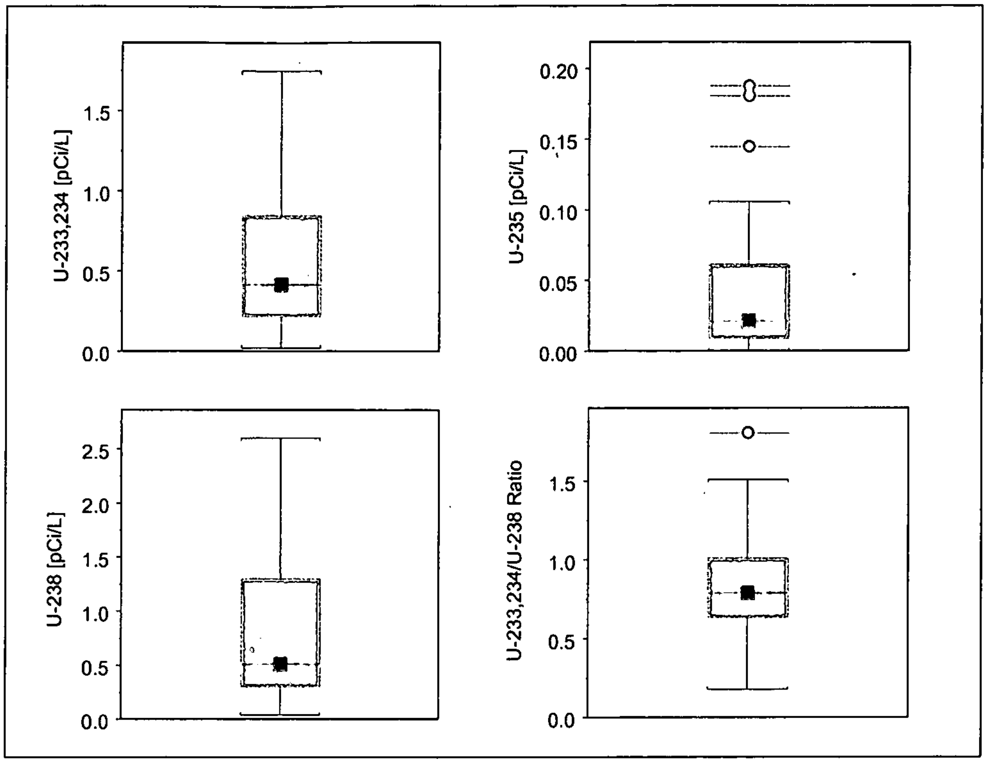

Figure 10-46. Storm-Event Uranium Box Plots for SW022: WY97–00.

Table 10-12. Summary Statistics for Continuous Flow-Paced Radionuclide Results from SW022 in WY97-00.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
TSS [mg/L]	0	NA	NA	NA	NA
Pu-239,240	6	0.065	0.244	0.546	7.058[a]
Am-241	6	0.008	0.046	0.144	0.364[a]
U-233,234	6	0.267	0.428	0.570	2.191[a] / 2.000[b]
U-235	6	0.003	0.029	0.046	
U-238	6	0.302	0.481	0.630	

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.
Uranium UTL given for total uranium.

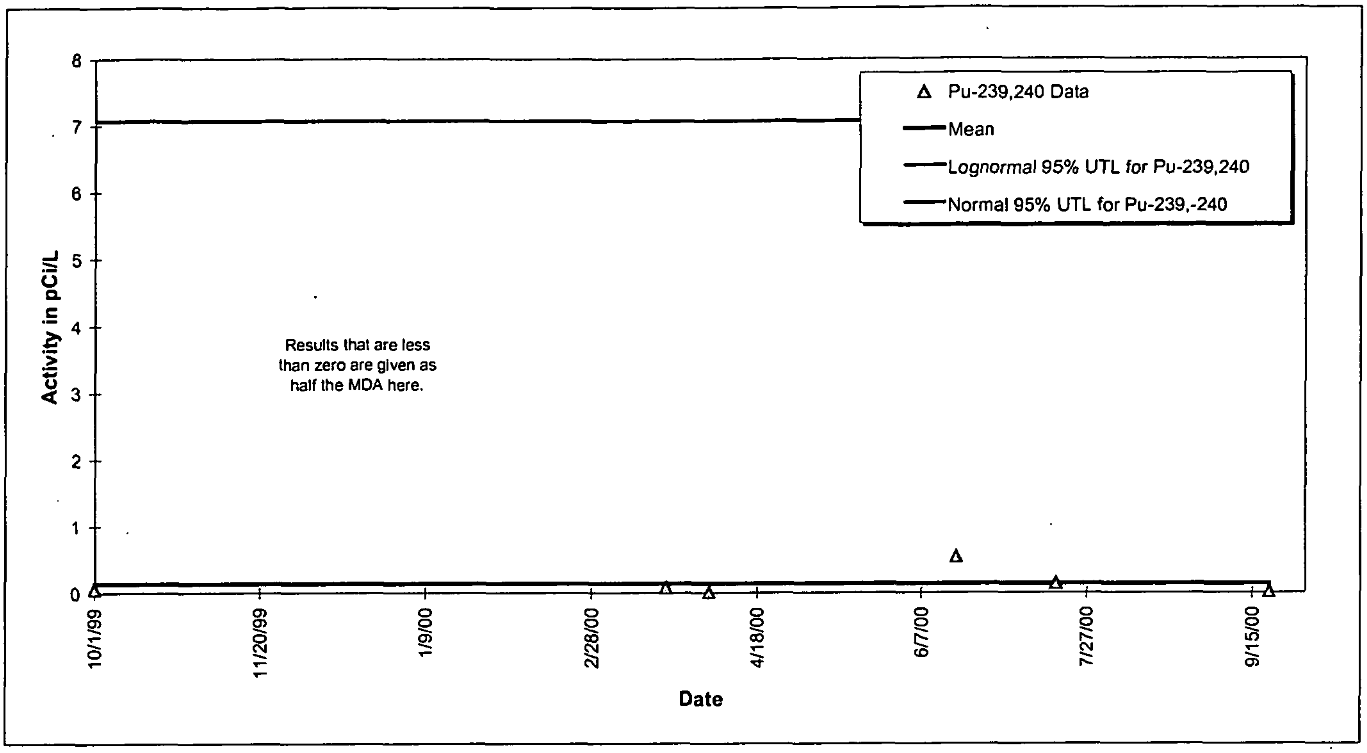

Figure 10-47. Continuous Flow-Paced 95% UTL Plot for Pu-239,240 at SW022: WY97-00.

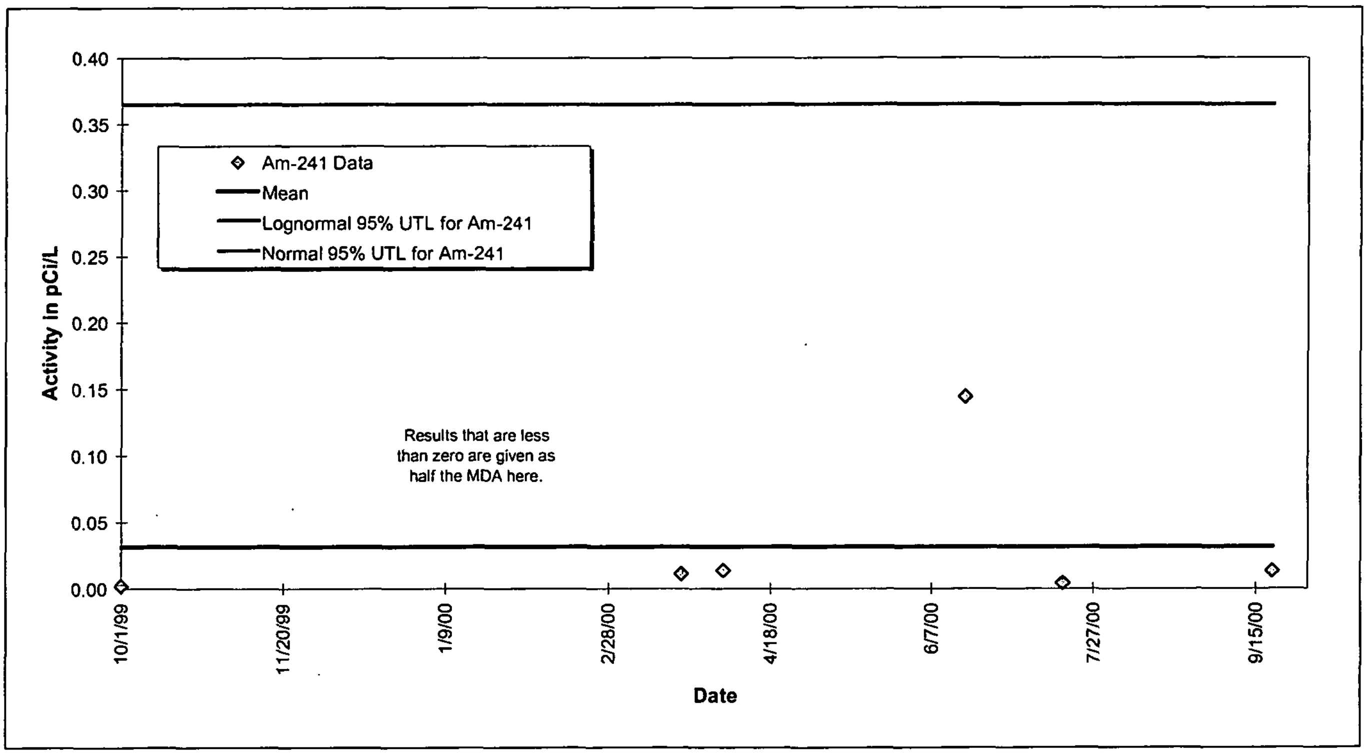

Figure 10-48. Continuous Flow-Paced 95% UTL Plot for Am-241 at SW022: WY97-00.

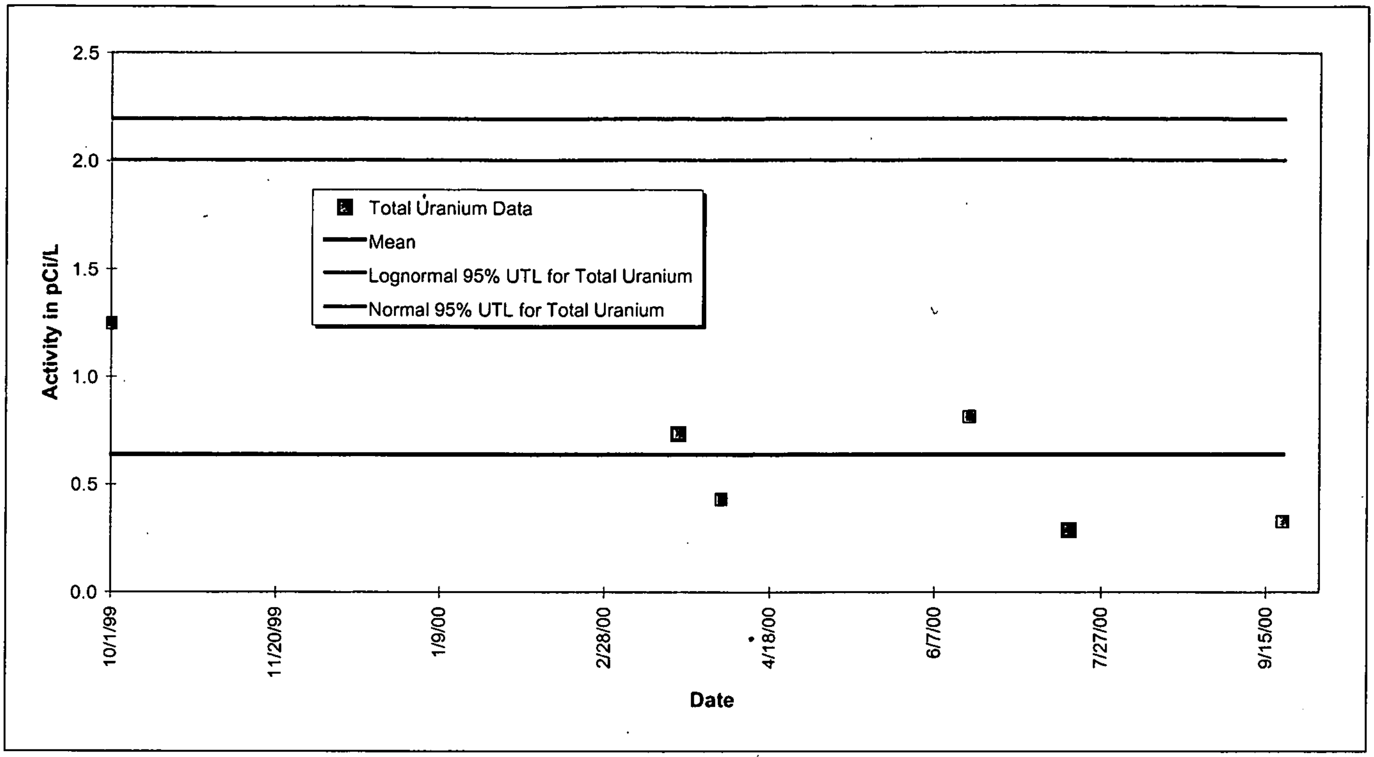

Figure 10-49. Continuous Flow-Paced 95% UTL Plot for Total Uranium at SW022: WY97-00.

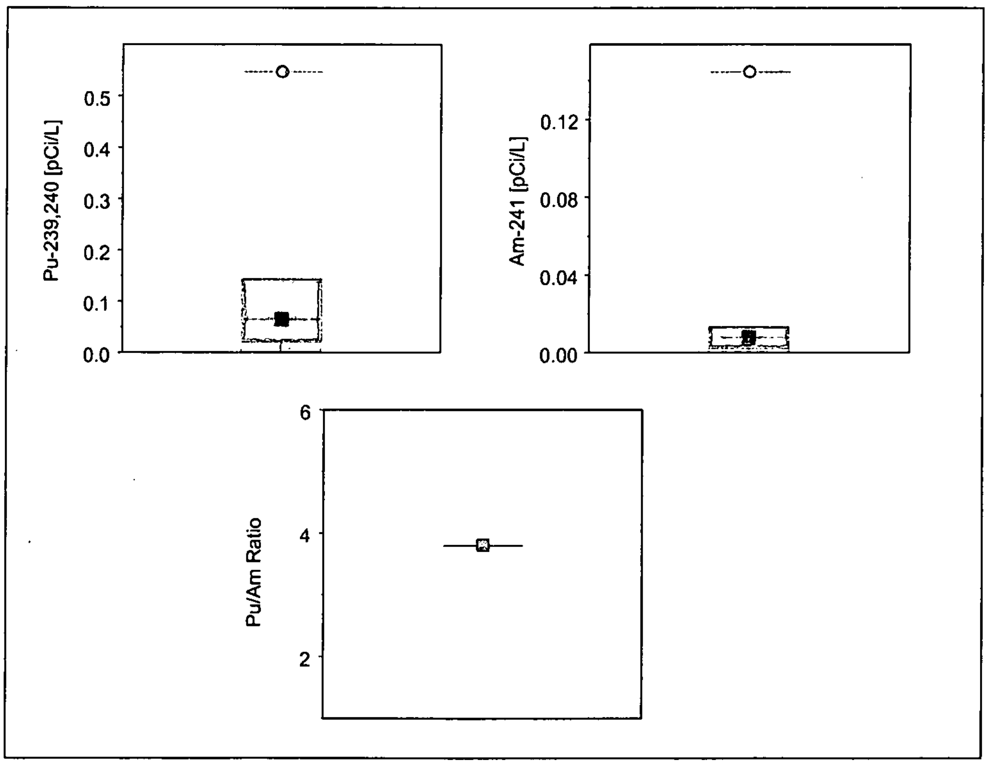

Figure 10-50. Continuous Flow-Paced Pu and Am Box Plots for SW022: WY97–00.

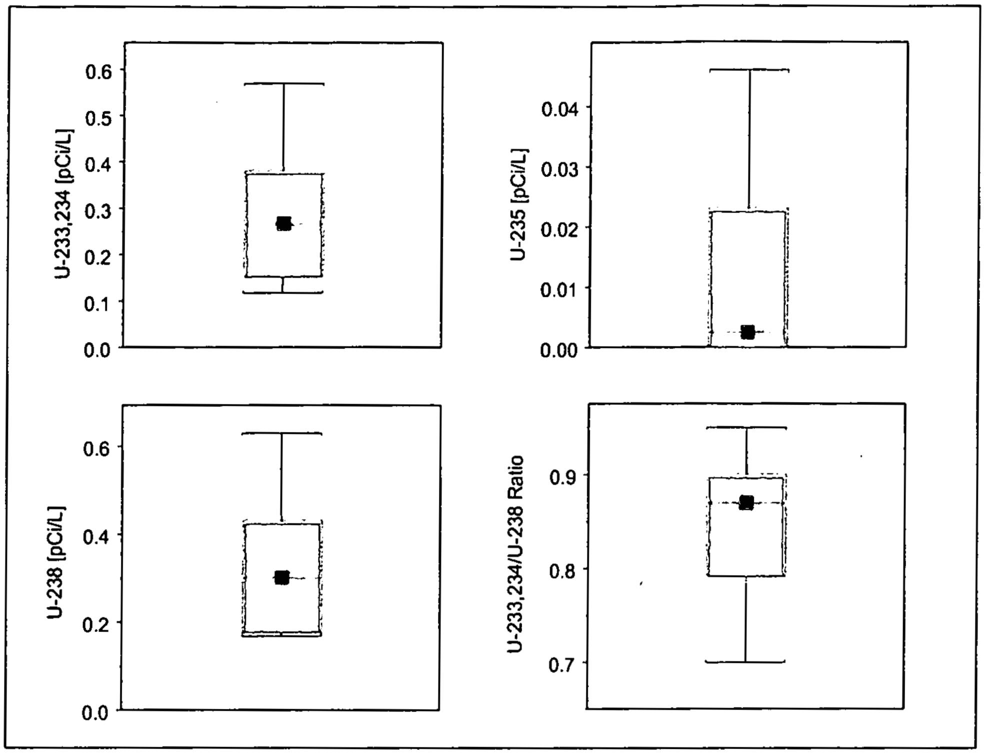

Figure 10-51. Continuous Flow-Paced Uranium Box Plots for SW022: WY97–00.

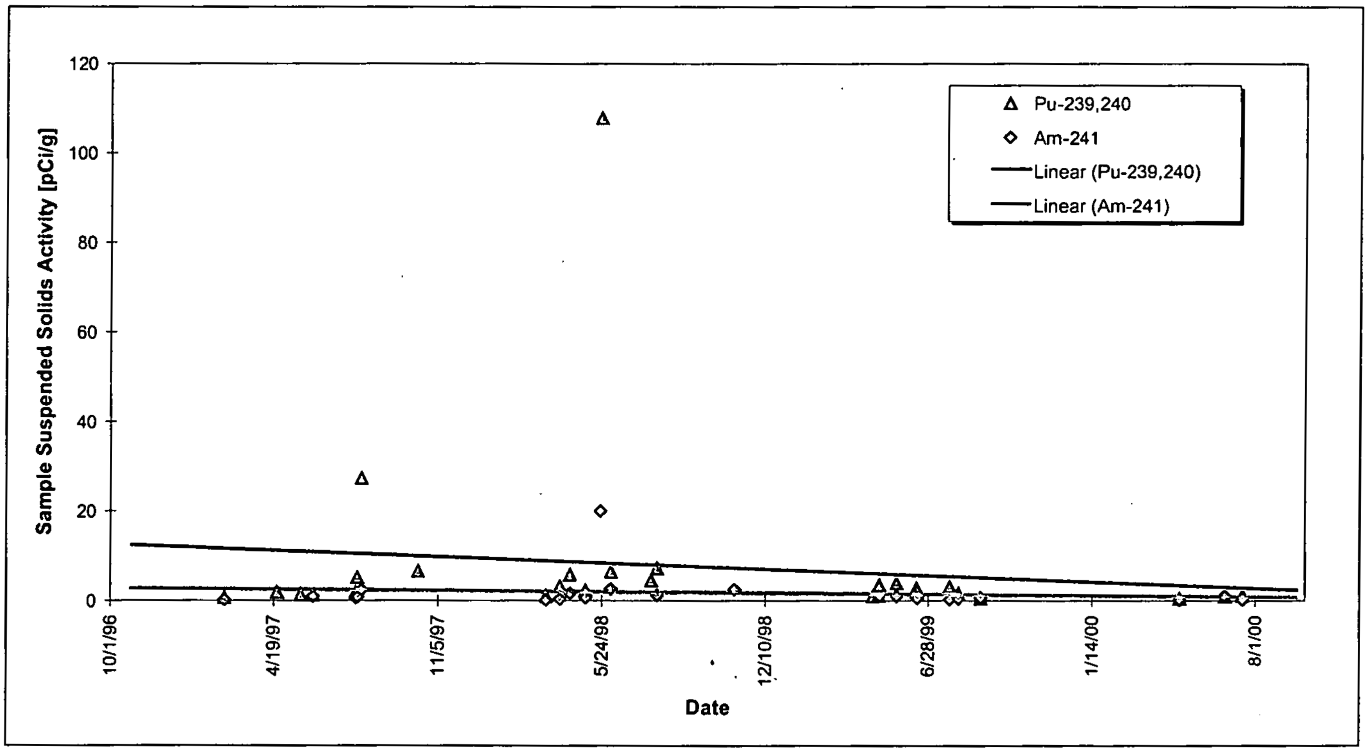

Figure 10-52. Temporal Variation of Suspended Solids Activity at SW022: WY97–00.

Table 10-13 shows the total metals results for samples collected at SW022. All metals results were obtained for storm-event samples. Figure 10-53 through Figure 10-57 show the UTL plots for the metals. For the metals with a determined distribution, most results did not exceed the calculated UTL. Metals Al, Ba, Be, Cr, Co, Cu, Fe, Mn, Ni, Tl, and V showed a result greater than the UTL. For all the metals except Tl, this result was from a sample for a large storm-event (5/20/99) with the corresponding TSS being the highest measured (360 mg/L). The high TSS likely explains the unusually high results. In all cases, the high measurements did not continue.

For the metals with undetermined distributions, all show 'suspect' values as indicated by the boxplots. The Na values are likely associated with salting operations (March and April samples). For both As and Sn, the high results were associated with the same large storm-event noted above. For Li, one of the results is associated with the 5/20/99 event, and the cause of the other result is unknown; however, the high values did not persist. For Hg, one of the results is associated with a high detection limit (0.2 μg/L); the other result is only 130% of the detection limit. For Ag, the high results are associated with a high detection limit.

Table 10-13. Summary Statistics for Metals Results from SW022 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median [μg/L]	85th Percentile [μg/L]	Maximum [μg/L]	95% UTL [μg/L]
ALUMINUM	25	0.0%	2650	9526	47300	35754[a]
ANTIMONY	25	0.0%	15.2	33.5	55.7	86.6[a]
ARSENIC	25	0.0%	2.10	3.74	15.2	[c]
BARIUM	25	0.0%	56.2	92.5	295	168[a]
BERYLLIUM	24	16.7%	0.11	0.51	2.90	1.73[a]
CADMIUM	25	12.0%	0.24	0.47	0.72	0.80[a]
CALCIUM	25	0.0%	20200	33860	39500	46284[a]
CHROMIUM	25	0.0%	3.80	11.5	44.3	34.6[a]
COBALT	25	12.0%	0.98	3.24	12.0	7.71[a]
COPPER	24	0.0%	8.65	15.9	35.6	25.3[a]
IRON	25	0.0%	2180	9732	40200	33153[a]
LEAD	24	0.0%	3.70	16.7	31.1	32.7[a]
LITHIUM	25	0.0%	5.10	12.9	122	[c]
MAGNESIUM	25	0.0%	3650	7608	9370	10353[a]
MANGANESE	25	0.0%	51.2	160	844	449[a]
MERCURY	24	95.8%	0.05	0.05	0.13	[c]
MOLYBDENUM	25	20.0%	0.94	1.74	2.40	2.52[b]
NICKEL	25	0.0%	3.20	8.88	33.9	17.9[a]
POTASSIUM	25	0.0%	3980	6128	11800	[c]
SELENIUM	25	80.0%	0.55	0.73	1.80	[c]
SILICON	5	0.0%	3520	7662	8340	24106[a]
SILVER	25	76.0%	0.175	0.23	0.59	[c]
SODIUM	25	0.0%	13300	43120	245000	[c]
STRONTIUM	25	0.0%	112	221	286	316[a]
THALLIUM	25	76.0%	0.45	0.76	2.20	2.00[a]
TIN	24	87.5%	0.55	0.96	1.50	[c]
VANADIUM	25	0.0%	6.80	22.7	86.9	42.1[a]
ZINC	25	0.0%	75.3	154	205	218[a]

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

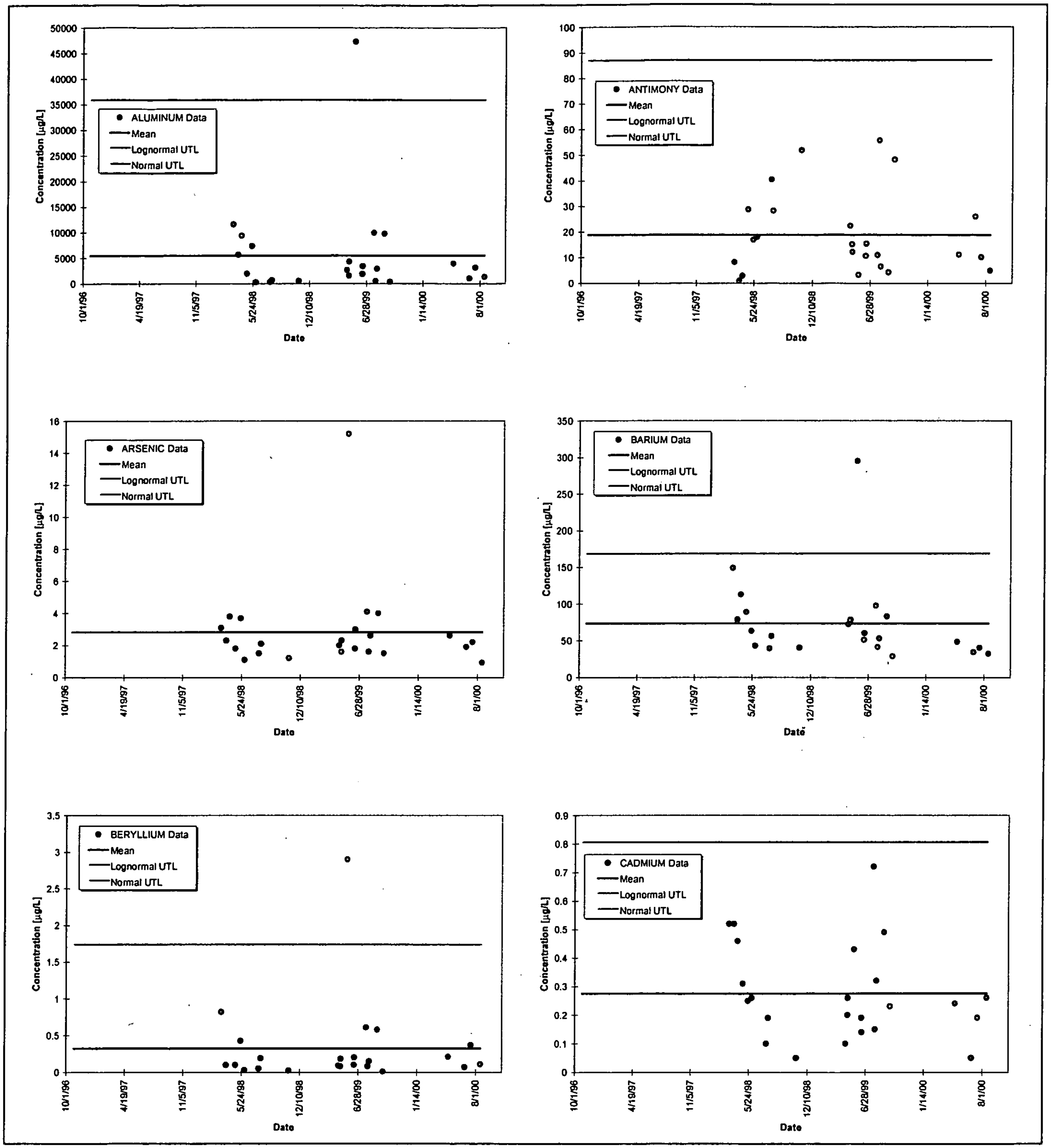

Figure 10-53. Total Metals UTL Plots for SW022: Aluminum through Cadmium.

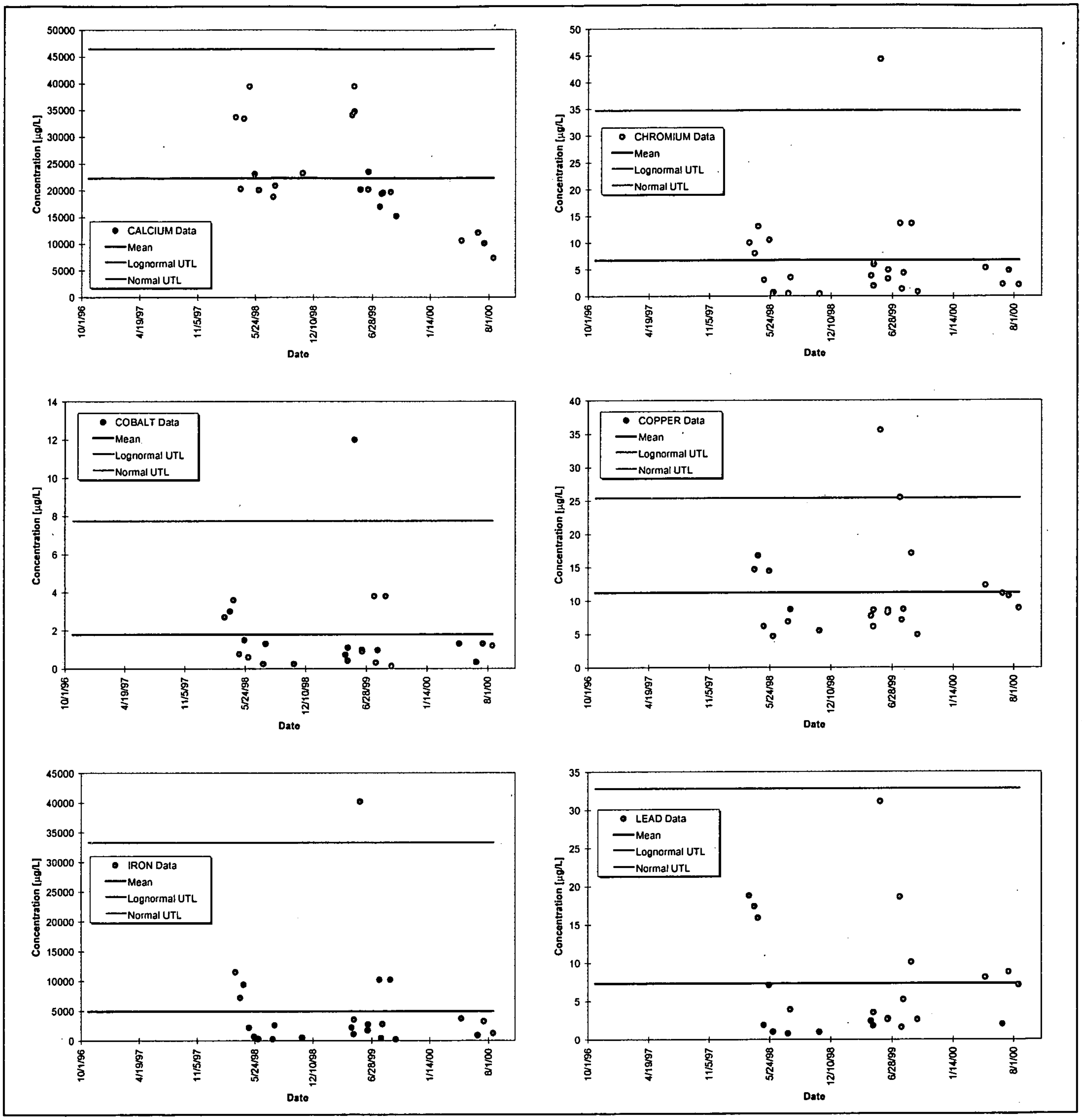

Figure 10-54. Total Metals UTL Plots for SW022: Calcium through Lead.

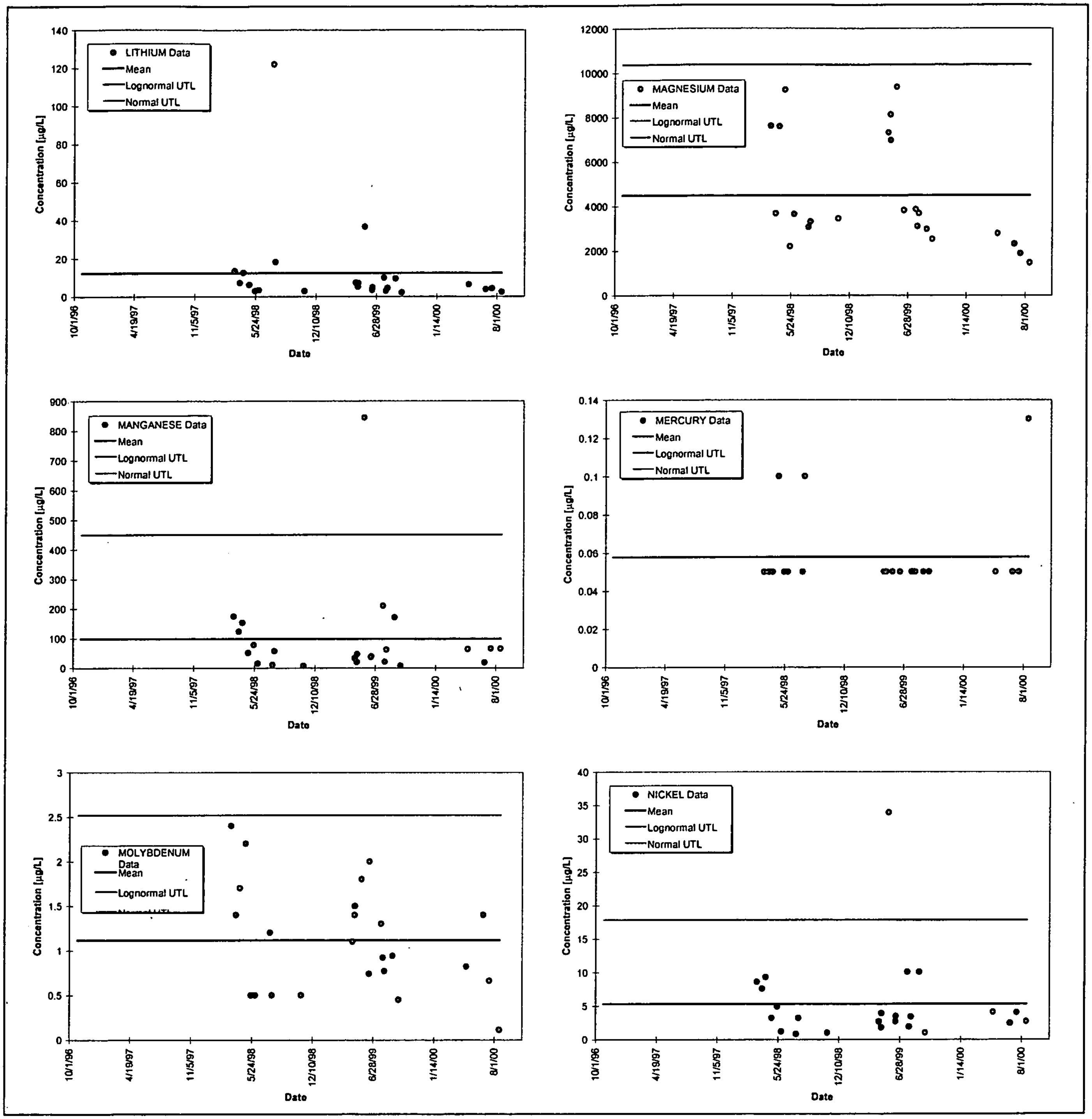

Figure 10-55. Total Metals UTL Plots for SW022: Lithium through Nickel.

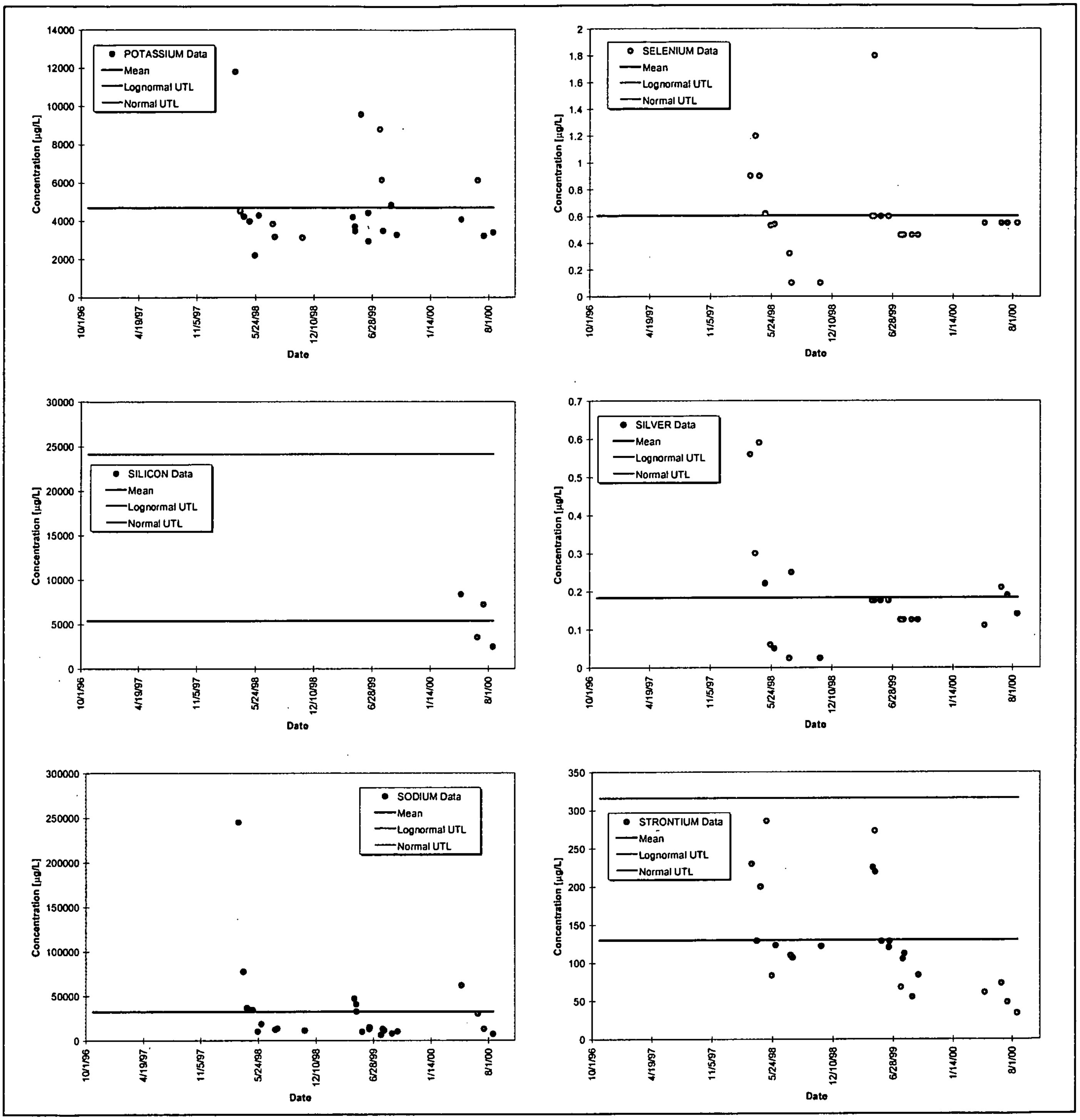

Figure 10-56. Total Metals UTL Plots for SW022: Potassium through Strontium.

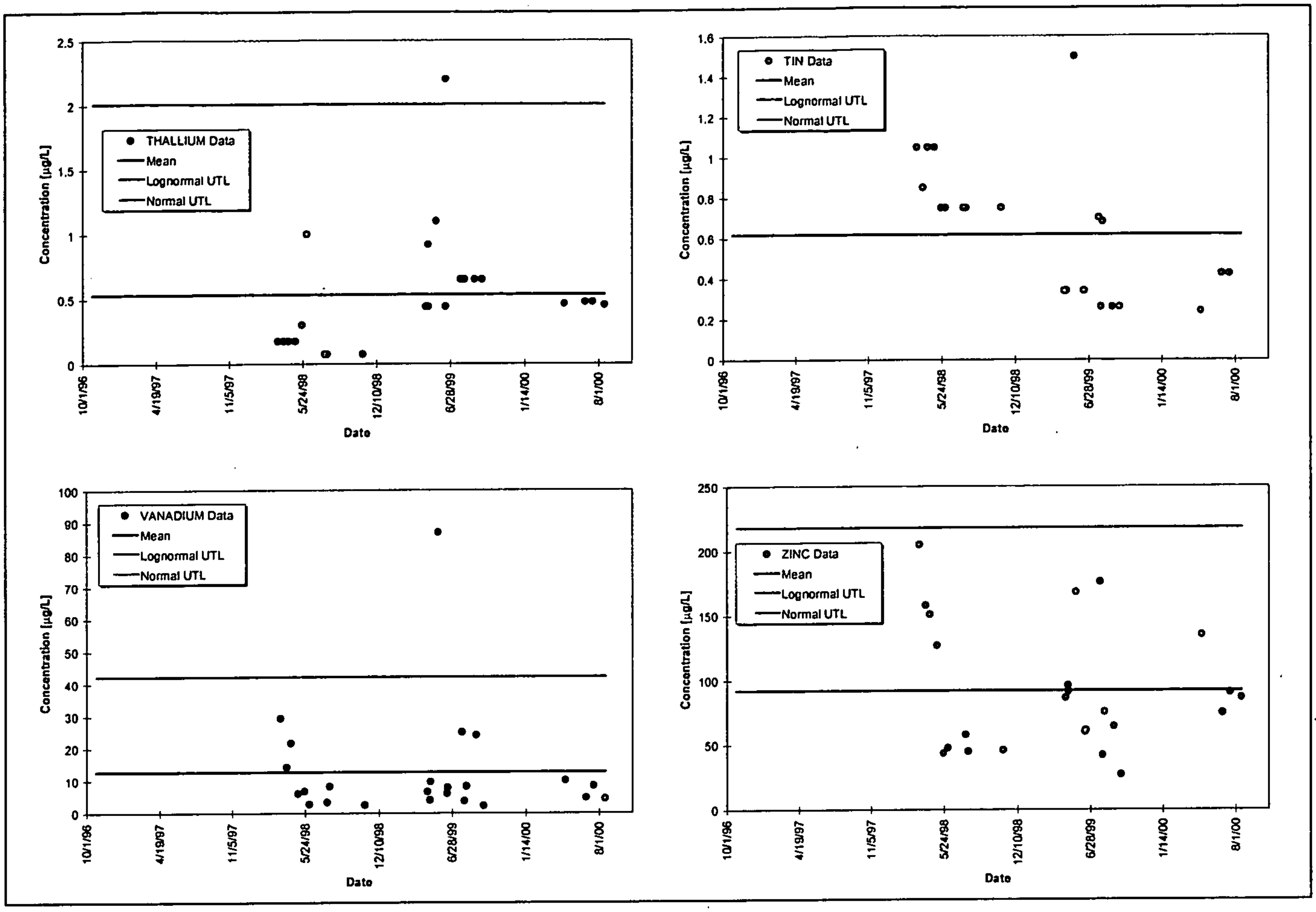

Figure 10-57. Total Metals UTL Plots for SW022: Thallium through Zinc.

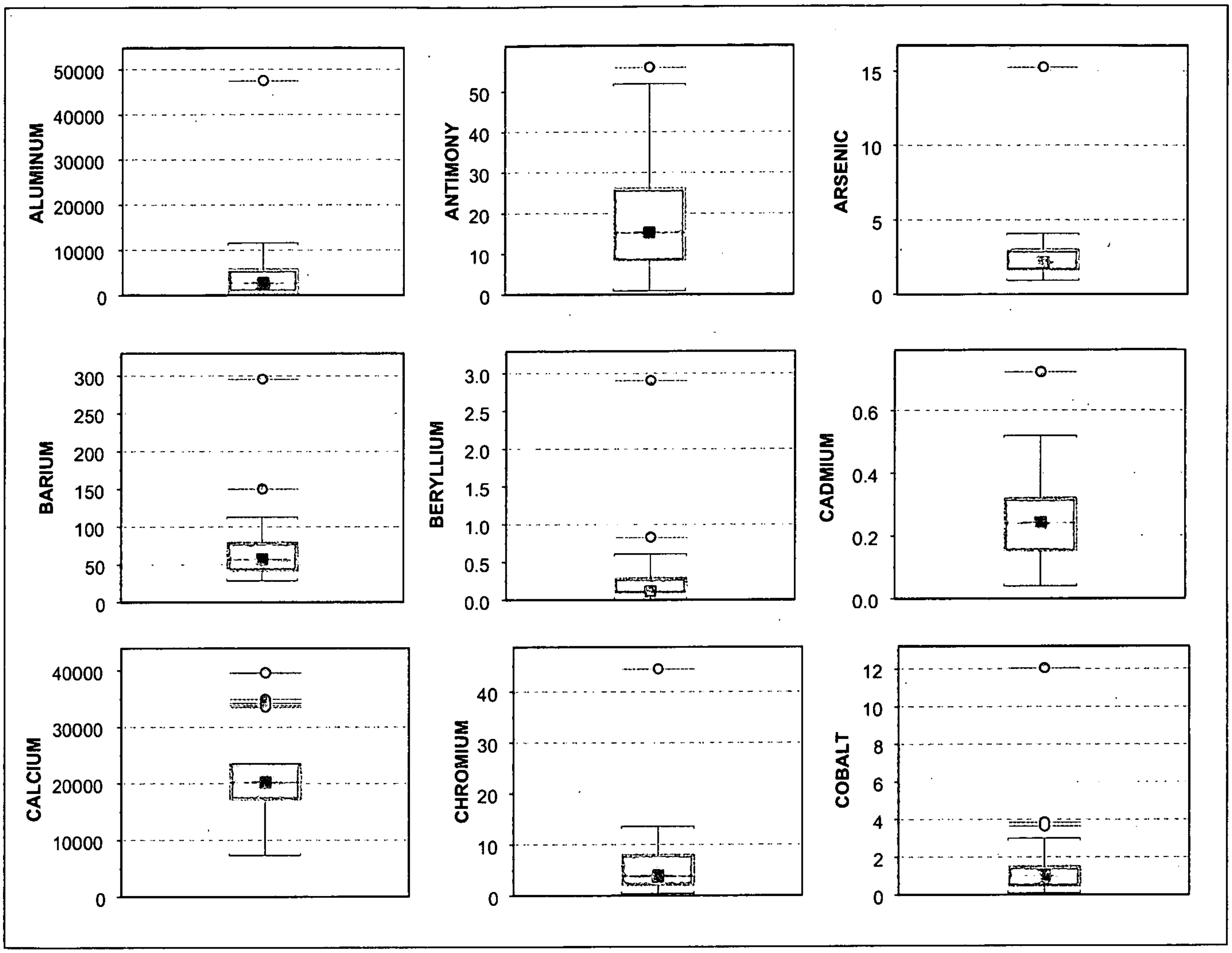

Figure 10-58. Total Metals Box Plots for SW022: Aluminum through Cobalt.

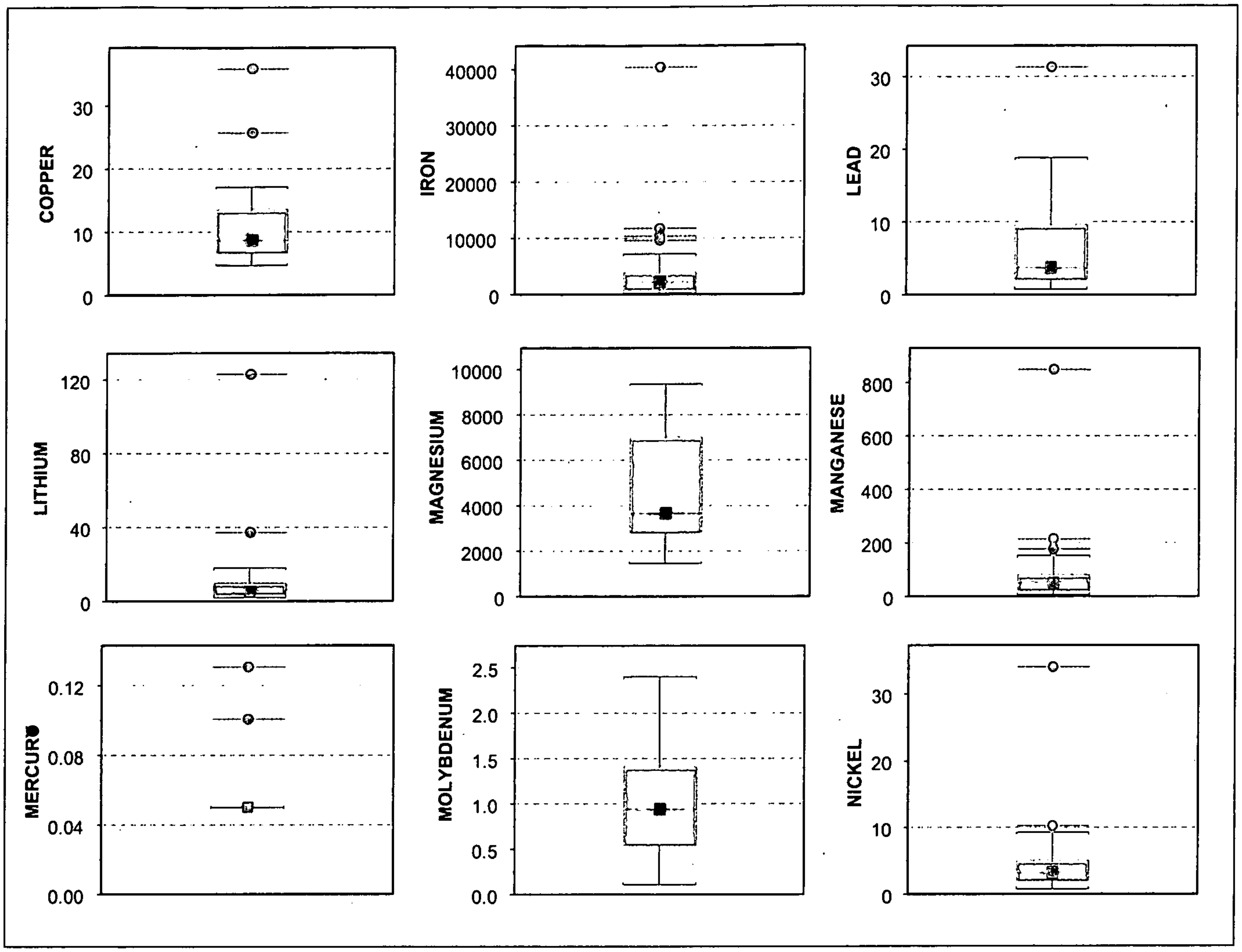

Figure 10-59. Total Metals Box Plots for SW022: Copper through Nickel.

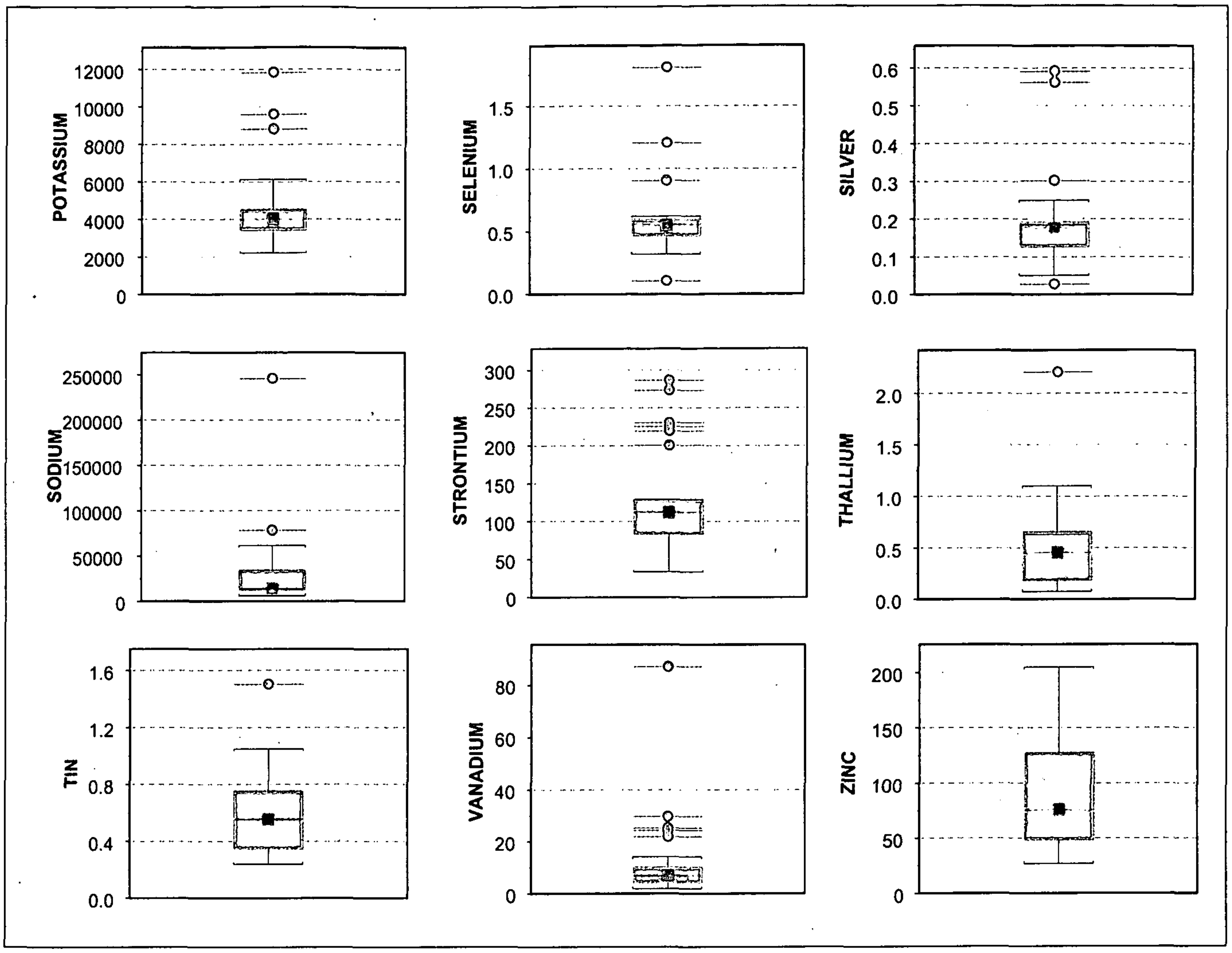

Figure 10-60. Total Metals Box Plots for SW022: Potassium through Zinc.

10.3.7 Buildings 771/774 and 776/777 D&D

Monitoring location SW120 was installed on 3/14/00 in support of the D&D of Buildings 771/774. This location also supports D&D activities for Building 776/777 and activities for the Solar Ponds. In support of the B776/777 D&D, tritium was added to the analyte suite in the end of WY00.[27] Figure 3-81 shows the drainage area for SW120.

Monitoring data collected at SW120 have somewhat higher Pu and Am activities than for other automated monitoring locations (Table 10-14). Figure 10-61 and Figure 10-62 show the UTL plots for Pu and Am, respectively. During WY97–00, no Pu or Am results exceeded the calculated UTL.

Monitoring data collected at SW120 show moderate median total uranium activities (Table 10-14). Figure 10-63 shows that none of the total uranium results were greater than the calculated UTL.

The temporal variation of suspended solids activity is not given since no samples were collected within TSS hold time criteria.

[27] Only 1 tritium result was available for the WY00 period.

No box plots are presented for any of the analytes due to small number of data points.

Table 10-14. Summary Statistics for Radionuclide Results from SW120 in WY97-00.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
TSS [mg/L]	NA	NA	NA	NA	NA
Pu-239,240	4	0.296	0.533	0.724	25.49[a]/1.84[b]
Am-241	4	0.105	0.202	0.269	2.066[a]/0.675[b]
Tritium	1	NA	NA	99	NA
U-233,234	4	1.015	2.827	4.190	NA
U-235	4	0.023	0.109	0.179	19.38[a]/17.00[b]
U-238	4	0.772	1.831	2.560	NA

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.
TSS is given in mg/L.
Uranium UTL given for total uranium.

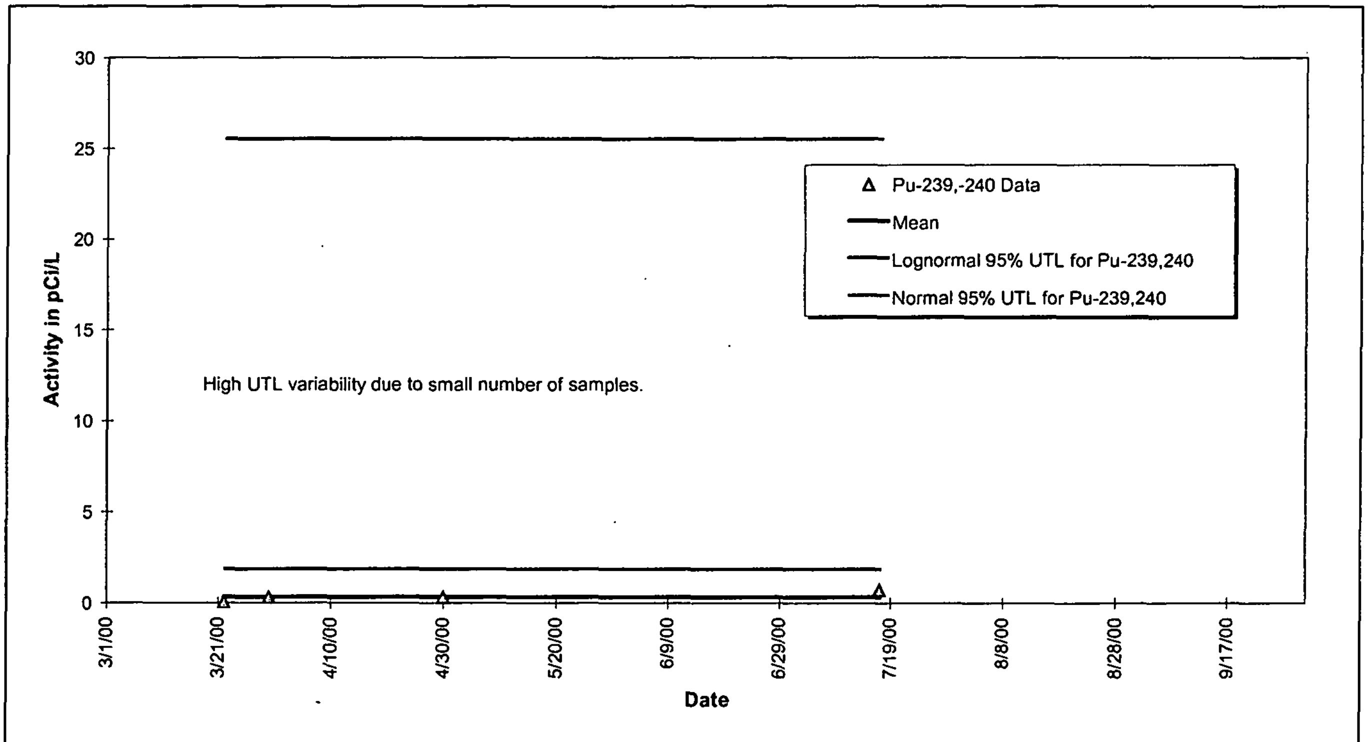

Figure 10-61. 95% UTL Plot for Pu-239,240 at SW120: WY97-00.

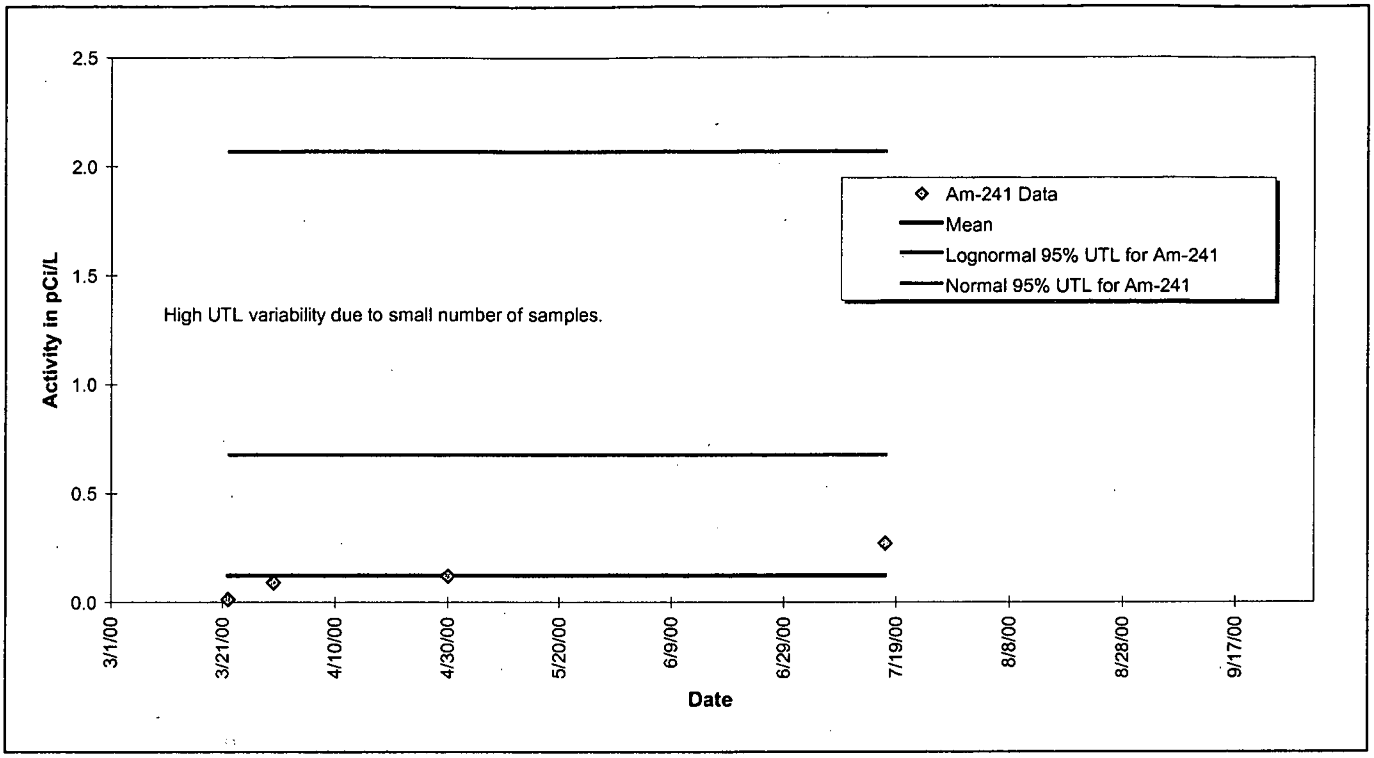

Figure 10-62. 95% UTL Plot for Am-241 at SW120: WY97-00.

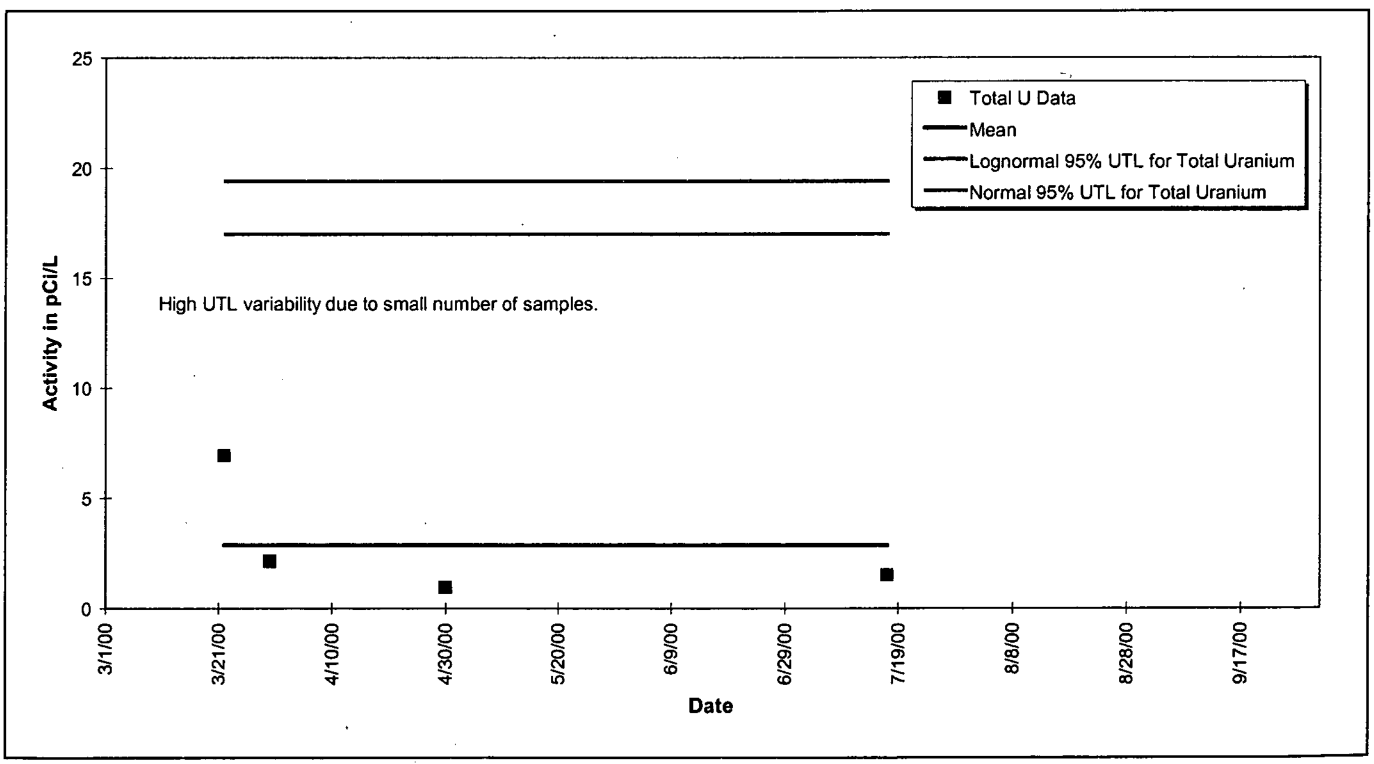

Figure 10-63. 95% UTL Plot for Total Uranium at SW120: WY97-00.

Table 10-15 shows the total metals results for samples collected at SW120. Figure 10-64 through Figure 10-68 show the UTL plots for the metals. For the metals with a determined distribution, no results exceeded the calculated UTL.

Data for metals Hg, Se, Ag, Tl, and Sn had undetermined distributions. All of the Hg, Ag, and Sn data were 'undetects'. For Se, three of the results were 'undetects'; the other result is only 118% of the detection limit. For Tl, three of the results were 'undetects'; the other result is only 130% of the detection limit.

No box plots are presented due to small number of data points.

Table 10-15. Summary Statistics for Metals Results from SW120 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median [μg/L]	85th Percentile [μg/L]	Maximum [μg/L]	95% UTL [μg/L]
ALUMINUM	4	0.0%	3115	6734	8701	97122[a]
ANTIMONY	4	0.0%	1.85	2.63	2.90	6.18[a]
ARSENIC	4	0.0%	3.18	5.64	6.20	31.8[a]
BARIUM	4	0.0%	182	301	325	1200[a]
BERYLLIUM	4	0.0%	0.19	0.36	0.43	2.74[a]
CADMIUM	4	0.0%	0.29	0.36	0.38	0.79[a]
CALCIUM	4	0.0%	56599	125450	156500	627358[a]
CHROMIUM	4	0.0%	4.30	7.68	8.98	44.1[a]
COBALT	4	0.0%	0.90	1.84	2.45	6.54[a]
COPPER	4	0.0%	10.6	18.6	20.5	83.9[a]
IRON	4	0.0%	2500	5387	6891	78660[a]
LEAD	4	25.0%	2.90	6.22	7.63	82.3[a]
LITHIUM	4	0.0%	19.2	43.6	59.9	157[a]
MAGNESIUM	4	0.0%	9990	23513	31050	97625[a]
MANGANESE	4	0.0%	51.7	86.3	109	617[a]
MERCURY	4	100.0%	0.05	0.05	0.05	[c]
MOLYBDENUM	4	0.0%	1.09	1.34	1.45	2.67[a]
NICKEL	4	0.0%	3.85	6.14	7.24	16.7[a]
POTASSIUM	4	0.0%	10090	12300	12300	25486[a]
SELENIUM	4	75.0%	0.55	0.76	0.93	[c]
SILVER	4	100.0%	0.13	0.14	0.14	[c]
SODIUM	4	0.0%	263650	546550	601000	7098220[a]
STRONTIUM	4	0.0%	338	762	949	3858[a]
THALLIUM	4	75.0%	0.46	0.87	1.20	[c]
TIN	4	100.0%	0.25	0.42	0.56	[c]
VANADIUM	4	0.0%	7.60	15.9	20.3	167[a]
ZINC	4	0.0%	81.1	85.0	85.1	170[a]

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

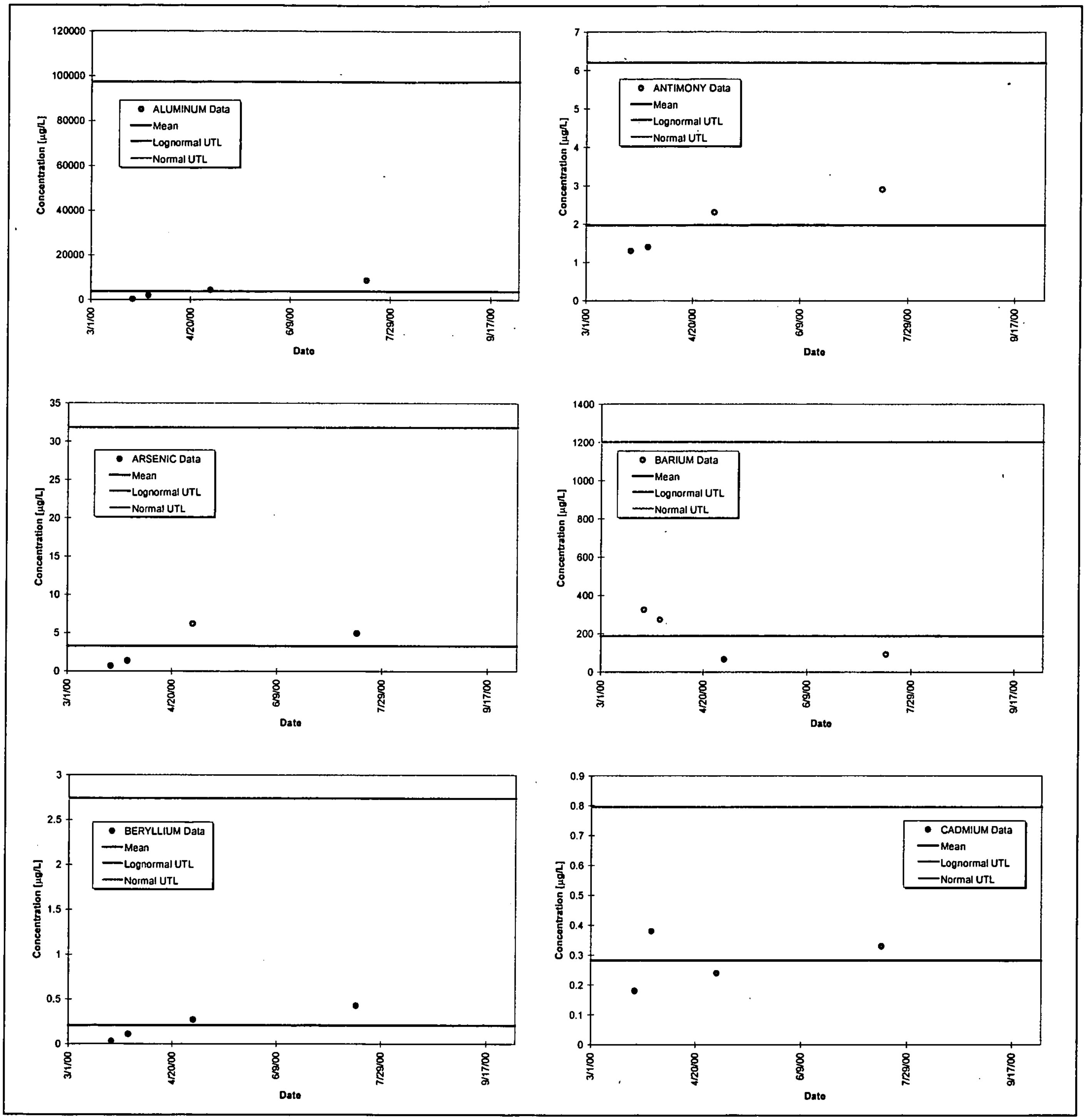

Figure 10-64. Total Metals UTL Plots for SW120: Aluminum through Cadmium.

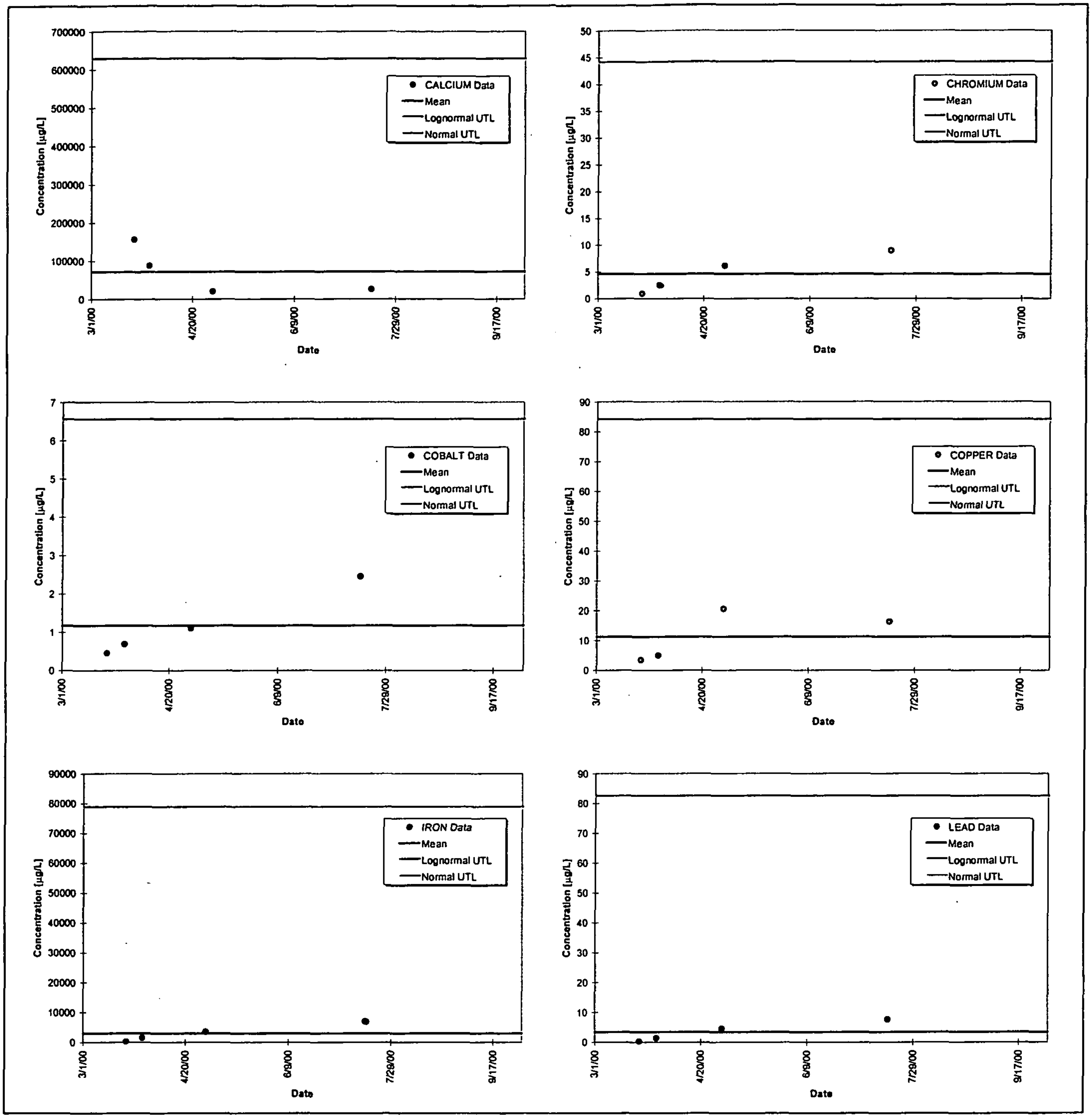

Figure 10-65. Total Metals UTL Plots for SW120: Calcium through Lead.

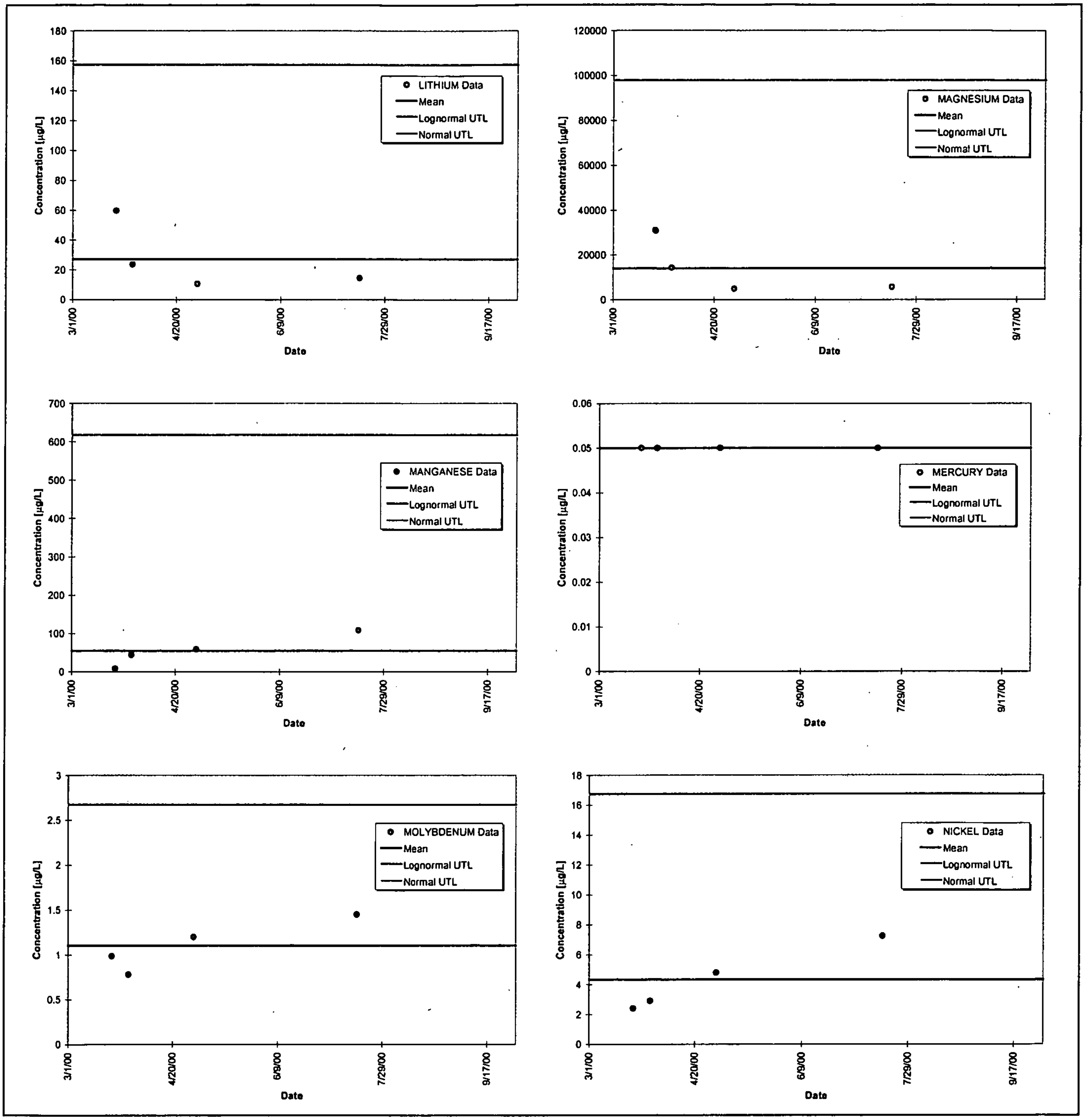

Figure 10-66. Total Metals UTL Plots for SW120: Lithium through Nickel.

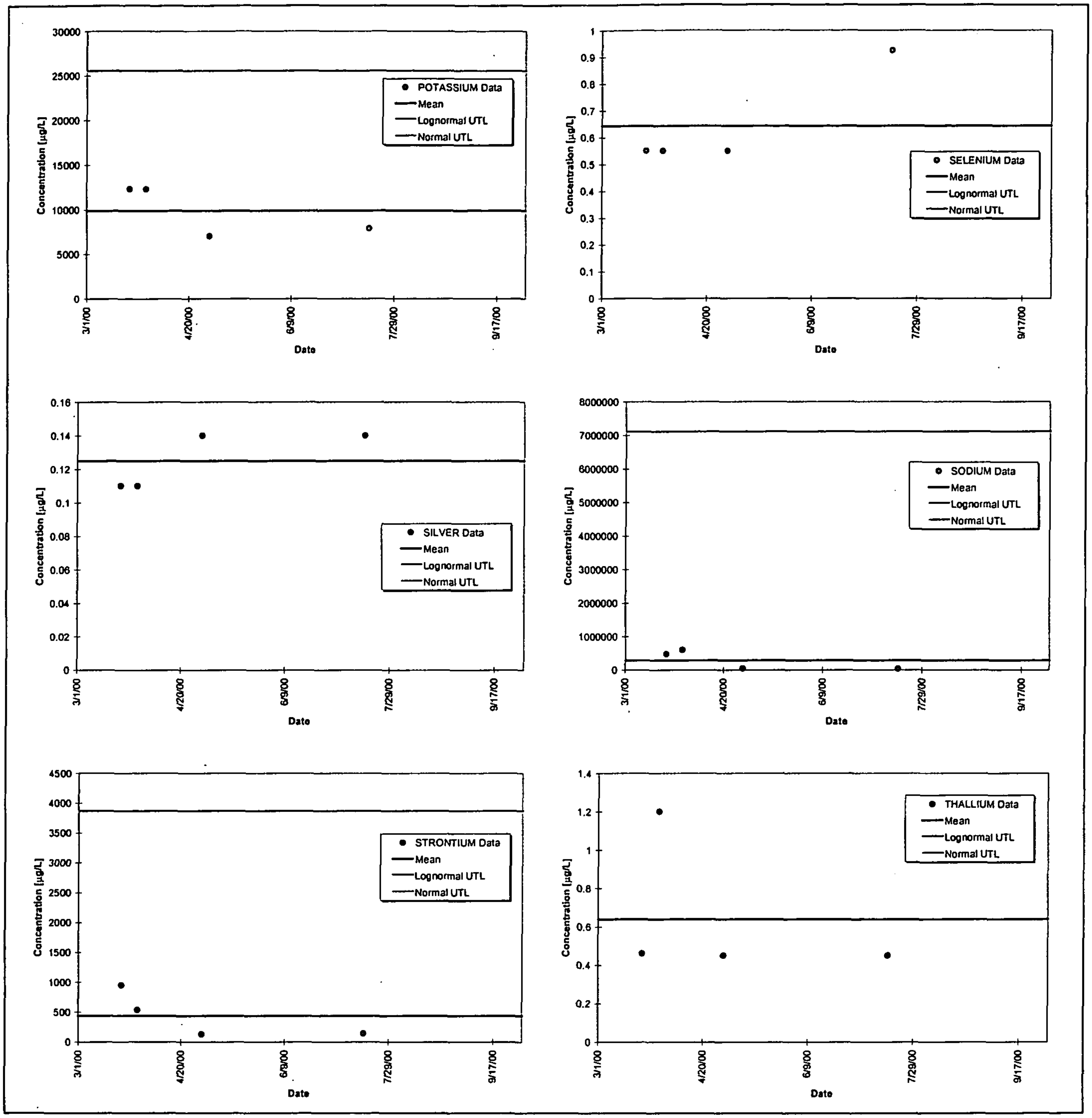

Figure 10-67. Total Metals UTL Plots for SW120: Potassium through Thallium.

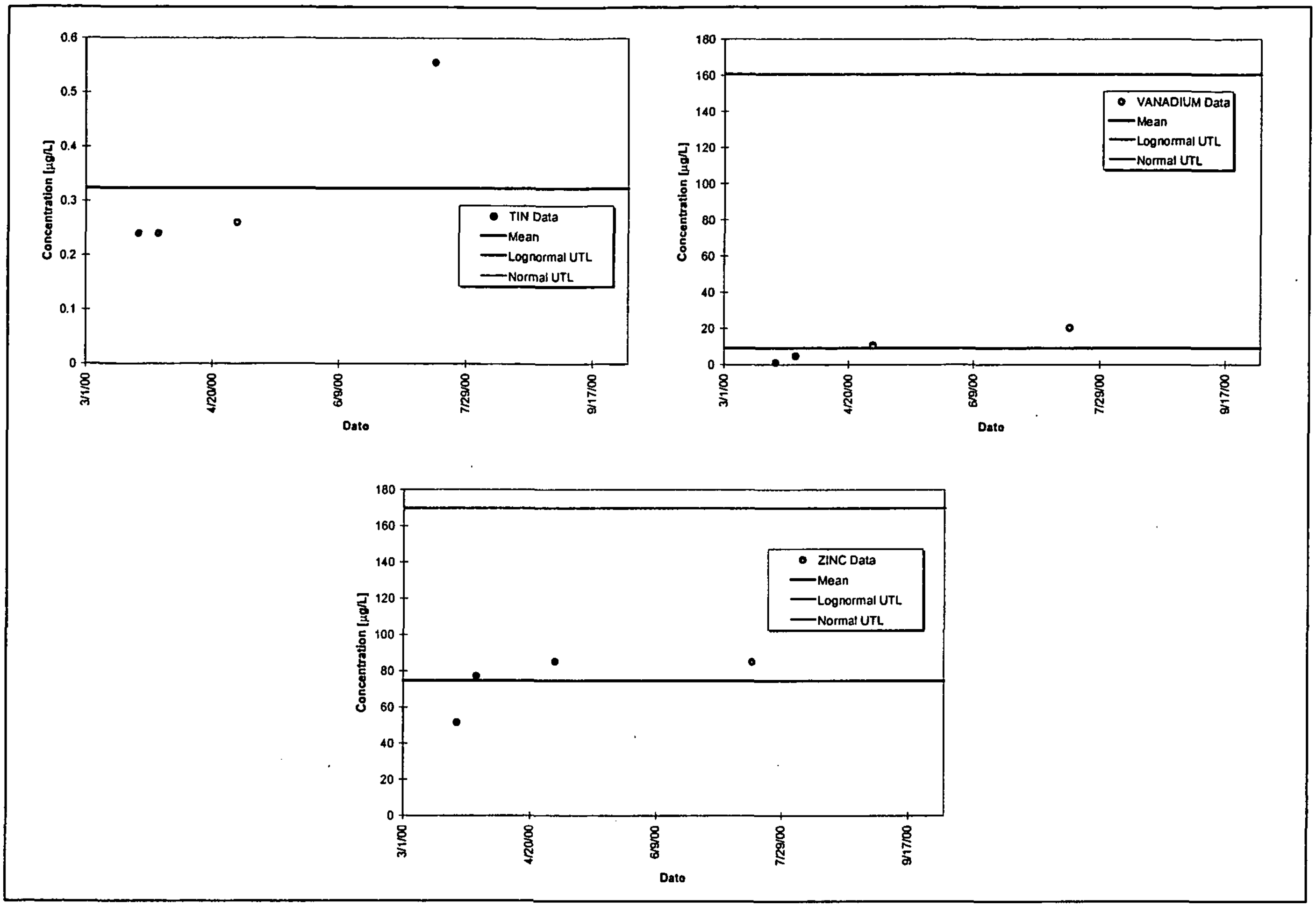

Figure 10-68. Total Metals UTL Plots for SW120: Tin through Zinc.

10.3.8 Building 886 D&D

Monitoring location GS43 was installed on 6/1/99 in support of the D&D of Building 886. Figure 3-59 shows the drainage area for GS43. Other buildings within this drainage include 875 and 880.

Monitoring data collected at GS43 show low Pu and Am activities (Table 10-16). Figure 10-69 and Figure 10-70 show the UTL plots for Pu and Am, respectively. During WY97–00, no Pu or Am results exceeded the calculated UTL.

Table 10-16 shows that GS43 has the highest uranium activities for automated monitoring locations, as expected due to the proximity of B886. Figure 10-71 shows that none of total uranium activities were greater than the UTL, indicating that the activities did not change significantly during the evaluation period. It should be noted that GS43 shows an average U-233,234/U-238 ratio significantly greater than 1, indicating the possible existence of enriched uranium. The ratios at this location are likely due to the proximity of GS43 to Building 886.

The Pu/Am ratio box plot is not included since only two samples met the MDA criteria. The trend plot for suspended solids activity is also not included since only two TSS results were available.

Table 10-16. Summary Statistics for Radionuclide Results from GS43 in WY97-00.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
TSS [mg/L]	2	19	28	32	NA
Pu-239,240	8	0.005	0.018	0.028	0.042[a] / 0.038[b]
Am-241	8	0.005	0.008	0.018	0.042[a] / 0.025[b]
U-233,234	5	8.090	11.840	11.900	35.757[b]
U-235	5	0.315	0.473	0.593	
U-238	5	2.470	3.358	3.610	

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.
TSS is given in mg/L.
Uranium UTL given for total uranium.

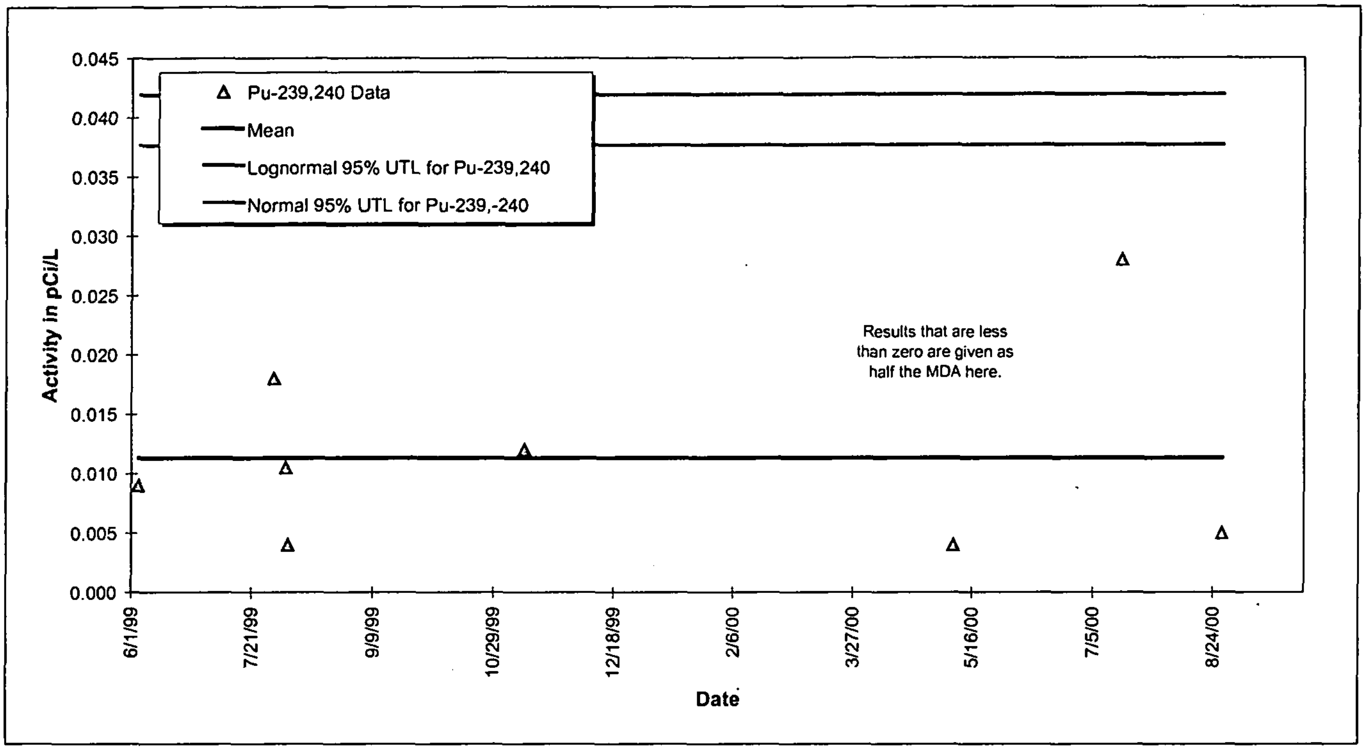

Figure 10-69. 95% UTL Plot for Pu-239,240 at GS43: WY97-00.

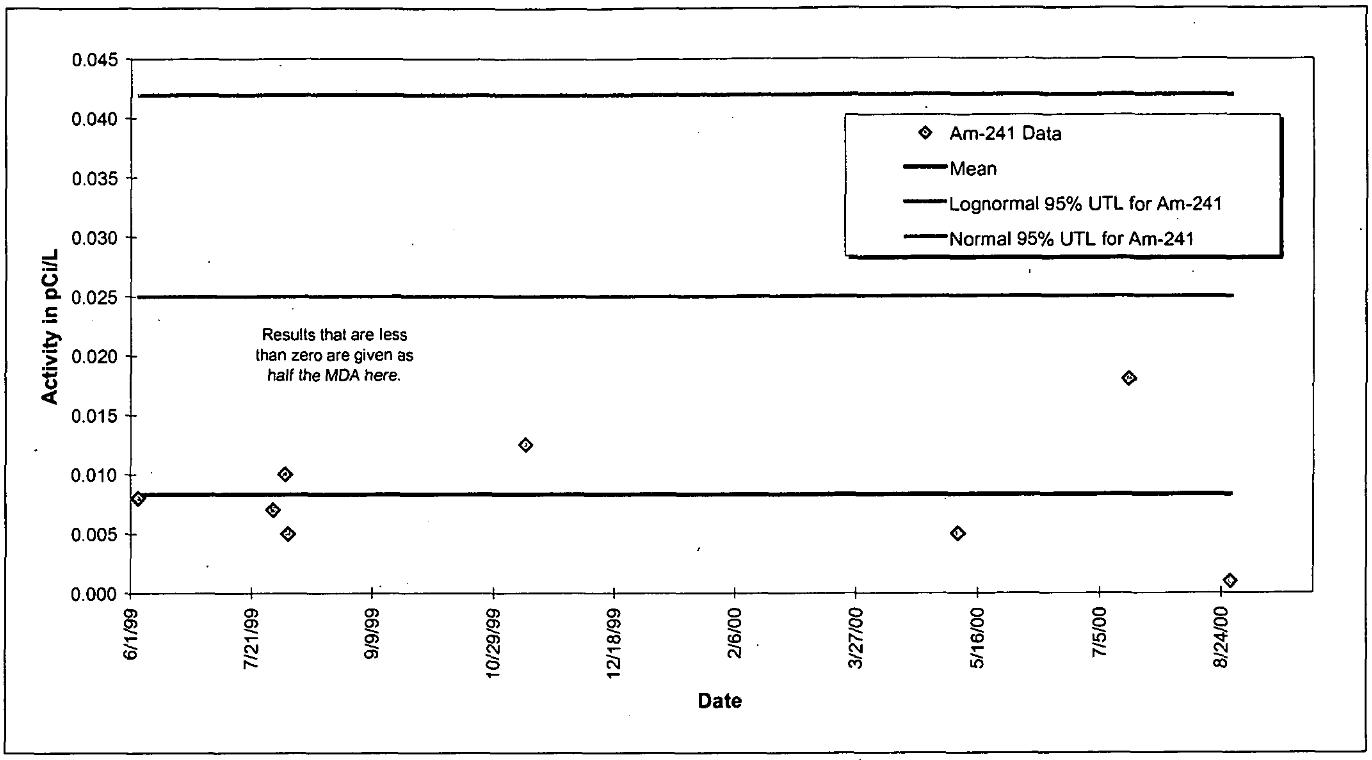

Figure 10-70. 95% UTL Plot for Am-241 at GS43: WY97-00.

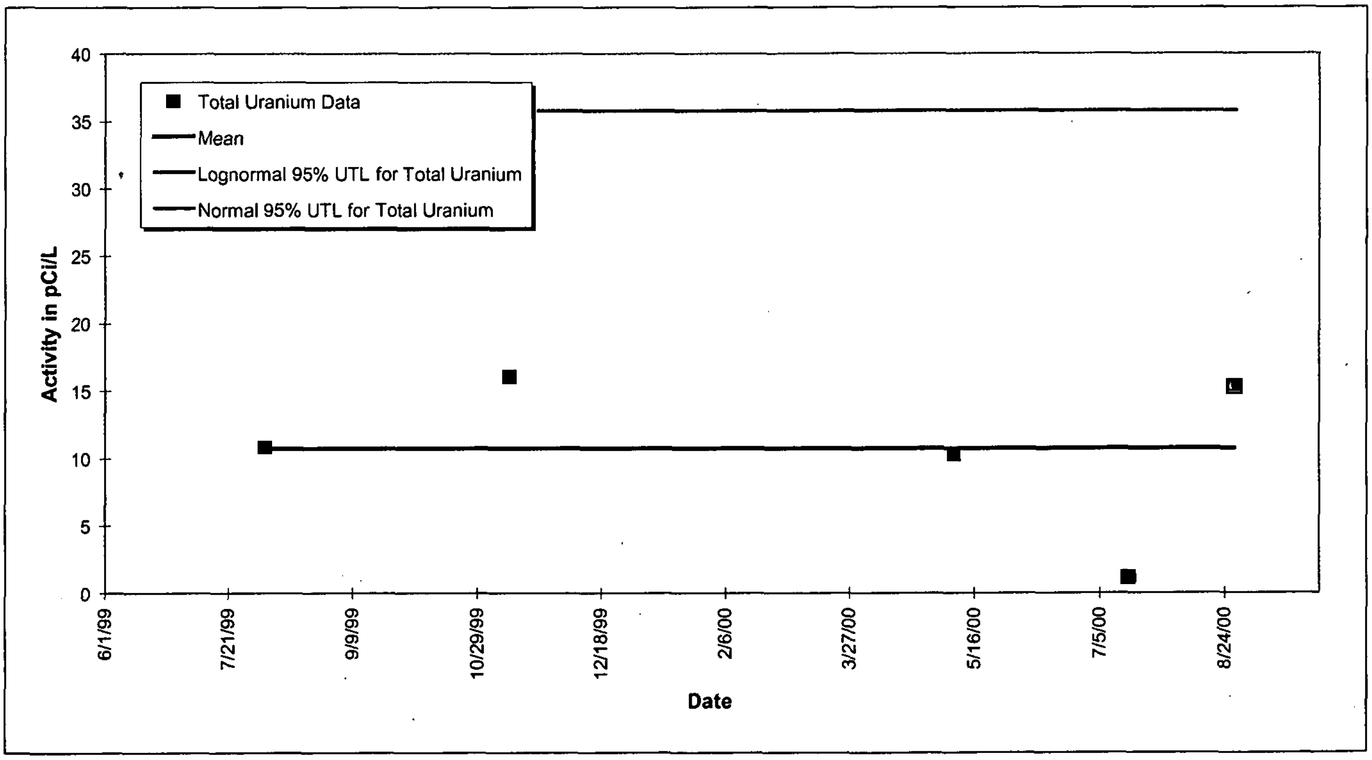

Figure 10-71. 95% UTL Plot for Total Uranium at GS43: WY97-00.

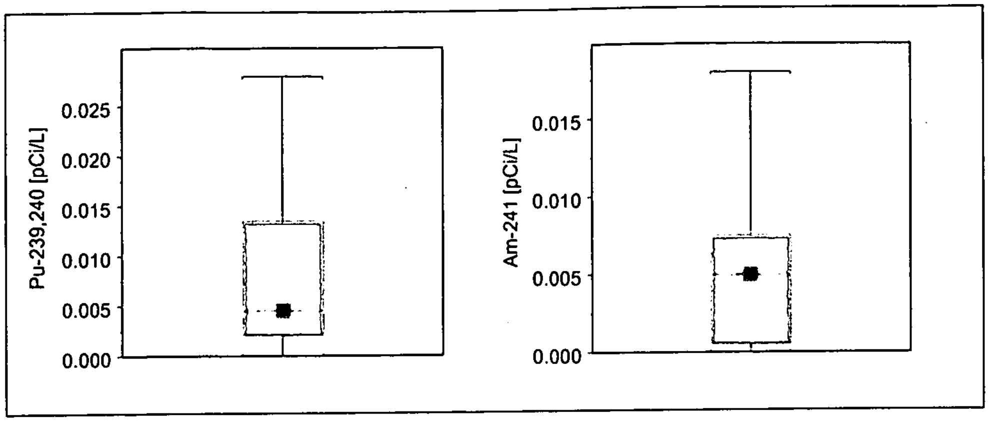

Figure 10-72. Pu and Am Box Plots for GS43: WY97–00.

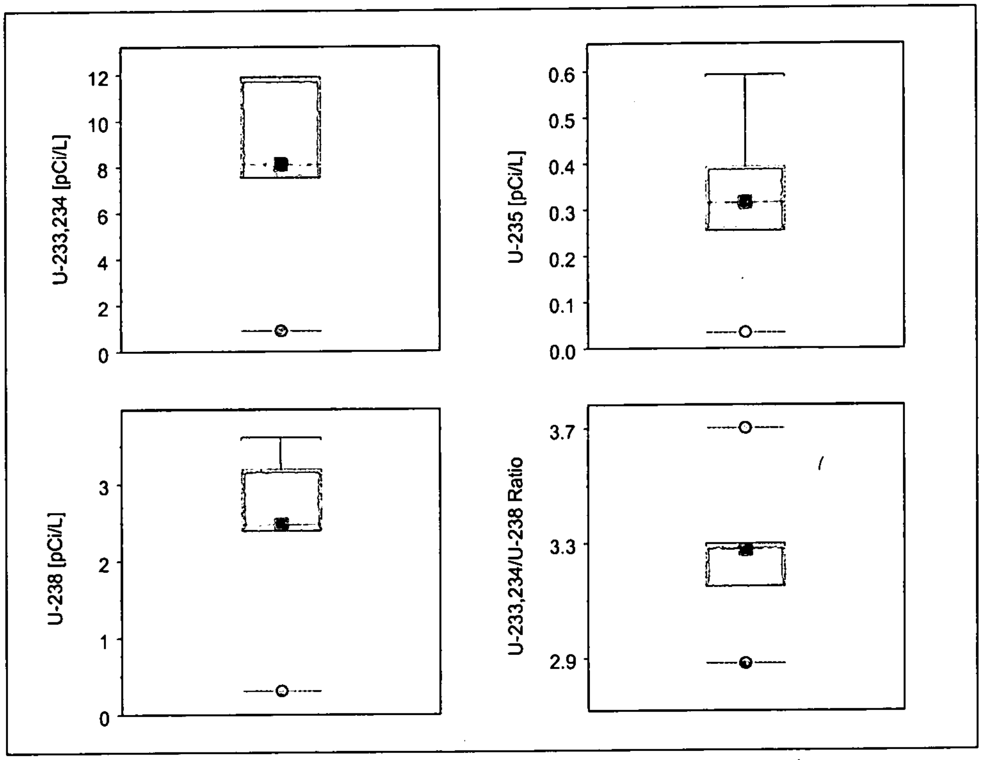

Figure 10-73. Uranium Box Plots for GS43: WY97–00.

Table 10-17 shows the total metals results for samples collected at GS43. Figure 10-74 through Figure 10-78 show the UTL plots for the metals. For the metals with a determined distribution, no results exceeded the calculated UTL.

For the metals with undetermined distributions, only Sn shows a 'suspect' value as indicated by the boxplot. However, that result is only 115% of the detection limit; all other results are 'undetects'..

Table 10-17. Summary Statistics for Metals Results from GS43 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median [µg/L]	85th Percentile [µg/L]	Maximum [µg/L]	95% UTL [µg/L]
ALUMINUM	8	0.0%	212	993	1190	7473[a]
ANTIMONY	8	25.0%	0.67	1.08	1.50	2.30[a]
ARSENIC	8	37.5%	0.85	1.00	1.20	1.96[a]
BARIUM	8	0.0%	86.3	101	112	219[a]
BERYLLIUM	8	25.0%	0.09	0.12	0.13	0.22[b]
CADMIUM	8	25.0%	0.12	0.22	0.26	0.45[a]
CALCIUM	8	0.0%	38500	47125	50400	104440[a]
CHROMIUM	8	0.0%	0.67	1.66	1.70	2.49[a]
COBALT	8	62.5%	0.10	0.33	0.39	[c]
COPPER	8	0.0%	2.80	4.37	5.20	9.31[a]
IRON	8	0.0%	164	719	860	4268[a]
LEAD	8	25.0%	0.79	2.52	3.10	5.73[a]
LITHIUM	8	0.0%	9.80	12.1	14.6	29.2[a]
MAGNESIUM	8	0.0%	15100	18500	18700	31913[b]
MANGANESE	8	0.0%	4.30	16.1	17.9	47.8[a]
MERCURY	7	100.0%	0.05	0.05	0.05	[c]
MOLYBDENUM	8	0.0%	3.70	5.00	6.00	13.4[a]
NICKEL	8	0.0%	0.78	1.18	1.60	1.89[a]
POTASSIUM	8	0.0%	4865	5111	5250	7222[b]
SELENIUM	8	25.0%	2.00	2.89	3.10	5.08[b]
SILVER	8	100.0%	0.13	0.14	0.14	0.17[a]
SODIUM	8	0.0%	33500	42685	44300	75636[b]
STRONTIUM	8	0.0%	414	512	536	888[b]
THALLIUM	8	100.0%	0.51	0.65	0.65	[c]
TIN	8	87.5%	0.26	0.32	0.60	[c]
VANADIUM	8	0.0%	3.00	3.79	4.50	5.41[a]
ZINC	8	0.0%	123	205	210	431[a]

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

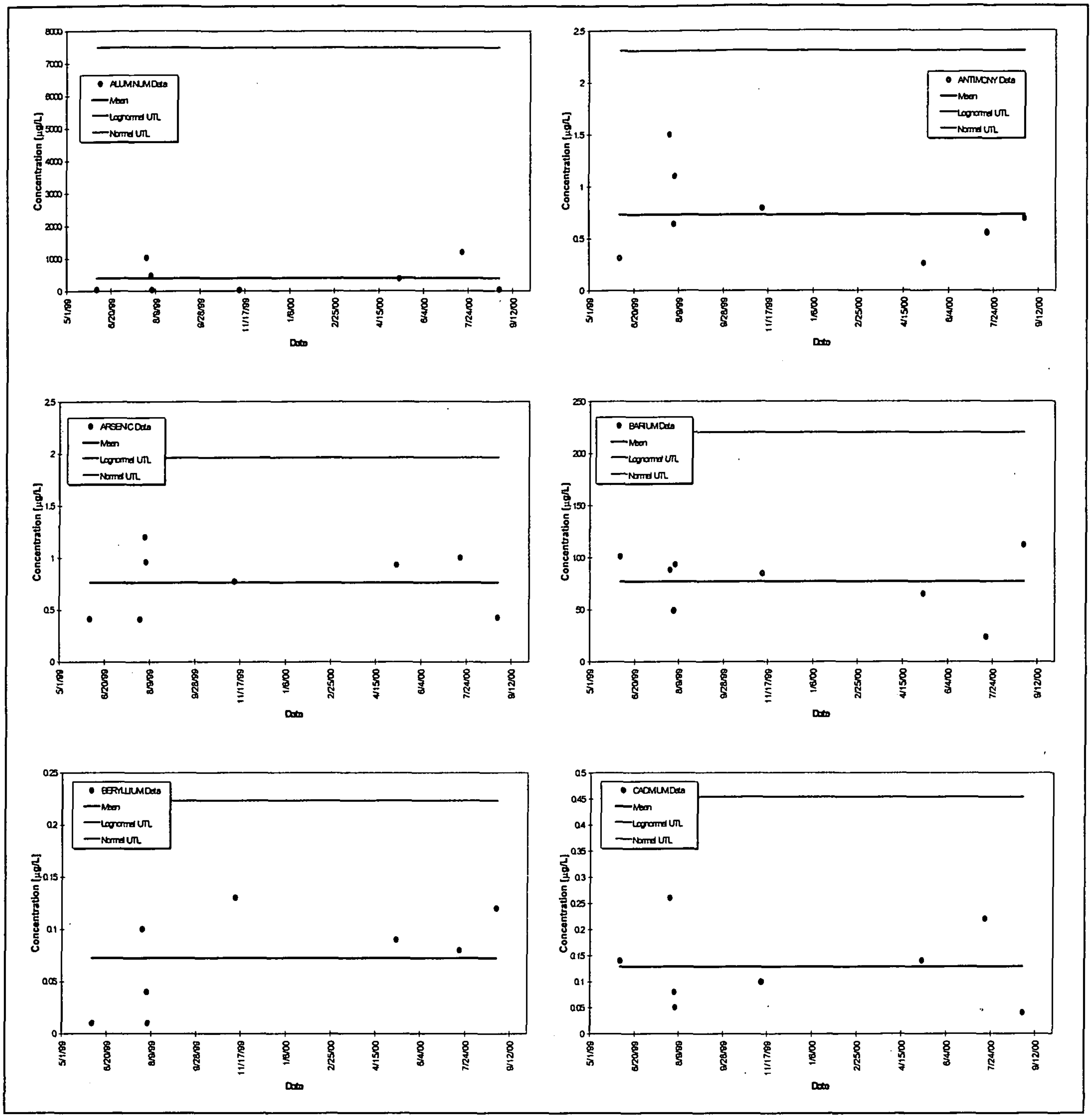

Figure 10-74. Total Metals UTL Plots for GS43: Aluminum through Cadmium.

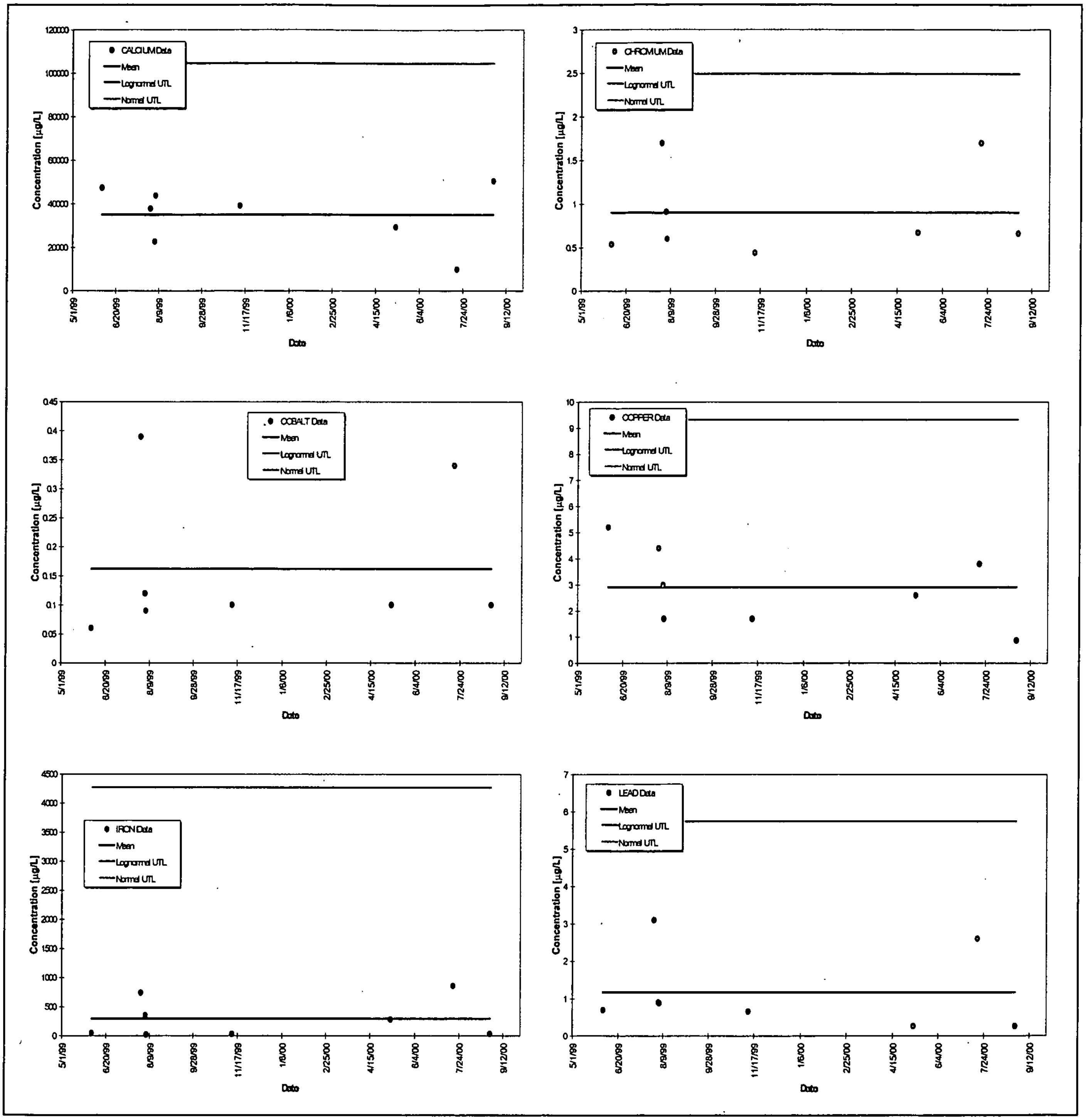

Figure 10-75. Total Metals UTL Plots for GS43: Calcium through Lead.

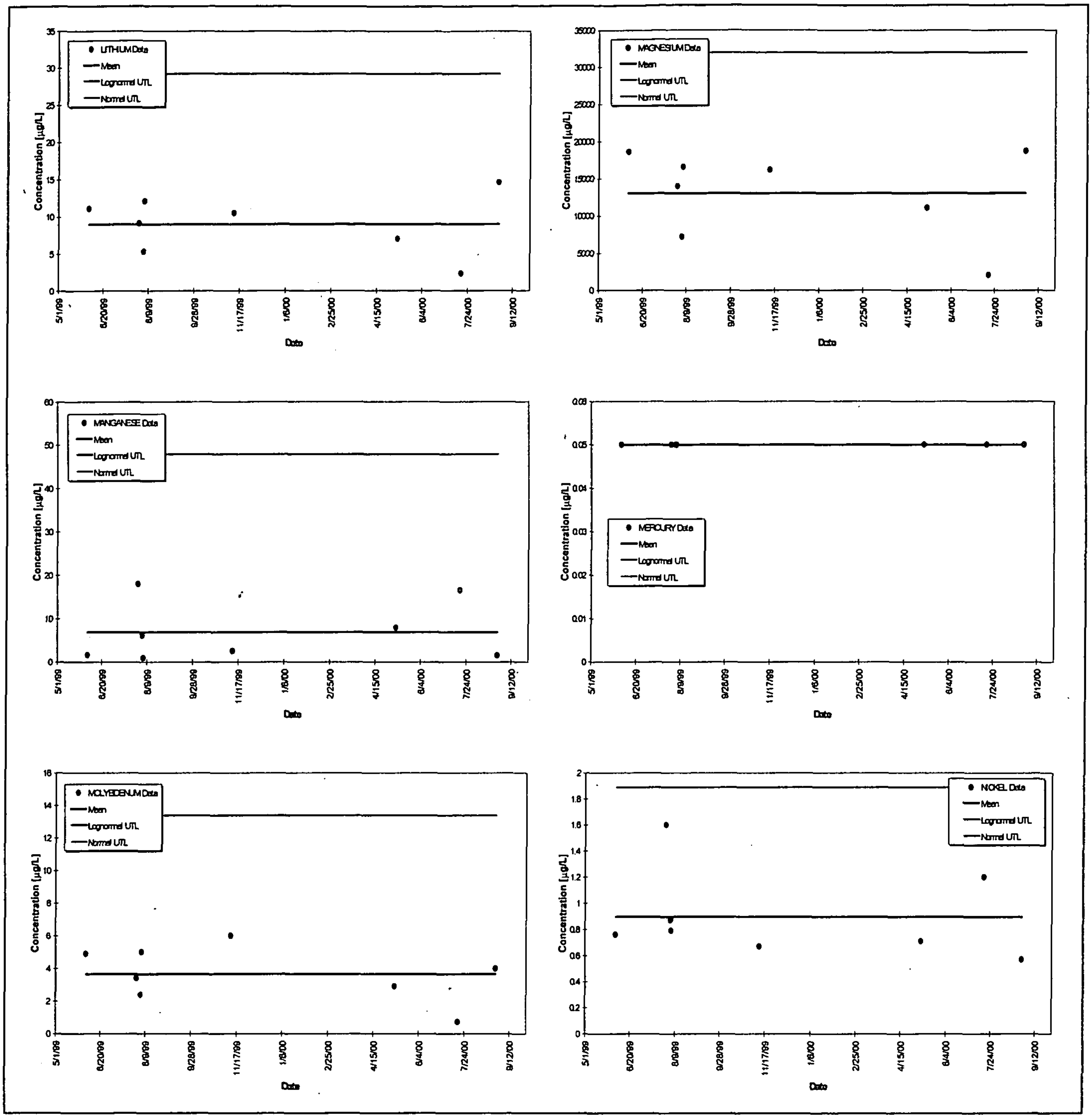

Figure 10-76. Total Metals UTL Plots for GS43: Lithium through Nickel.

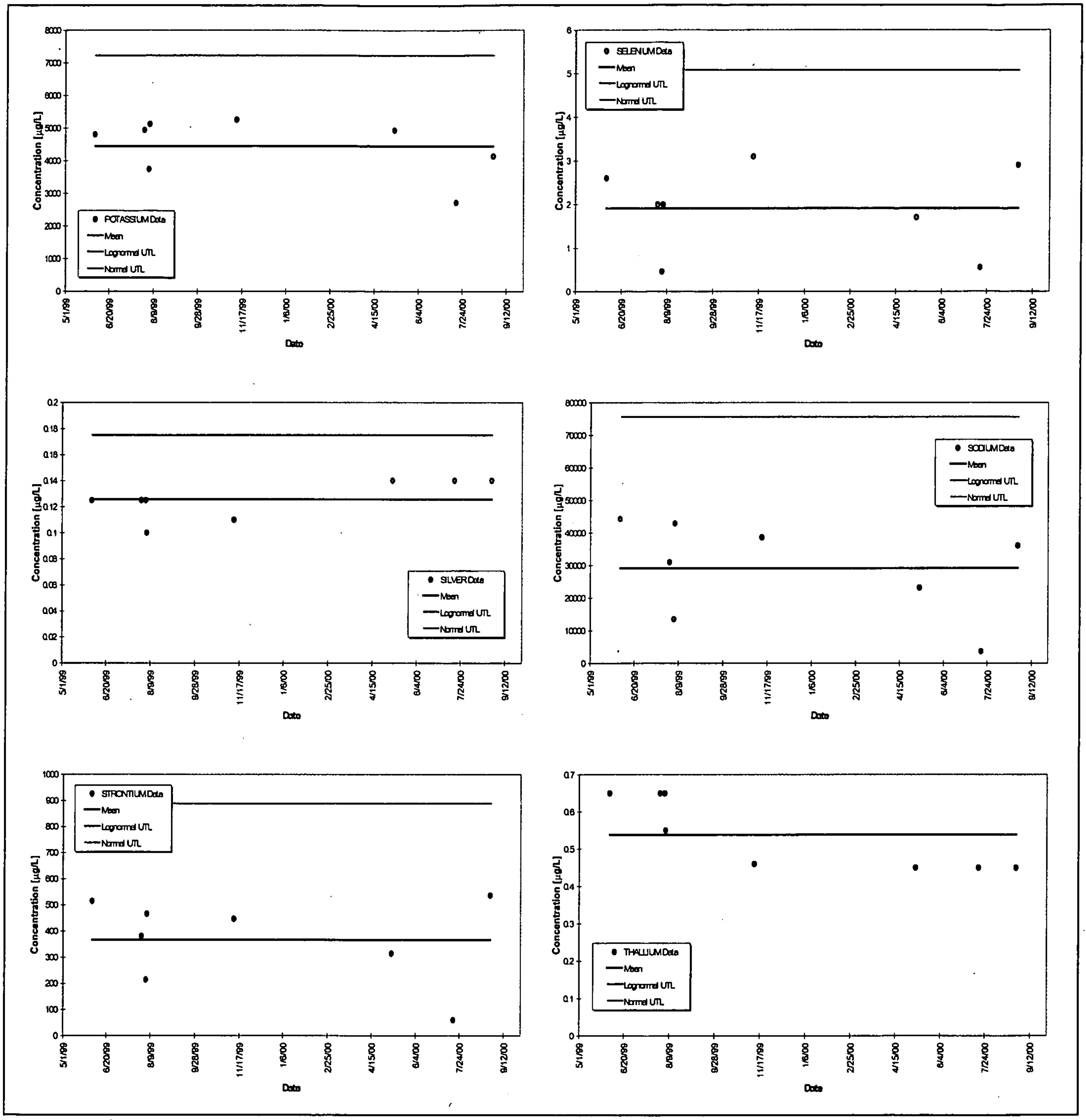

Figure 10-77. Total Metals UTL Plots for GS43: Potassium through Thallium.

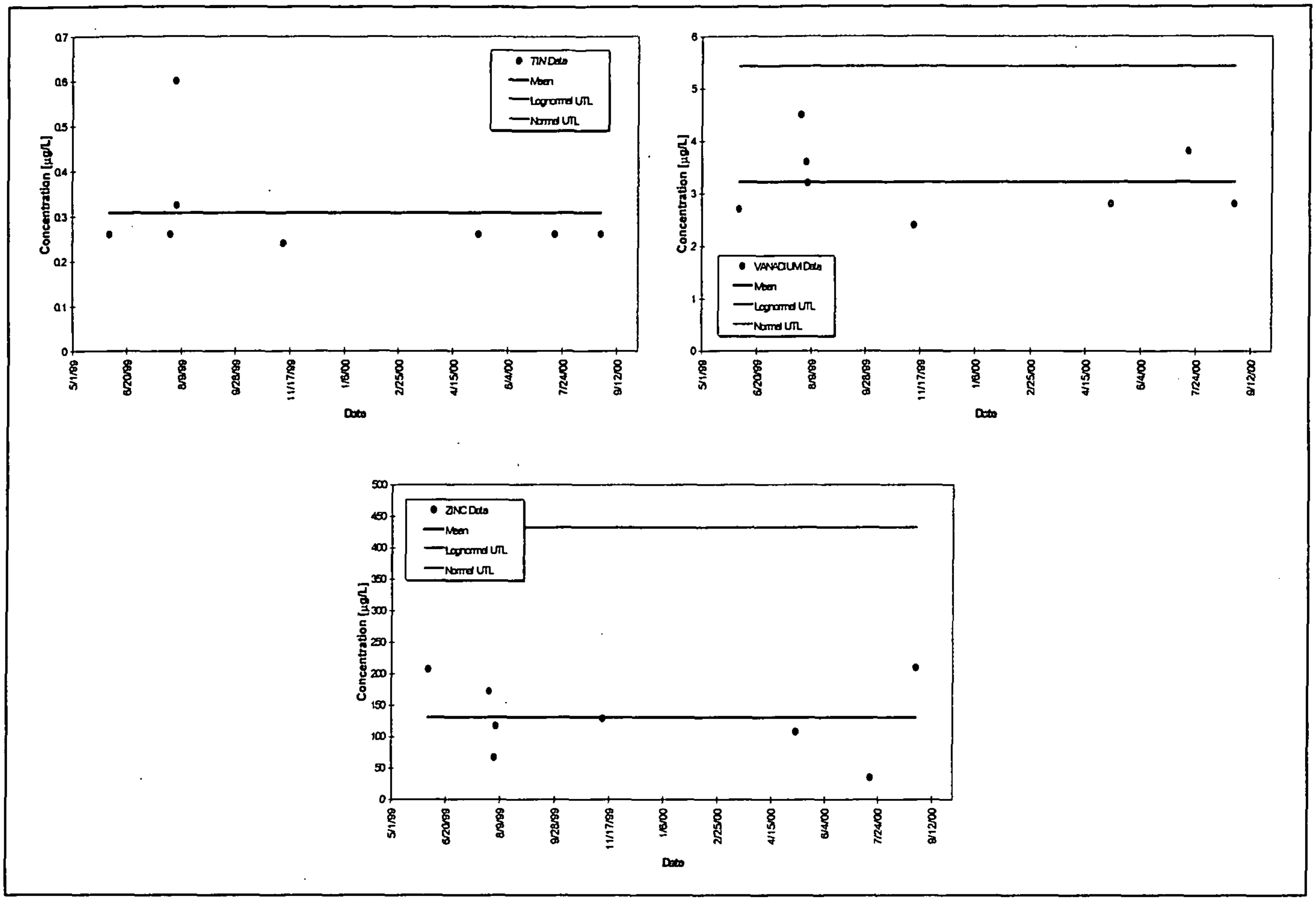

Figure 10-78. Total Metals UTL Plots for GS43: Tin through Zinc.

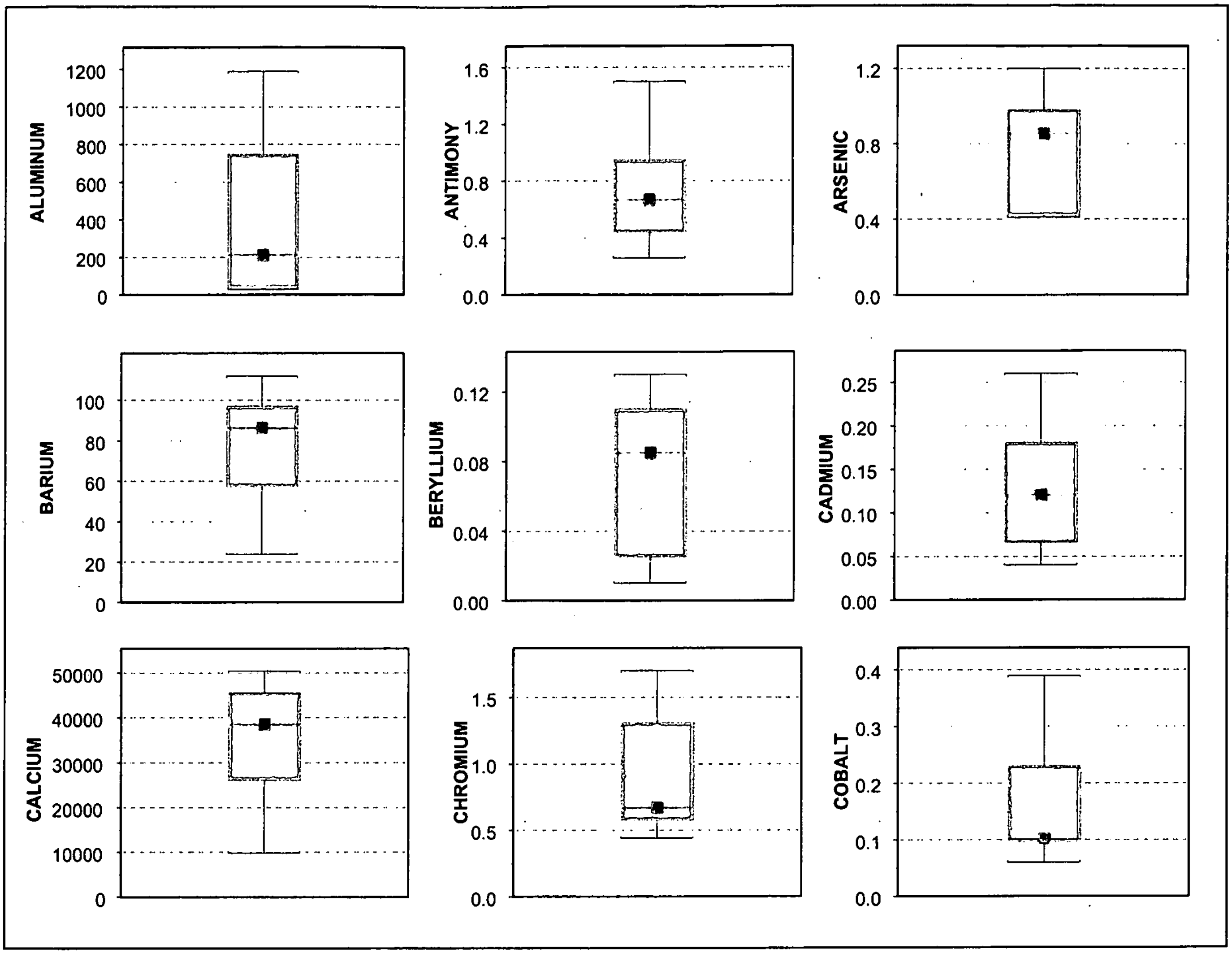

Figure 10-79. Total Metals Box Plots for GS43: Aluminum through Cobalt.

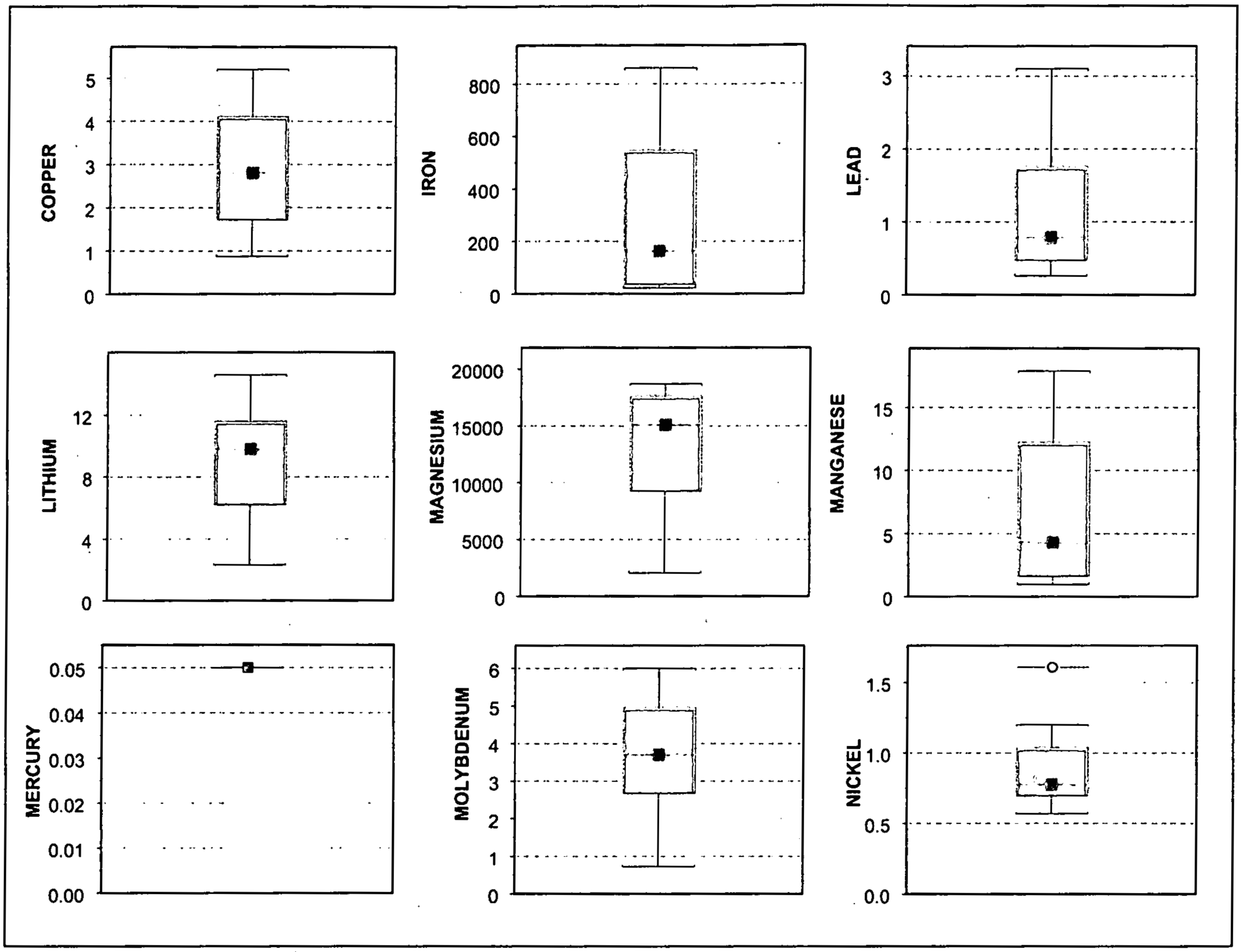

Figure 10-80. Total Metals Box Plots for GS43: Copper through Nickel.

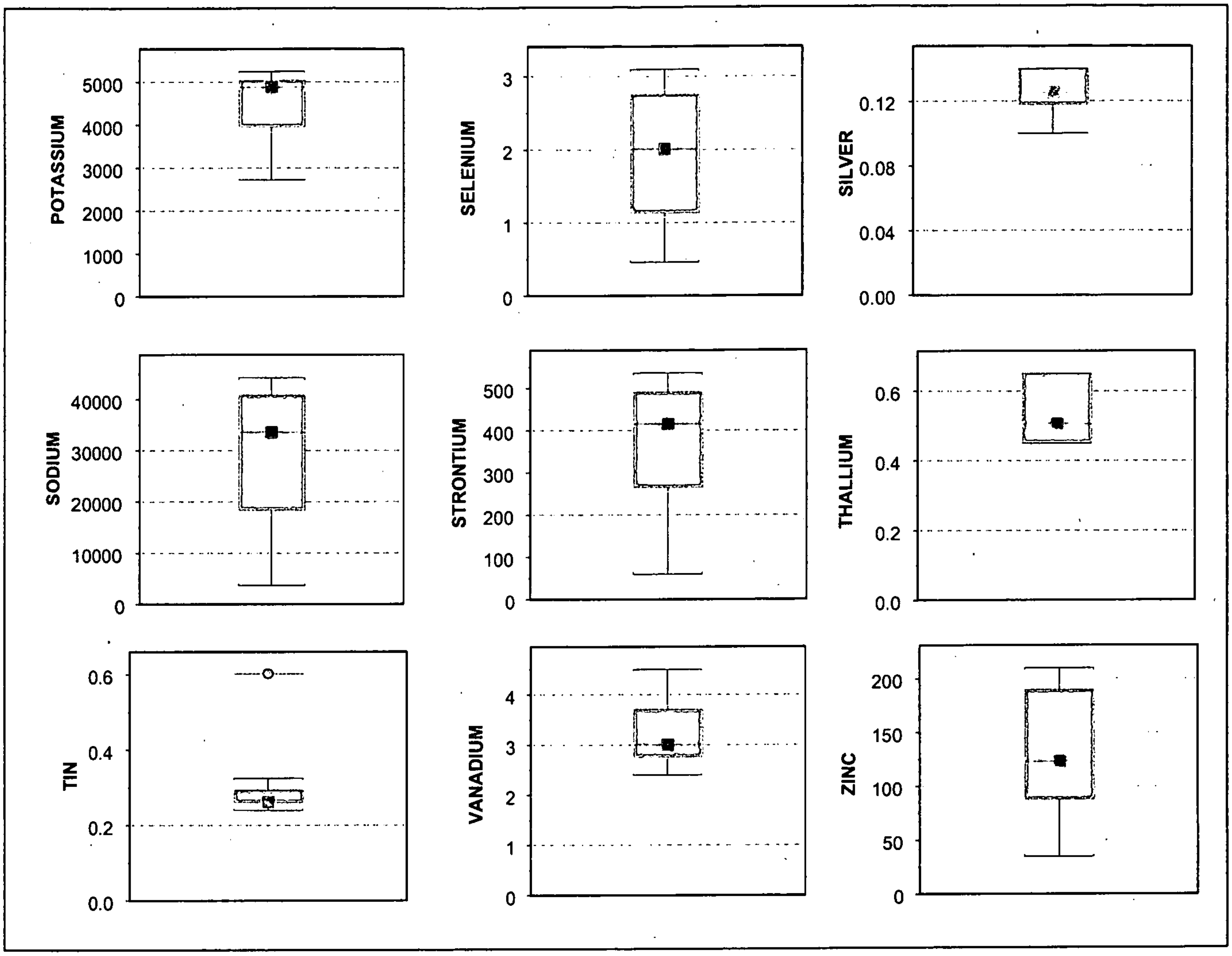

Figure 10-81. Total Metals Box Plots for GS43: Potassium through Zinc.

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11. NEW SOURCE DETECTION MONITORING

The New Source Detection (NSD) monitoring objective provides comprehensive coverage of the entire IA but is not specifically focused on individual actions within the IA. Performance monitoring of specific activities within the IA (or elsewhere) may be carried out under the Performance monitoring objective. This NSD objective monitors the performance of all remedial activities within the IA with respect to their impact on surface waters. However, it does not necessarily identify and locate a specific source within the IA[28]. This monitoring objective provides for monitoring of all main drainages from the IA into the three main channels of Stream Segment 5.

11.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

This objective requires contaminant concentration data from surface-water samples taken at permanent monitoring locations located on the five main surface-water pathways to the Site detention ponds. Analyses are performed for each of the contaminants and parameters listed below in order to establish a baseline. After a baseline has been established, evaluations will be performed as required by the decision rules. The basis for selecting these contaminants of concern and indicator parameters is described below.

- Pu, U, and Am are primary contaminants of concern to the regulators and the public.
- Turbidity, pH, nitrate (NO_3^-), and conductivity are analyses performed continuously because they are inexpensive per measurement and can be used as real-time indicators to provide or negate reasonable cause to analyze for other specific contaminants.
- Turbidity may indicate increased contaminant loads in general and increased Pu specifically. (Pu in surface water is generally bound to particulates).
- pH can be used to detect an acid or caustic spill.
- Nitrate can be used in real-time to detect chemical spills that include plutonium nitrate.
- Conductivity can be used to corroborate a pH reading and to detect salt solution spills or significant concentrations of ionic contaminants.
- Precipitation data are used to determine whether a flow event results from rain/snow runoff, an operational discharge[29], or a spill. Precipitation data are collected at 10 locations across the Site. From these, effective precipitation for a given monitoring location drainage can be calculated.
- Water flow rate is needed to identify an event, trigger an automatic sampler, control the flow-paced sampling, and evaluate the magnitude of the spill or contaminant source (mass loading).
- Small changes to apparent base flow not attributable to rain and snow melt, or unusual runoff hydrograph shapes, may indicate a spill or operational discharge.

This monitoring objective is limited to information collected at the IA boundary, as represented by surface-water monitoring stations SW022, SW091, SW093, SW027, and GS10[30] (see Figure 11-1). This monitoring focuses on runoff into the three main drainage areas leaving the IA: North Walnut Creek, South Walnut Creek, and the South Interceptor Ditch / Pond C-2 drainage (see Figure 2-3). SW022 waters are normally monitored subsequently at GS10, so there is some redundancy in this set of monitoring stations. SW022 has been included at the request of

[28] Location of a specific source would be performed under the Source Location monitoring objective described in Section 6.

[29] An operational discharge can be defined as a footing drain or sump discharged to ground, an incidental water discharged to ground, spray water used for dust suppression during D&D, fire hydrant testing, a utility line break, etc.

[30] Subdrainage monitoring stations within the IA are used for Performance monitoring and source location but are excluded from the planned monitoring for this NSD decision rule.

the EPA to provide increased sensitivity for its drainage area. Data from SW022 would also be used to aid the location of any new source detected at GS10.

For SW022 (10/1/96 – 9/30/99) and SW091, sampling is event-specific, focused on the time period during which the first-flush conditions prevail; specifically, during the rising limb of a direct runoff hydrograph after any storm event.[31] Starting on 10/1/99, SW022 began collecting continuous flow-paced composite samples. For SW093, GS10, and SW027, the analytical data used for the NSD objective will be the same data as collected from the continuous flow-paced sampling used for monitoring Segment 5 Action Level compliance (see Section 12).

Only surface-water runoff from the IA is included, (i.e., baseflow, stormwater runoff flow, operational discharges, and spills to surface water). Spills are only included in this NSD monitoring as a secondary monitoring objective if an increase in flow rate is detected and cannot be attributed to precipitation runoff or other identified discharge. However, other management controls (e.g., Spill Prevention, Control, and Countermeasures Plan [SPCC; RFCSS 2002] and Storm Water Pollution Prevention Plan [SWPPP; RFCSS 2001) address monitoring of spills as a primary objective. Three of these NSD locations also provide confirmation that containment measures for spills or accidental discharges have been effective through monitoring of the real-time indicator parameters.[32]

Indicator monitoring will be performed for the parameters specified at the top of each column of Table 11-1. The first three columns are Analytes of Interest (AoIs) monitored directly through sample analytical measurements. Although these three columns and rows have a different relationship than the others, they have been included so that all monitored parameters are shown on the same table. The remaining columns are indicator parameters that are monitored with inexpensive real-time probes in lieu of analyzing for the AoIs identified at the left of each row.

Table 11-1. Screening for New Source Detection: AoIs vs. Indicator Parameters.

	Routinely Monitored Parameters							
	Monitored AoIs			Indicator Parameters for AoIs				
AoIs	Pu	U	Am	Turbidity	pH	Conductivity	Nitrate	Flow Rate; Precipitation[a]
Plutonium	X			X			X	X
Uranium		X						X
Americium			X	X				X
Turbidity				X				X
pH					X		X	X
Conductivity						X		X
Nitrate						X	X	X
Chromium					X	X	X	X
Beryllium						X		X
Silver						X		X
Cadmium						X	X	X

Notes: [a] Precipitation data are collected at Sitewide locations. Precipitation data collection is not required at each NSD location, but Sitewide data are used for NSD evaluation.

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[31] Descriptions of sample collection protocols are given in the RFETS Automated Surface-Water Monitoring Work Plan.

[32] Real-time indicator measurement at SW022 and SW091 has proven impractical due to the ephemeral nature of the flow at these locations. The real-time water quality probes require that their sensors remain wet at all times. Since these locations are dry except during periods of direct runoff, the Site has historically employed 'sump' systems that use tap water to keep the sensors wet. These systems were designed to flush during direct runoff so that the tap water was replaced by runoff water. However, the relatively slow response time of the sensors often resulted in data that was poor or unusable. These sump systems were also susceptible the freezing during cold weather, which occasionally resulted in damage to the equipment. For these reasons, the Site has very limited real-time indicator data for SW022 and SW091, and water-quality probes are not routinely deployed at these locations.

11.2 WY97-00 MONITORING SCOPE

Table 11-2. New Source Detection Monitoring Locations.

ID Code	Location	Primary Flow Measurement Device	Telemetry
SW093	N. Walnut Cr. 1300' upstream from the A-1 Bypass	36" Suppressed Rectangular Sharp-Crested Weir	Yes
SW091	Gully NE of Solar Ponds outside inner fence	6" Cutthroat Flume	Yes
GS10	S. Walnut Cr. upstream from the B-1 Bypass	9" Parshall Flume	Yes
SW022	Central Avenue Ditch at inner east fence	9.5" Parshall Flume	Yes
SW027	South Interceptor Ditch just upstream of Pond C-2	Dual Parallel 120° V-Notch Weirs	Yes

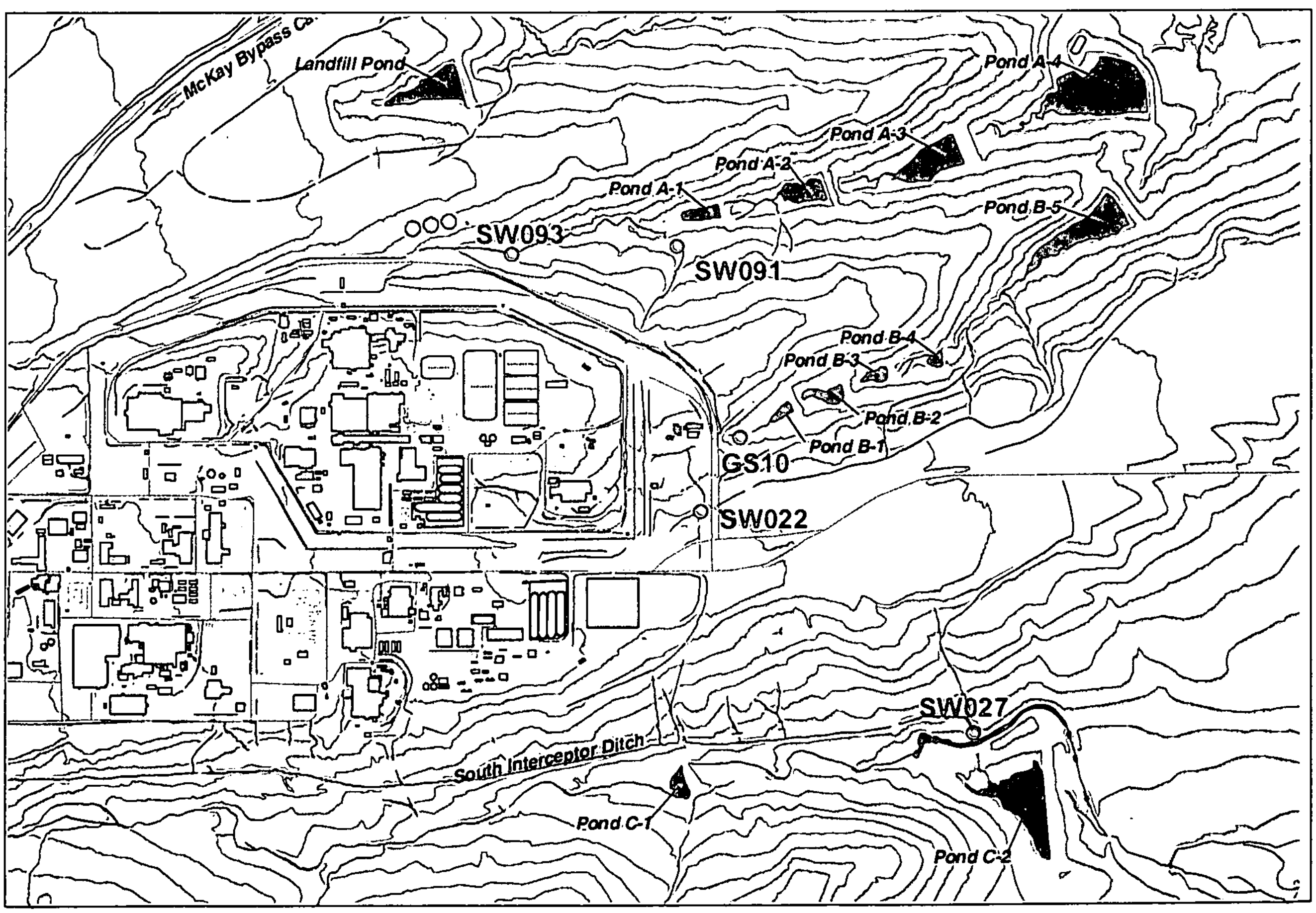

Figure 11-1. Water Year 1997-2000 New Source Detection Monitoring Locations.

Table 11-3. New Source Detection Field Data Collection: Parameters and Frequency.

ID Code	Parameter		
	Discharge	Real-Time pH, Conductivity, Turbidity, Nitrate	Precipitation
SW093	15-min continuous	15-min continuous	NA
SW091	15-min continuous	See footnote 32	NA
GS10	15-min continuous	15-min continuous	NA
SW022	15-min continuous	See footnote 32	5-min continuous
SW027	15-min continuous	15-min continuous	NA

Table 11-4. New Source Detection Sample Collection Protocols.

ID Code	Frequency[a]	Type[b]
SW093	12 per year[c]	Continuous flow-paced composites
SW091	1 per month[d]	Storm-event rising-limb flow-paced composites
GS10	12 per year[c]	Continuous flow-paced composites
SW022	1 per month[d]; 12 per year[c]	Storm-event rising-limb flow-paced composites (10/1/96 – 9/30/99; Continuous flow-paced composites (10/1/99 -)
SW027	12 per year[c]	Continuous flow-paced composites

Notes: [a] Only SW091 and SW022 are sampled on the rising limb of the hydrograph, as originally specified for this decision rule. Stations SW093, SW027, and GS10 are the Segment 5 Action Level (POE) monitoring stations (see Section 12). At these Segment 5 stations, NSD is performed by statistically testing the continuous flow-paced sample results required for the POE objective. The same test criterion will be used, except that continuous flow-paced samples will be tested against flow-paced variability. These locations will collect more than the target 12 samples for the NSD objective. All results collected at these locations under the POE objective will be used in the NSD objective.
[b] Sample types are defined in the RFETS Automated Surface-Water Monitoring Work Plan.
[c] Sample frequency distribution during the year for SW093, GS10, and SW027 (POEs) is given in Section 12.
[d] Storm-event sampling at locations which are often dry, and normally only receive direct runoff, is opportunistic. These locations may see flow only during wet months. Every attempt is made to achieve the target sample frequency; however, this is not always possible.

Table 11-5. New Source Detection Analytical Targets (Analyses per Year).

ID Code	Pu, U, Am
SW093[a]	12
SW091	12
GS10[a]	12
SW022	12
SW027[a]	12

Notes: [a] Stations SW093, SW027, and GS10 are the Segment 5 Action Level (POE) monitoring stations (see Section 12). At these Segment 5 stations, NSD will be performed by statistically testing the continuous flow-paced sample results required for the POE objective. The same test criterion will be used, except that continuous flow-paced samples will be tested against flow-paced variability. These locations will collect more than the target 12 samples for the NSD objective. All results collected at these locations under the POE objective will be used in the NSD objective.

11.3 DATA EVALUATION

Indicator monitoring is performed for the parameters specified at the top of each column of Table 11-1. The first three columns are Analytes of Interest (AoIs) monitored directly through sample analytical measurements. The remaining columns are indicator parameters that are monitored with inexpensive real-time probes in lieu of analyzing for the AoIs identified at the left of each row. If a significant increase is detected in any one of these indicator parameters, then there is reasonable cause to suspect the presence of the AoI identified at the left end of the row in which an "X" appears. For example, if the nitrate probe detects a high nitrate concentration, then the Site would have reasonable cause to suspect the presence of plutonium nitrate, extreme pH, cadmium nitrate, and, of course, high nitrate, all of which are AoIs for Segment 5. If there were reasonable cause to suspect the presence of these analytes of interest, then the Site would perform additional analytical procedures specific for the analytes of interest.

Data collected by water-quality probes at New Source Detection locations are considered and evaluated, at a minimum, in the following ways:

- Daily average values are checked qualitatively (daily on work days) using the radio telemetry equipment;
- A general qualitative evaluation of data is performed (generally monthly);
- A detailed work-up of 15-minute data is generated and archived (generally monthly); and
- A detailed work-up and evaluation of daily averages is completed and archived (generally monthly).

Each of these data evaluation activities is completed for all water-quality parameters measured by the probes. Additional evaluation may be performed for a variety of reasons including spill investigations, special requests, and studies of probe performance. The above listed data evaluation activities are described individually, in greater detail in Appendix B.5: Real-Time Water-Quality Parameters. Due to the relatively high error associated with the nitrate sensor readings (see footnote in Appendix B.5.1), nitrate data are not presented in this section. Nitrate data are presented in Appendix B.5.2 for reference. Plots of the other mean daily water-quality parameter values are given below. More detailed data for all parameters are presented in Appendix B.5.2.

Generally, analytical data evaluation is performed as data become available, especially if an initial qualitative screening based on process knowledge indicates that an analytical result is higher than normal for a particular location. The desired evaluation frequency is semi-monthly, within one week of the 15th and last day of any given month.

Screening for reasonable cause to suspect a new source:

IF — The mean concentration of any of the screening indicator variables in Table 11-1 exceeds the 95% UTL/LTL of baseline for that variable,

THEN — The Site will evaluate the need for further action under RFCA ALF, such as source evaluation and control. Evaluations will address persistence, trends, and risk of Action Level exceedances at POEs.

Table 11-6. New Source Detection Monitoring Analytical Data Evaluation.

ID Code	Evaluation Type[a]
SW093	95% UTLs; Loading Analysis
SW091	95% UTLs
GS10	95% UTLs; Loading Analysis
SW022	95% UTLs
SW027	95% UTLs; Loading Analysis

Notes: [a] Details on the evaluation of analytical results are given in the RFETS Automated Surface-Water Monitoring Work Plan.

The following sections present the NSD monitoring data evaluations on a location-specific basis. Each section includes a table of summary statistics for the location-specific analytes of interest, 95% UTL plots, box-whisker plots, and plots of the temporal variation of suspended solids Pu and Am activity.

The following evaluations include all results that were not rejected through the verification/validation process. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' value and the 'duplicate'. When a sample has multiple 'real' analyses (Site requested 're-runs'), the value used in calculations is the arithmetic average of the multiple 'real' analyses. Total uranium is calculated by summing the activities for the analyzed isotopes (U-233,234 + U-235 + U-238).

For the summary tables, when a negative radionuclide result (e.g. -0.002 pCi/l) is returned from the laboratory due to blank correction, then a value of 0.0 pCi/l is used for calculation purposes. When TSS results are returned from the laboratory as 'undetect', ½ of the detection limit is used for calculation purposes.

The method for calculating UTLs is given in Appendix B.1: Data Evaluation Methods. For this report, the four year period of WY97–00 was used to calculate the UTL values. UTL lines are shown on the plots only for the determined distribution. When the data may satisfy either distribution, both UTL lines are plotted; when no distribution is determined, no line is plotted.

Box-whisker plots were calculated using S-Plus statistical evaluation software. For these plots, when a negative radionuclide result (e.g. -0.002 pCi/l) is returned from the laboratory due to blank correction, then a value of 0.0 pCi/l is used for calculation purposes. A key describing the components of the box-whisker plots is given in Appendix B.1: Data Evaluation Methods.

The temporal variation of suspended solids activity plots are included as an indication of changes in the contamination characteristics of a particular drainage basin. A suspended solids activity that decreases over time may indicate that contaminant sources have been removed from the drainage, clean solids have become more available to runoff, or contaminant sources have been naturally attenuated over time. Similarly, a suspended solids activity that increases over time may indicate that new contaminant sources have become available for transport in the drainage. TSS analysis is only performed for composite samples that are collected over a period of less than the TSS hold time (7 days). Consequently, not all samples collected at the locations below were analyzed for TSS. Only values greater than the detection limit (generally 5 mg/L for TSS, 0.015 pCi/L for Pu and Am) are included.

Plots of mean daily water temperature, pH, specific conductivity, and turbidity are also included.[33] The methods used for the water-quality parameter evaluations are given in Appendix B.5: Real-Time Water-Quality Parameters.

The loading analysis for GS10, SW027, and SW093 is presented in Section 5.

11.3.1 Location GS10

Monitoring location GS10 is located on S. Walnut Cr. at the perimeter of the IA just upstream of the B-Series ponds. Figure 3-25 shows the drainage area for GS10. The 100, 300, 400, 500, 600, 700, 800, and 900 areas all contribute flow to GS10.

Monitoring data collected at GS10 show the highest Pu and Am activities measured for the NSD monitoring locations (Table 11-7). Figure 11-2 and Figure 11-3 show the UTL plots for Pu and Am, respectively. During WY97–00, several Pu results exceeded the calculated UTL, with significant variability in the results. A distribution could not be determined for Am, but the UTL plot also shows significant variability with numerous 'suspect' results indicated by the box plot (Figure 11-5). These higher activities frequently resulted in reportable 30-day averages under the POE monitoring objective (Section 12). In response, the Site was required to perform multiple source evaluations to address these reportable values. A summary of the extensive investigations is given in Section 6.3.

[33] Mean daily water-quality values are given for days of measurable flow. Some data may be missing due to equipment failures and removal for calibration.

Table 11-7 shows moderate uranium activities at GS10. A distribution could not be determined for uranium, but the UTL plot (Figure 11-4) shows moderate variability with no 'suspect' results indicated by the box plot (Figure 11-5).

GS10 shows a decreasing temporal trend in suspended solids activity (Figure 11-6), but the correlation is weak.

Table 11-7. Summary Statistics for Radionuclide Results from GS10: Water Years 1997-2000.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
Pu-239,240	135	0.054	0.203	2.270	0.862[a]
Am-241	132	0.062	0.212	8.385	[c]
Total Uranium	135	2.867	4.009	5.750	[c]

Note: Total uranium is calculated as the sum of the isotopic (U-233,234; U-235; U-238) activities.
[a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

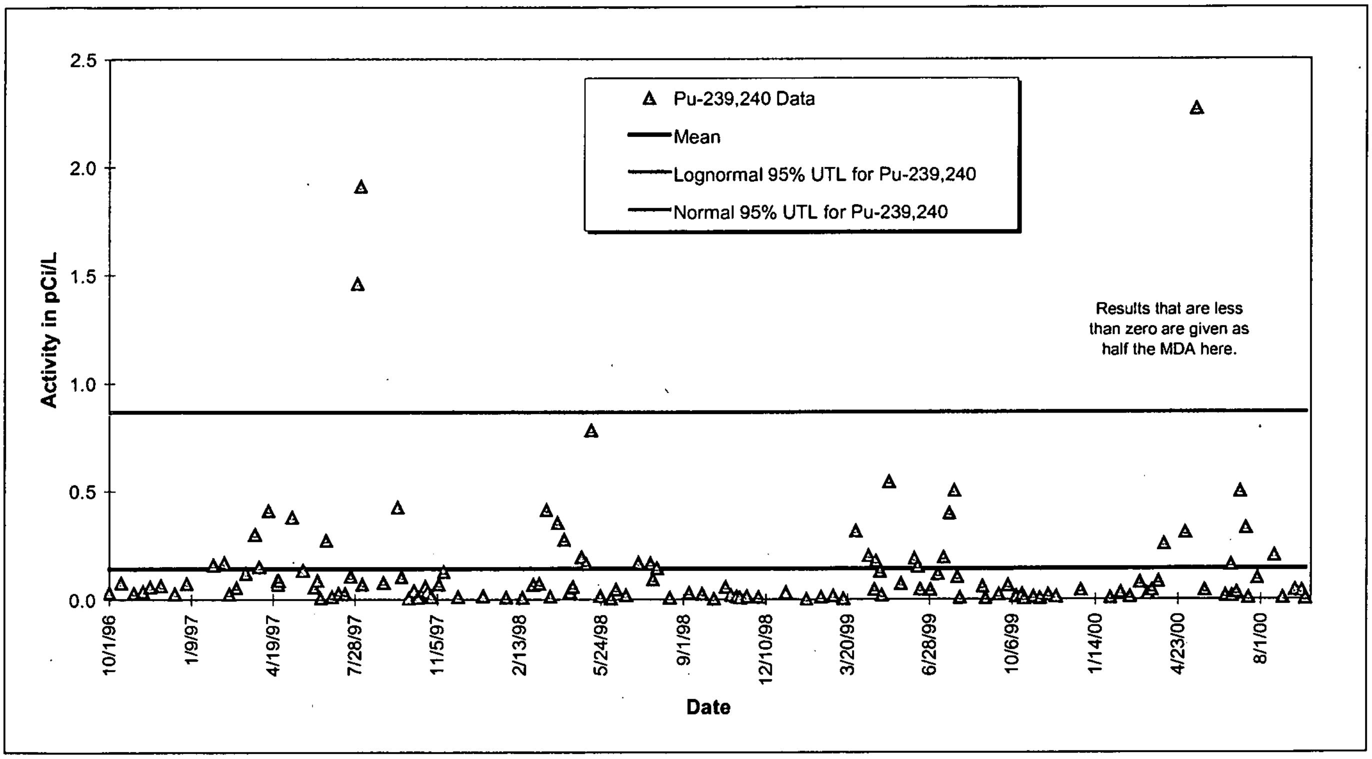

Figure 11-2. 95% UTL Plot for Pu-239,240 at GS10: WY97-00.

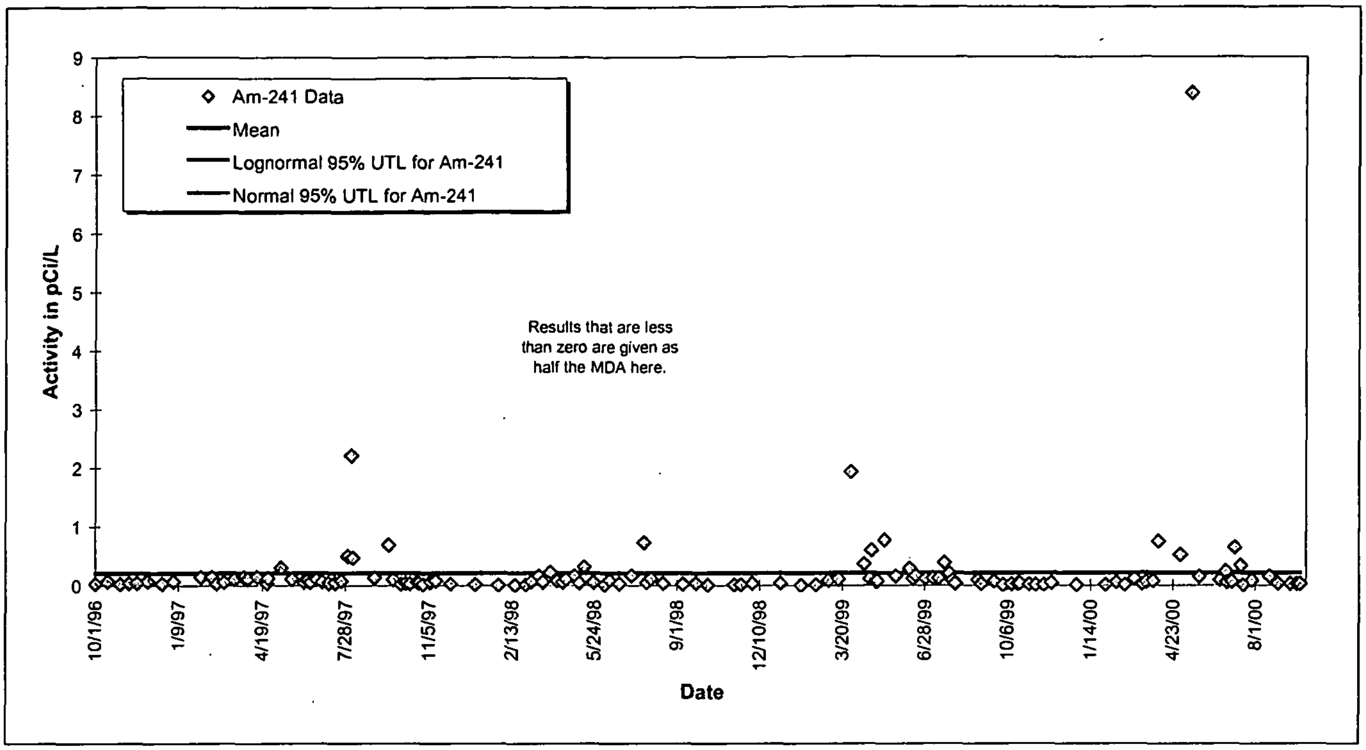

Figure 11-3. 95% UTL Plot for Am-241 at GS10: WY97-00.

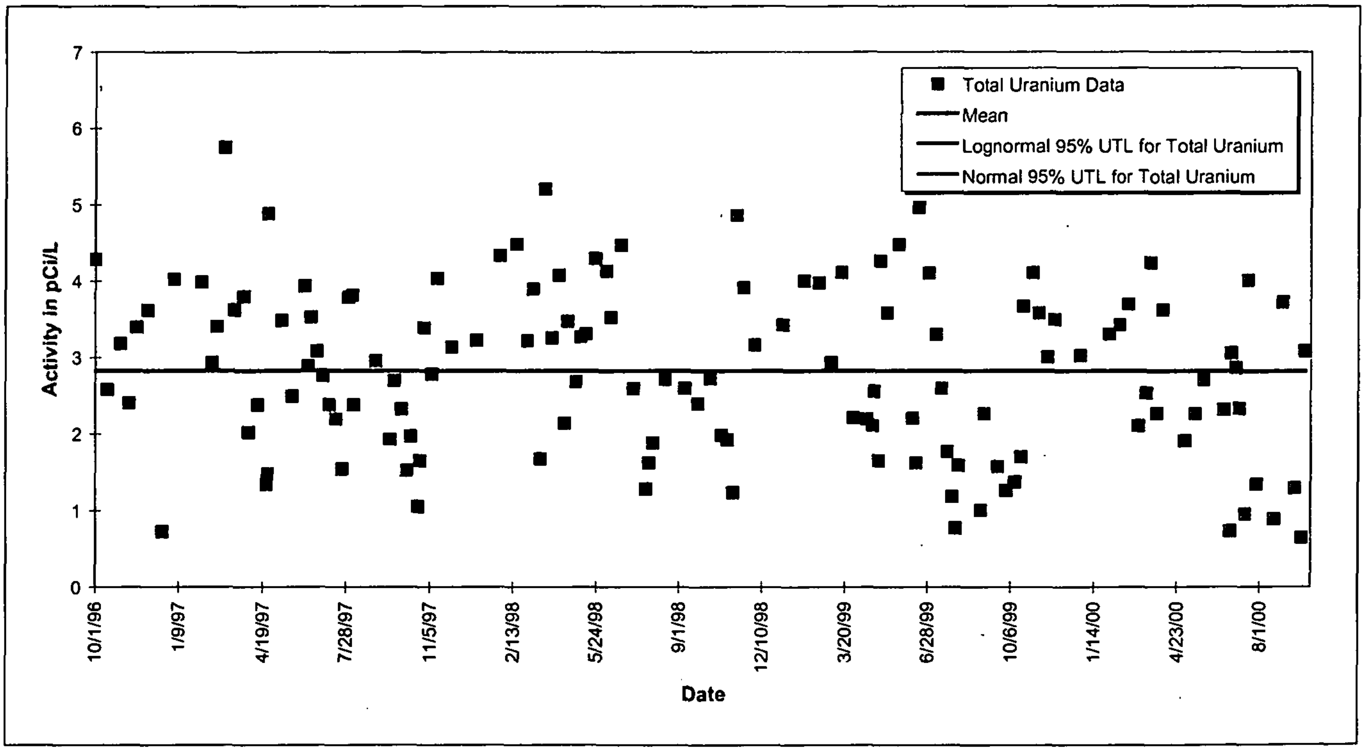

Figure 11-4. 95% UTL Plot for Total Uranium at GS10: WY97-00.

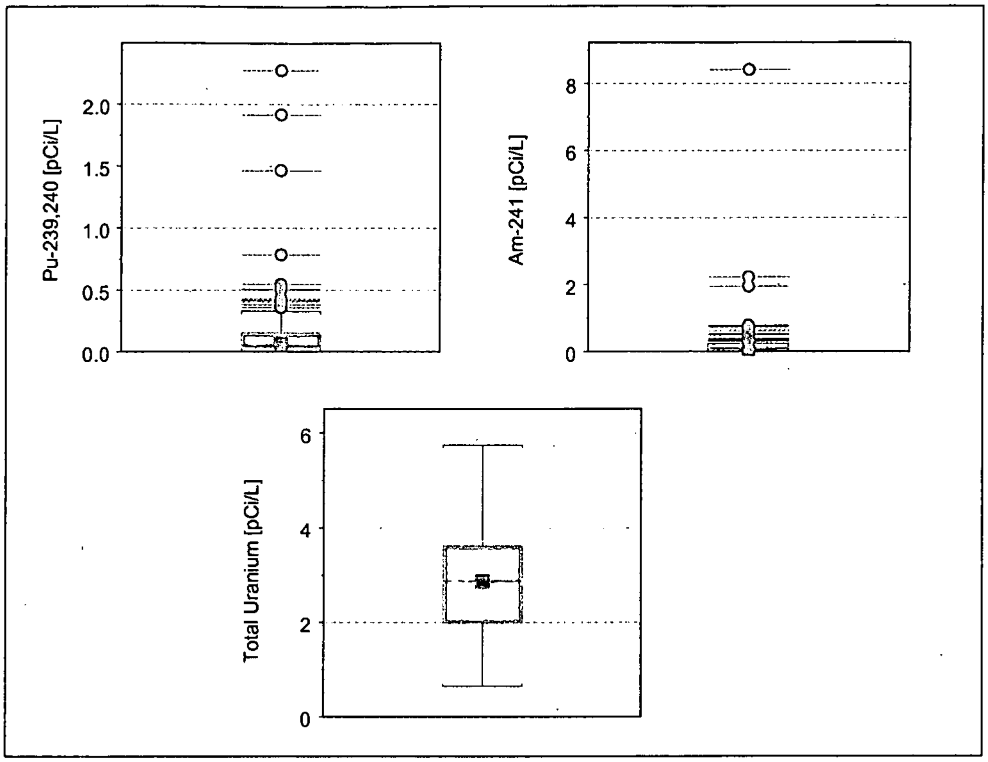

Figure 11-5. Radionuclide Box Plots for GS10: WY97–00.

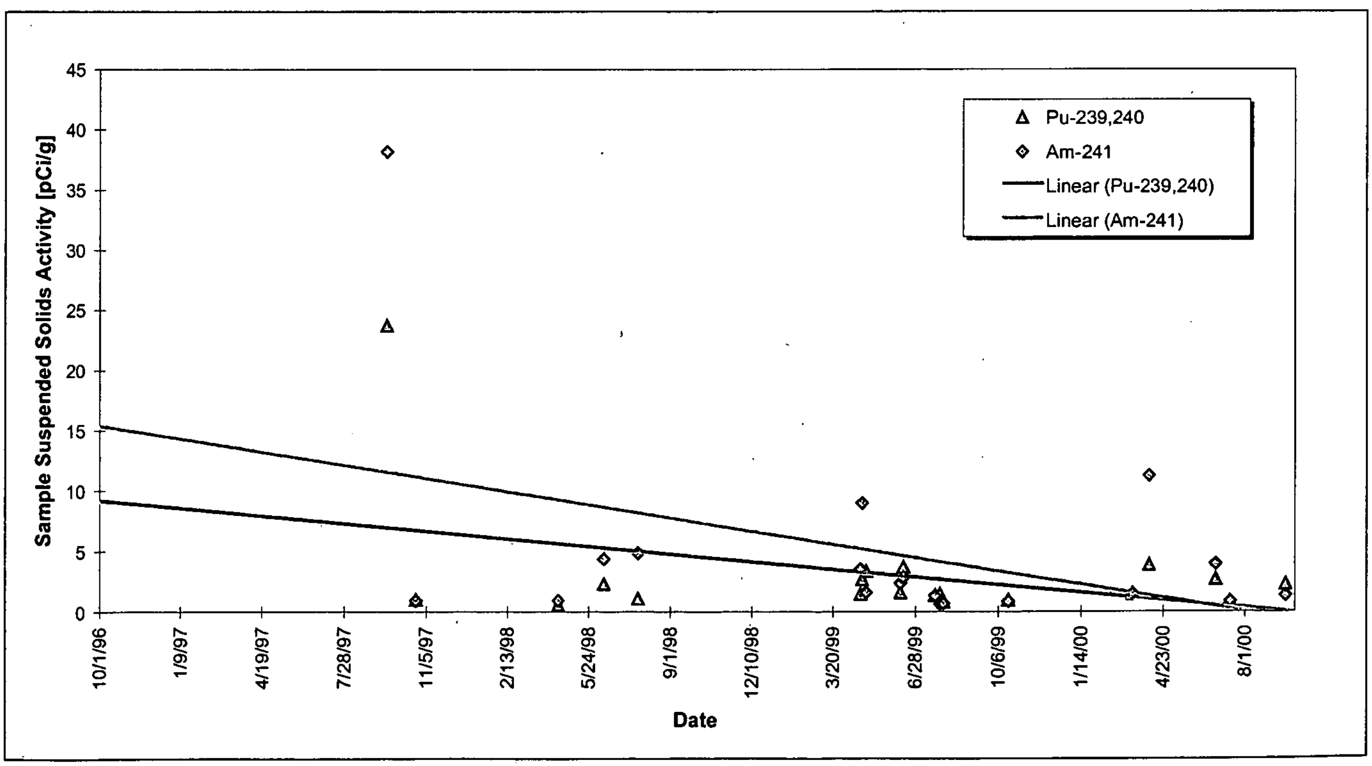

Figure 11-6. Temporal Variation of Suspended Solids Activity at GS10: WY97–00.

Mean daily water-quality parameter data are plotted in Figure 11-7 through Figure 11-10 along with the mean daily flow rate. Figure 11-7 shows the expected annual variation in water temperature. Figure 11-8 shows elevated conductivities during the winter months, most likely a result of road and walkway deicing operations.

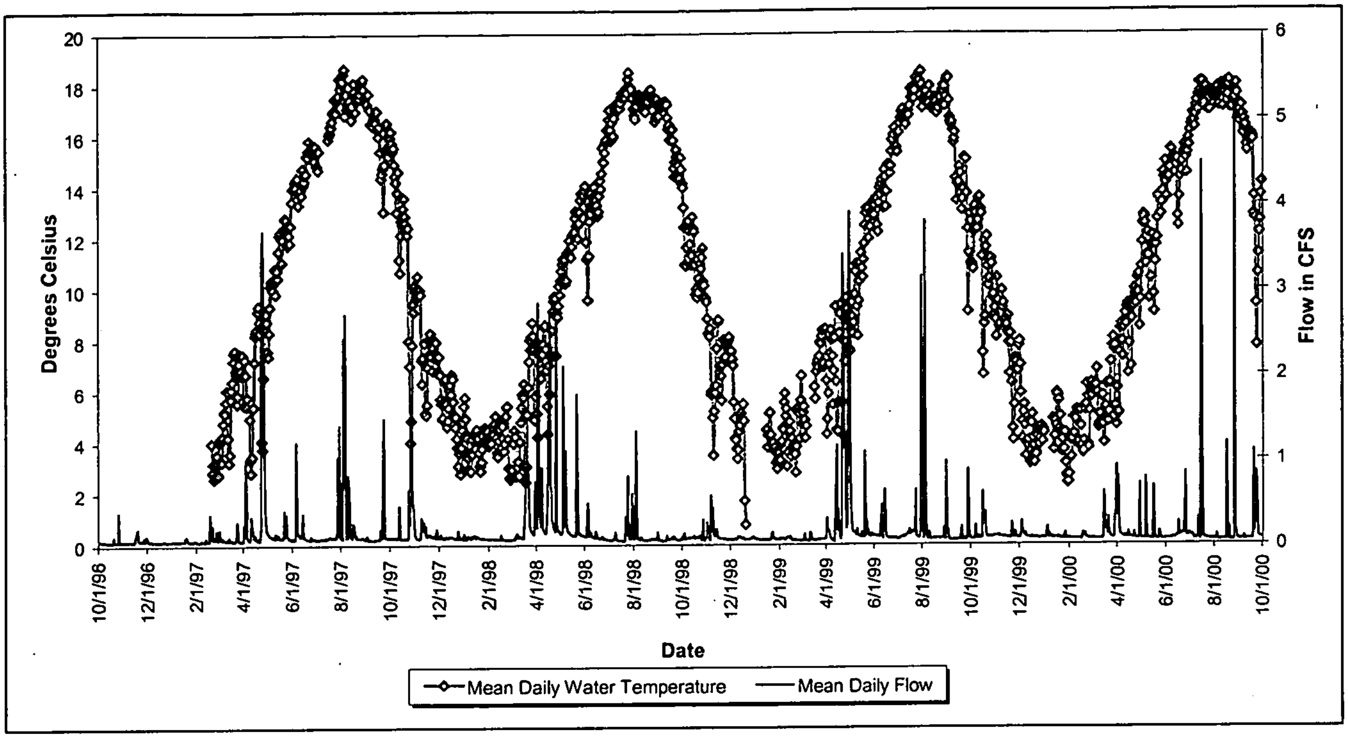

Figure 11-7. Mean Daily Water Temperature at GS10: Water Years 1997 – 2000.

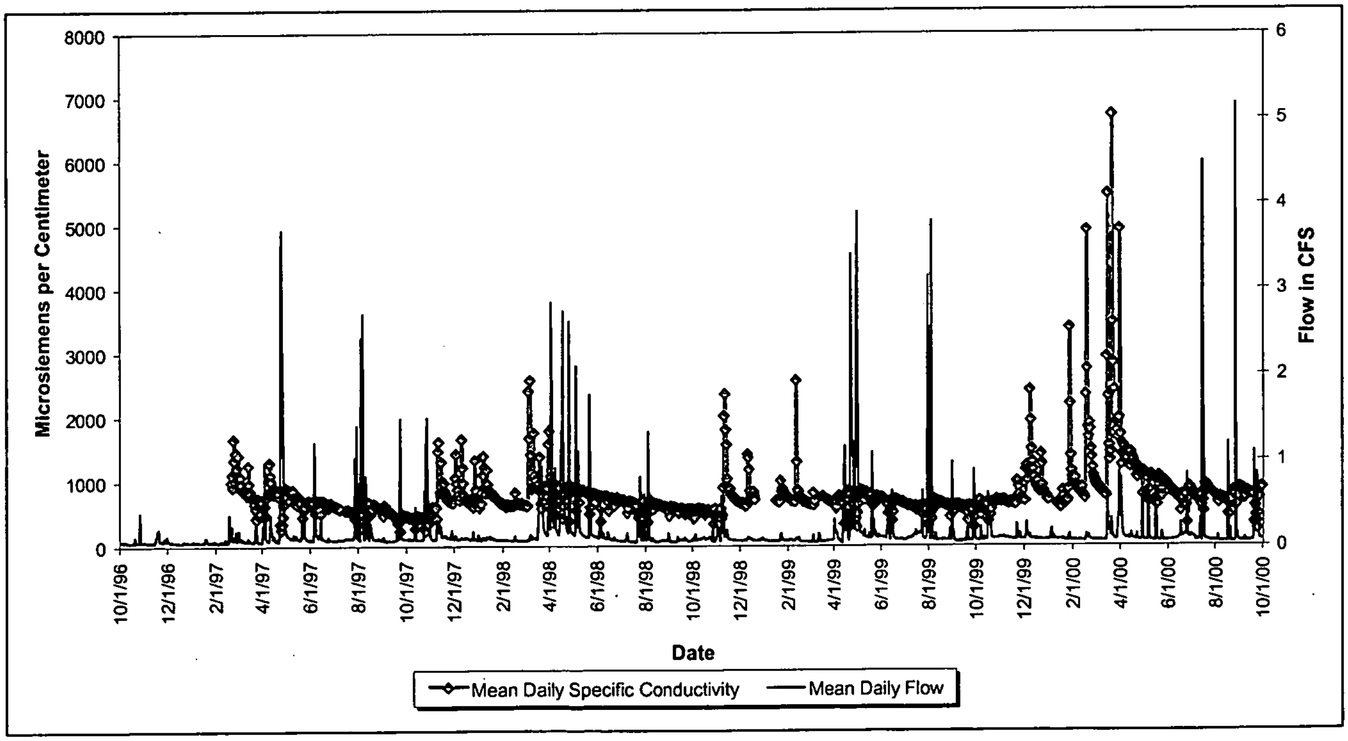

Figure 11-8. Mean Daily Specific Conductivity at GS10: Water Years 1997 – 2000.

Figure 11-9 shows the mean daily pH varying between 7.0 and 8.5. Finally, Figure 11-10 shows elevated turbidity measurements tracking the flow rate in time and magnitude, as expected when higher flow rates transport more suspended solids.

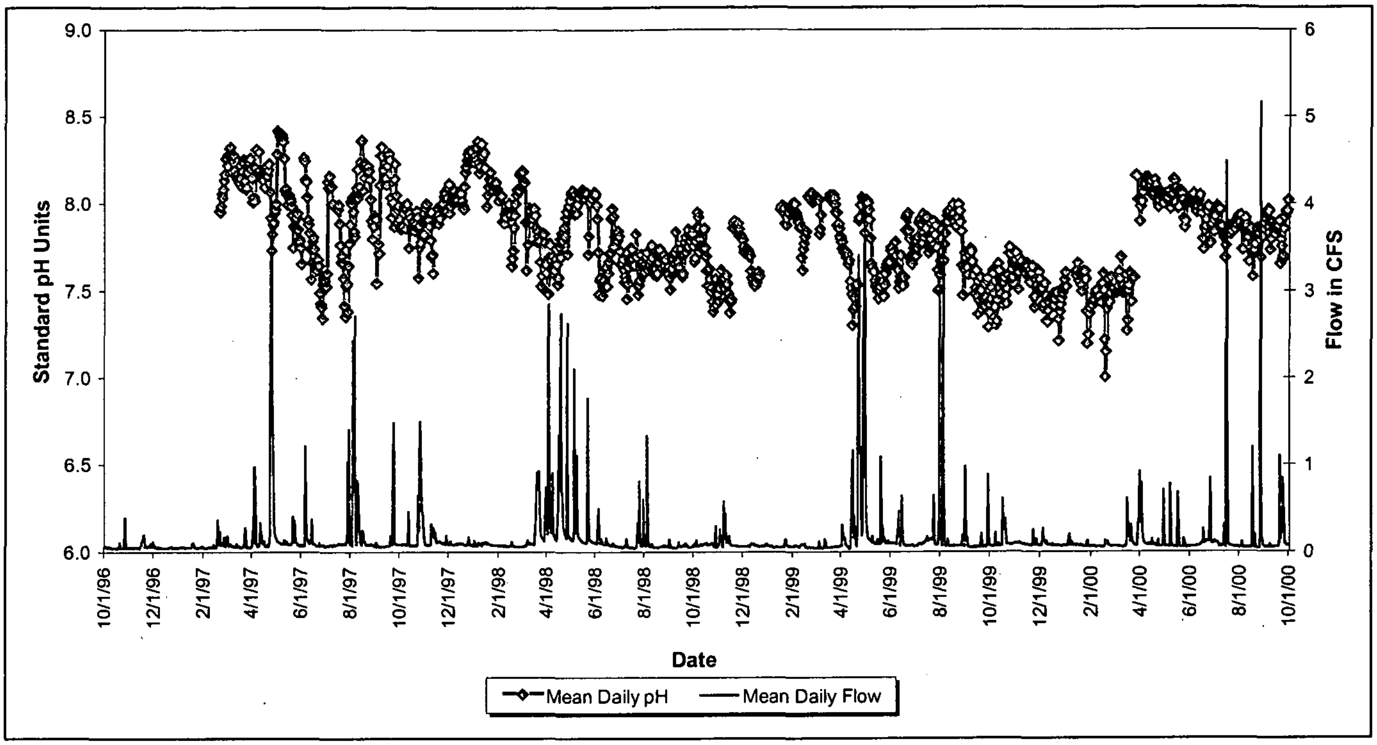

Figure 11-9. Mean Daily pH at GS10: Water Years 1997 – 2000.

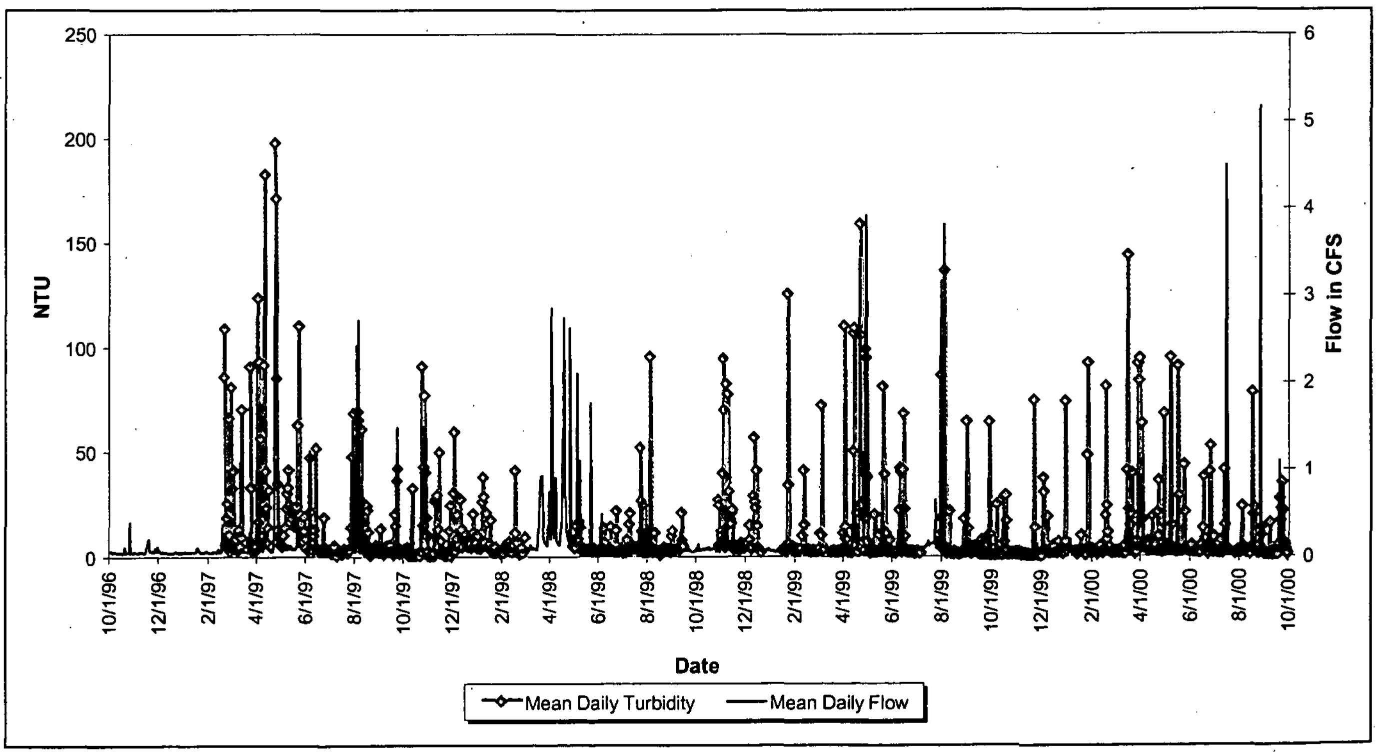

Figure 11-10. Mean Daily Turbidity at GS10: Water Years 1997 – 2000.

11.3.2 Location SW022

Monitoring location SW022 is located at the end of Central Avenue Ditch just upstream of the diversion structure that routes flows to S. Walnut Cr. and GS10. Figure 3-68 shows the drainage area for SW022. The 100, 400, 600, 800, and 900 areas all contribute flow to SW022.

Prior to WY00, SW022 collected storm-event rising-limb flow-paced composite samples.[34] Starting in WY00, SW022 began collecting more representative continuous flow-paced composite samples. Therefore, radionuclide evaluation below is performed separately for each sample type.

Monitoring data collected at SW022 show moderate median Pu and Am activities (Table 11-8 and Table 11-9), although several higher results have been obtained (Figure 11-14 and Figure 11-18). Figure 11-11 and Figure 11-15 show the Pu UTL plots for storm-event and continuous flow-paced samples, respectively. Figure 11-12 and Figure 11-16 show the Am UTL plots for storm-event and continuous flow-paced samples, respectively. During WY97–00, a single Pu and Am result exceeded the calculated UTL, and several higher results were noted. Although this sample was collected prior to excavation at T-1[35], staging of structures and equipment occurred during this time with disturbance of the surrounding soils taking place. Runoff was noted from the area surrounding the tent showing significant amounts of TSS. Although the measured TSS concentrations at SW022 were not unusually high for these samples, this area includes some of the higher surface-soil activities in the SW022 drainage. It is possible that this disturbed area resulted in runoff with unusually high activities. After completion of the project and revegetation[36], activities returned to more normal levels.

Monitoring data collected at SW022 show moderate median total uranium activities (Table 11-8 and Table 11-9). Figure 11-13 and Figure 11-17 show that none of the total uranium results were greater than the calculated UTL.

The temporal variation of suspended solids activity (Figure 10-52) shows a slight trend downward, though the correlation is weak.

Table 11-8. Summary Statistics for Storm-Event Radionuclide Results from SW022 in WY97-00.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
Pu-239,240	35	0.089	0.936	9.490	7.267[a]
Am-241	36	0.028	0.144	1.760	0.701[a]
Total Uranium	36	0.968	2.990	3.913	5.729[a]

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.
Includes the last synoptic sample collected 10/22/00.

[34] Sample types are defined in the Automated Surface-Water Monitoring Work Plan.

[35] Excavation began in June 1998.

[36] Revegetation occurred early in FY99.

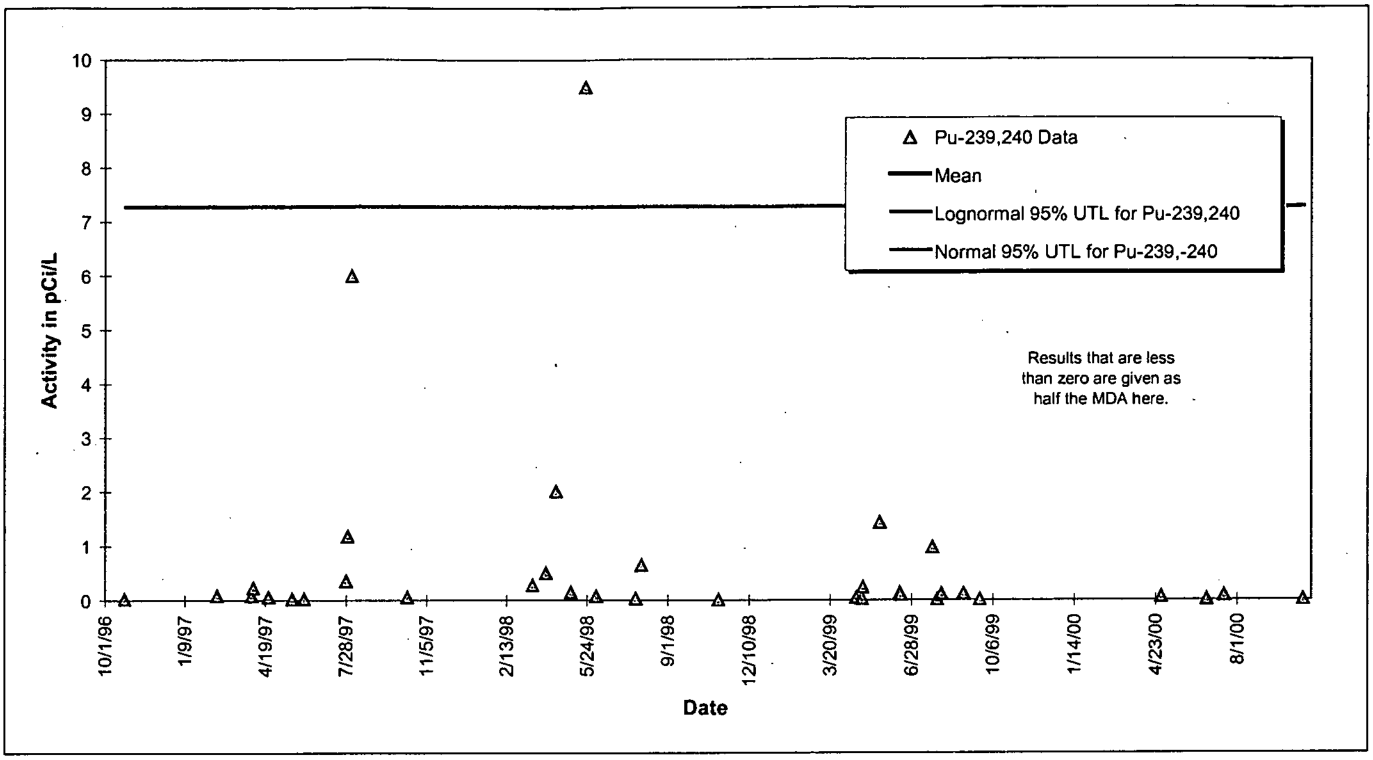

Figure 11-11. Storm-Event 95% UTL Plot for Pu-239,240 at SW022: WY97-00.

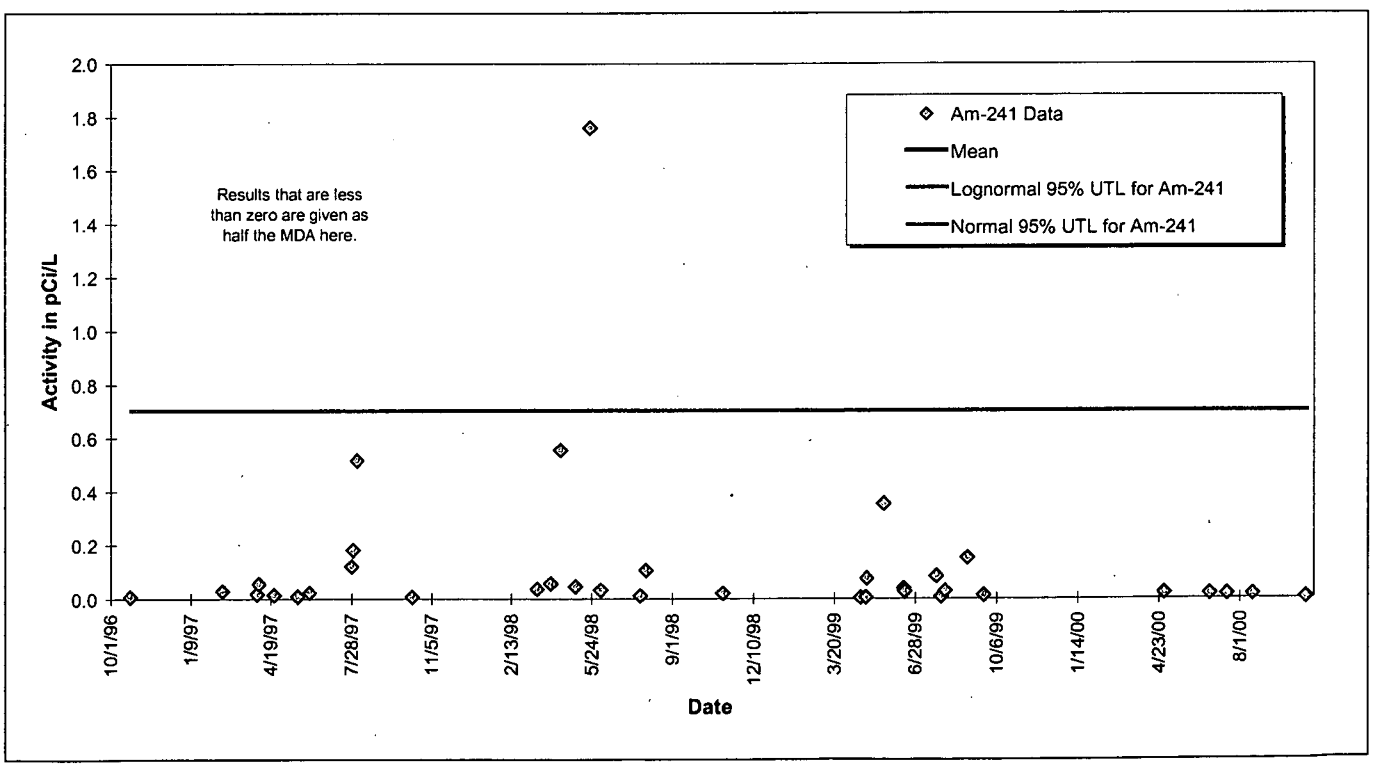

Figure 11-12. Storm-Event 95% UTL Plot for Am-241 at SW022: WY97-00.

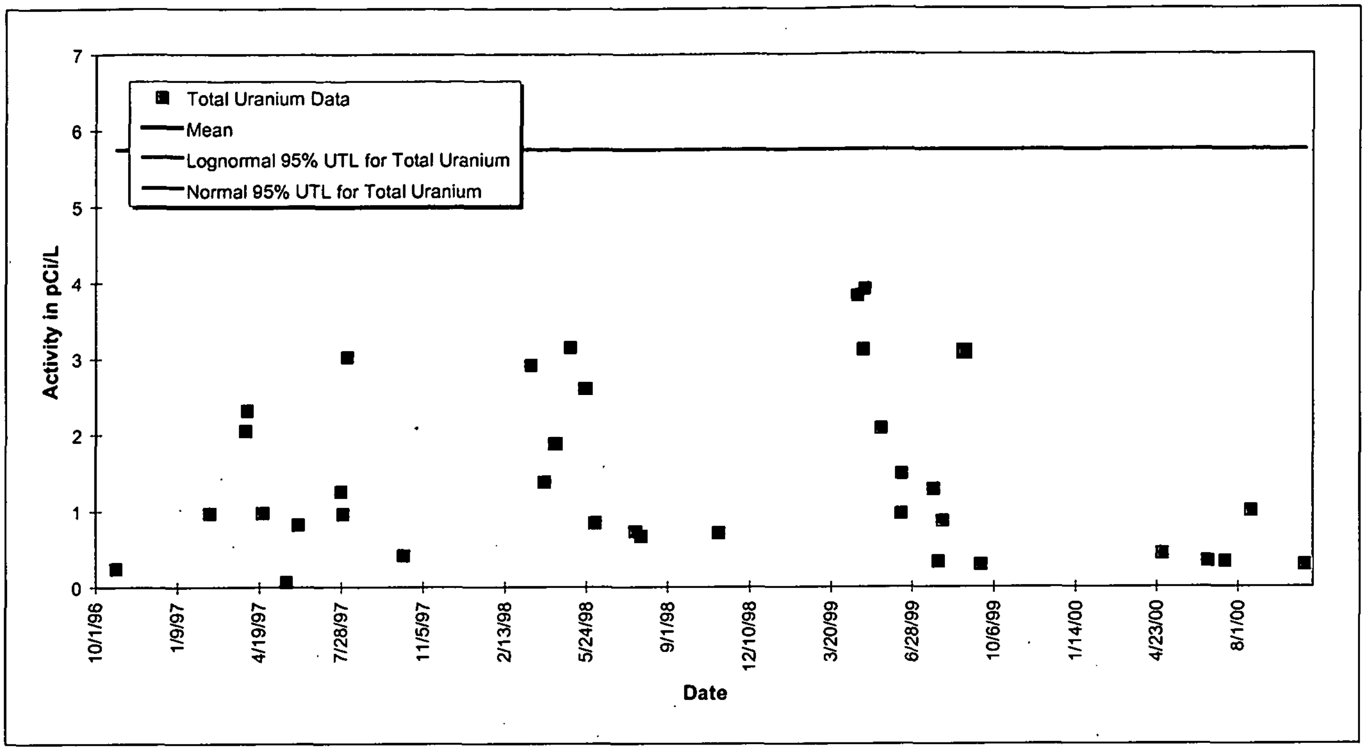

Figure 11-13. Storm-Event 95% UTL Plot for Total Uranium at SW022: WY97-00.

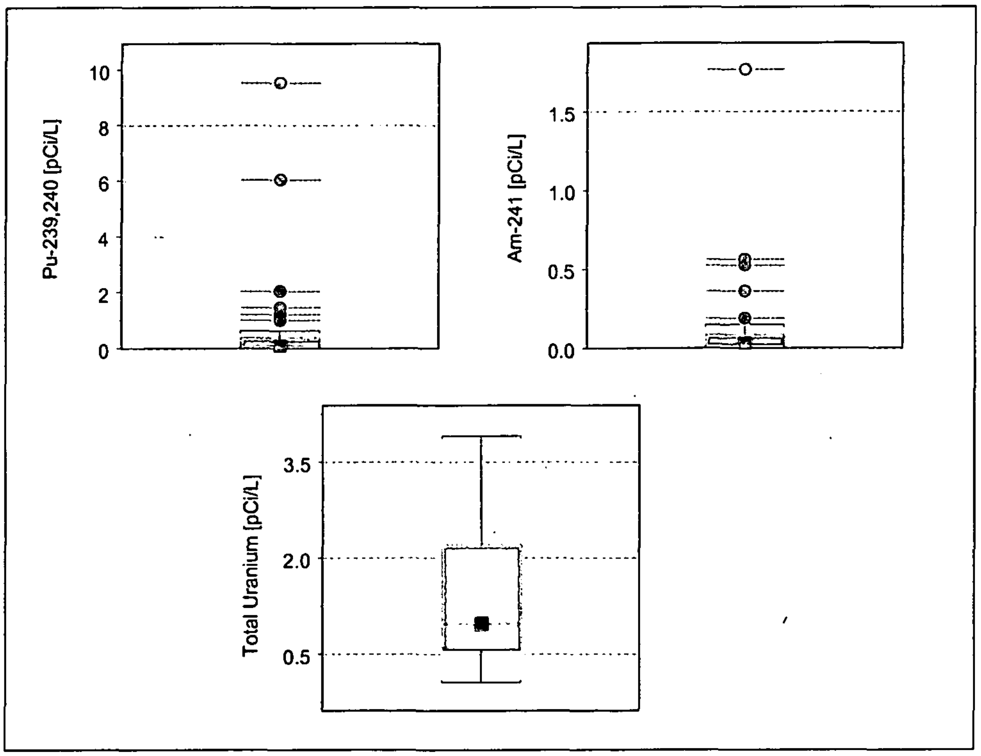

Figure 11-14. Storm-Event Radionuclide Box Plots for SW022: WY97–00.

Table 11-9. Summary Statistics for Continuous Flow-Paced Radionuclide Results from SW022 in WY97-00.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
Pu-239,240	6	0.065	0.244	0.546	7.058[a]
Am-241	6	0.008	0.046	0.144	0.364[a]
Total Uranium	6	0.582	0.921	1.246	2.191[a] / 2.000[b]

Note: [a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

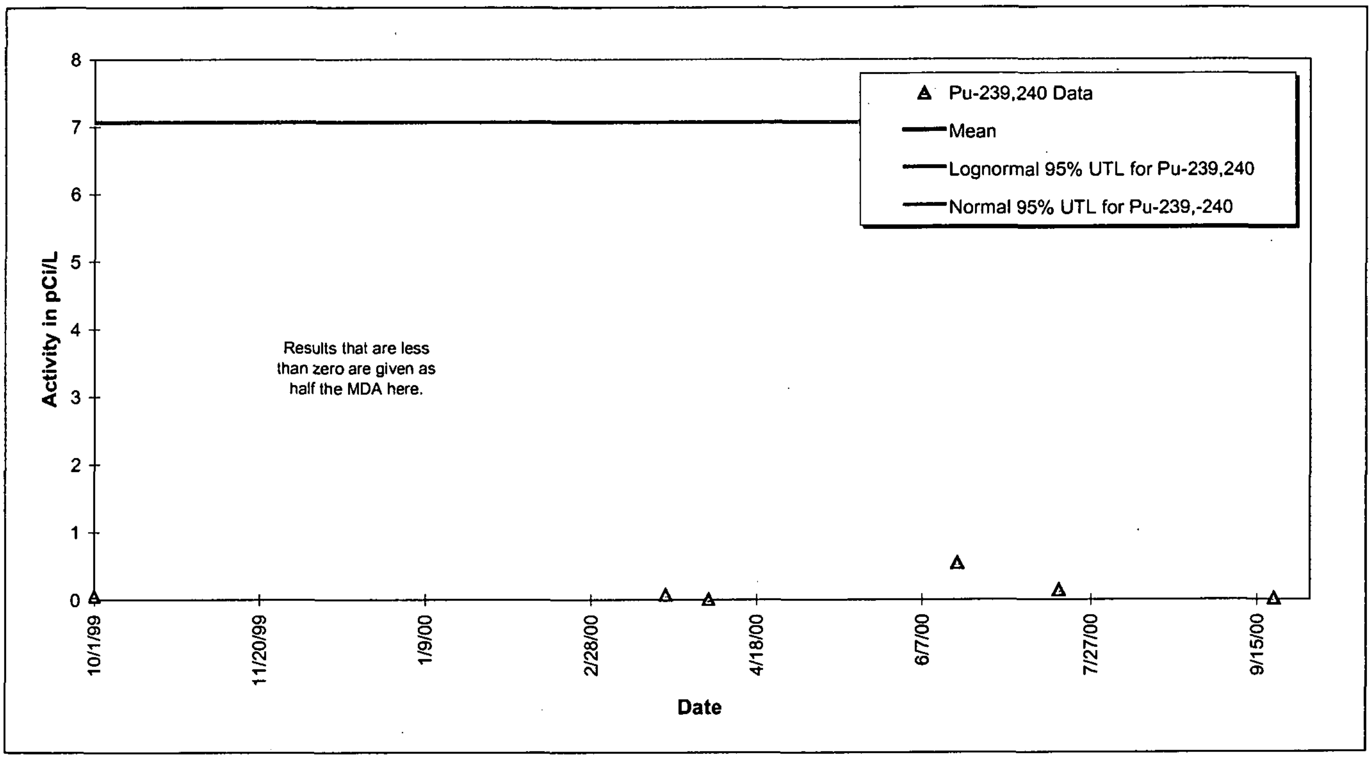

Figure 11-15. Continuous Flow-Paced 95% UTL Plot for Pu-239,240 at SW022: WY97-00.

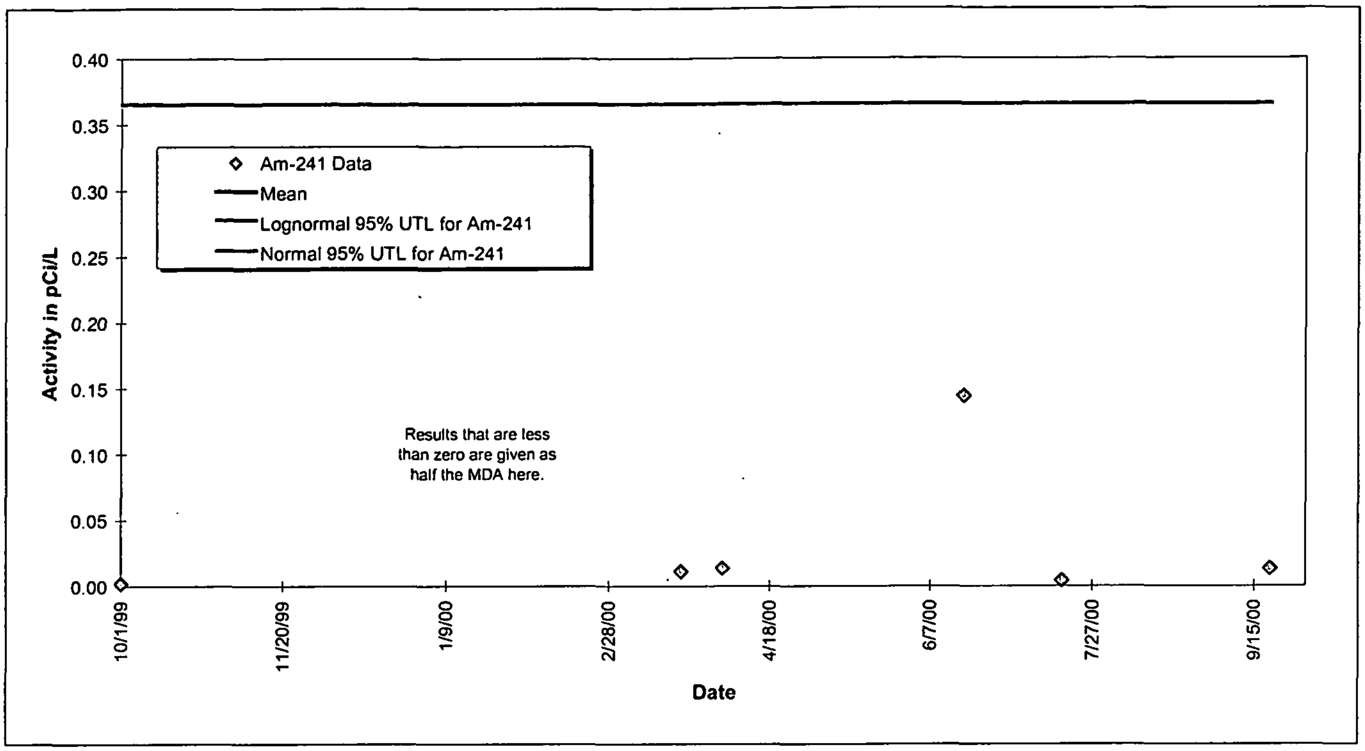

Figure 11-16. Continuous Flow-Paced 95% UTL Plot for Am-241 at SW022: WY97-00.

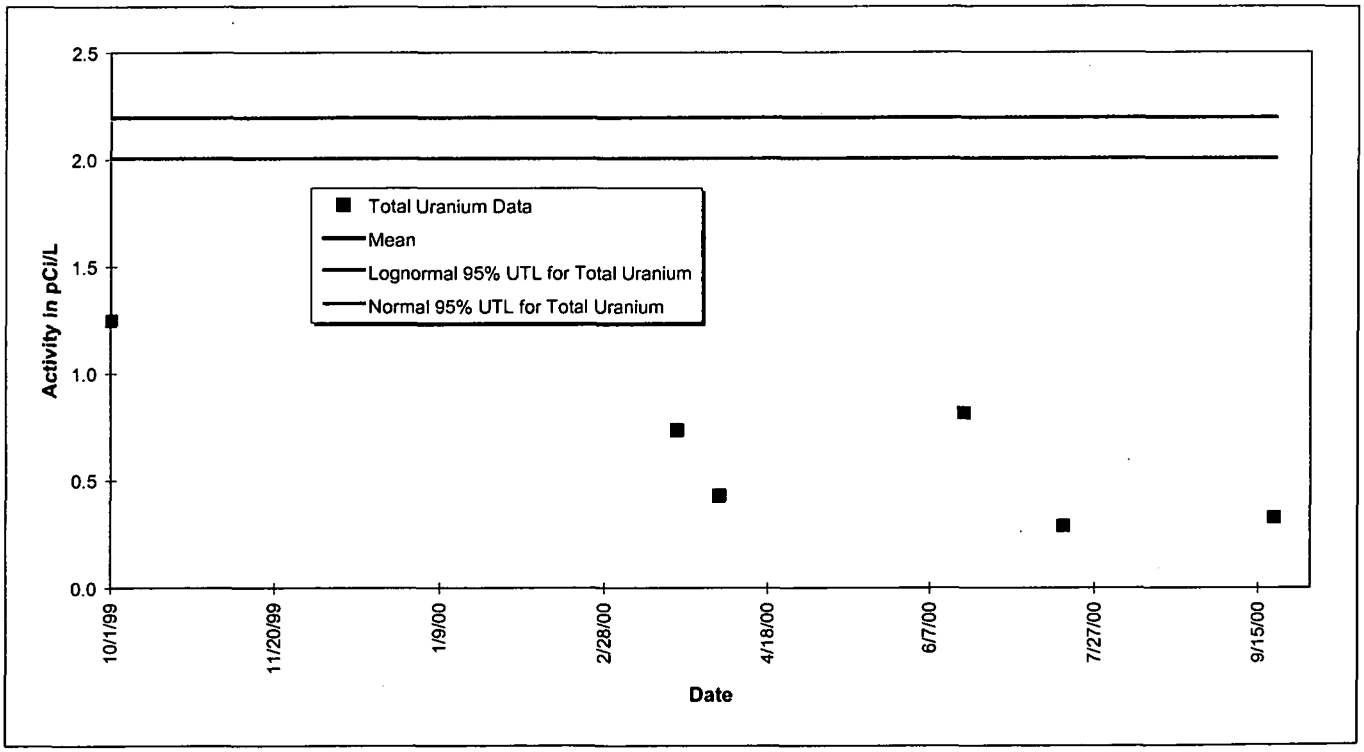

Figure 11-17. Continuous Flow-Paced 95% UTL Plot for Total Uranium at SW022: WY97-00.

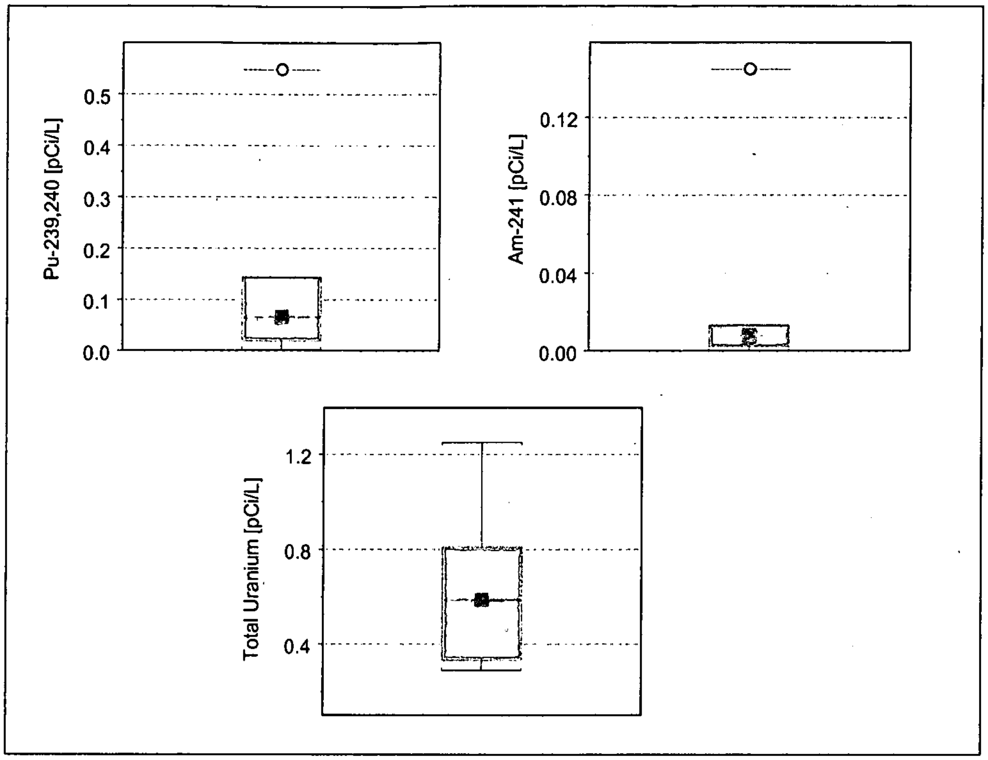

Figure 11-18. Continuous Flow-Paced Radionuclide Box Plots for SW022: WY97–00.

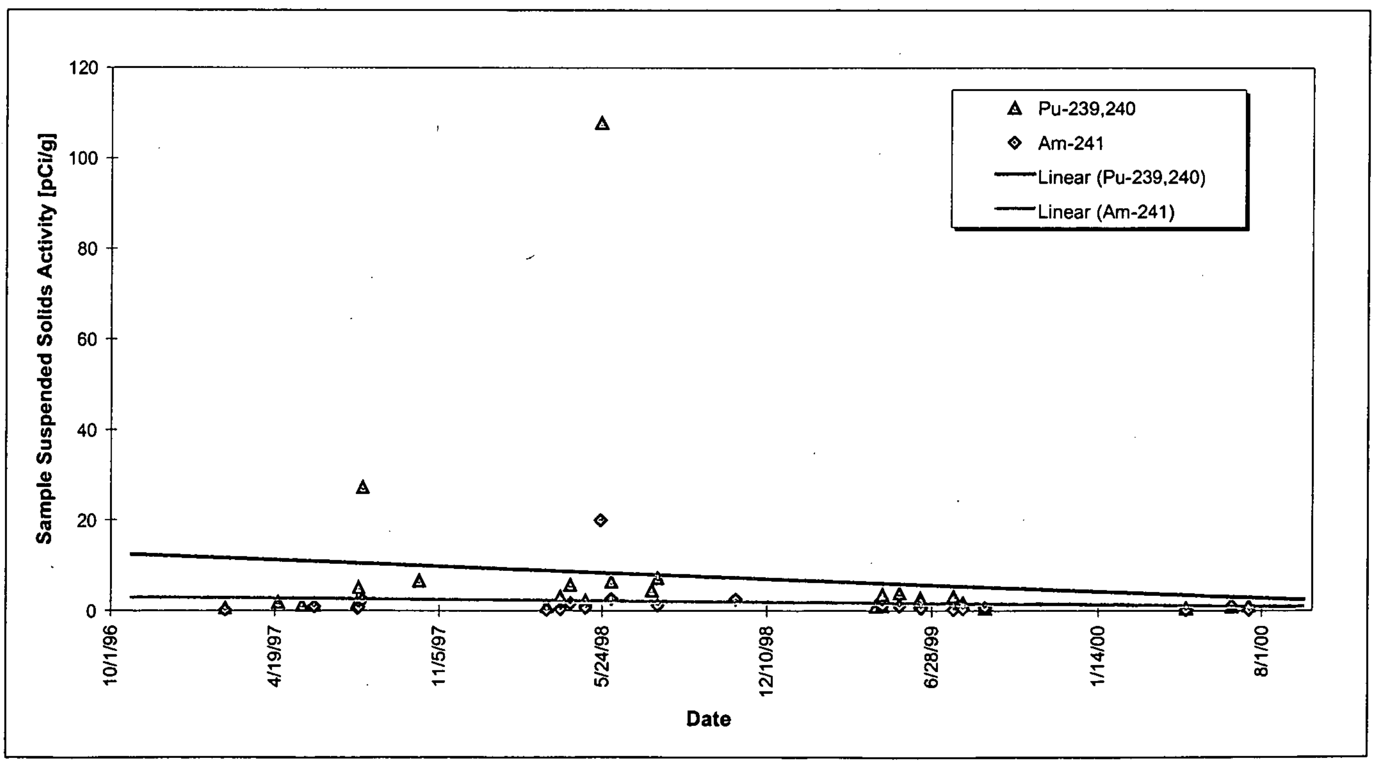

Figure 11-19. Temporal Variation of Suspended Solids Activity at SW022: WY97–00.

11.3.3 Location SW027

Monitoring location SW027 is located at the end of the SID at the inlet to Pond C-2. Figure 3-71 shows the drainage area for SW027. The 100, 400, 600, 800, and 900 areas all contribute flow to SW027.

Monitoring data collected at SW027 show moderate Pu and Am activities, though some higher results have been obtained (Table 11-10 and Figure 11-23). Figure 11-20 and Figure 11-21 show the UTL plots for Pu and Am, respectively. During WY97–00, two Pu and Am results exceeded the calculated UTL, with significant variability in the results. These higher activities resulted in reportable 30-day averages under the POE monitoring objective (Section 12). In response, the Site was required to perform two source evaluations to address these reportable values. A summary of the extensive investigations is given in Section 6.3.

Table 11-10 shows moderate uranium activities at SW027. A single result exceeded the UTL (Figure 11-22) by a very small amount, and was considerably below the POE action level (11 pCi/L total uranium).

SW027 shows no temporal trend in suspended solids activity (Figure 11-24) for the few TSS results obtained.

Table 11-10. Summary Statistics for Radionuclide Results from SW027: Water Years 1997-2000.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
Pu-239,240	34	0.031	0.137	1.030	0.762[a]
Am-241	34	0.008	0.028	0.177	0.106[a]
Total Uranium	34	1.925	3.086	4.476	4.439[b]

Note: Total uranium is calculated as the sum of the isotopic (U-233,234; U-235; U-238) activities.
[a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

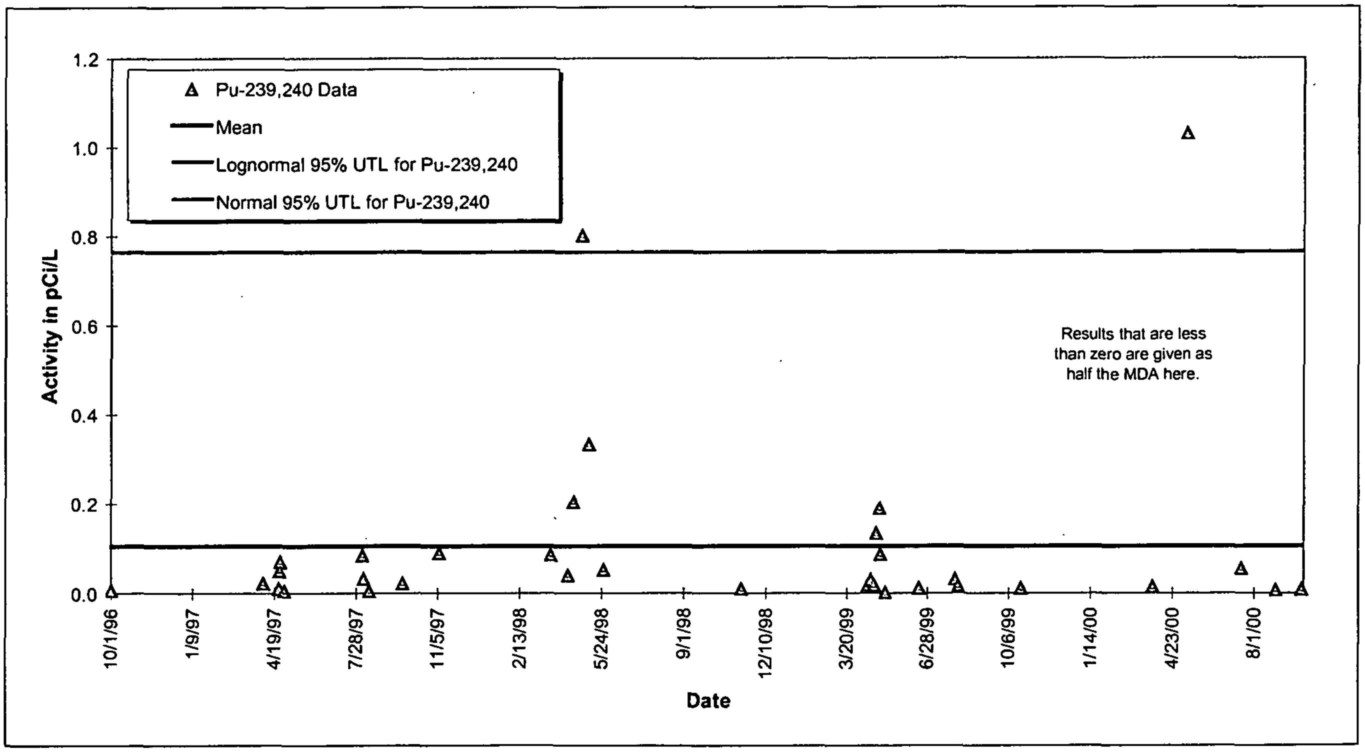

Figure 11-20. 95% UTL Plot for Pu-239,240 at SW027: WY97-00.

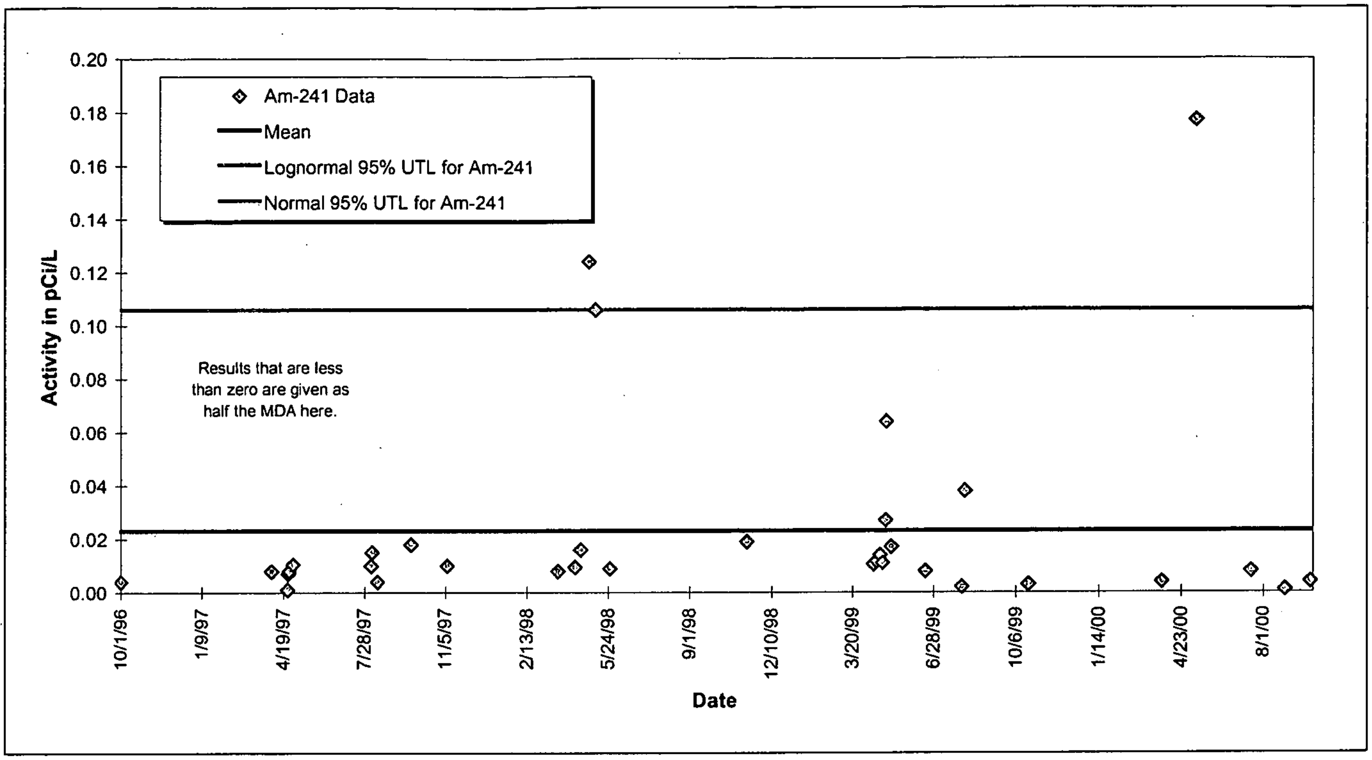

Figure 11-21. 95% UTL Plot for Am-241 at SW027: WY97-00.

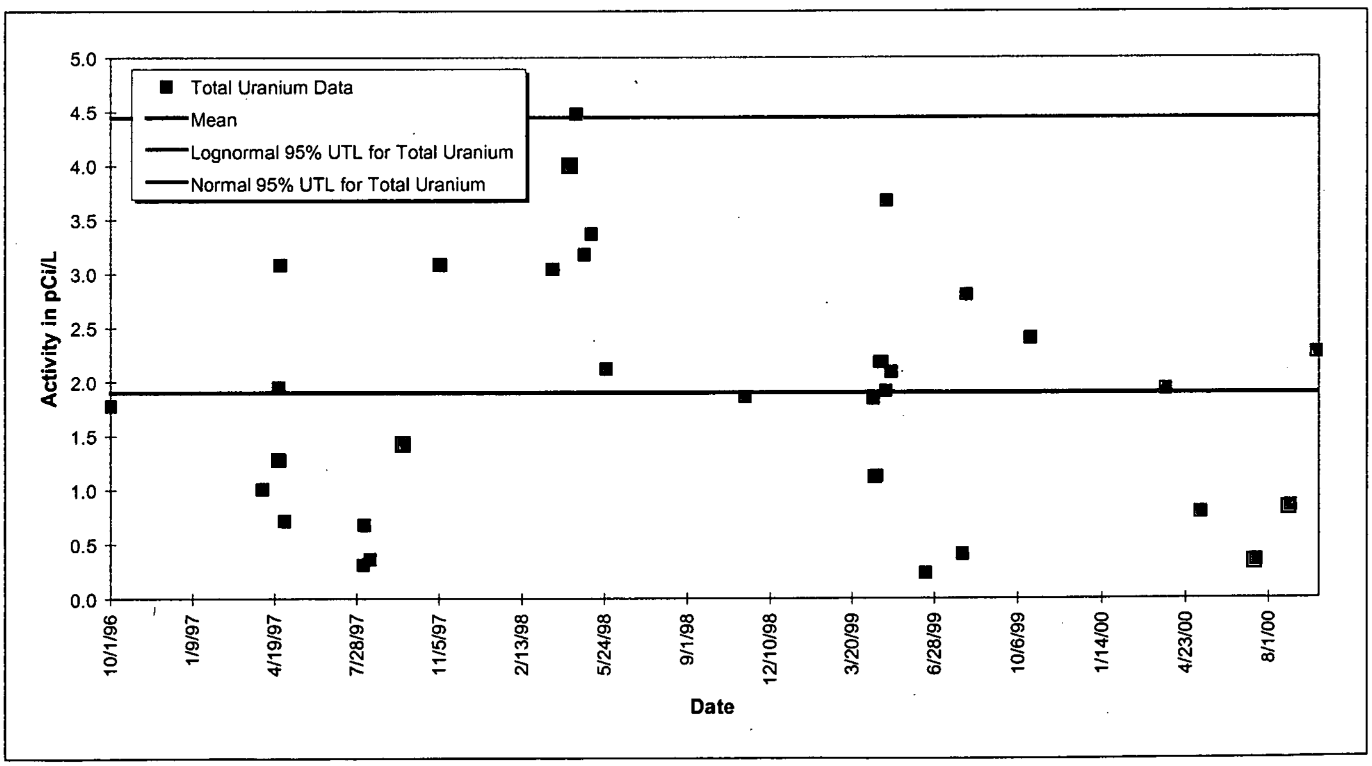

Figure 11-22. 95% UTL Plot for Total Uranium at SW027: WY97-00.

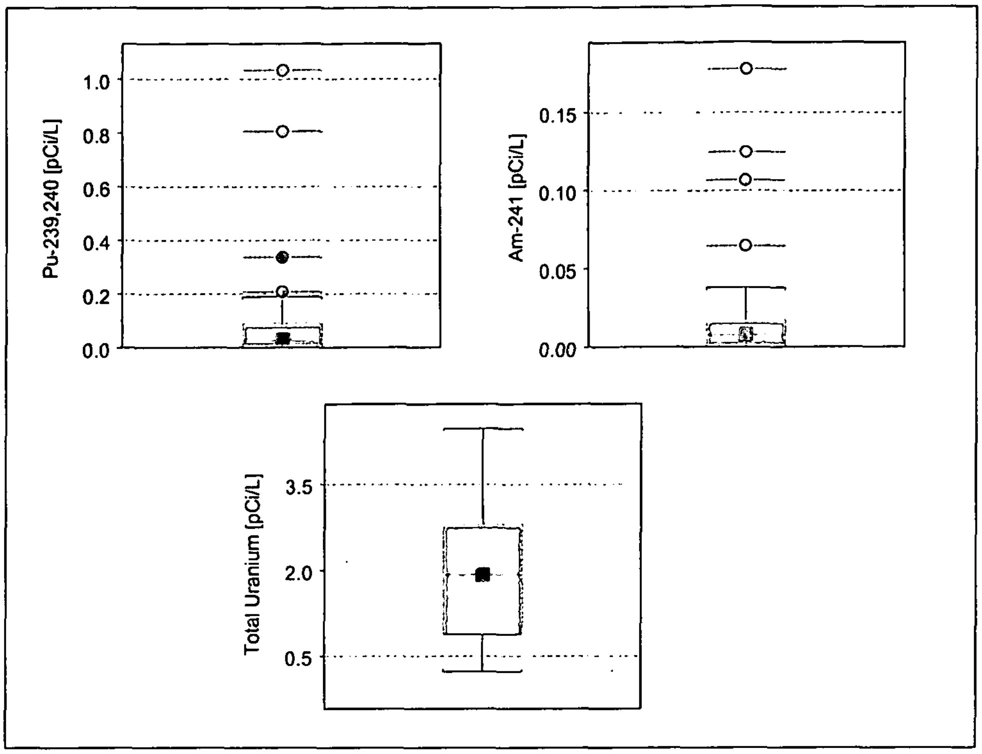

Figure 11-23. Radionuclide Box Plots for SW027: WY97–00.

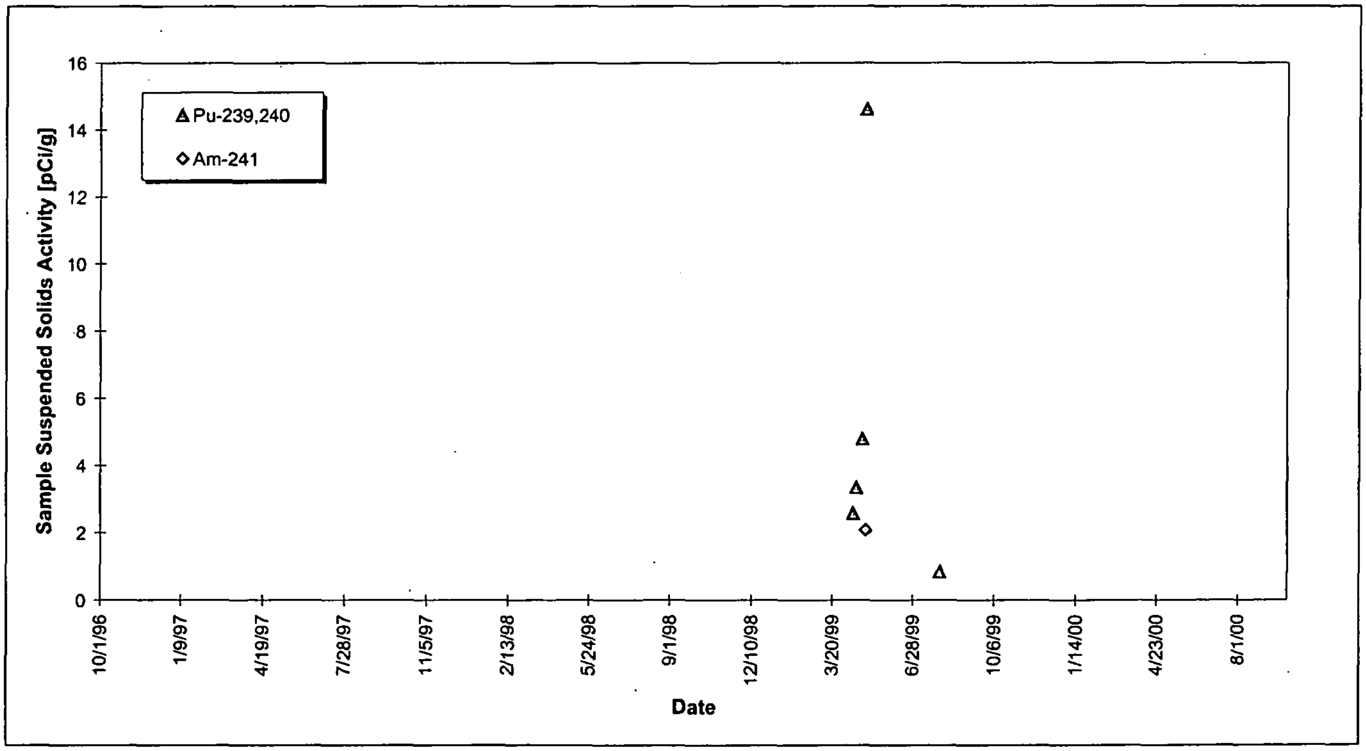

Figure 11-24. Temporal Variation of Suspended Solids Activity at SW027: WY97–00.

Mean daily water-quality parameter data are plotted in Figure 11-25 through Figure 11-28 along with the mean daily flow rate. Figure 11-25 shows the expected annual variation in water temperature. Figure 11-26 shows elevated conductivities during the winter months, most likely a result of road and walkway deicing operations.

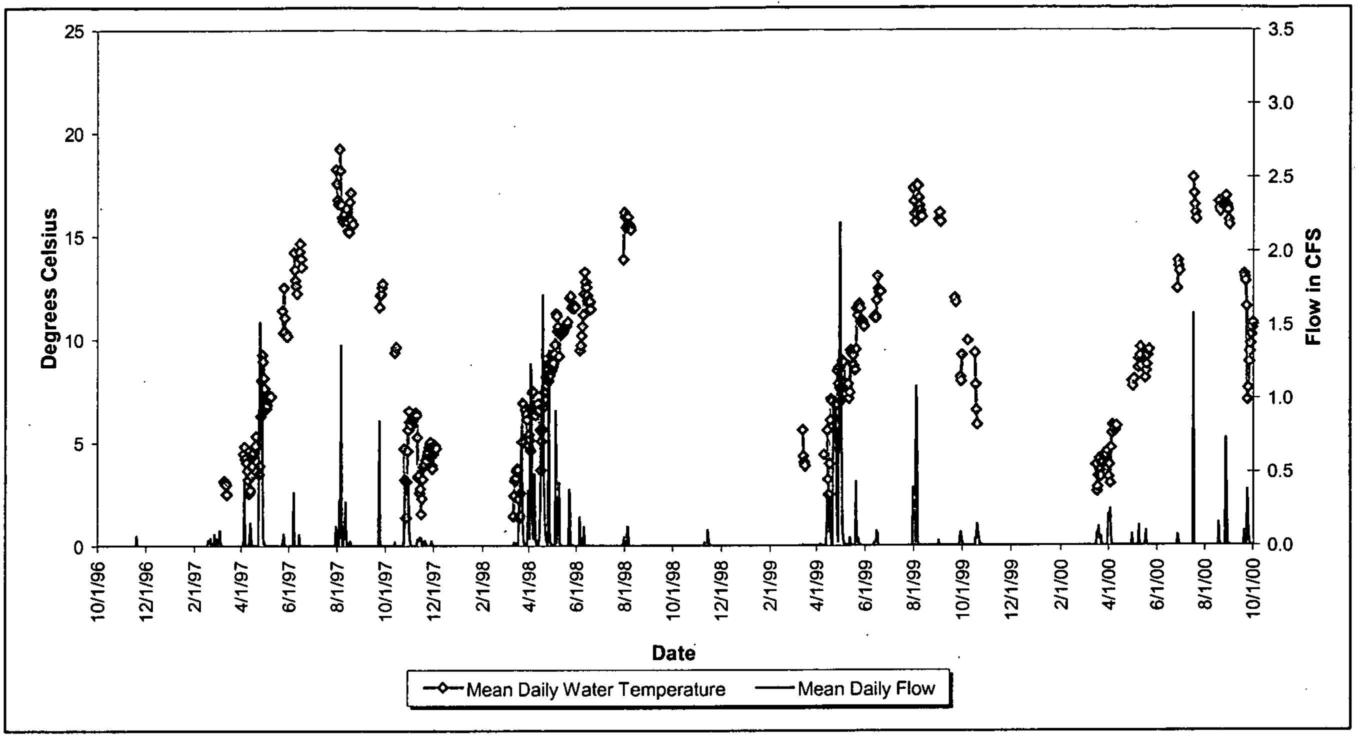

Figure 11-25. Mean Daily Water Temperature at SW027: Water Years 1997 – 2000.

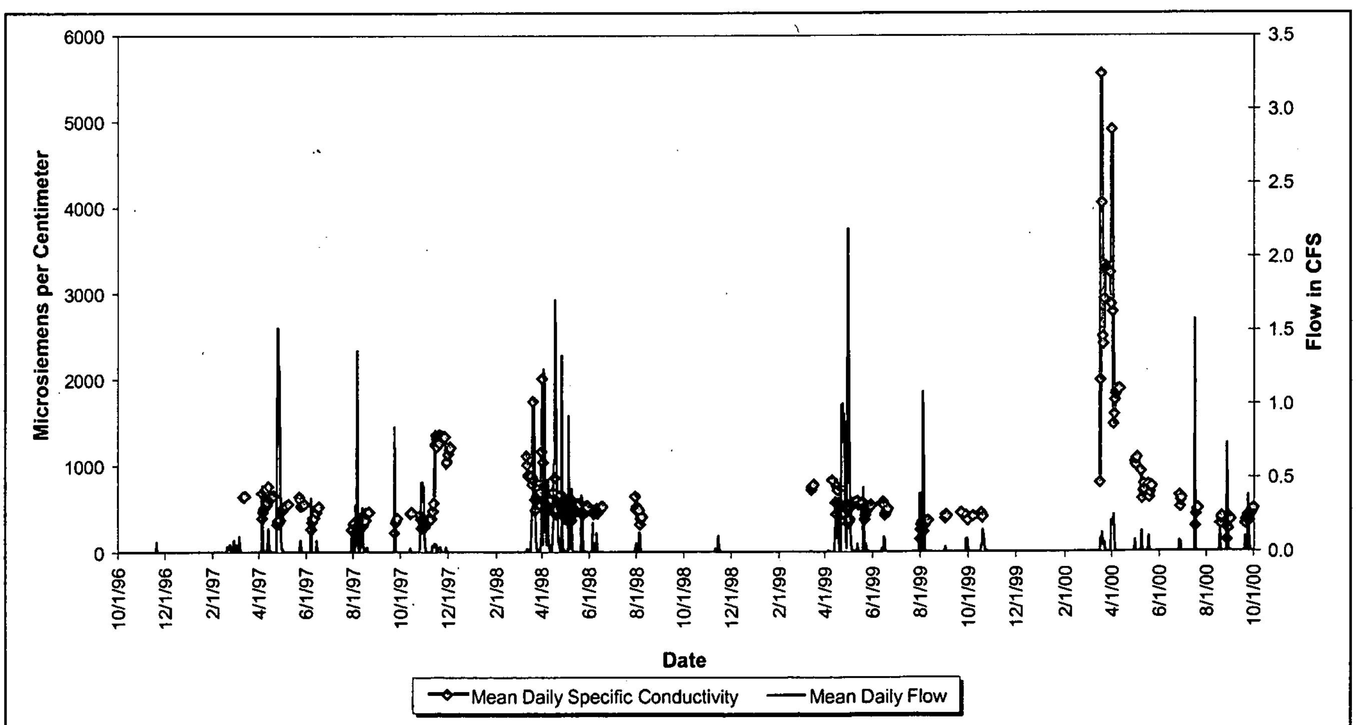

Figure 11-26. Mean Daily Specific Conductivity at SW027: Water Years 1997 – 2000.

Figure 11-27 shows the mean daily pH varying between 7.0 and 8.5. Finally, Figure 11-28 shows elevated turbidity measurements tracking the flow rate in time and magnitude, as expected when higher flow rates transport more suspended solids.

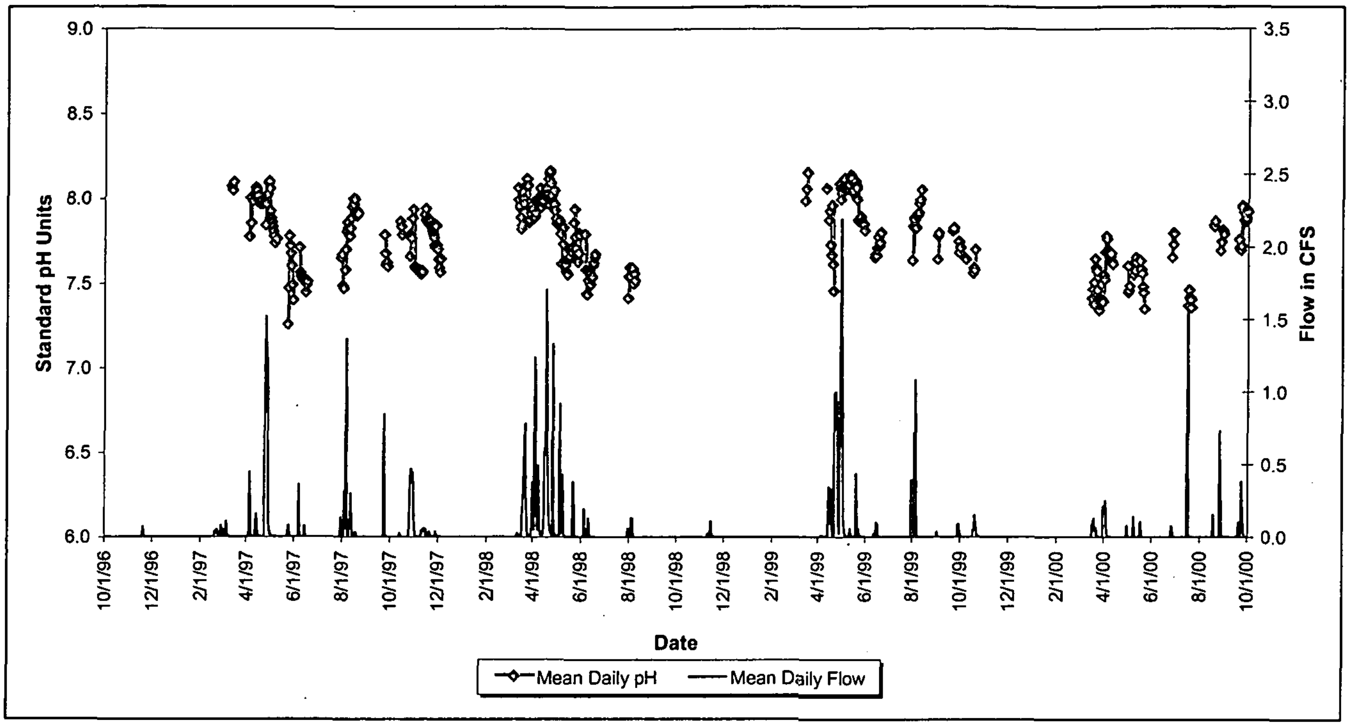

Figure 11-27. Mean Daily pH at SW027: Water Years 1997 – 2000.

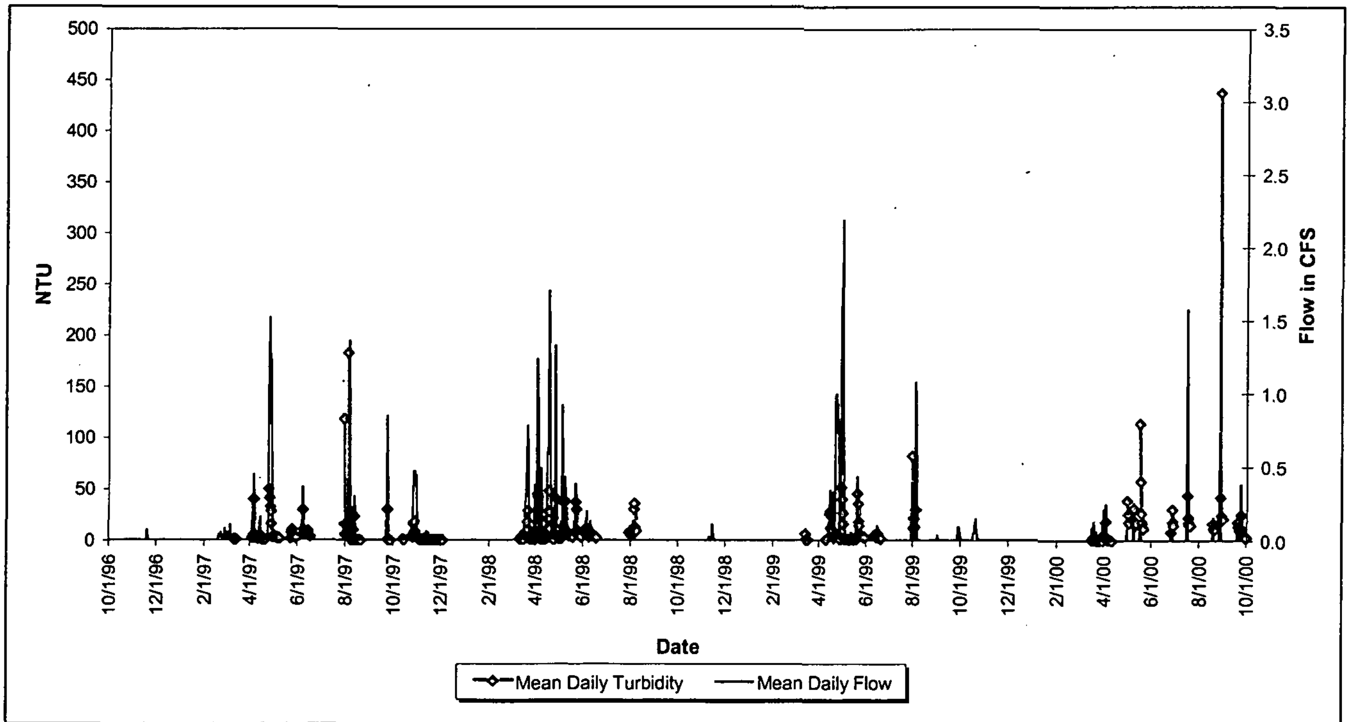

Figure 11-28. Mean Daily Turbidity at SW027: Water Years 1997 – 2000.

11.3.4 Location SW091

Monitoring location SW091 is located at the end of a small drainage swale just upstream of N. Walnut Cr.[37] Figure 3-74 shows the drainage area for SW091. The area east of the Solar Ponds contributes runoff to SW091.

Monitoring data collected at SW091 show moderate Pu and Am activities, though some higher results have been obtained (Table 11-11 and Figure 11-32). Figure 11-29 and Figure 11-30 show the UTL plots for Pu and Am, respectively. During WY97–00, no Pu and Am results exceeded the calculated UTL

Table 11-11 shows moderate uranium activities at SW091. During WY97–00, no uranium results exceeded the calculated UTL.

SW091 shows a slight increasing temporal trend in suspended solids activity (Figure 11-33), though the correlation is weak.

Table 11-11. Summary Statistics for Radionuclide Results from SW091: Water Years 1997-2000.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
Pu-239,240	13	0.070	0.324	0.958	2.764[a]
Am-241	13	0.048	0.241	0.686	0.990[a]
Total Uranium	13	4.390	5.361	6.970	9.238[a] / 8.130[b]

Note: Total uranium is calculated as the sum of the isotopic (U-233,234; U-235; U-238) activities.
[a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

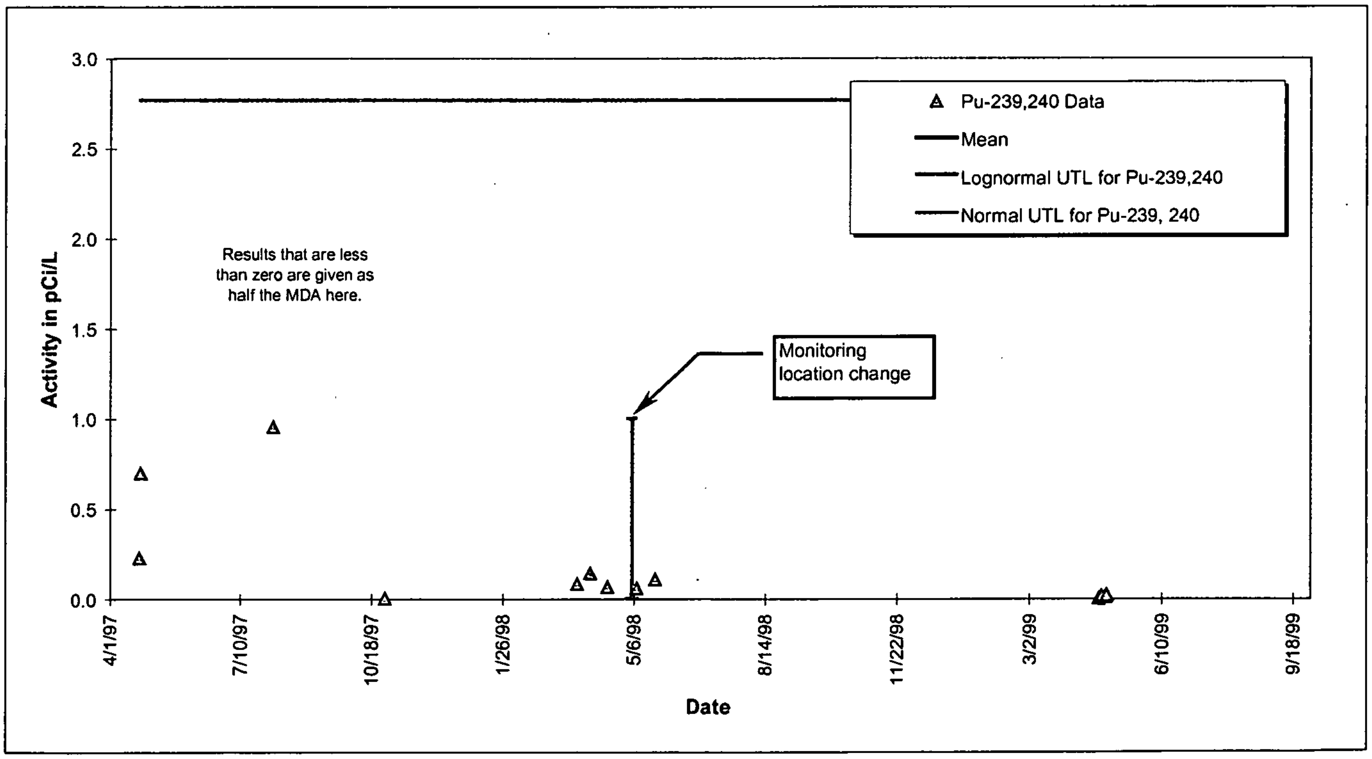

Figure 11-29. 95% UTL Plot for Pu-239,240 at SW091: WY97-00.

[37] SW091 was originally located 500' upstream of the current location. Due to problems associated with extreme sedimentation and icing, the monitoring instrumentation was moved downstream on 5/4/98. The change in location is noted on the plots.

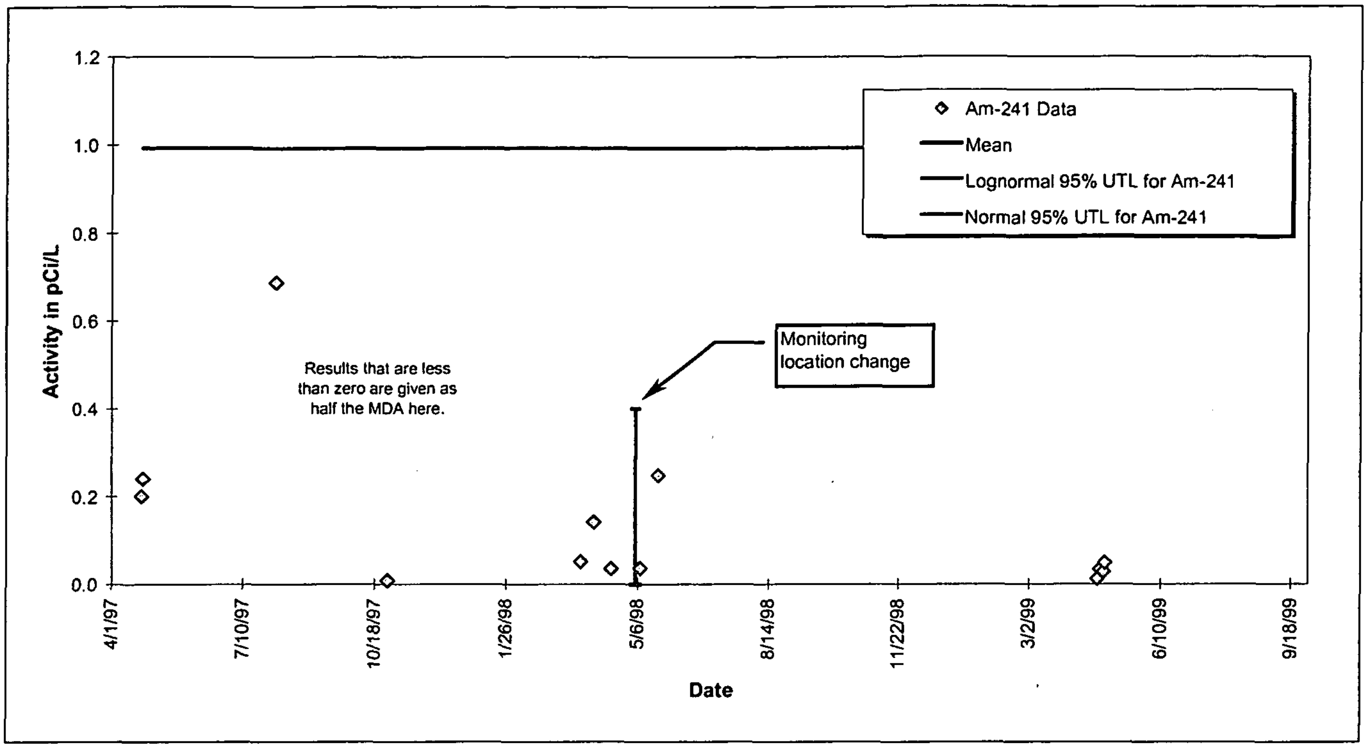

Figure 11-30. 95% UTL Plot for Am-241 at SW091: WY97-00.

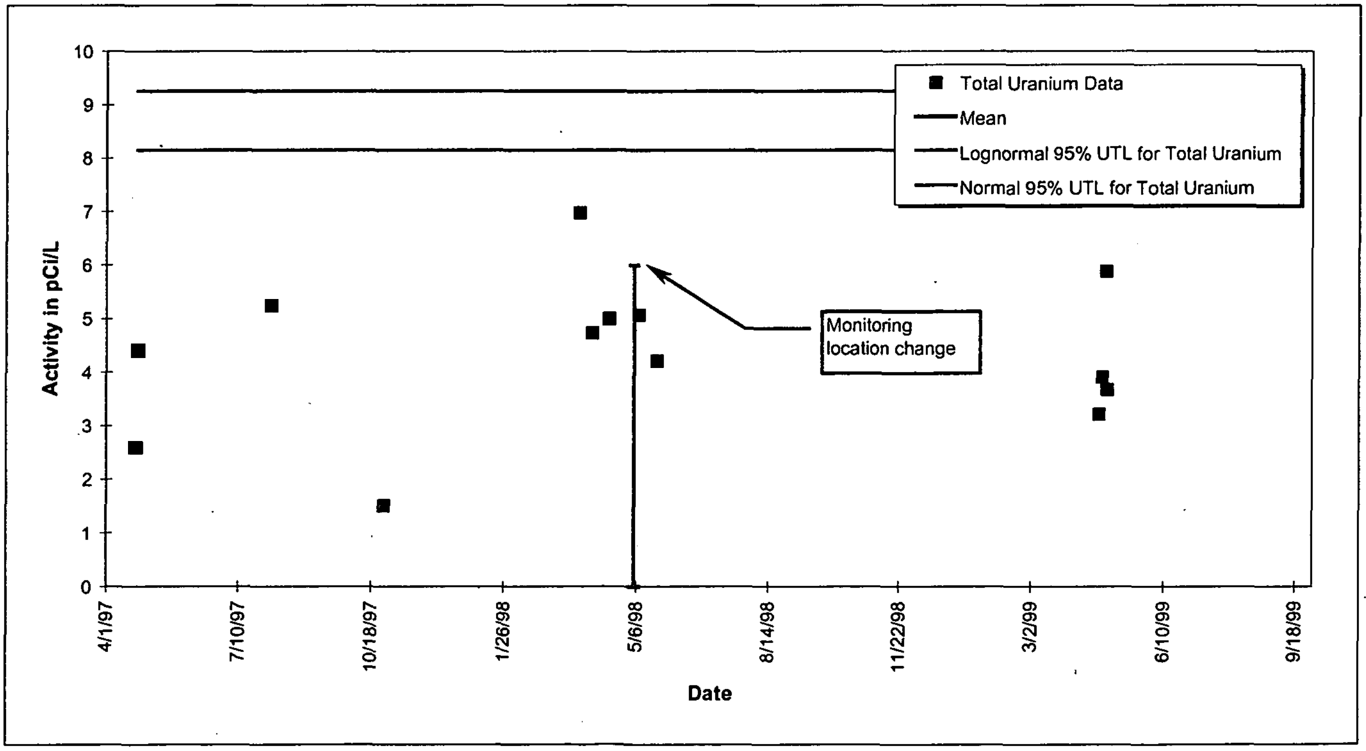

Figure 11-31. 95% UTL Plot for Total Uranium at SW091: WY97-00.

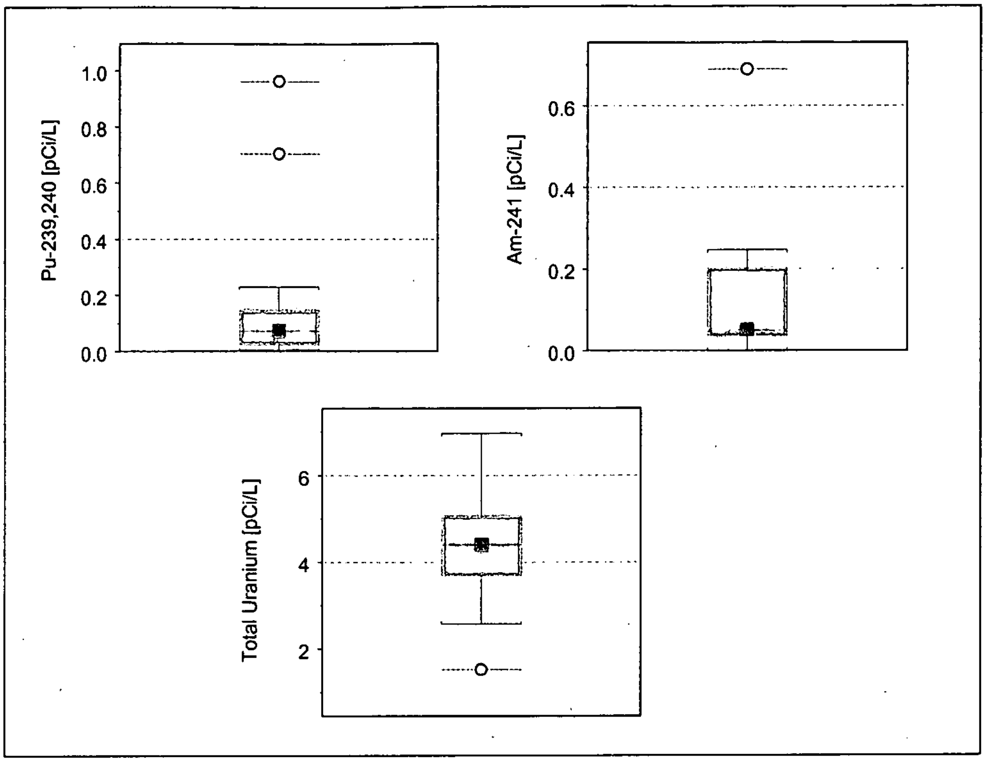

Figure 11-32. Radionuclide Box Plots for SW091: WY97–00.

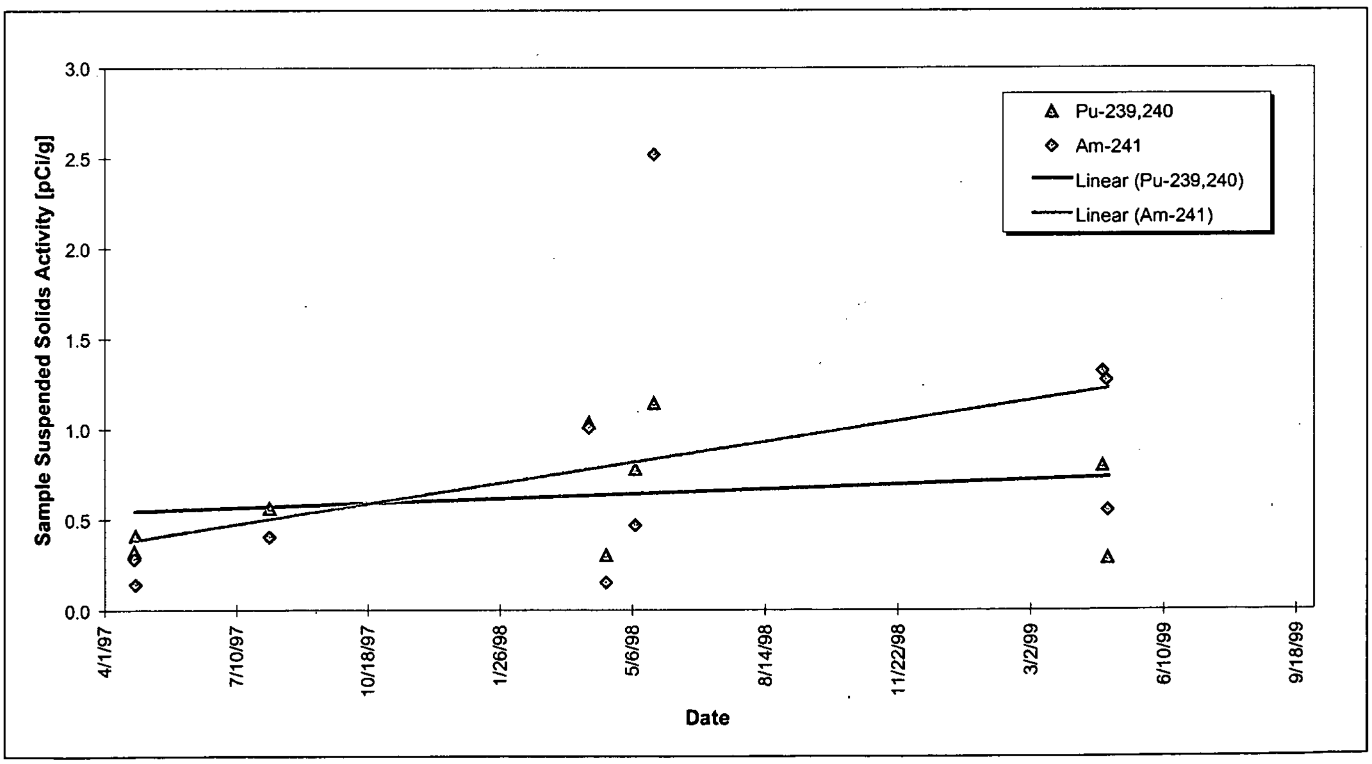

Figure 11-33. Temporal Variation of Suspended Solids Activity at SW091: WY97–00.

11.3.5 Location SW093

Monitoring location SW093 is located on N. Walnut Cr. at the perimeter of the IA 1300' upstream of the A-Series ponds. Figure 3-76 shows the drainage area for SW093. The 100, 300, 500, 700, and 900 areas all contribute flow to SW093.

Monitoring data collected at SW093 show low median Pu and Am activities (Table 11-12), although several higher results have been obtained (Table 11-12 and Figure 11-37). Figure 11-34 and Figure 11-35 show the UTL plots for Pu and Am, respectively. During WY97–00, several Pu results exceeded the calculated UTL, with significant variability in the results. A distribution could not be determined for Am, but the UTL plot also shows significant variability with numerous 'suspect' results indicated by the box plot (Figure 11-37). These higher activities resulted in reportable 30-day averages under the POE monitoring objective (Section 12) during the Summer of 1999. In response, the Site was required to perform a source evaluation to address these reportable values. A summary of the extensive investigations is given in Section 6.3.

Table 11-12 shows moderate uranium activities at SW093. The UTL plot (Figure 11-36) shows a few results greater than the calculated UTL. However, there appears to be a downward temporal trend in uranium activities. This downward trend could be due to the natural attenuation of the Solar Ponds uranium plume and/or the installation of the Solar Ponds passive treatment system.

SW093 shows a decreasing temporal trend in suspended solids activity (Figure 11-38), but the correlation is weak.

Table 11-12. Summary Statistics for Radionuclide Results from SW093: Water Years 1997-2000.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
Pu-239,240	145	0.007	0.052	1.060	0.152[a]
Am-241	143	0.008	0.037	0.628	[c]
Total Uranium	145	2.741	4.319	6.640	6.139[a] / 5.610[b]

Note: Total uranium is calculated as the sum of the isotopic (U-233,234; U-235; U-238) activities.
[a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

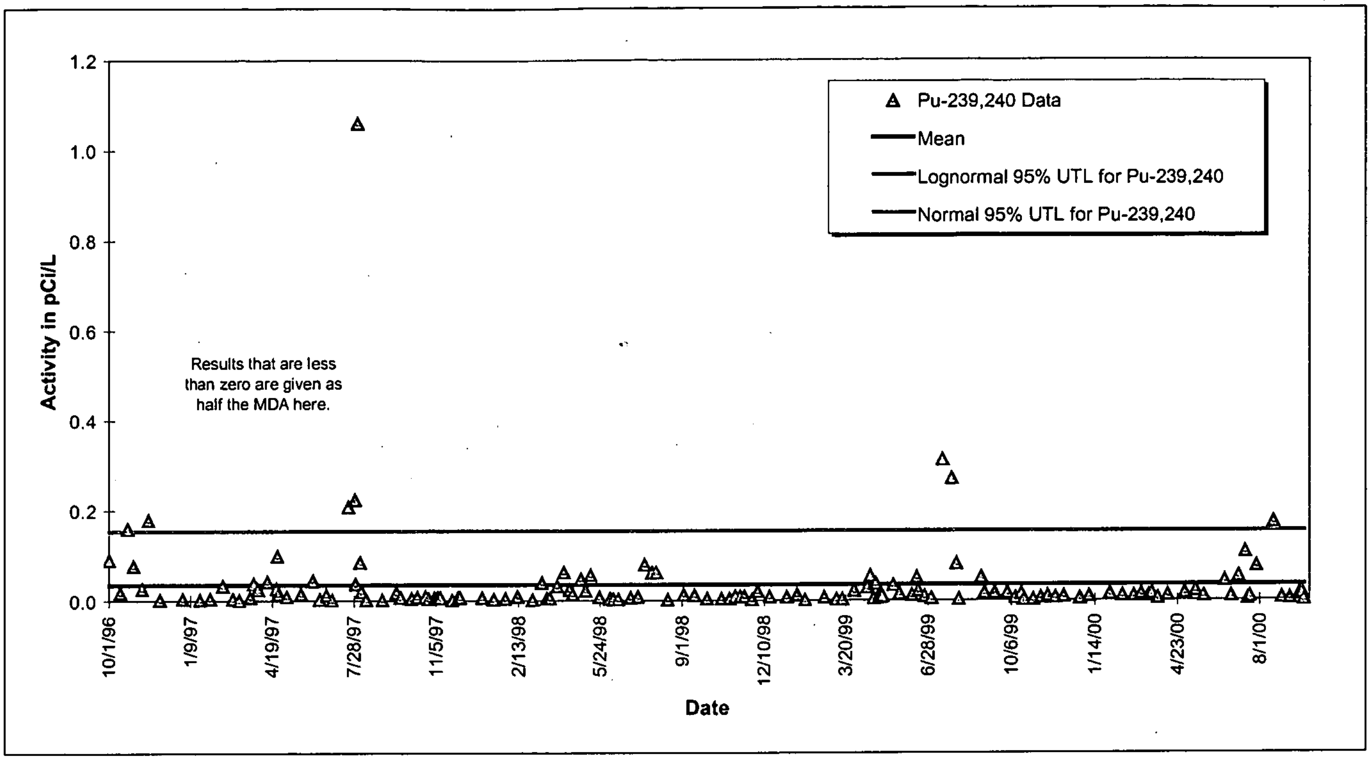

Figure 11-34. 95% UTL Plot for Pu-239,240 at SW093: WY97-00.

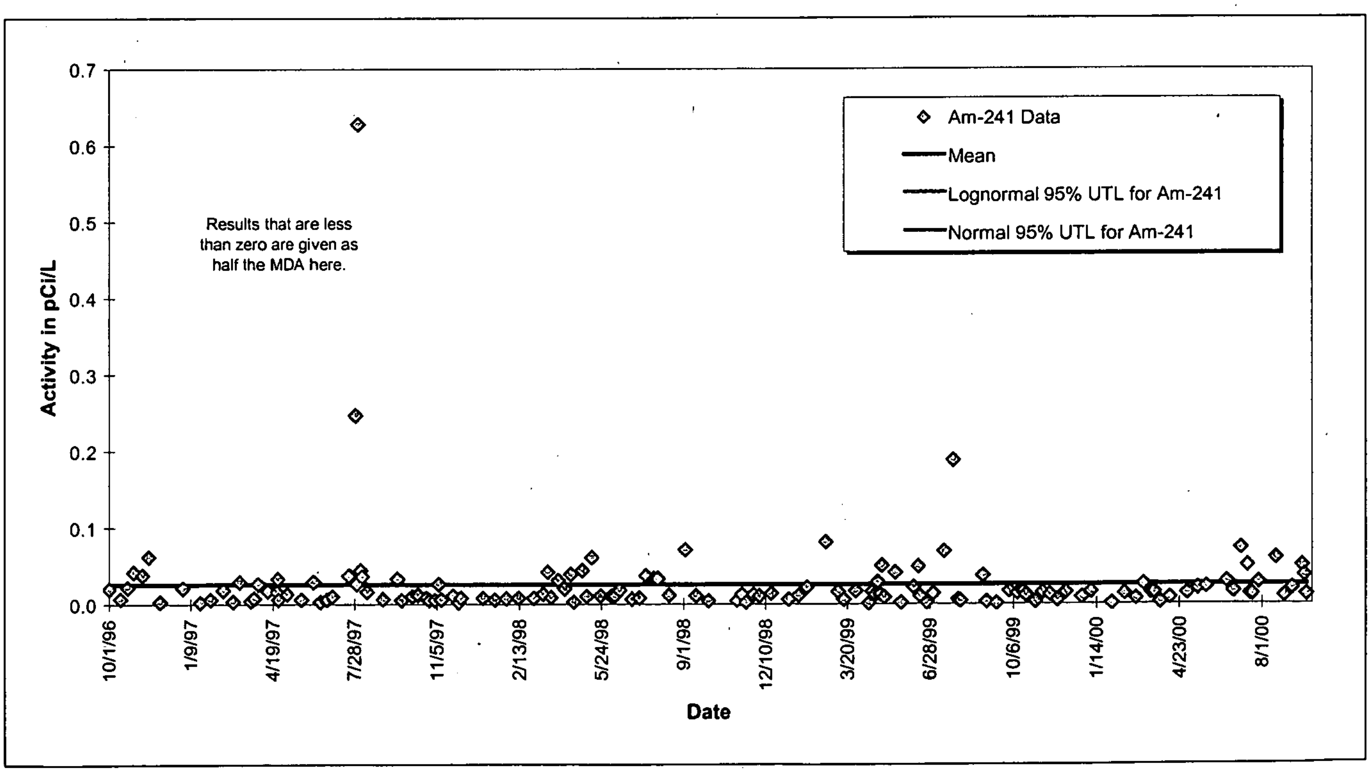

Figure 11-35. 95% UTL Plot for Am-241 at SW093: WY97-00.

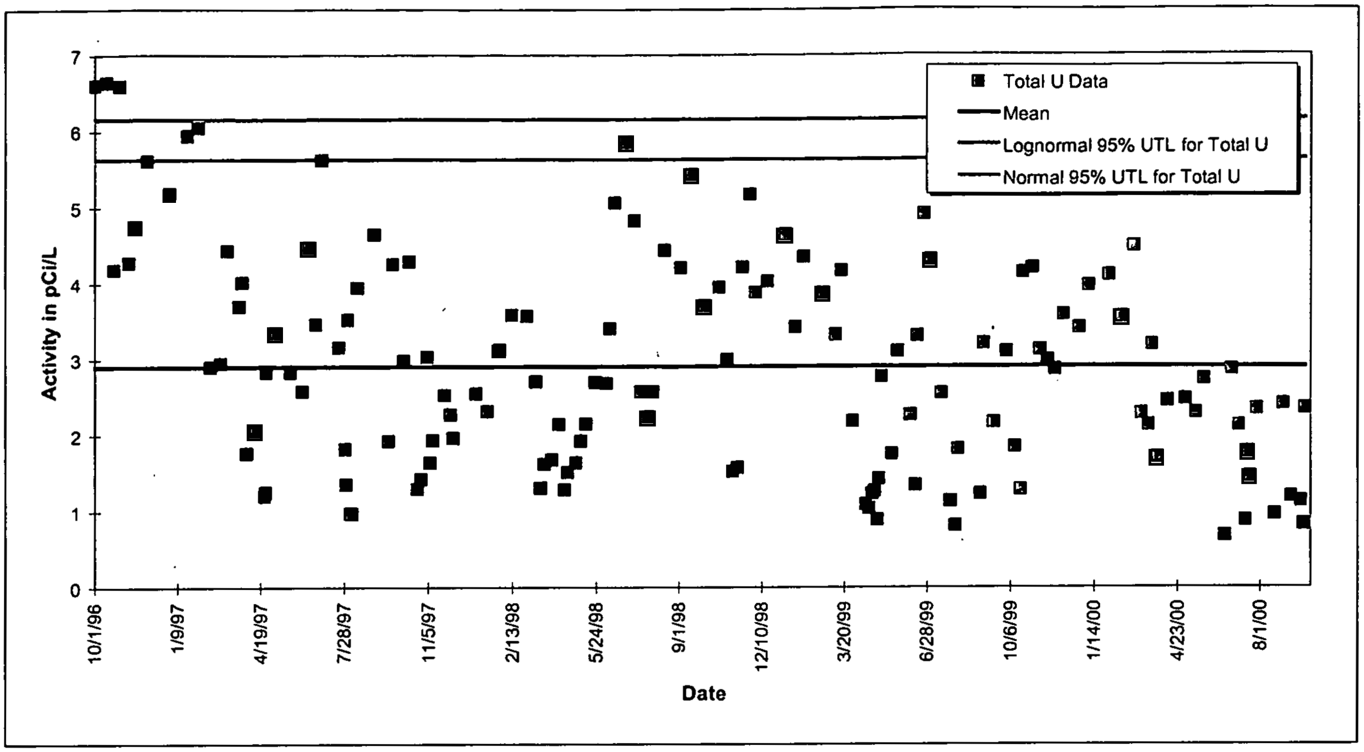

Figure 11-36. 95% UTL Plot for Total Uranium at SW093: WY97-00.

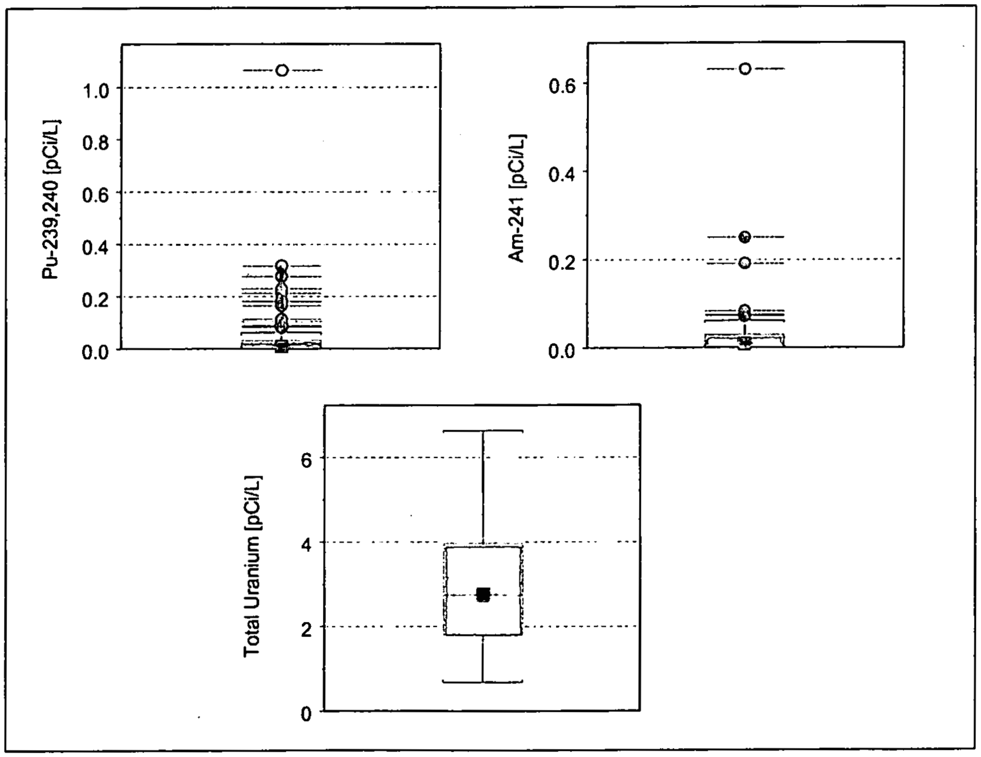

Figure 11-37. Radionuclide Box Plots for SW093: WY97–00.

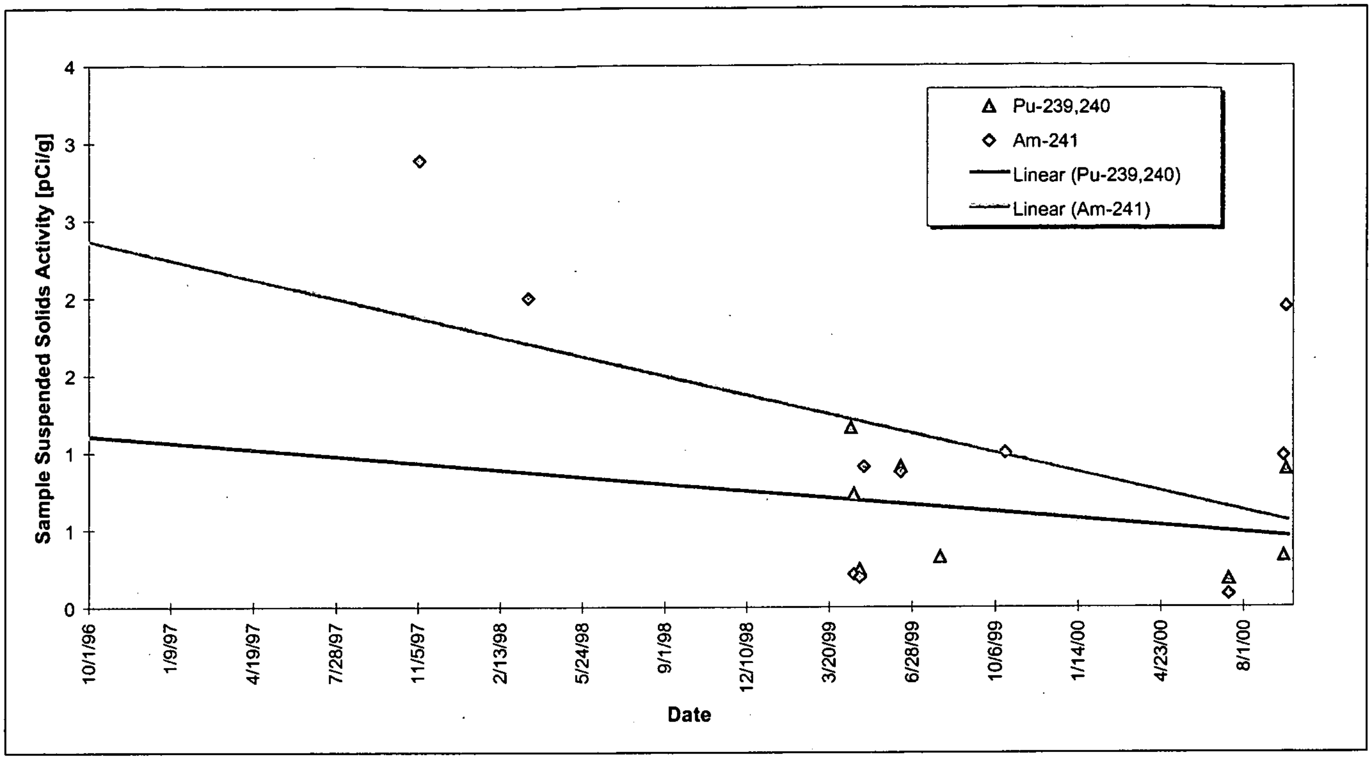

Figure 11-38. Temporal Variation of Suspended Solids Activity at SW093: WY97–00.

Mean daily water-quality parameter data are plotted in Figure 11-39 through Figure 11-42 along with the mean daily flow rate. Figure 11-39 shows the expected annual variation in water temperature. Figure 11-40 shows elevated conductivities during the winter months, most likely a result of road and walkway deicing operations.

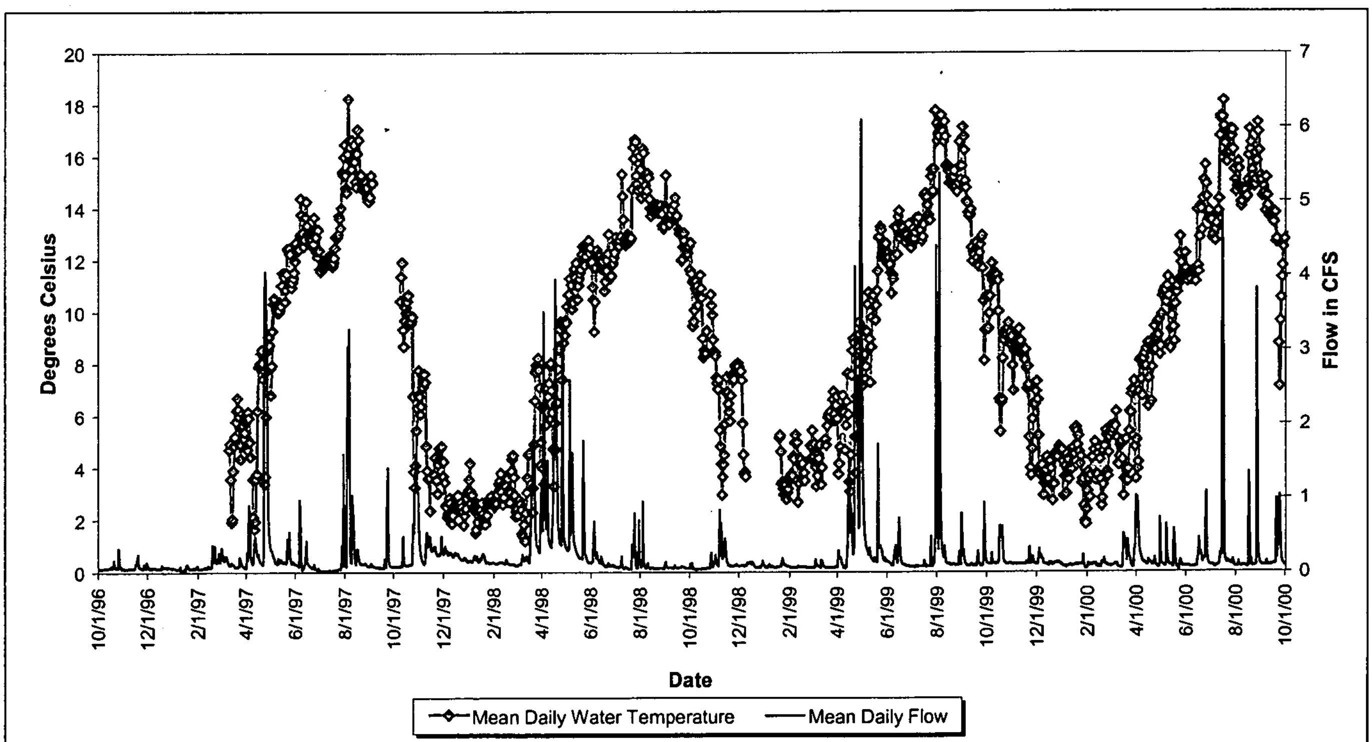

Figure 11-39. Mean Daily Water Temperature at SW093: Water Years 1997 – 2000.

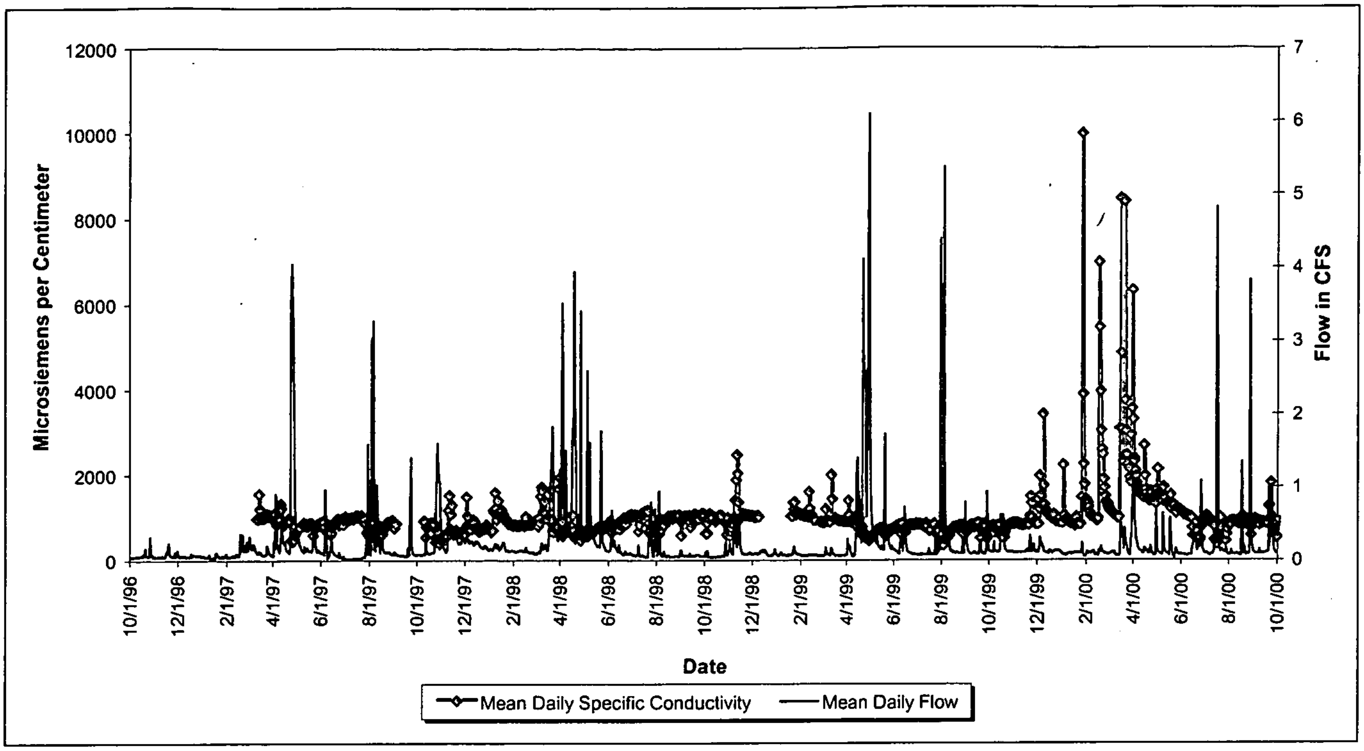

Figure 11-40. Mean Daily Specific Conductivity at SW093: Water Years 1997 – 2000.

Figure 11-41 shows the mean daily pH varying between 7.0 and 8.5. Finally, Figure 11-42 shows elevated turbidity measurements tracking the flow rate in time and magnitude, as expected when higher flow rates transport more suspended solids.

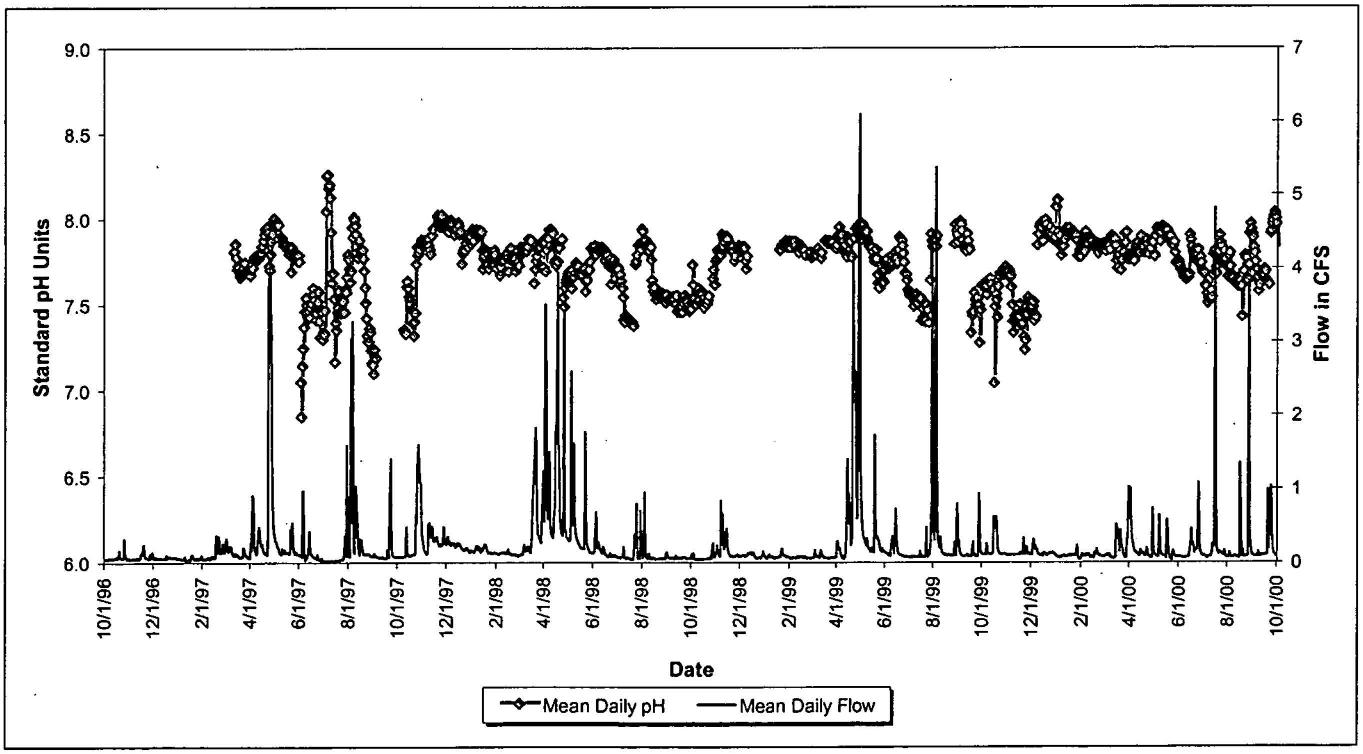

Figure 11-41. Mean Daily pH at SW093: Water Years 1997 – 2000.

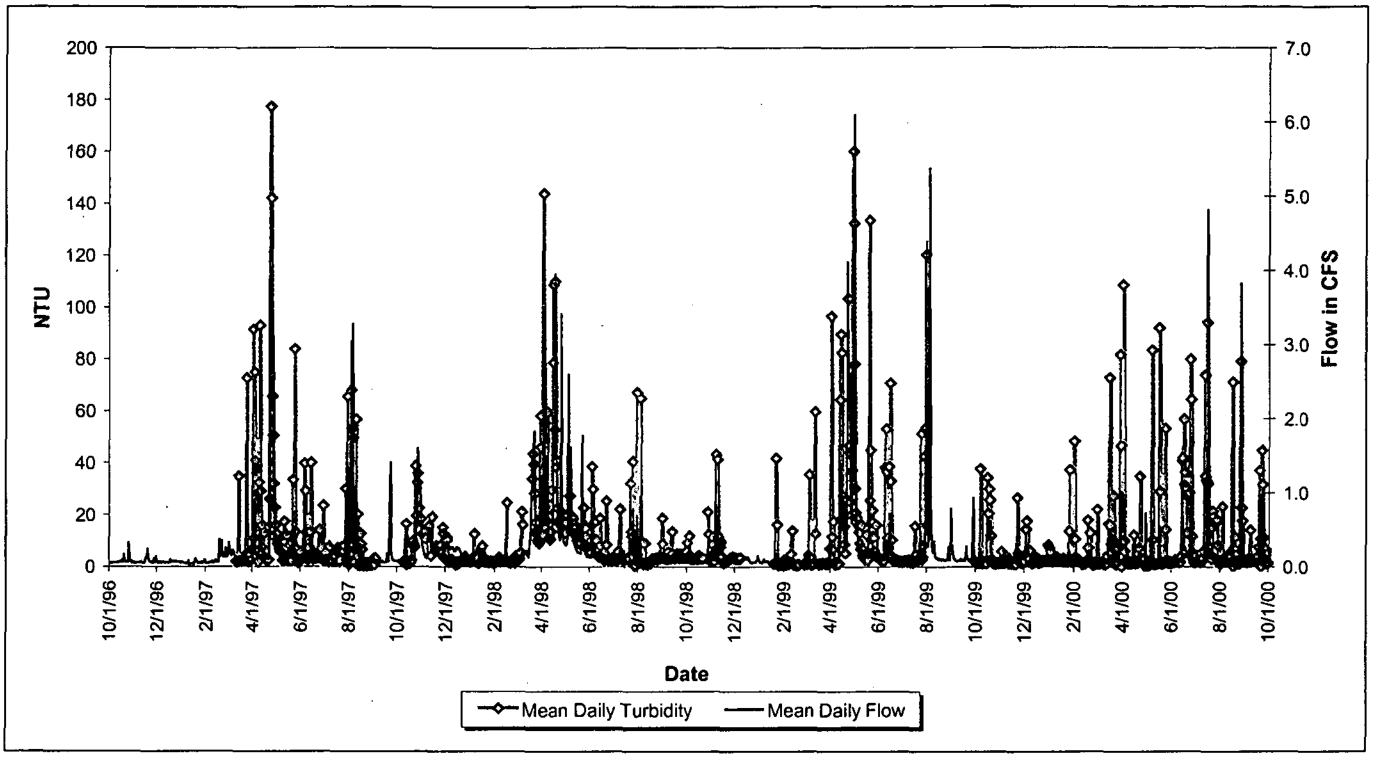

Figure 11-42. Mean Daily Turbidity at SW093: Water Years 1997 – 2000.

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12. STREAM SEGMENT 5 POINT OF EVALUATION MONITORING

This monitoring objective deals with POE monitoring of Segment 5 for adherence with the RFCA Action Level Framework (ALF). Response to exceedances of Action Levels at POEs are different than the responses associated with contaminated runoff before it reaches Segment 5 or after it enters Segment 4. IA monitoring upgradient of Segment 5 is designed to detect new contaminant sources within the IA. Downstream, Segment 4 is monitored at POCs to protect designated uses, the ecology, and the public health.

Data collected during RFCA monitoring have resulted in reportable levels for Pu and Am under the RFCA action level criteria at the designated POEs. Such exceedances have required source evaluation and the development of a mitigation plan, when appropriate. These reportable values have caused the Site to invoke the Source Location decision rule, perform special monitoring tailored to the specific source evaluation, and take action upstream of Segment 5 to protect Segment 5 from contaminant sources that caused such exceedances.

12.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

The analytical decision inputs are those analytes specified as the Segment 5 AoIs per Table 12-1, as sampled at the POEs for Stream Segment 5. RFCA provides specific criteria for virtually every possible contaminant for the main stream channels of Segment 5. In developing the IMP, the DQO team identified a subset of those contaminants that are of sufficient interest to warrant monitoring under ALF.

Segment 5 includes North and South Walnut Creek between the IA and the terminal ponds, and the SID between the IA and Pond C-2. Monitoring will be performed for Stream Segment 5 only as represented by POEs SW093, SW027, and GS10 (see Figure 2-2).

Sampling for AoIs at POEs is performed by collecting continuous flow-paced composite samples. The recommended monitoring design detailed in the IMP is to take samples for WY97-00 as specified in Table 12-5 and Table 12-6. The intent is to take no less than one sample per quarter, and no more than four composite samples per month from each of the three monitoring locations.

Table 12-5 presents the approximate location-specific number of samples per month based on recommendations by statisticians at Pacific Northwest National Laboratory (PNNL) that worked with the DQO working group. There are both practical and statistical advantages to this sample allocation design. Averaging a larger number of samples is more expensive, but it protects the Site from regulatory action in response to a spurious, non-representative monitoring result.

There are secondary advantages to this monitoring plan. A larger number of samples allows for estimates of variability that can be used to refine the monitoring plan over time. The monitoring program specified in the IMP is a technically defensible approach that represents a compromise between a statistical design, a design based on professional judgement, and a design based on budgetary constraints. This design will generate data that are representative of actual contaminant levels and loads.

This design is consistent with the intent of the 30-day moving average specified in RFCA but allows some flexibility. Where there is no significant flow, there may be no samples completed within a 30-day period, and where the flows, loads, and variability are expected to be higher, sample numbers are also higher. Note that flow-paced monitoring will continue during dry periods, although flows may be so low that it takes more than 30 days to fill the composite sample container.

Indicator parameters are measured using real-time water-quality probes as discussed in Section 11 for the NSD monitoring objective. These data may be used in this decision rule for correlations and trending.

Table 12-1. RFCA Segment 5 AoIs.

Radionuclides:	Total Pu-239,240	High level of public concern. Known carcinogen. Known past releases (within the past 8 years) have exceeded RFCA stream standards and action levels. This provides reasonable cause to expect future releases in excess of RFCA Action Levels.
	Total U-233,234, U-235, U-238	Known renal toxicity. Present on Site. Past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Total Am-241	Known carcinogen. Present on Site. Known past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
Metals:	Total Be	Known to cause berylliosis in susceptible individuals when exposed by inhalation. May also cause contact dermatitis. Present on Site. Will be monitored as an indicator of releases from process and waste storage areas.
	Total Cr	Physiological and dermal toxicity. High level of regulatory concern due, in part to the chromic acid incident of 1989. Low levels can cause significant ecological damage.
	Dissolved Ag	Highly toxic to fish at low levels if chronic. State of Colorado has temporarily removed its stream standard for silver, while under study. The study has been completed, and the standard will be reinstated at the next triennial review of South Platte stream standards, if not before. Used on Site only for photographic development. Routinely accepted by POTWs as municipal waste, but discharge is regulated. May be removed from this list later, if data do not support concern.
	Dissolved Cd	Highly toxic to fish at low levels if chronic. Known human carcinogen (prostate cancer) and depletes physiologic calcium. Used on Site in plating processes. Monitoring data for the Interceptor Trench System (ITS) and the proposed discharge of untreated ITS waters into Walnut Creek provide reasonable cause to expect future releases in excess of RFCA Action Levels.
	Hardness	Required to evaluate metals analyses, due to its effect on solubility of these metals.
Real Time Monitoring of Physical and Indicator Parameters:	pH	Toxicity to humans and ecology. Regulatory concern due to chromic acid incident. Real-time monitoring is inexpensive and effective method of detecting acid spills such as (chromic acid or plutonium nitrate) or failure of treatment systems.
These parameters provide real-time alarms for a wide variety of regulated contaminants, and are also a required component of monitoring for AoIs.	Conductivity	Conductivity is an indicator of total dissolved solids, metals, anions, and pH. Real-time monitoring of conductivity is an inexpensive indicator of overall water quality.
They require no laboratory analyses, and are the Site's most cost effective defensive monitoring.	Turbidity	Turbidity is a general indicator of elevated contaminant levels, and may be correlated with Pu.
	Nitrate	Past releases near RFCA stream standards and action levels upstream of ponds provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels. ITS discharges are often high in nitrate, and may challenge RFCA action levels.
	Flow	Required to detect flow events, pace automated samplers, evaluate contaminant loads, and plan pond operations and discharges. Affects nearly every decision rule, and is the most commonly discussed attribute of Site surface waters.

Notes: ITS = Interceptor Trench System; POTW = Publicly owned treatment works; VOA = Volatile organic analysis

12.2 WY97-00 MONITORING SCOPE

Table 12-2. POE Monitoring Locations.

ID Code	Location	Primary Flow Measurement Device	Telemetry
SW093	N. Walnut Cr. 1300' upstream from the A-1 Bypass	36" Suppressed Rectangular Sharp-Crested Weir	Yes
GS10	S. Walnut Cr. upstream from the B-1 Bypass	9" Parshall Flume	Yes
SW027	South Interceptor Ditch just upstream of Pond C-2	Dual Parallel 120° V-Notch Weirs	Yes

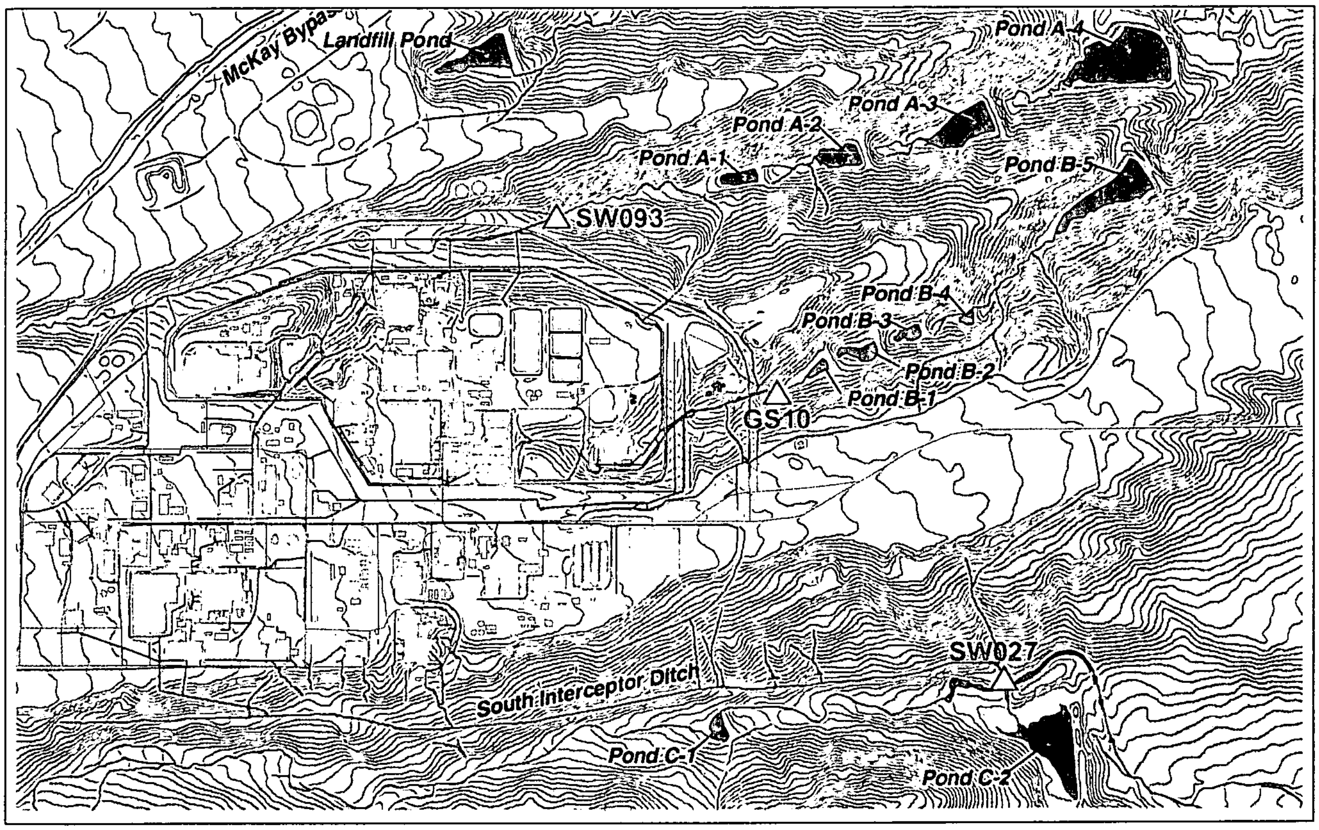


Figure 12-1. Water Year 1997-2000 Point of Evaluation Monitoring Locations.

Table 12-3. POE Field Data Collection: Parameters and Frequency.

ID Code	Parameter	
	Discharge	Real-Time pH, Conductivity, Turbidity, Nitrate
SW093	15-min continuous	15-min continuous
GS10	15-min continuous	15-min continuous
SW027	15-min continuous	15-min continuous

Note: All locations collect 5- and 15-minute flow data.

Table 12-4. POE Sample Collection Protocols.

ID Code	Frequency[a]	Type[b]
SW093	36 per year	Continuous flow-paced composites
GS10	34 per year	Continuous flow-paced composites
SW027	17 per year	Continuous flow-paced composites

Notes: [a] Sample frequency distribution during the year for SW093, GS10, and SW027 (POEs) is given in Table 12-5.
[b] Sample types are defined in the RFETS Automated Surface-Water Monitoring Work Plan.

Table 12-5. POE Target Sample Distribution.

Month	SW093	GS10	SW027	Totals
Oct	2	3	1	6
Nov	3	2	1	6
Dec	2	1	0	3
Jan	2	1	1	4
Feb	2	2	0	4
Mar	4	3	1	8
Apr	4	4	4	12
May	4	4	4	12
Jun	4	3	2	9
Jul	3	4	1	8
Aug	4	4	1	9
Sep	2	3	1	6
Totals	**36**	**34**	**17**	**87**

Table 12-6. POE Analytical Targets (Analyses per Year).

ID Code	Dissolved Ag, Total Be, Dissolved Cd, Total Cr	Hardness	Pu, U, Am
SW093	36	36	36
GS10	34	34	34
SW027	17	17	17

12.3 DATA EVALUATION

Sampling for AoIs at POEs is performed by collecting continuous flow-paced composite samples. Indicator parameters are measured using real-time water-quality probes. The AoIs are evaluated using 30-day moving averages, as specified in RFCA and implemented by the ALF or DQO working groups involving consensus of all parties to RFCA. Pu, Am, U, Be, Cr, dissolved Ag, and dissolved Cd are evaluated using volume-weighted 30-day moving averages at POEs[38]. Indicator parameters are evaluated qualitatively to assess chronic trends and annual variability.

[38] The 30-day average for a particular day is calculated as a volume-weighted average of a 'window' of time containing the previous 30-days which had flow. Each day has its own discharge volume (measured at the location with a flow meter) and activity (analytical result from the sample in place at the end of that day). Therefore, there are 365 30-day moving average values for a location that flows all year (366 values in a leap year). At locations which monitor pond discharges or have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no activity is available, either due to a failed lab analysis or non-sufficient quantity (NSQ) for analysis, no 30-day average is reported. The calculation of 30-day averages is discussed in detail in Appendix B1: Data Evaluation Methods.

The parties to RFCA agree that continuous monitoring probes will be used as indicators that may suggest a need for additional monitoring, mitigating action, or management decision. The parties agree that compliance and enforcement issues will be resolved based on standard analytical procedures required by the applicable agreement or regulations, e.g., RFCA, or CERCLA. The parties agree that continuous monitoring field probes should NOT be used to determine compliance or serve as a basis for enforcement action, unless the applicable regulation specifies such a probe as the enforceable analytical method for a particular measurement.

Generally, analytical data evaluation is performed as preliminary data become available. If an initial qualitative screening indicates that an analytical result is higher than the action level for a particular AoI, then the 30-day average is calculated immediately upon receipt of the preliminary result. The desired evaluation frequency is semi-monthly, within one week of the 15th and last day of any given month.

IF	The appropriate summary statistic for any AoI in the main stream channels of Stream Segment 5, as monitored at the designated POEs, exceeds the appropriate RFCA action level[39] (Table 12-8)
THEN	The Site must notify EPA and CDPHE, evaluate for source location, and implement mitigating action[40] if appropriate[41].

Table 12-7. POE Monitoring Analytical Data Evaluation.

ID Code	Evaluation Type[a]
SW093	30-Day Volume-Weighted Moving Averages; Loading Analysis
GS10	30-Day Volume-Weighted Moving Averages; Loading Analysis
SW027	30-Day Volume-Weighted Moving Averages; Loading Analysis

Notes: [a] Details on the evaluation of analytical results are given in Appendix B.1: Data Evaluation Methods. Loading analysis for POEs is given in Section 5.

Table 12-8. POE Monitoring RFCA Action Levels.

Analyte	Action Level
Am-241	0.15 pCi/L
Pu-239,240	0.15 pCi/L
Total Uranium	10 pCi/L (GS10 and SW093); 11 pCi/L (SW027)
Total Be	4 µg/L
Dissolved Cd	1.5 µg/L
Total Cr	50 µg/L
Dissolved Ag	0.6 µg/L

[39] Appropriate action levels and standards for volume-weighted 30-day moving averages are specified for individual contaminants in RFCA.

[40] Mitigating action may include, but not be limited to, the following examples: 1) Immediate action to halt a discharge or contain a spill; or 2) Use of the Source Location decision rule to seek out and mitigate upstream contaminant sources.

[41] EPA determines the consequences for an exceedance of any action level (not just those for AoIs) at any location within the segment (not just at the consensus monitoring points). This decision rule presents the consensus decision rule that drives our monitoring activities. It is an implementation, rather than a reiteration, of RFCA.

The following sections include summary tables and plots showing the 30-day volume-weighted averages, periodic volume-weighted averages, and 365 calendar-day volume-weighted averages for the POE analytes. Prior to 1/1/00, the action levels for both dissolved Cd and Ag were calculated to take into account the toxicity of these metals in relation to hardness. The action levels were calculated for each day using the corresponding 30-day volume-weighted hardness values. Therefore, the action levels vary with varying hardness. Starting on 1/1/00, in consultation with the Regulators and Stakeholders, the action levels used for these metals assumes a fixed hardness of 143 mg/L, which is consistent with State water-quality standard methodology.

The following evaluations include all results that were not rejected through the verification/validation process. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' value and the 'duplicate'. When a sample has multiple 'real' analyses (Site requested 're-runs'), the value used in calculations is the arithmetic average of the multiple 'real' analyses. Total uranium is calculated by summing the activities for the analyzed isotopes (U-233,234 + U-235 + U-238).

The methods used for the evaluations are given in Appendix B.1: Data Evaluation Methods.

The loading analysis for GS10, SW027, and SW093 is presented in Section 5.

Real-time water quality data are not presented in this section. Plots of mean daily water temperature, specific conductivity, pH, and turbidity values are given in Section 11: New Source Detection Monitoring. More detailed data for all parameters are presented in Appendix B.5.2. The methods used for the water-quality parameter evaluations are given in Appendix B.5: Real-Time Water-Quality Parameters.

12.3.1 Location GS10

Monitoring location GS10 is located on S. Walnut Cr. at the perimeter of the IA just upstream of the B-Series ponds. Figure 3-25 shows the drainage area for GS10. The 100, 300, 400, 500, 600, 700, 800, and 900 areas all contribute flow to GS10.

Table 12-9 shows that most of the annual average Pu and Am activities were greater than 0.15 pCi/L. Additionally, the long-term Pu and Am averages (WY97-00) are greater than 0.15 pCi/l. The total uranium average activities are well below 10 pCi/L.

Figure 12-2 shows multiple occurrences of reportable 30-day averages. In response, the Site was required to perform multiple source evaluations to address these reportable values. A summary of the extensive investigations is given in Section 6.3.

Figure 12-3 shows that the 30-day average for uranium was below reporting levels for the entire period.

Figure 12-6 shows the 365 calendar-day averages using the proposed post-Closure calculation method (see Appendix B.1: Data Evaluation Methods). It can be seen that by using this method the variability is 'dampened' by the longer evaluation period, but many values would still be reportable using the current 0.15 pCi/L Action Level.

Table 12-9. Annual Volume-Weighted Average Radionuclide Activities at GS10 in WY97-00.

	Volume-Weighted Average Activity (pCi/L)		
Water Year	***Am-241***	***Pu-239,-240***	***Total Uranium***
1997	0.302	0.295	2.849
1998	0.105	0.152	2.985
1999	0.276	0.140	2.483
2000	0.397	0.185	2.191
Total	0.261	0.190	2.645

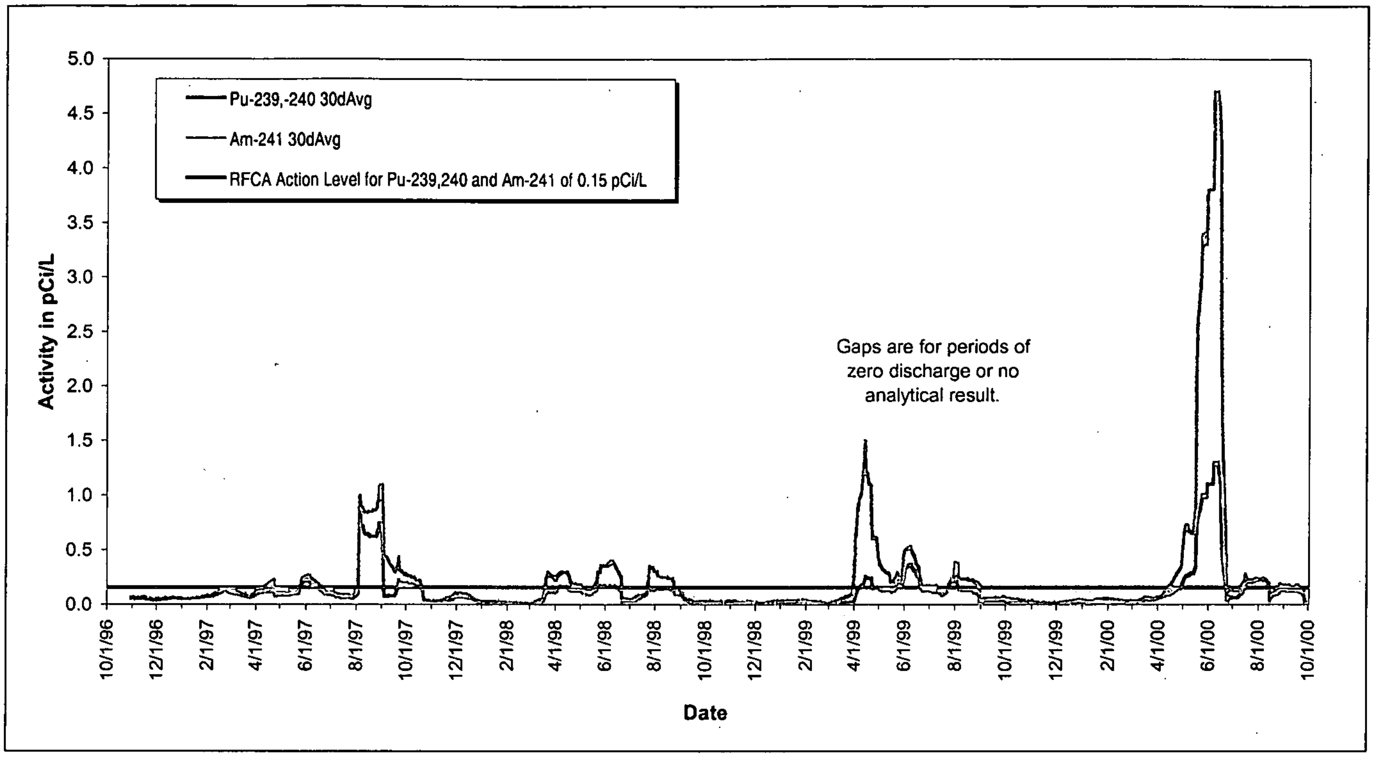


Figure 12-2. Volume-Weighted 30-Day Average Pu and Am Activities at GS10: WY97–00.

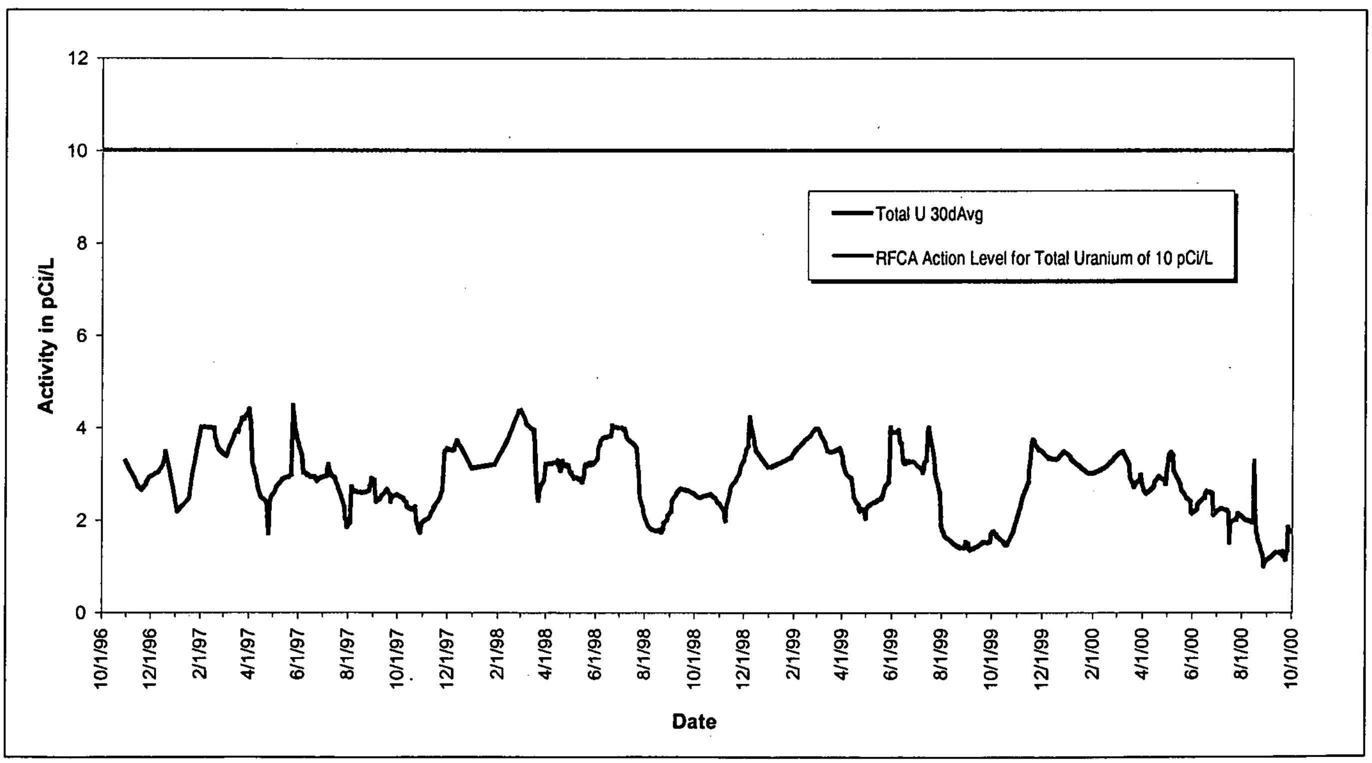


Figure 12-3. Volume-Weighted 30-Day Average Total Uranium Activities at GS10: WY97–00.

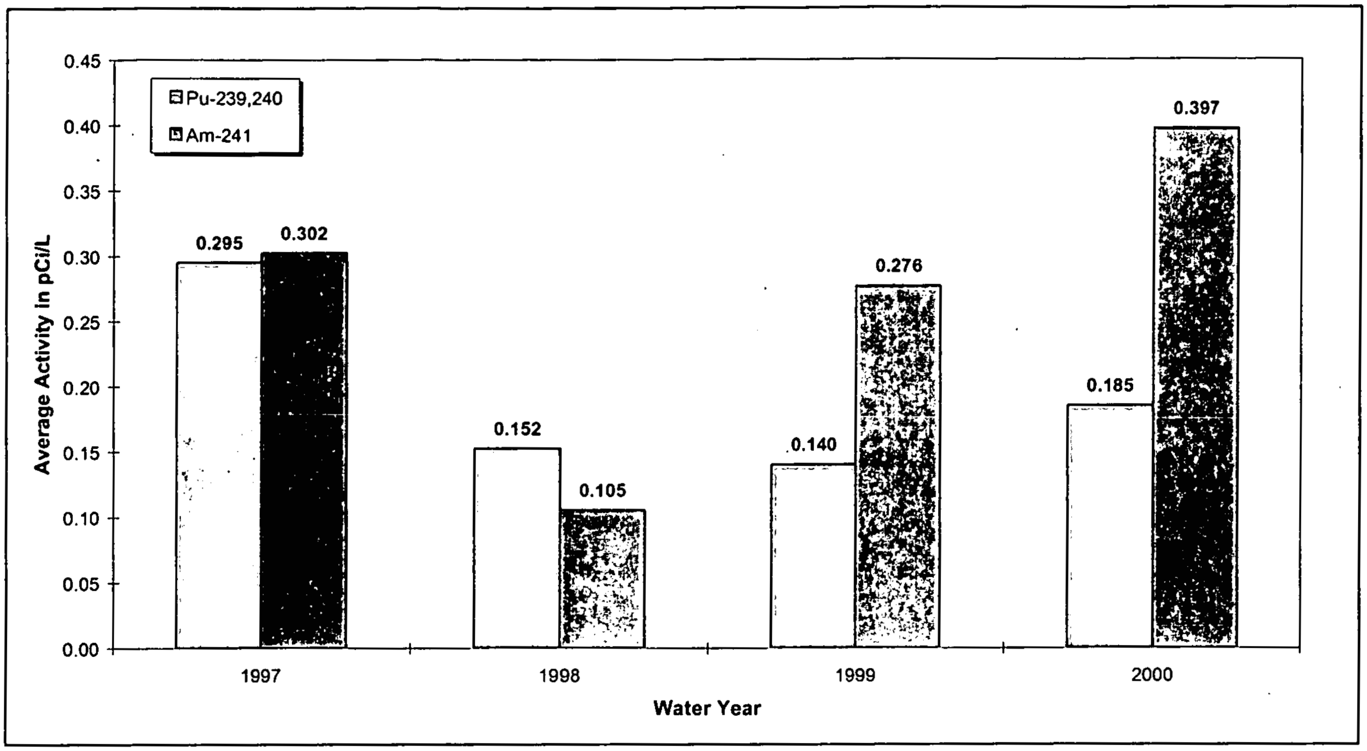


Figure 12-4. Annual Volume-Weighted Average Pu and Am Activities at GS10: WY97–00.

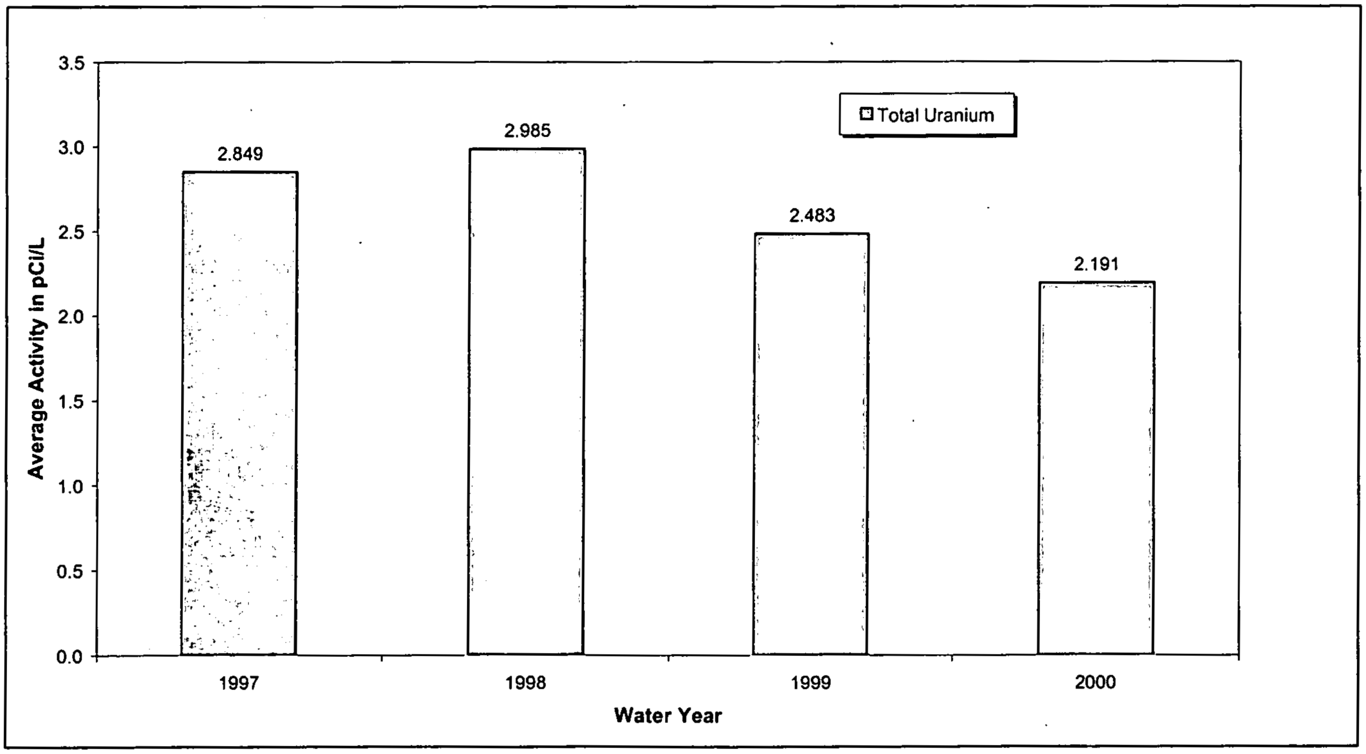
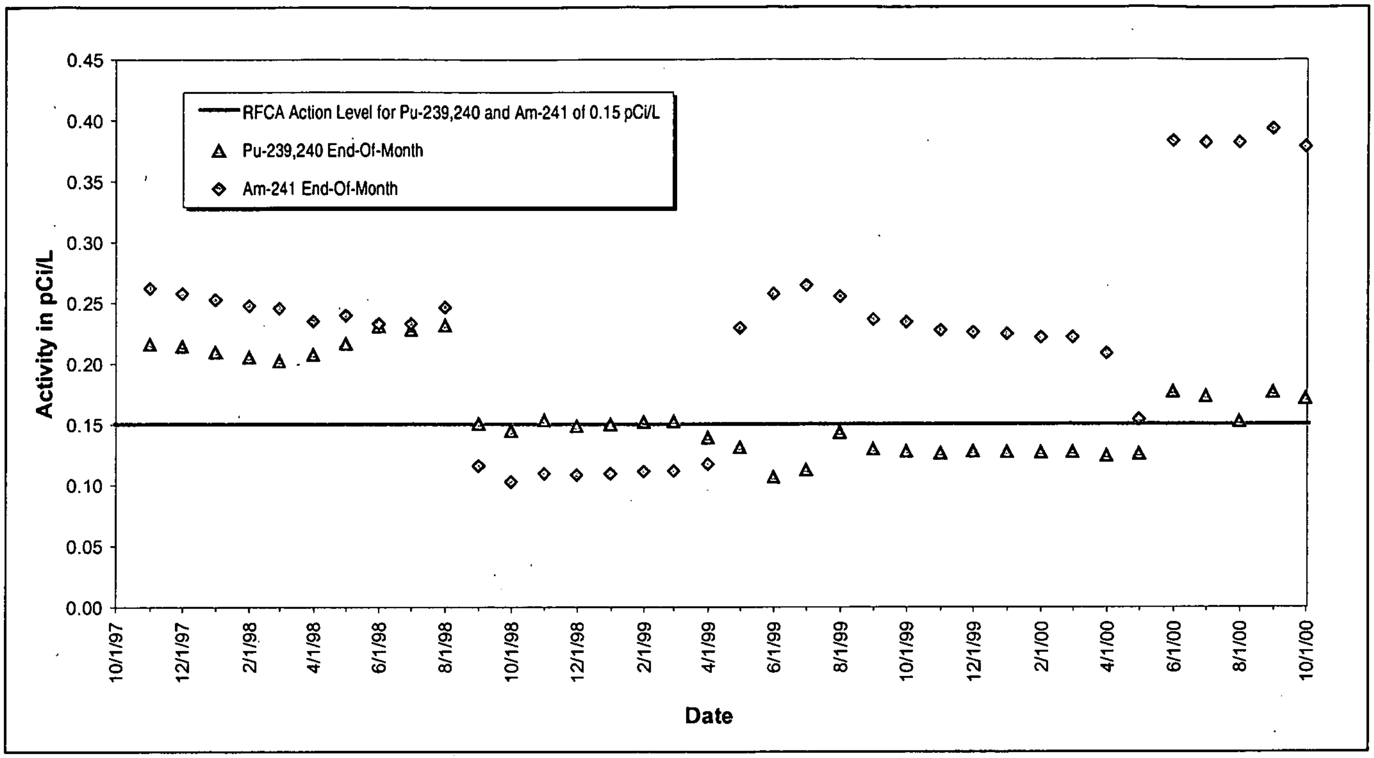


Figure 12-5. Annual Volume-Weighted Average Total Uranium Activities at GS10: WY97–00.



Note: The 365 calendar-day average activities are calculated for the last day of each month for the previous 365 days.

Figure 12-6. Volume-Weighted 365 Calendar-Day Average Pu and Am Activities at GS10: WY97–00.

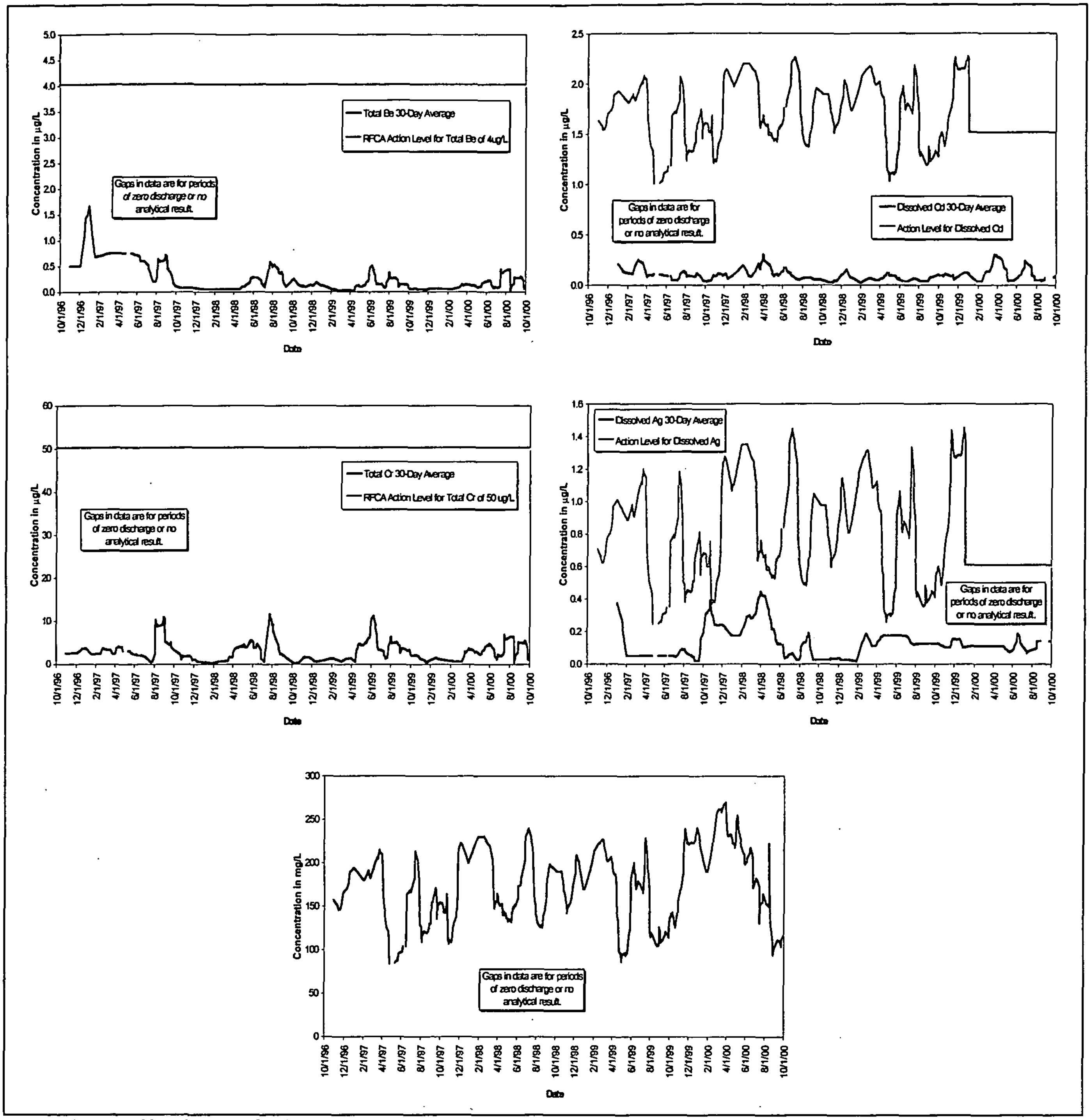
Table 12-10 shows that all of the annual average metals concentrations were less than the action level. Additionally, the long-term metals averages (WY97-00) were less than the action levels.

Figure 12-7 shows that none of the 30-day averages were reportable.

Table 12-10. Annual Volume-Weighted Average Hardness and Metals Concentrations at GS10 in WY97-00.

Water Year	Volume-Weighted Average Concentration (µg/L)				
	Hardness [mg/L]	Total Be	Dissolved Cd	Total Cr	Dissolved Ag
1997	137	0.64	0.09	4.62	0.08
1998	159	0.14	0.13	3.19	0.24
1999	134	0.17	0.07	4.09	0.13
2000	173	0.20	0.11	3.53	0.11
Total	150	0.28	0.10	3.84	0.14

Note: Hardness units mg/L.



Note: Prior to 1/1/00, action levels for dissolved Cd and Ag were calculated using the analyte specific toxicity equation incorporating the 30-day volume-weighted hardness values.

Figure 12-7. Volume-Weighted 30-Day Average Metals and Hardness Concentrations at GS10: WY97–00.

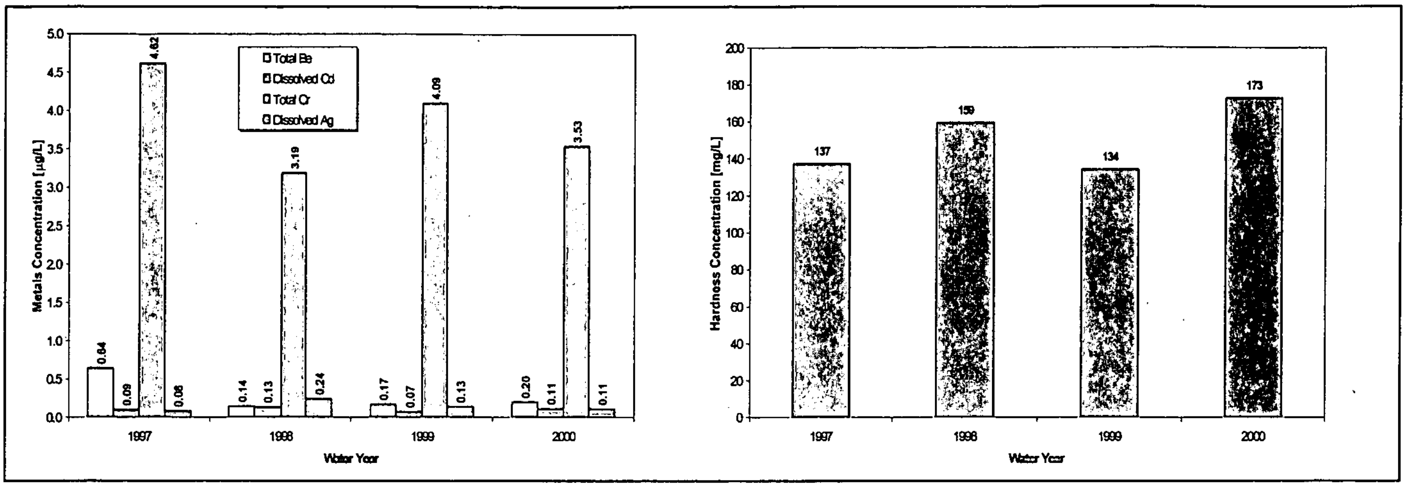


Figure 12-8. Annual Volume-Weighted Average Metals and Hardness Concentrations at GS10: WY97–00.

12.3.2 Location SW027

Monitoring location SW027 is located at the end of the SID at the inlet to Pond C-2. Figure 3-71 shows the drainage area for SW027. The 100, 400, 600, 800, and 900 areas all contribute flow to SW027.

Table 12-11 shows that most of the annual average Pu and Am activities were less than 0.15 pCi/L. Additionally, neither of the long-term Pu and Am averages (WY97-00) is greater than 0.15 pCi/l. The total uranium average activities are well below 11 pCi/L.

Figure 12-9 shows two periods of reportable 30-day averages for Pu. In response, the Site was required to perform source evaluations to address these reportable values. A summary of the extensive investigations is given in Section 6.3.

Figure 12-10 shows that the 30-day average for uranium was below reporting levels for the entire period.

Figure 12-13 shows the 365 calendar-day averages using the proposed post-Closure calculation method (see Appendix B.1: Data Evaluation Methods). It can be seen that by using this method the variability is 'dampened' by the longer evaluation period, but several values would still be reportable using the current 0.15 pCi/L Action Level.

Table 12-11. Annual Volume-Weighted Average Radionuclide Activities at SW027 in WY97-00.

Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	*Pu-239,-240*	*Total Uranium*
1997	0.007	0.037	1.432
1998	0.021	0.140	3.208
1999	0.018	0.067	1.870
2000	0.059	0.327	1.212
Total	0.021	0.118	2.191

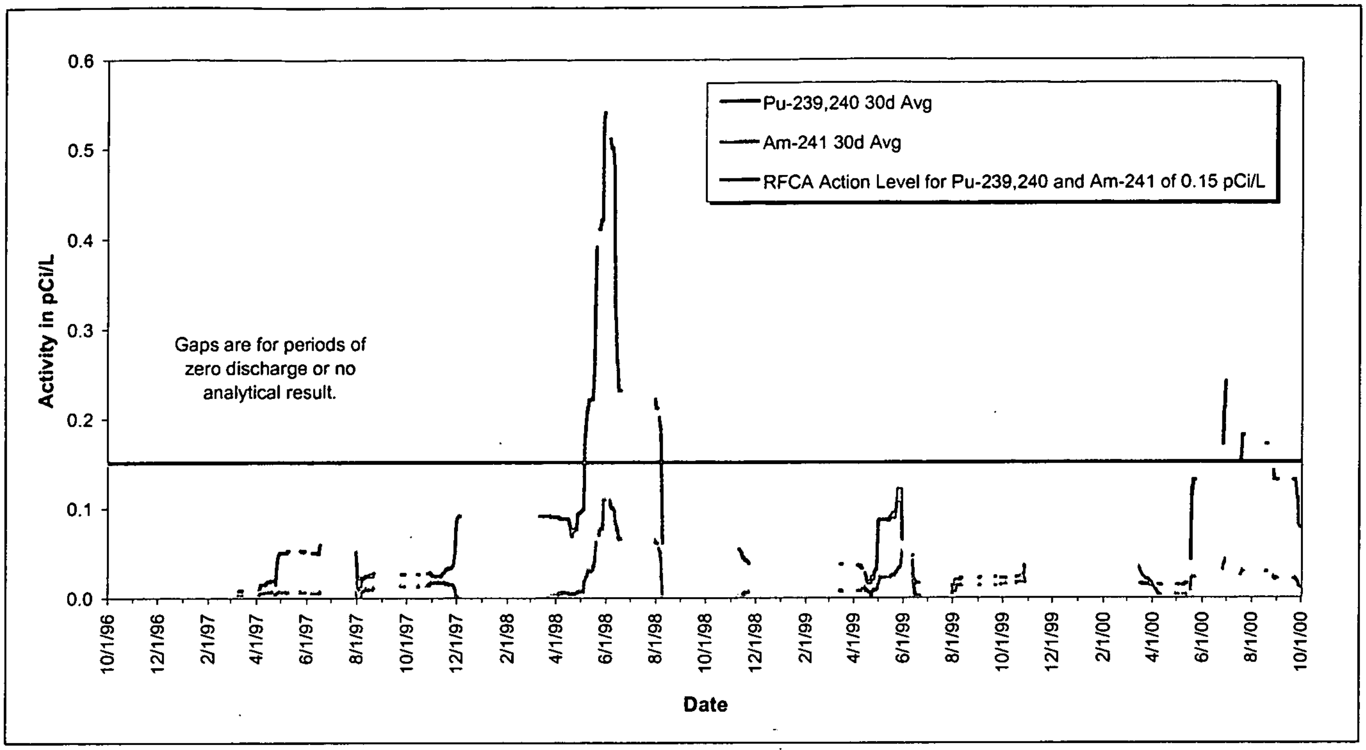


Figure 12-9. Volume-Weighted 30-Day Average Pu and Am Activities at SW027: WY97–00.

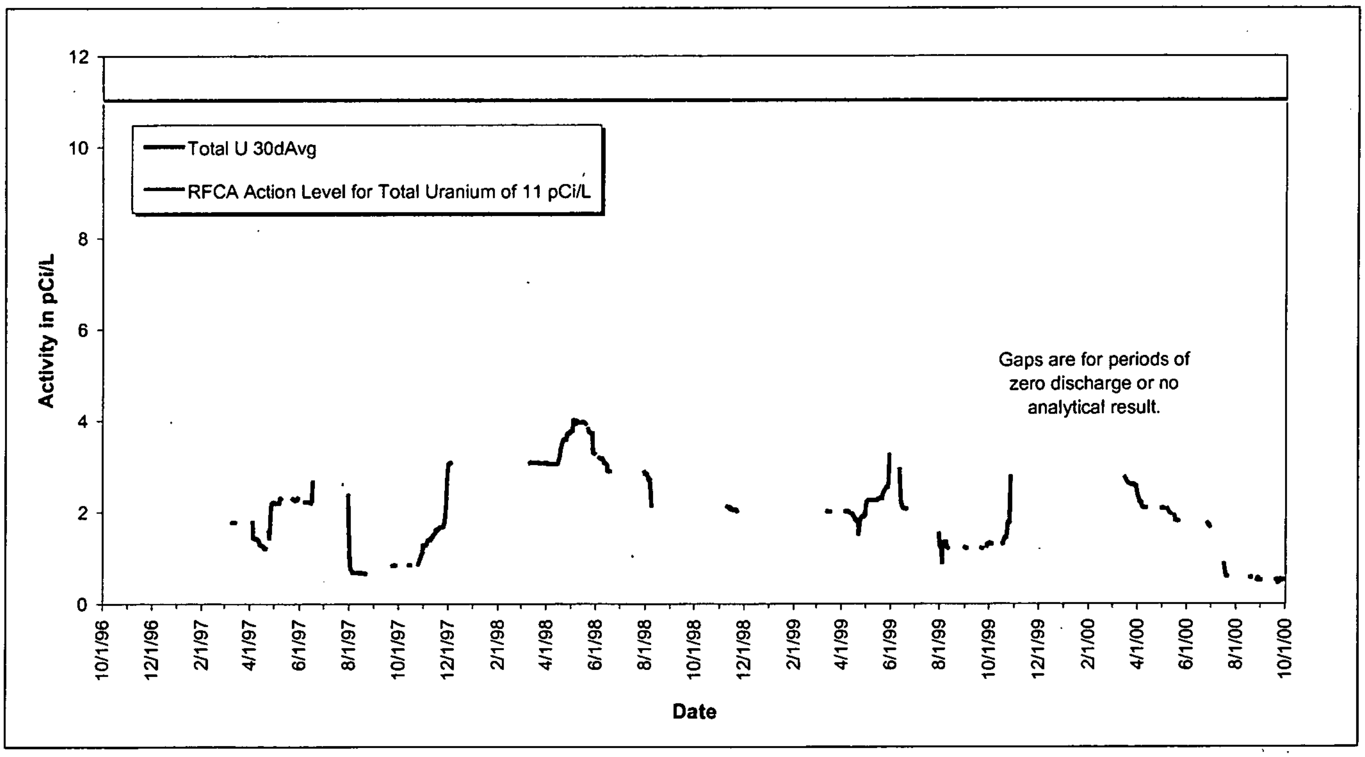


Figure 12-10. Volume-Weighted 30-Day Average Total Uranium Activities at SW027: WY97–00.

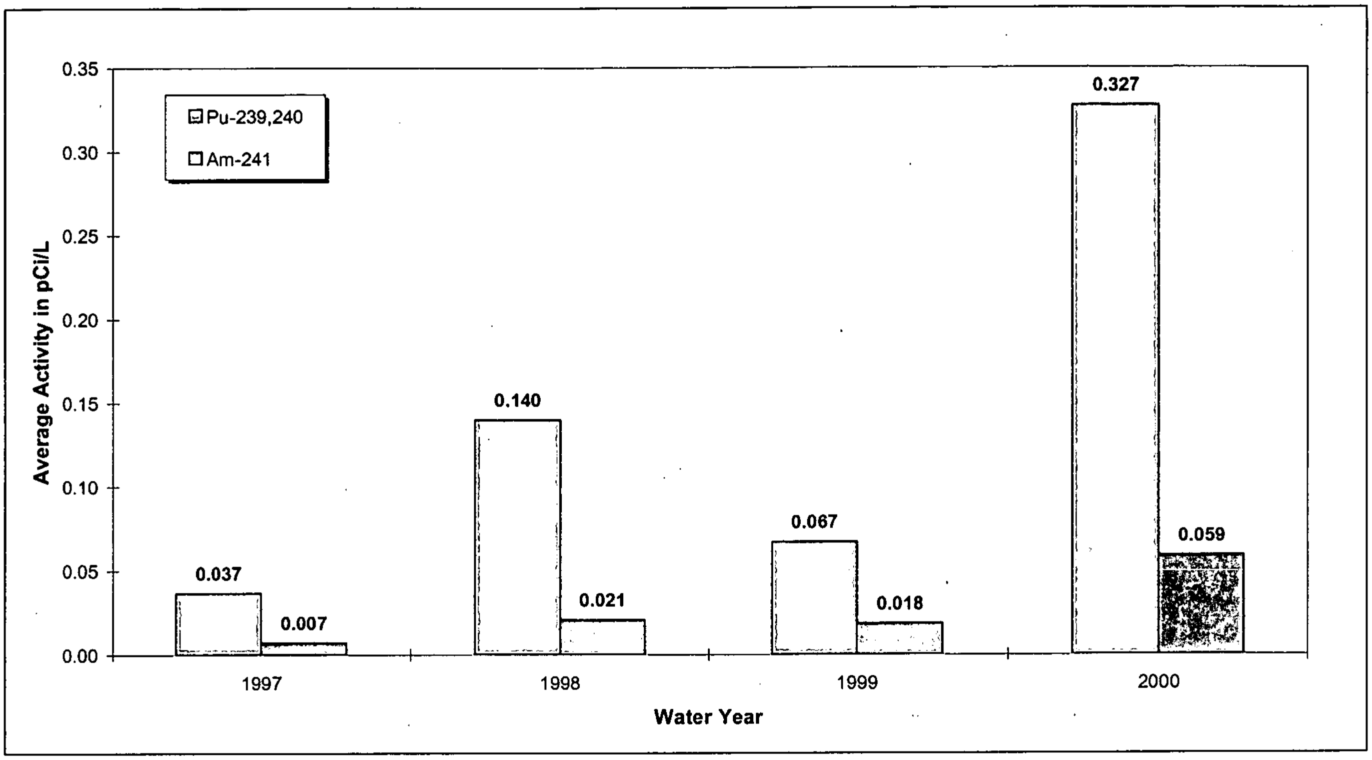


Figure 12-11. Annual Volume-Weighted Average Pu and Am Activities at SW027: WY97–00.

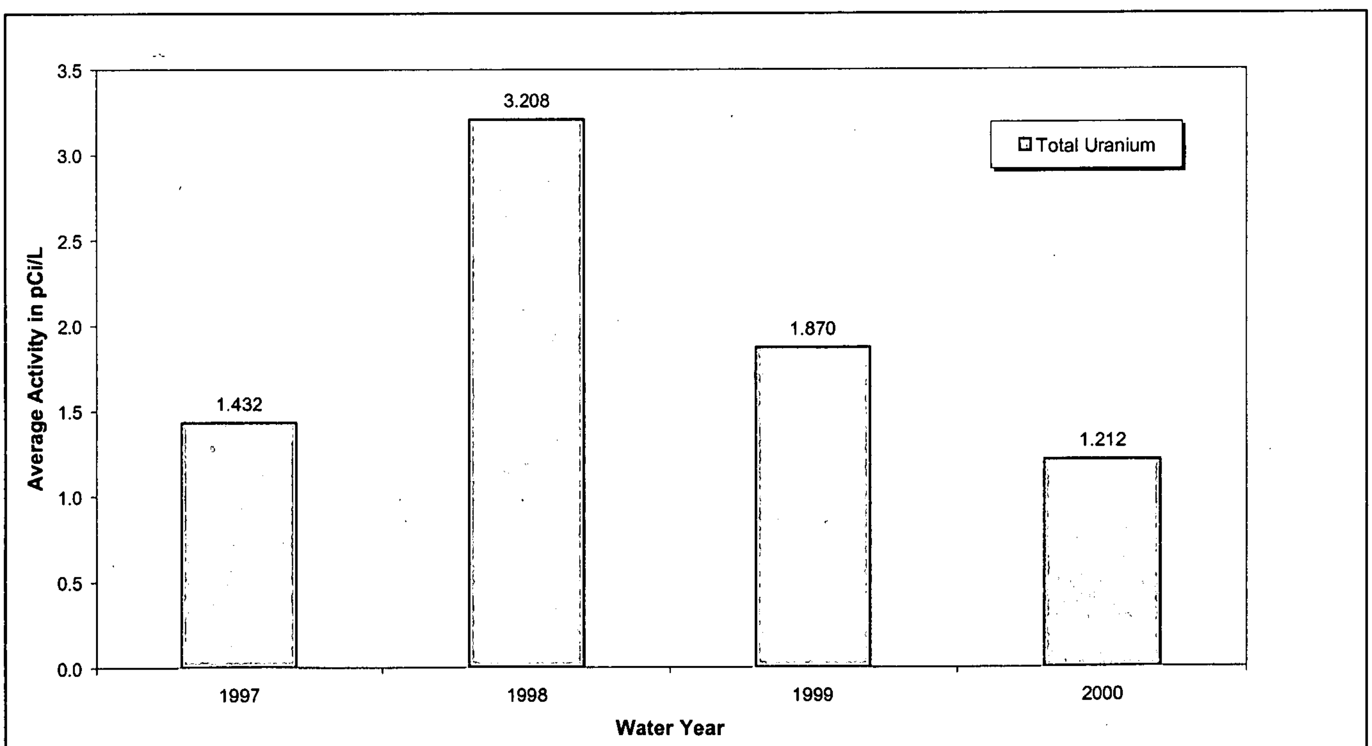
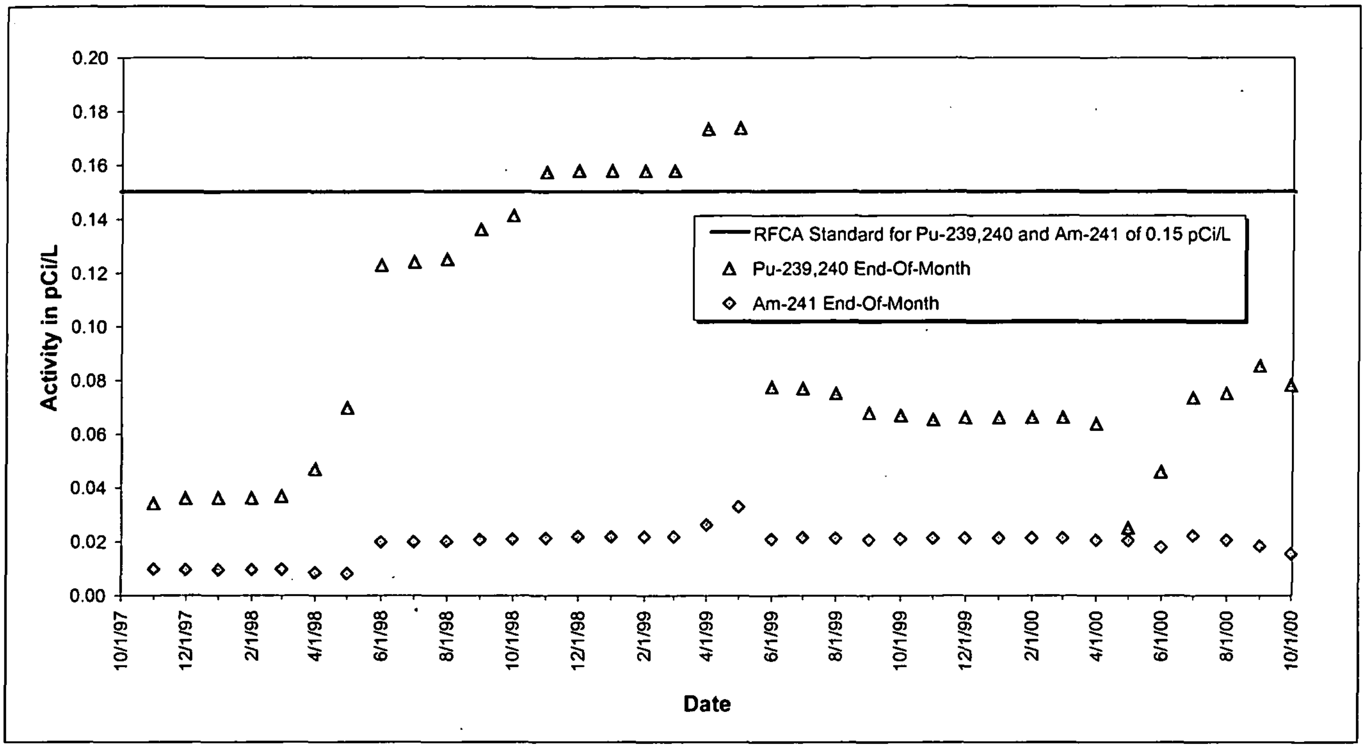


Figure 12-12. Annual Volume-Weighted Average Total Uranium Activities at SW027: WY97–00.



Note: The 365 calendar-day average activities are calculated for the last day of each month for the previous 365 days.

Figure 12-13. Volume-Weighted 365 Calendar-Day Average Pu and Am Activities at SW027: WY97–00.

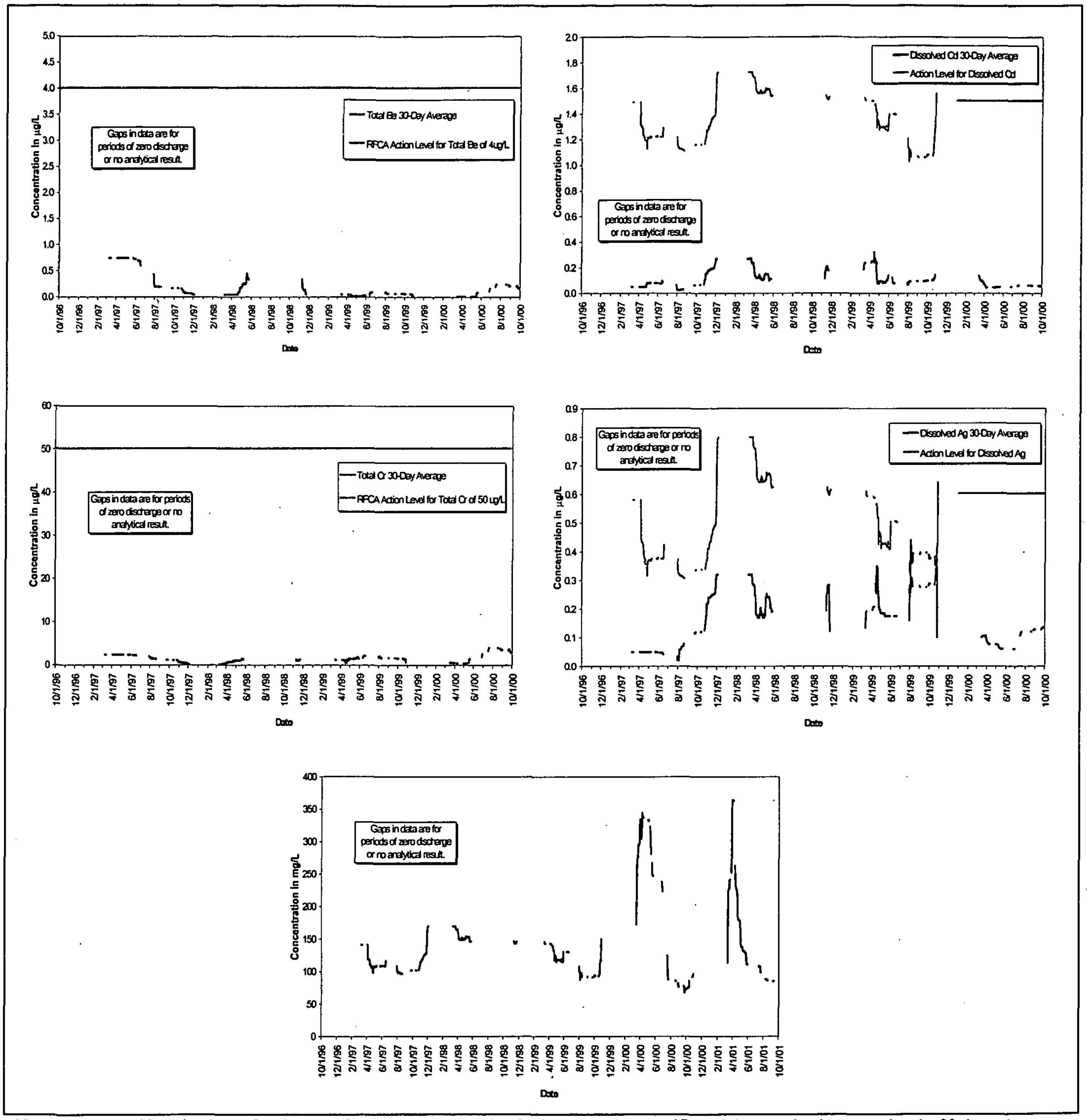
Table 12-12 shows that all of the annual average metals concentrations were less than the action level. Additionally, the long-term metals averages (WY97-00) were less than the action levels.

Figure 12-14 shows that none of the 30-day averages were reportable for Be, Cr, and Cd. For dissolved Ag, the 30-day average was above the hardness-adjusted action level. However, using the agreed upon fixed hardness of 143 mg/L noted above, these values were not reportable.

Table 12-12. Annual Volume-Weighted Average Hardness and Metals Concentrations at SW027 in WY97-00.

Water Year	Volume-Weighted Average Concentration (µg/L)				
	Hardness [mg/L]	Total Be	Dissolved Cd	Total Cr	Dissolved Ag
1997	103	0.53	0.06	2.01	0.06
1998	149	0.13	0.15	0.85	0.21
1999	109	0.03	0.10	1.56	0.25
2000	148	0.26	0.06	3.92	0.09
Total	127	0.21	0.11	1.67	0.18

Note: Hardness units mg/L.



Note: Prior to 1/1/00, action levels for dissolved Cd and Ag were calculated using the analyte specific toxicity equation incorporating the 30-day volume-weighted hardness values.

Figure 12-14. Volume-Weighted 30-Day Average Metals and Hardness Concentrations at SW027: WY97–00.

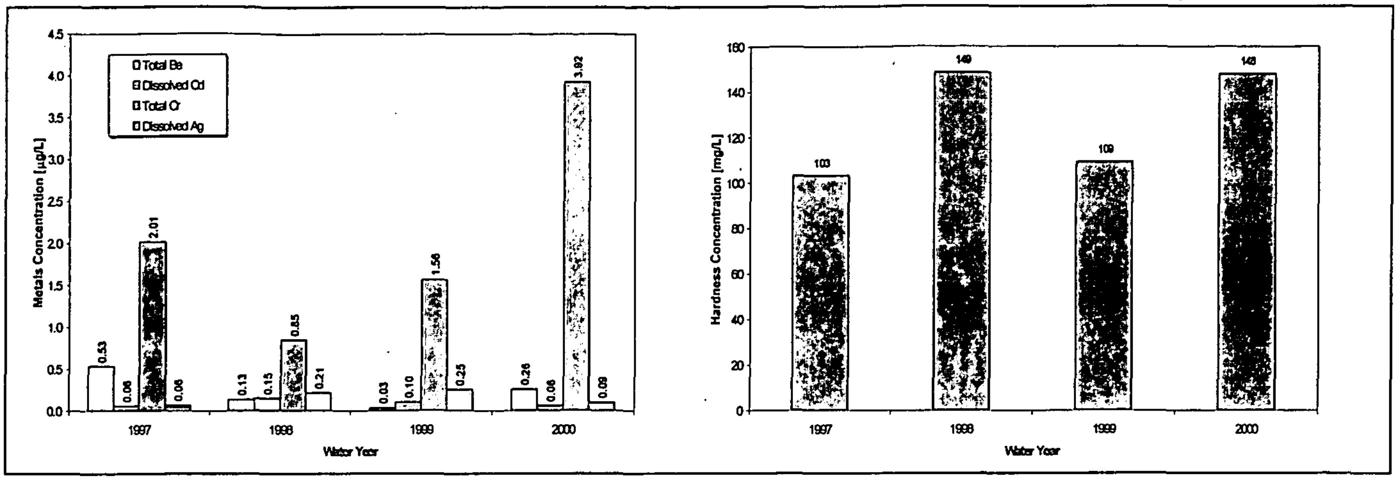


Figure 12-15. Annual Volume-Weighted Average Metals and Hardness Concentrations at SW027: WY97–00.

12.3.3 Location SW093

Monitoring location SW093 is located on N. Walnut Cr. at the perimeter of the IA 1300' upstream of the A-Series ponds. Figure 3-76 shows the drainage area for SW093. The 100, 300, 500, 700, and 900 areas all contribute flow to SW093.

Table 12-13 shows that all of the annual average Pu and Am activities were less than 0.15 pCi/L. Additionally, neither of the long-term Pu and Am averages (WY97-00) is greater than 0.15 pCi/l. The total uranium average activities are well below 10 pCi/L.

Figure 12-16 shows one period of reportable 30-day averages for Pu. In response, the Site was required to perform a source evaluation to address these reportable values. A summary of the extensive investigations is given in Section 6.3.

Figure 12-17 shows that the 30-day average for uranium was below reporting levels for the entire period.

Figure 12-20 shows the 365 calendar-day averages using the proposed post-Closure calculation method (see Appendix B.1: Data Evaluation Methods). It can be seen that by using this method the variability is 'dampened' by the longer evaluation period, and no values would be reportable using the current 0.15 pCi/L Action Level.

Table 12-13. Annual Volume-Weighted Average Radionuclide Activities at SW093 in WY97-00.

	Volume-Weighted Average Activity (pCi/L)		
Water Year	***Am-241***	***Pu-239,-240***	***Total Uranium***
1997	0.045	0.073	2.764
1998	0.018	0.019	2.116
1999	0.025	0.039	1.935
2000	0.022	0.038	2.137
Total	0.026	0.040	2.205

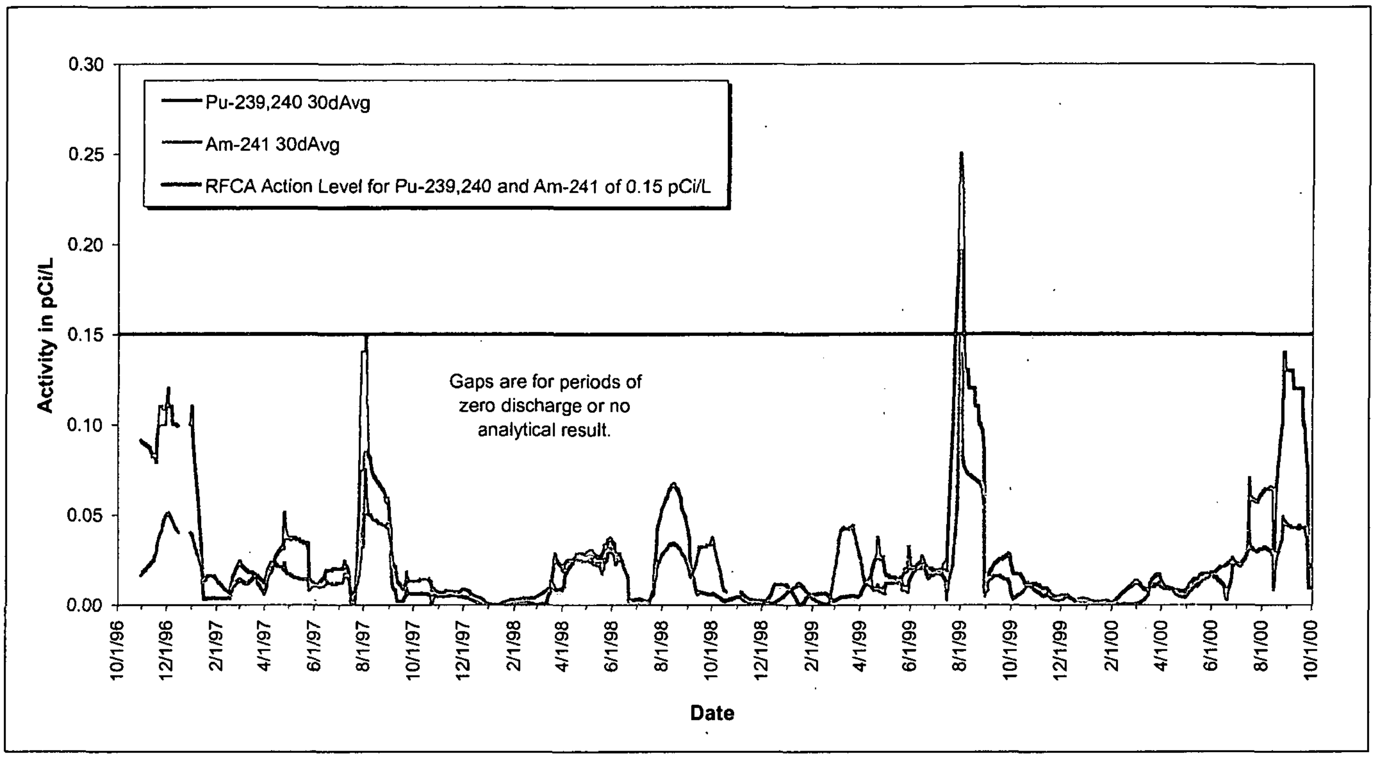


Figure 12-16. Volume-Weighted 30-Day Average Pu and Am Activities at SW093: WY97–00.

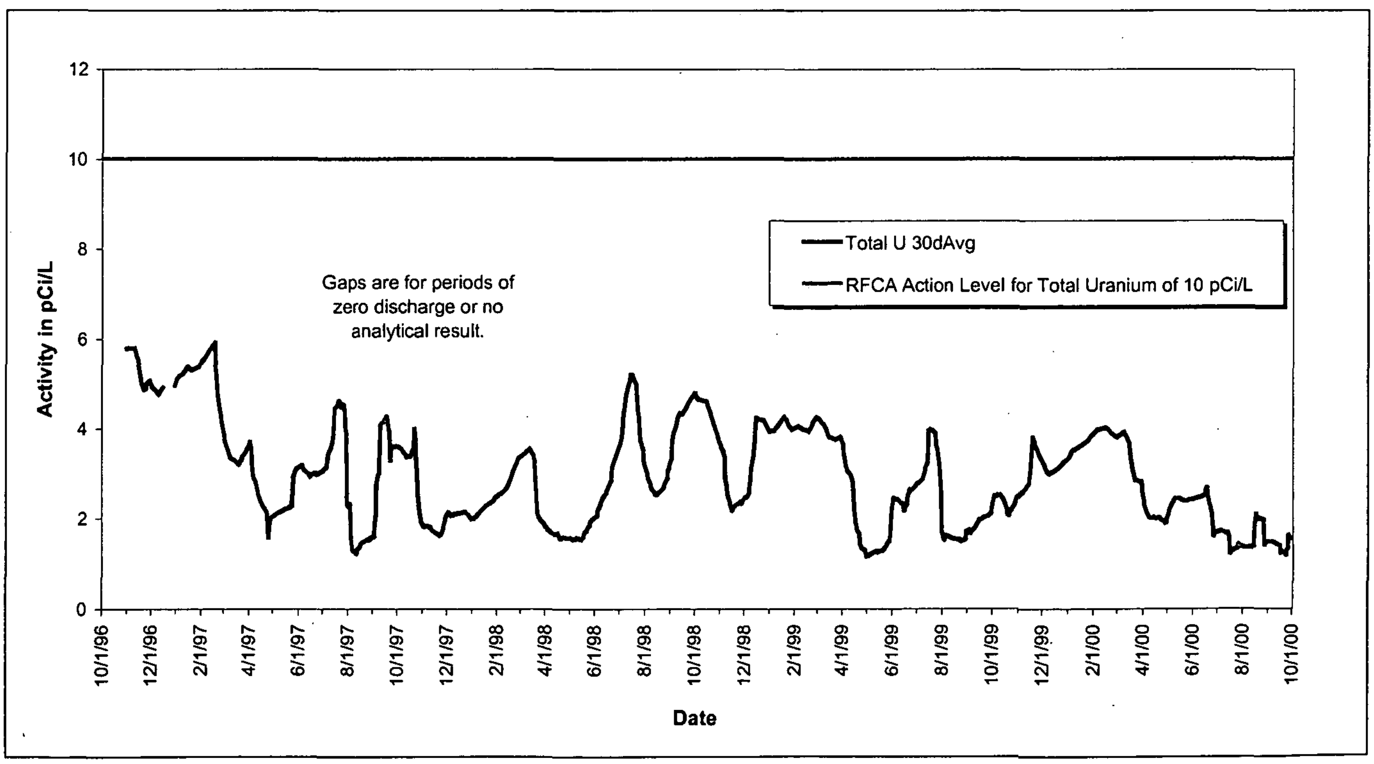


Figure 12-17. Volume-Weighted 30-Day Average Total Uranium Activities at SW093: WY97–00.

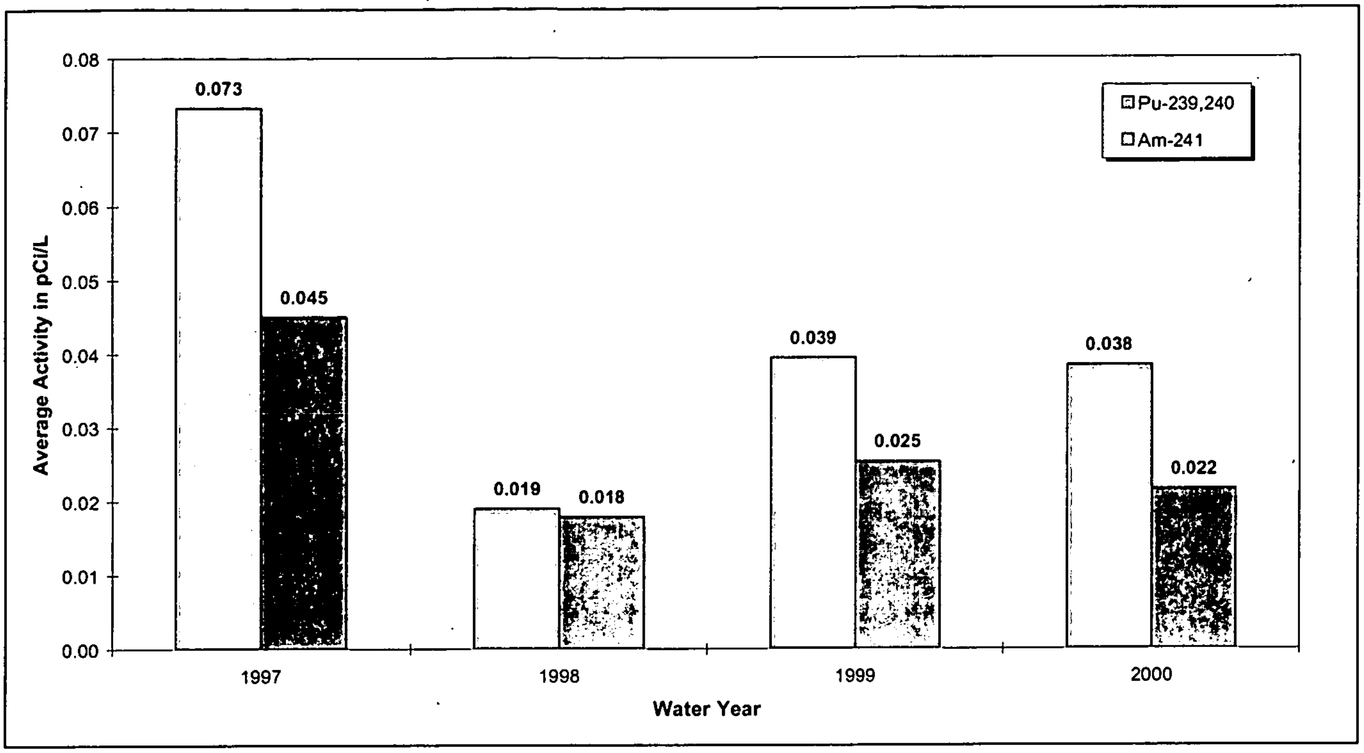


Figure 12-18. Annual Volume-Weighted Average Pu and Am Activities at SW093: WY97–00.

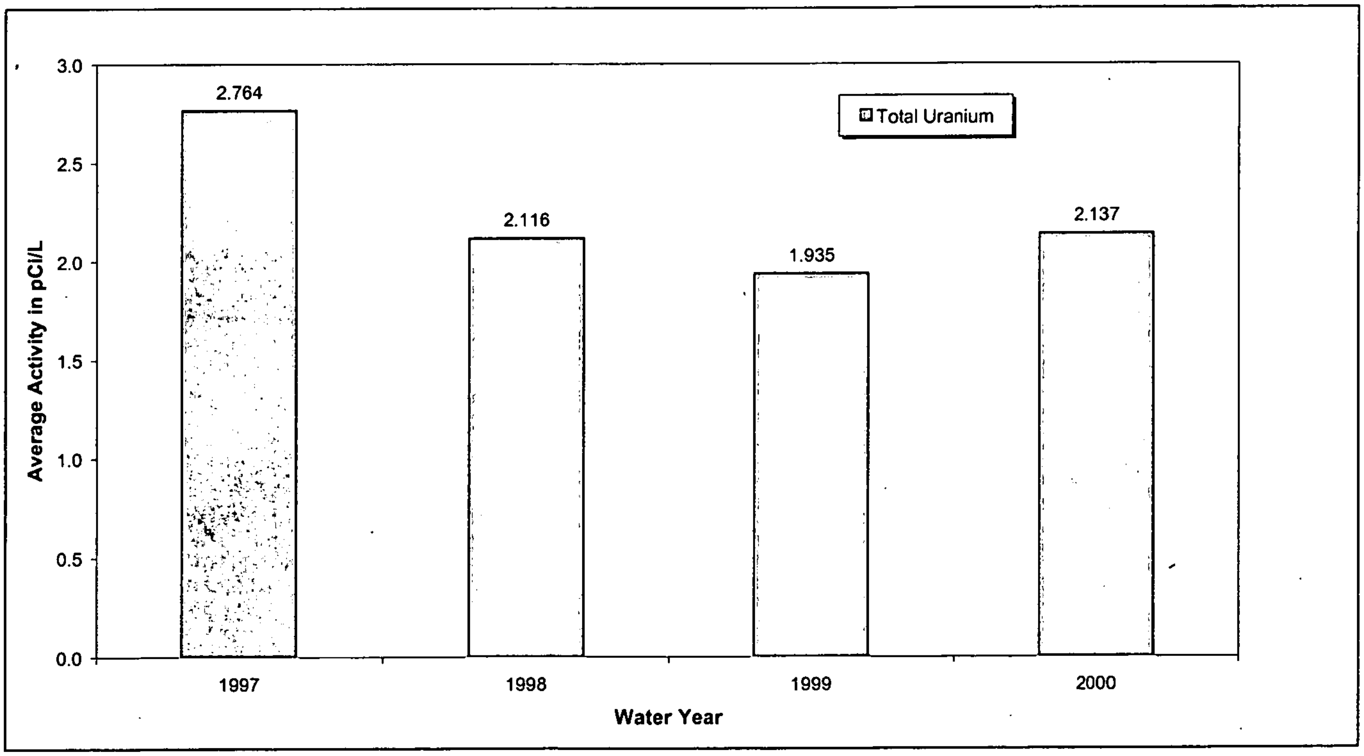
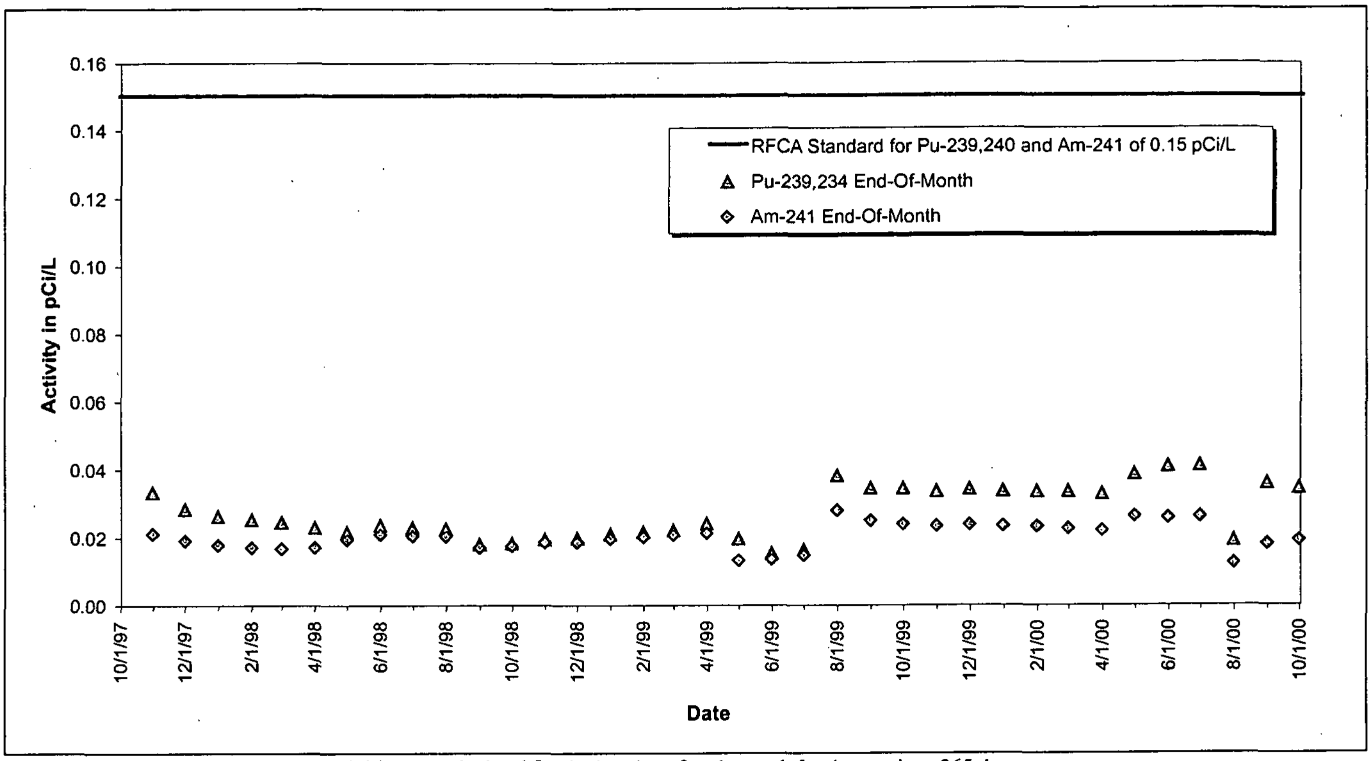


Figure 12-19. Annual Volume-Weighted Average Total Uranium Activities at SW093: WY97–00.



Note: The 365 calendar-day average activities are calculated for the last day of each month for the previous 365 days.

Figure 12-20. Volume-Weighted 365 Calendar-Day Average Pu and Am Activities at SW093: WY97–00.

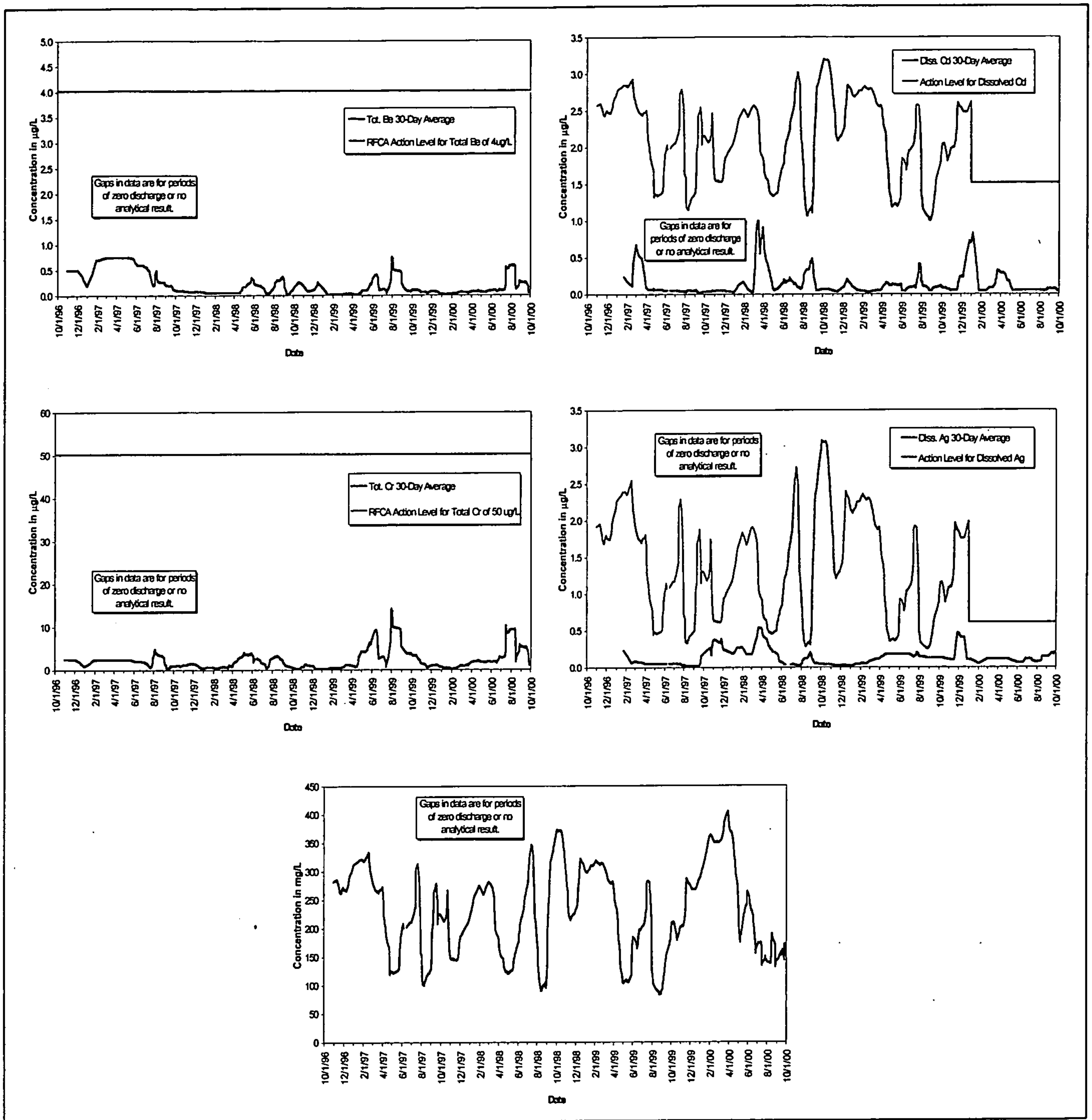
Table 12-14 shows that all of the annual average metals concentrations were less than the action level. Additionally, the long-term metals averages (WY97-00) were less than the action levels.

Figure 12-21 shows that none of the 30-day averages were reportable.

Table 12-14. Annual Volume-Weighted Average Hardness and Metals Concentrations at SW093 in WY97-00.

Water Year	Volume-Weighted Average Concentration (µg/L)				
	Hardness [mg/L]	Total Be	Dissolved Cd	Total Cr	Dissolved Ag
1997	172	0.57	0.09	2.79	0.06
1998	175	0.12	0.20	2.12	0.25
1999	151	0.21	0.10	5.16	0.14
2000	220	0.20	0.13	3.85	0.13
Total	177	0.26	0.14	3.44	0.16

Note: Hardness units mg/L.



Note: Prior to 1/1/00, action levels for dissolved Cd and Ag were calculated using the analyte specific toxicity equation incorporating the 30-day volume-weighted hardness values.

Figure 12-21. Volume-Weighted 30-Day Average Metals and Hardness Concentrations at SW093: WY97–00.

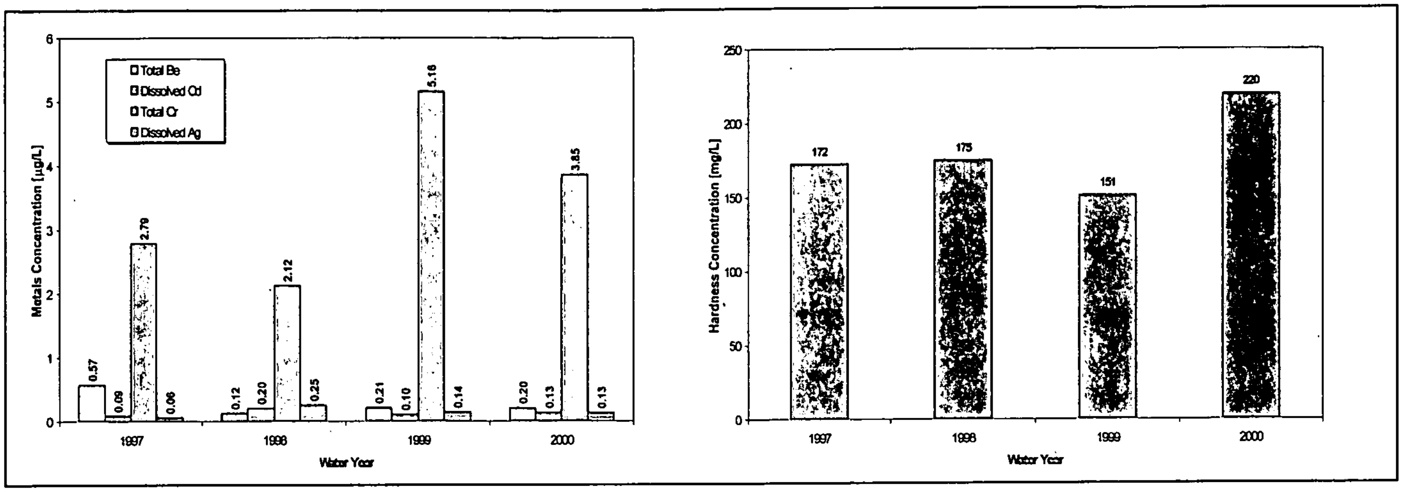


Figure 12-22. Annual Volume-Weighted Average Metals and Hardness Concentrations at SW093: WY97–00.

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13. STREAM SEGMENT 4 POINT OF COMPLIANCE MONITORING

RFCA provides specific standards for Walnut and Woman Creeks below the terminal ponds (Segment 4). These criteria and the responses to them are different than the criteria and actions associated with Segment 5. This section deals only with monitoring discharges from the terminal ponds into Segment 4 and the additional POCs for Segment 4 at Indiana Street. Terminal pond discharges are monitored by POCs GS11, GS08, and GS31. Walnut Creek is monitored at Indiana Street by POC GS03. Woman Creek is monitored at Indiana Street by POC GS01. These locations are shown on Figure 13-1.

With the completion of the Woman Creek Reservoir, located just east of Indiana Street and operated by the city of Westminster, all Woman Creek flows are detained in cells of the reservoir until the water quality has been assured by monitoring of Woman Creek at Indiana Street. There is concern that solely monitoring Pond C-2 discharge does not adequately demonstrate that all water leaving the Site via Woman Creek is meeting the radiologic standards. All Woman Creek water, either combined with Pond C-2 discharge or flowing in the absence of any Pond C-2 water, enters the Woman Creek Reservoir. This is the basis for setting an additional RFCA POC for Woman Creek at Indiana Street (GS01) for those radiologic contaminants that could be directly attributable to the Site (i.e., not naturally occurring).

For Walnut Creek, a similar POC, GS03, has been established at Walnut Creek and Indiana Street. As for Woman Creek, it is possible that contaminated overland runoff or landfill drainage may enter Walnut Creek below the terminal pond monitoring points (GS11 and GS08), yet upstream of Indiana Street.

13.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

The analytical decision inputs are those analytes specified as the Segment 4 AoIs (Table 13-1), as sampled at the POCs for Stream Segment 4. Monitoring performed for Stream Segment 4 is limited to POCs GS11, GS08, GS31, GS03, and GS01.

Sampling for AoIs at POCs is performed by collecting continuous flow-paced composite samples. The recommended monitoring design detailed in the IMP is to take samples for WY97–00 as specified in Table 13-4 and Table 13-5. Flow-paced monitoring is maintained at all times for all five POCs in Segment 4, although no samples are anticipated from terminal pond stations except during planned pond discharges.

Historically, terminal pond discharges occurred on average once per year for Pond C-2 and 9 times per year for A-4 and B-5 combined. Since the DQO process originally targeted 3 composite samples per discharge (for WY97), terminal pond POCs targeted 30 composite samples to be collected annually.

During WY97, all routine North and South Walnut Creek water was discharged from A-4 (B-5 was pump transferred to A-4, except during periods of high stormwater runoff). Starting in WY98, Pond B-5 began routine direct discharge to Walnut Creek, effectively dividing discharges to Walnut Creek between Ponds A-4 and B-5. Therefore, sampling protocols starting in WY98 were modified such that the total number of continuous flow-paced composite samples to be collected annually for discharges from both A-4 and B-5 would be comparable to the WY97 targets. For Fiscal Years 1993 through 1997, the total combined discharge volume for A-4 and B-5 was 687 MG in 43 discharge batches, or 16 MG per discharge batch on average. Targeting three composite samples per discharge gives one composite sample per 5.3 MG of discharge volume. This composite sample frequency (1 per 5.3 MG) will preserve the targeted sampling frequencies (based on discharge volume) while maintaining effective cost controls (based on total sample costs). For WY98 - 2000 planning purposes, 8 samples were targeted to be collected from A-4, and 19 from B-5, resulting in the collection of a targeted 27 composite samples (see Table 13-5). However, this sample planning is also dependent on the routing for the WWTP effluent. Any future changes in the management of Walnut Creek water could result in sampling protocol modifications to preserve the initial intent of the DQO process.

Table 13-1. RFCA Segment 4 AoIs.

Terminal Pond POCs		
Radionuclides:	Total Pu-239,240	Known carcinogen. High level of public concern. Known releases (within the past 8 years) have exceeded RFCA stream standards and action levels. This provides reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Total U-233,234, U-235, U-238	Known renal toxicity. Present onsite. Past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Total Am-241	Known carcinogen. Present onsite. Known past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
Real Time Monitoring of Physical and Indicator Parameters:	pH	Extremes are toxic to humans and ecology. Regulatory concern due to chromic acid incident. Real-time monitoring is inexpensive and effective method of detecting acid spills such as (chromic acid or plutonium nitrate) or failure of treatment systems.
These parameters provide real-time alarms for a variety of regulated contaminants, and are also a required component of monitoring for AoIs.	Conductivity	Conductivity is an indicator of total dissolved ions, metals, anions, and pH. Real-time monitoring of conductivity is an inexpensive indicator of overall water quality.
They require no laboratory analyses, and are the Site's most cost effective defensive monitoring.	Turbidity	Turbidity is a general indicator of elevated contaminant levels, and may be correlated with Pu.
	Nitrate	Past releases near RFCA stream standards and action levels upstream of ponds provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels. Certain discharges often include nitrate, and may challenge RFCA action levels.
	Flow	Required to detect flow events, pace automatic samplers, evaluate contaminant loads, and plan pond operations and discharges. Affects nearly every decision rule, and is the most commonly discussed attribute of Site surface waters.
Indiana Street POCs		
Radionuclides:	Total Pu-239,240	High level of public concern. Known carcinogen. Known past releases (within the past 8 years) have exceeded RFCA stream standards and action levels. This provides reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Total Am-241	Known carcinogen. Present onsite. Known past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Tritium	Tritium is an AoI for the cities, due to the past release of tritium (1973).
Real Time Monitoring of Physical and Indicator Parameters:	Water-Quality Parameters	Indiana Street is not a point of compliance for the real-time monitoring parameters.
	Flow	Required to detect flow events, pace automatic samplers, and evaluate contaminant loads. Affects nearly every decision rule, and is the most commonly discussed attribute of Site surface waters.

The source(s) of the water sampled at the Indiana Street POCs (GS01 and GS03) must be determined prior to sample planning at these locations. Monitoring at GS01 and GS03 calls for samples to be segregated based on water origin (natural creek flows or terminal pond discharges commingled with natural flows).

POC GS01 collects 3 samples during each Pond C-2 discharge; storm runoff and baseflow samples will be based on average annual volumes. During storm runoff and baseflow, the target at GS01 is one sample per 500,000 gallons, with a maximum of 4 samples during any one month (see Table 13-5). GS03 collects the targeted 27 samples during A-4 and B-5 discharges (GS03 collects the same number of composite samples as the terminal pond POCs for each discharge). During storm runoff and baseflow periods between pond discharges, GS03 targets 2 composite samples every 15 days. The goal is to have at least 2 analytical results for any 30-day period for averaging purposes. The Site may combine samples of the same flow pacing to reduce analytical costs and avoid samples of non-sufficient quantity for analysis.

13.2 WY97-00 MONITORING SCOPE

Table 13-2. POC Monitoring Locations.

ID Code	Location	Primary Flow Measurement Device	Telemetry
GS11	Pond A-4 outlet works	24" Parshall Flume	Yes
GS08	Pond B-5 outlet works	24" Parshall Flume	Yes
GS31	Pond C-2 outlet works	24" Parshall Flume	Yes
GS03	Walnut Creek and Indiana St.	6" and 36" Parallel Parshall Flumes	Yes
GS01	Woman Creek and Indiana St.	9" Parshall Flume	Yes

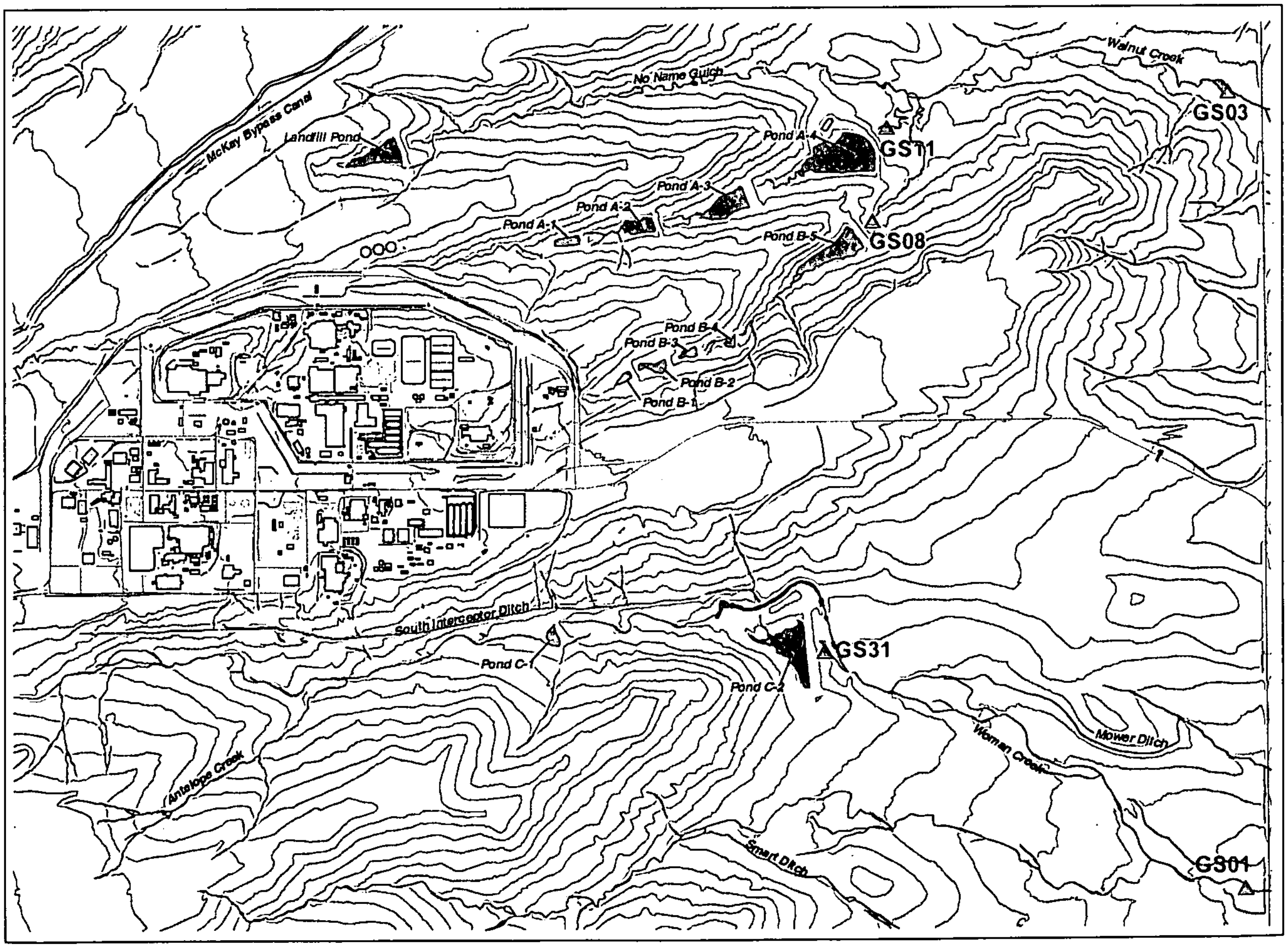


Figure 13-1. Water Year 1997-2000 Point of Compliance Monitoring Locations.

Table 13-3. POC Field Data Collection: Parameters and Frequency.

ID Code	Parameter	
	Discharge	Real-Time pH, Conductivity, Turbidity, Nitrate
GS11	15-min continuous	15-min continuous
GS08	15-min continuous	15-min continuous
GS31	15-min continuous	15-min continuous
GS03	15-min continuous	None
GS01	15-min continuous	None

Notes: All locations collect 5- and 15-minute flow data.

Table 13-4. POC Sample Collection Protocols.

ID Code	Frequency	Type[b]
GS11	8 per year[a]	Continuous flow-paced composites
GS08	19 per year[a]	Continuous flow-paced composites
GS31	3 per year[c]	Continuous flow-paced composites
GS03	55 per year[a]	Continuous flow-paced composites
GS01	28 per year[c]	Continuous flow-paced composites

Notes: [a] Assuming one composite sample per 5.3 MG of terminal pond discharge volume. Number may vary due to pond-water management activities.
[b] Sample types are defined in the RFETS Automated Surface-Water Monitoring Work Plan.
[c] Assumes one C-2 discharge per year; 3 composite samples per discharge.

Table 13-5. POC Target Sample Distribution.[42]

Time Period	Pond			Walnut Cr. at Indiana St. [GS03]	Woman Cr. at Indiana St. [GS01]	Total Number of Samples
	A-4 [GS11]	B-5 [GS08]	C-2 [GS31]			
During Discharge	8[a]	19[a]	3[b]	27[a]	3[b]	60
Storm and Base Flow						
January	NA	NA	NA	3	1	4
February	NA	NA	NA	2	1	3
March	NA	NA	NA	3	2	5
April	NA	NA	NA	2	2	4
May	NA	NA	NA	3	2	5
June	NA	NA	NA	2	3	5
July	NA	NA	NA	3	4	7
August	NA	NA	NA	2	4	6
September	NA	NA	NA	2	4	6
October	NA	NA	NA	3	1	4
November	NA	NA	NA	1	1	2
December	NA	NA	NA	2	0	2
Annual Totals	8	19	3	55	28	113

Notes: [a] Assuming one composite sample per 5.3 MG of terminal pond discharge volume. Number may vary due to pond-water management activities.
[b] Assumes one C-2 discharge per year; 3 composite samples per discharge.
[c] GS01 and GS31 distribution based on PNNL recommendations; GS03 distribution based on average monthly number of day without a terminal pond discharge using historic data (period when neither A-4 or B-5 direct discharged) assuming approximately one composite every 8 days.

[42] The number of samples collected at each pond depends on the amount of water discharged from each pond. Of the combined North and South Walnut Creek inflows, 64% flows to B-5 and 36% flows to A-4, on average. Depending on pond operation protocols, it is possible that no water could be direct discharged from Pond B-5, and no samples would be collected at GS08. All B-5 water would be pumped to A-4, and all POC samples for both A-4 and B-5 would then be collected at GS11. Regardless, the targeted 27 samples is specified for budget planning purposes.

Table 13-6. POC Analytical Targets (Analyses per Year).

ID Code	TSS[a]	Pu, U, Am	Pu, Am, Tritium
GS11	8	8	NA
GS08	19	19	NA
GS31	3	3	NA
GS03	55	NA	55
GS01	28	NA	28

Notes: [a] Ideally, TSS would be analyzed for all samples collected at the above locations. However, continuous flow-paced sampling protocols often result in composite samples which are collected over periods exceeding the 7-day hold time for TSS analyses. Therefore, TSS can not be analyzed for all continuous flow-paced composite samples, but will be analyzed when possible.

13.3 DATA EVALUATION

Sampling for AoIs at POCs is performed by collecting continuous flow-paced composite samples. Indicator parameters are measured using real-time water-quality probes. These AoIs and indicator parameters are evaluated using 30-day or 1-day moving averages, as specified in RFCA and implemented by the ALF or DQO working groups involving consensus of all parties to RFCA. Pu, Am, U, and tritium are evaluated using volume-weighted 30-day moving averages at POCs[43]. Indicator parameters pH and nitrate are evaluated as 1-day arithmetic averages. Indicators are not evaluated under this monitoring objective for the Indiana Street POCs.

The parties to RFCA agree that continuous monitoring probes will be used as indicators that may suggest a need for additional monitoring, mitigating action, or management decision. The parties agree that compliance and enforcement issues will be resolved on the basis of standard analytical procedures specified by the applicable regulation or agreement, e.g., NPDES, RFCA, or CERCLA. The parties agree that continuous monitoring field probes should NOT be used to determine compliance or serve as a basis for enforcement action, unless the applicable regulation specifies such a probe as the enforceable analytical method for a particular measurement.

Generally, analytical data evaluation is performed as data become available. If an initial qualitative screening indicates that an analytical result is higher than the standard for a particular AoI, then the 30-day average is calculated immediately. If the 30-day average values are reportable, then validation is requested for all data packages used in the calculation. The desired evaluation frequency is semi-monthly, within one week of the 15th and last day of any given month. RFCA requires that DOE, RFFO inform regulators within 15 days of DOE, RFFO gaining knowledge (not just a suspicion) that an exceedance (verified) has (actually) occurred.

IF The volume-weighted 30-day moving average for any AoI in Stream Segment 4, as represented by samples from the specified RFCA POCs (i.e., terminal pond discharges and Indiana Street) exceeds the appropriate RFCA standard (Table 13-8)

THEN The Site must:

- Notify EPA, CDPHE, and either Broomfield or Westminster, whichever is affected;
- Submit a plan and schedule to evaluate for source location, and implement mitigating action if appropriate; and
- The Site may receive a notice of violation.

[43] The 30-day average for a particular day is calculated as a volume-weighted average of a 'window' of time containing the previous 30-days which had both flow and an analytical result. Each day has its own discharge volume (measured at the location with a flow meter) and activity (analytical result from the sample in place at the end of that day). Therefore, there are 365 30-day moving averages for a location which flows all year (366 in a leap year). At locations which monitor pond discharges or have intermittent flows, 30-day averages are calculated as averages of the previous 30 days of greater than zero flow. For days where no activity is available, either due to failed lab analysis or NSQ for analysis, no 30-day average is reported. The calculation of 30-day averages is discussed in detail in Section 7.3.2.2 of the RFETS Automated Surface-Water Monitoring FY98 Work Plan.

Table 13-7. POC Monitoring Analytical Data Evaluation.

ID Code	Evaluation Type[a]
GS11	30-Day Volume-Weighted Moving Averages; Loading Analysis
GS08	30-Day Volume-Weighted Moving Averages; Loading Analysis
GS31	30-Day Volume-Weighted Moving Averages; Loading Analysis
GS03	30-Day Volume-Weighted Moving Averages; Loading Analysis
GS01	30-Day Volume-Weighted Moving Averages; Loading Analysis

Notes: [a] Details on the evaluation of analytical results are given in the RFETS Automated Surface-Water Monitoring Work Plan. Loading analysis for POCs is given in Section 5.

Table 13-8. POC Monitoring RFCA Standards.

Analyte	Standard
Am-241	0.15 pCi/L
Pu-239,240	0.15 pCi/L
Total Uranium	10 pCi/L (Walnut Cr.); 11 pCi/L (Woman Cr.)
Tritium	500 pCi/L

The following sections include summary tables and plots showing the 30-day moving averages, periodic volume-weighted averages, and 365 calendar-day volume-weighted averages for the POC analytes.

The following evaluations include all results that were not rejected through the verification/validation process. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' value and the 'duplicate'. When a sample has multiple 'real' analyses (Site requested 're-runs'), the value used in calculations is the arithmetic average of the multiple 'real' analyses. Total uranium is calculated by summing the activities for the analyzed isotopes (U-233,234 + U-235 + U-238).

The methods used for the evaluations are given in Appendix B.1: Data Evaluation Methods.

The loading analysis for the POCs is presented in Section 5.

Plots of mean daily water temperature, specific conductivity, pH, and turbidity values (terminal pond POCs only) are given below.[44] Plots of mean daily water temperature, specific conductivity, and pH for the Indiana Street POCs (GS01 and GS03) are given in Section 14: Non-POC Monitoring at Indiana Street. More detailed data for all parameters are presented in Appendix B.5.2. The methods used for the water-quality parameter evaluations are given in Appendix B.5: Real-Time Water-Quality Parameters.

13.3.1 Location GS01

Monitoring location GS01 is located on Woman Cr. at Indiana Street. Figure 3-8 shows the drainage area for GS01. The southern portion of the IA and Pond C-2 contribute flow to GS01.

Table 13-9 shows that all of the annual average Pu and Am activities were well below 0.15 pCi/L. Additionally, the long-term Pu and Am averages (WY97-00) are well below 0.15 pCi/l. The average tritium activities are all well below 500 pCi/L.

Figure 13-2 and Figure 13-3 show no occurrences of reportable 30-day averages.

[44] Mean daily water-quality values are given for days of measurable flow. Some data may be missing due to equipment failures and removal for calibration.

Figure 13-6 shows the 365 calendar-day averages using the proposed post-Closure calculation method (see Appendix B.1: Data Evaluation Methods). It can be seen that by using this method the variability is 'dampened' by the longer evaluation period, and no values would be reportable using the current 0.15 pCi/L Action Level.

Table 13-9. Annual Volume-Weighted Average Radionuclide Activities at GS01 in WY97-00.

Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	*Pu-239,-240*	*Tritium*
1997	0.003	0.010	70
1998	0.005	0.006	136
1999	0.005	0.008	107
2000	0.004	0.003	80
Total	0.005	0.007	111

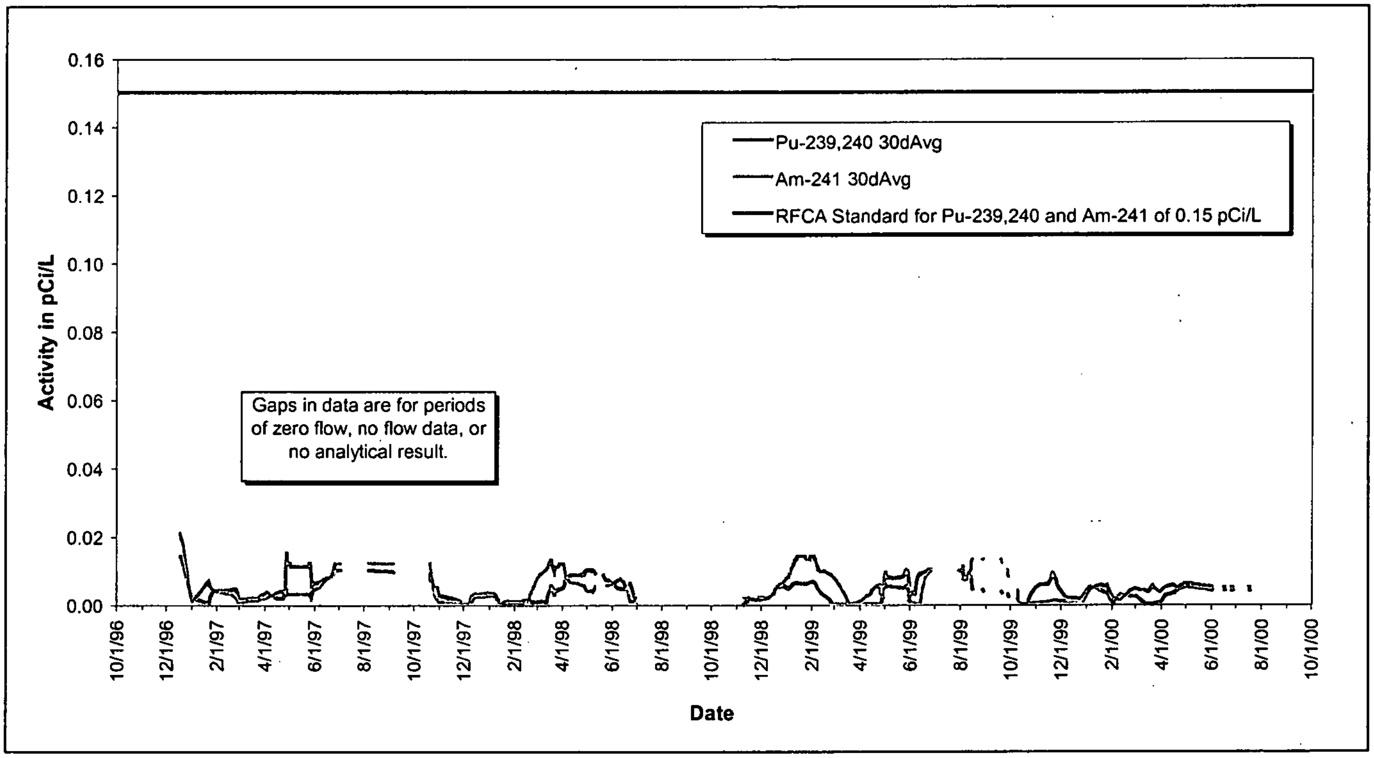


Figure 13-2. Volume-Weighted 30-Day Average Pu and Am Activities at GS01: WY97–00.

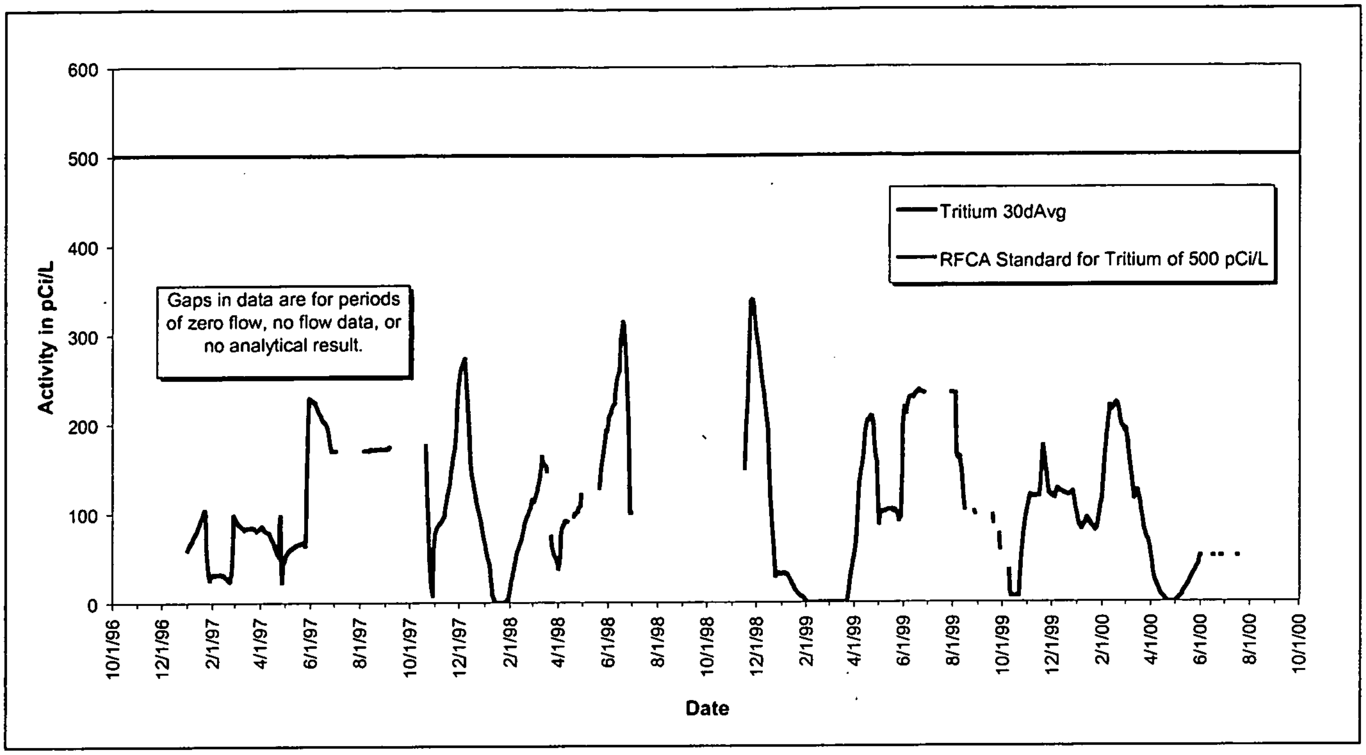


Figure 13-3. Volume-Weighted 30-Day Average Tritium Activities at GS01: WY97–00.

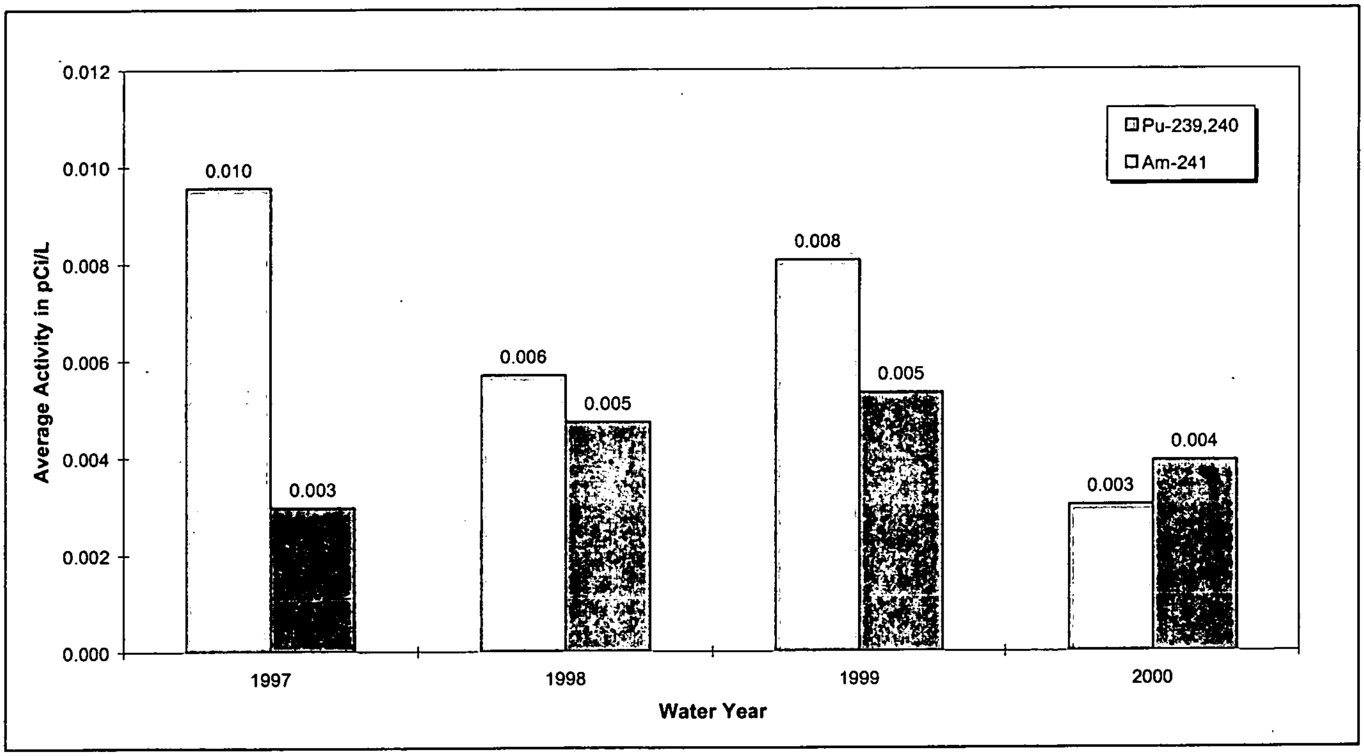


Figure 13-4. Annual Volume-Weighted Average Pu and Am Activities at GS01: WY97–00.

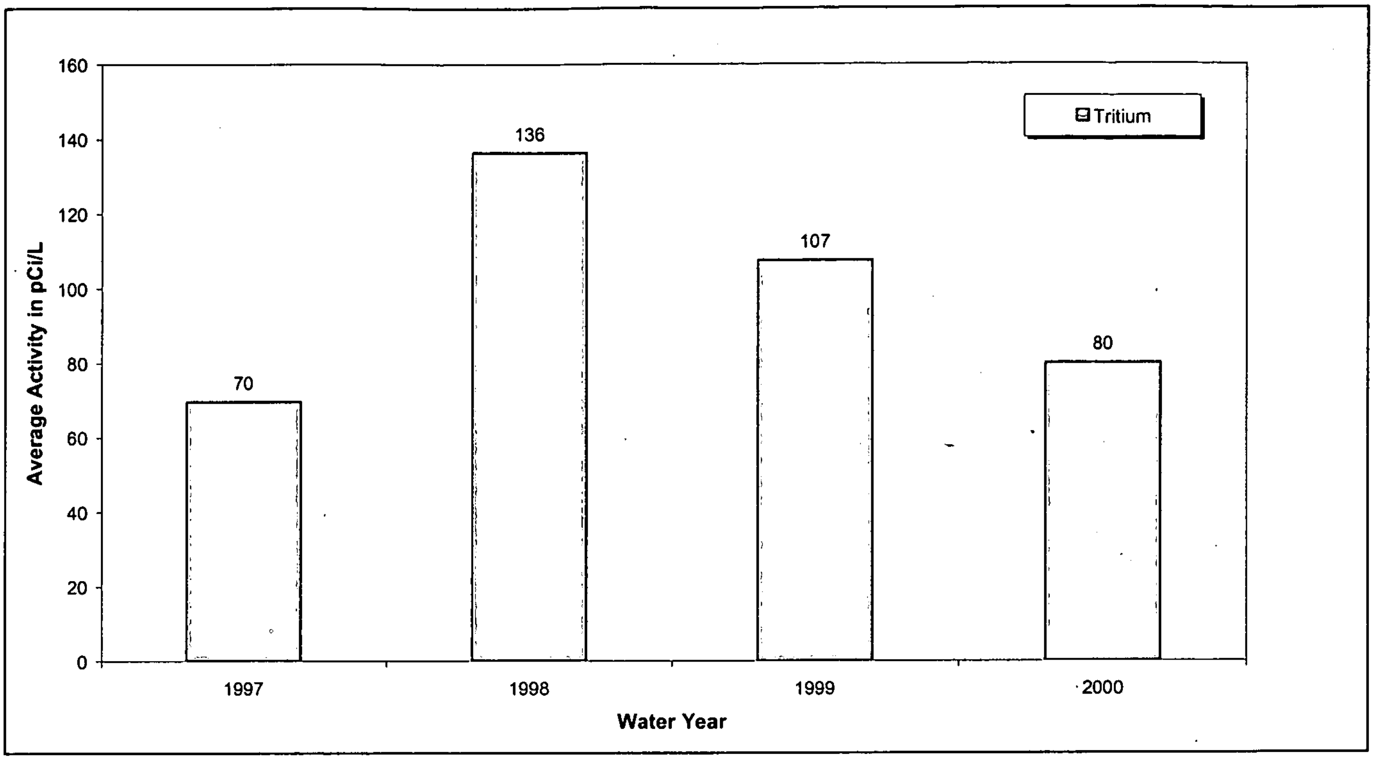
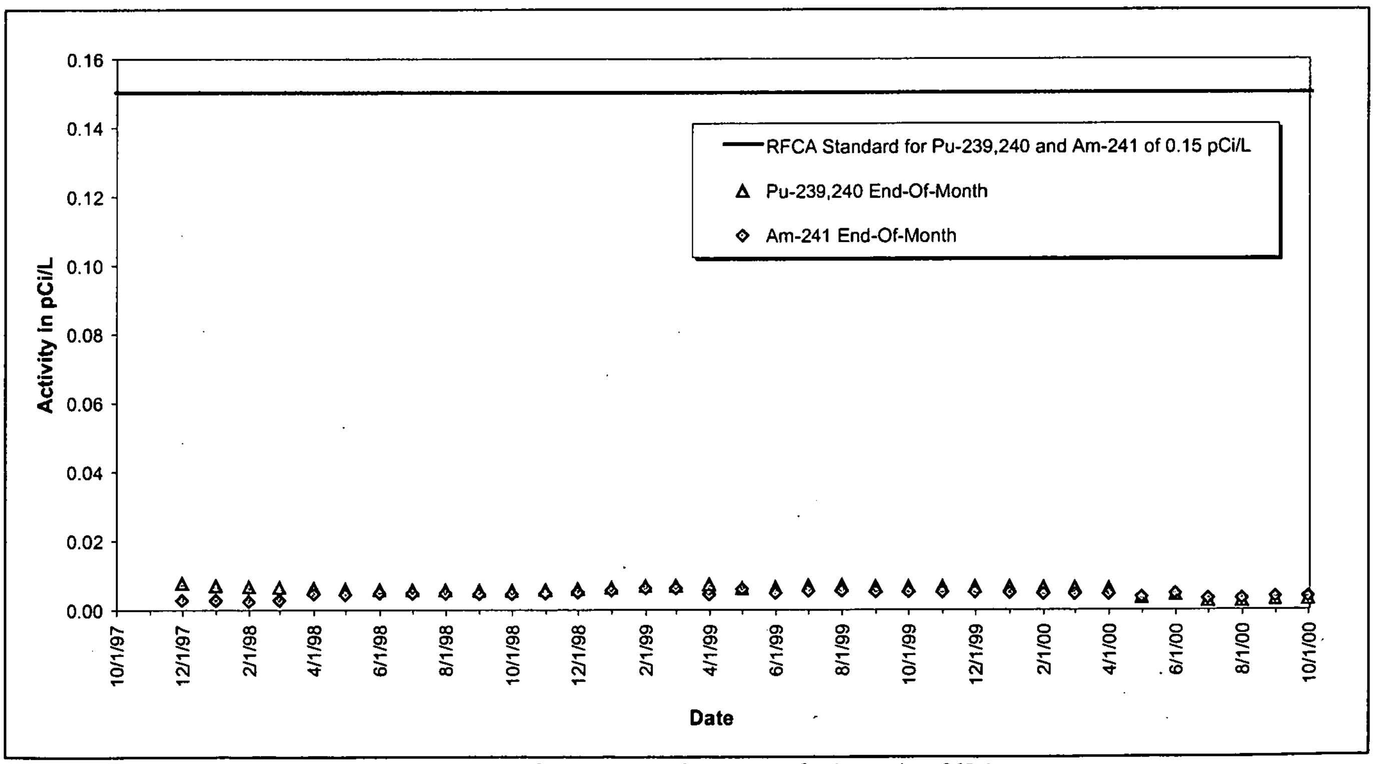


Figure 13-5. Annual Volume-Weighted Average Tritium Activities at GS01: WY97–00.



Note: The 365 calendar-day average activities are calculated for the last day of each month for the previous 365 days.

Figure 13-6. Volume-Weighted 365 Calendar-Day Average Pu and Am Activities at GS01: WY97–00.

13.3.2 Location GS03

Monitoring location GS03 is located on Walnut Cr. at Indiana Street. Figure 3-12 shows the drainage area for GS03. The majority of the IA, Pond A-4, and Pond B-5 contribute flow to GS03.

Table 13-10 shows that all of the annual average Pu and Am activities were well below 0.15 pCi/L. Additionally, the long-term Pu and Am averages (WY97-00) are well below 0.15 pCi/l. The average tritium activities are all well below 500 pCi/L.

Figure 13-7 and Figure 13-8 show no occurrences of reportable 30-day averages.

Figure 13-11 shows the 365 calendar-day averages using the proposed post-Closure calculation method (see Appendix B.1: Data Evaluation Methods). It can be seen that by using this method the variability is 'dampened' by the longer evaluation period, and no values would be reportable using the current 0.15 pCi/L Action Level.

Table 13-10. Annual Volume-Weighted Average Radionuclide Activities at GS03 in WY97-00.

Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	*Pu-239,-240*	*Tritium*
1997	0.015	0.030	108
1998	0.009	0.012	167
1999	0.010	0.015	108
2000	0.007	0.005	71
Total	0.011	0.016	126

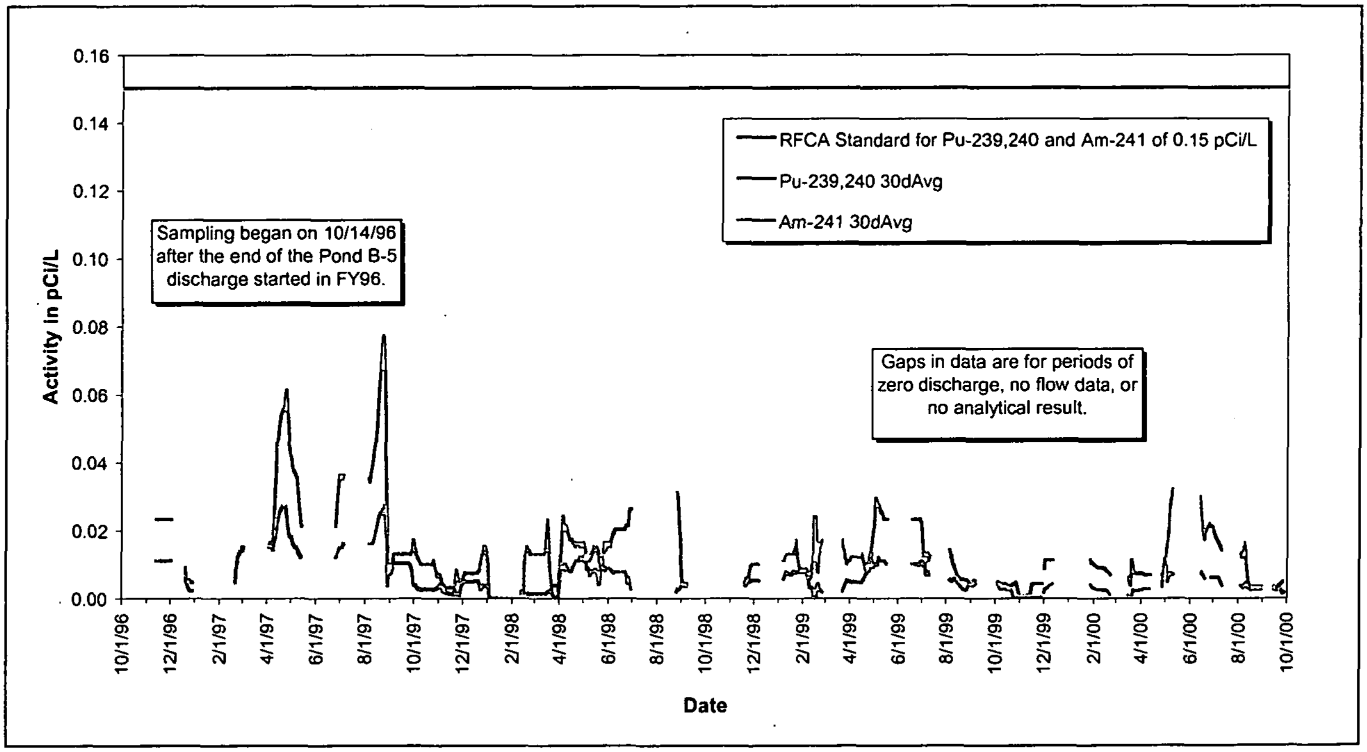


Figure 13-7. Volume-Weighted 30-Day Average Pu and Am Activities at GS03: WY97–00.

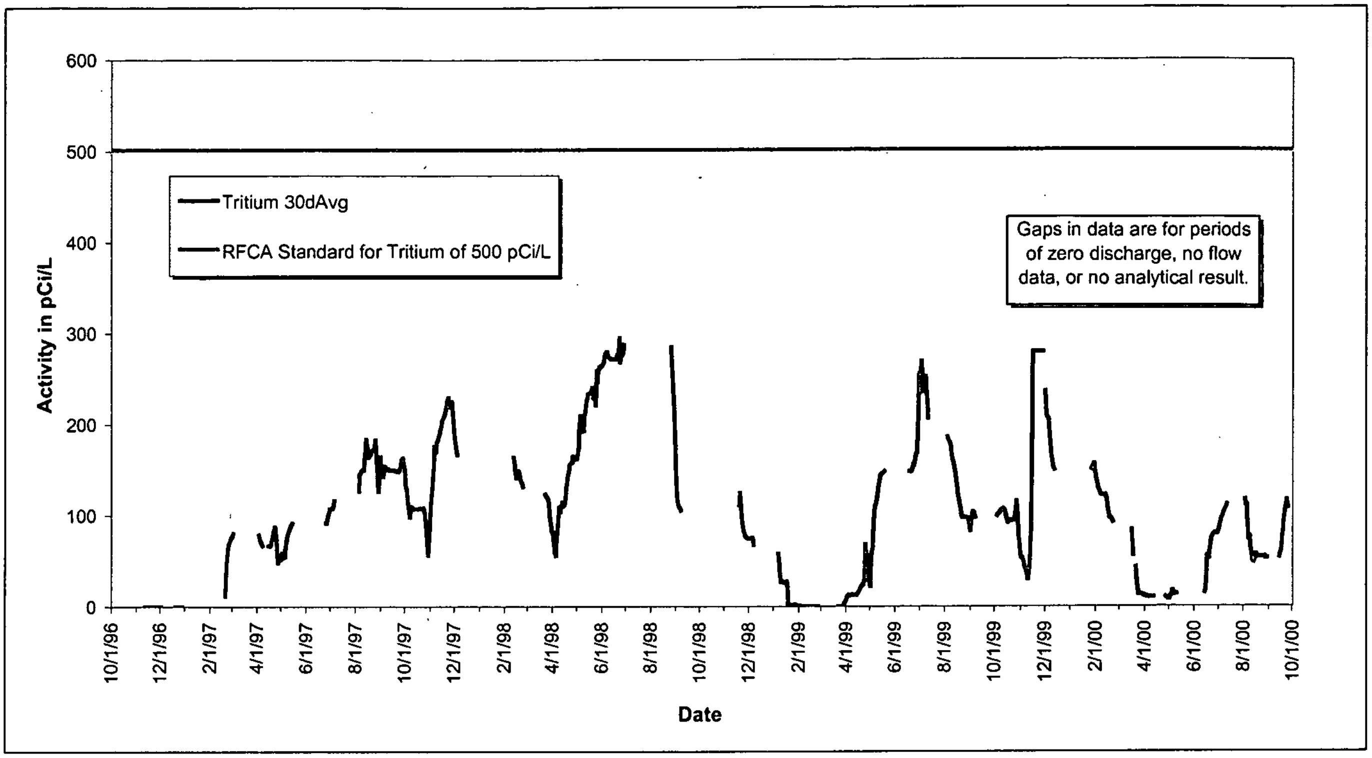


Figure 13-8. Volume-Weighted 30-Day Average Tritium Activities at GS03: WY97–00.

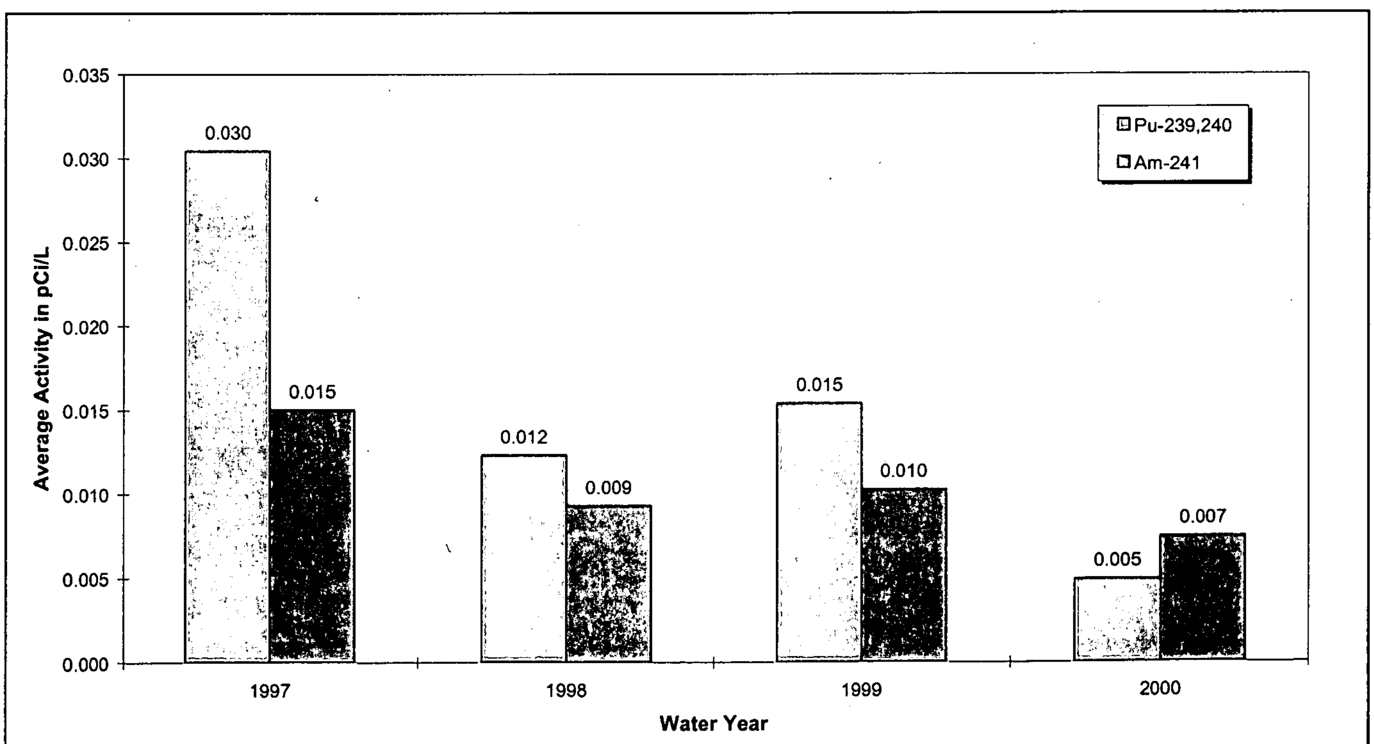


Figure 13-9. Annual Volume-Weighted Average Pu and Am Activities at GS03: WY97–00.

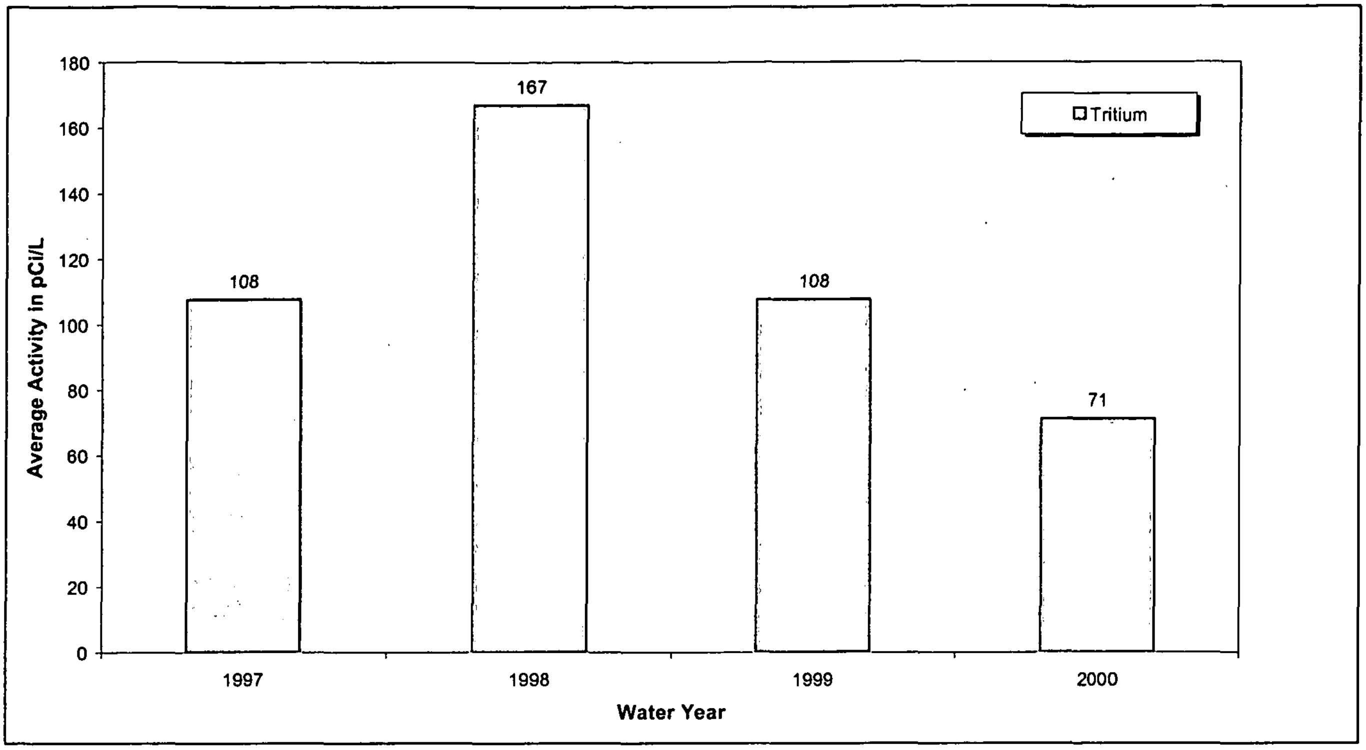
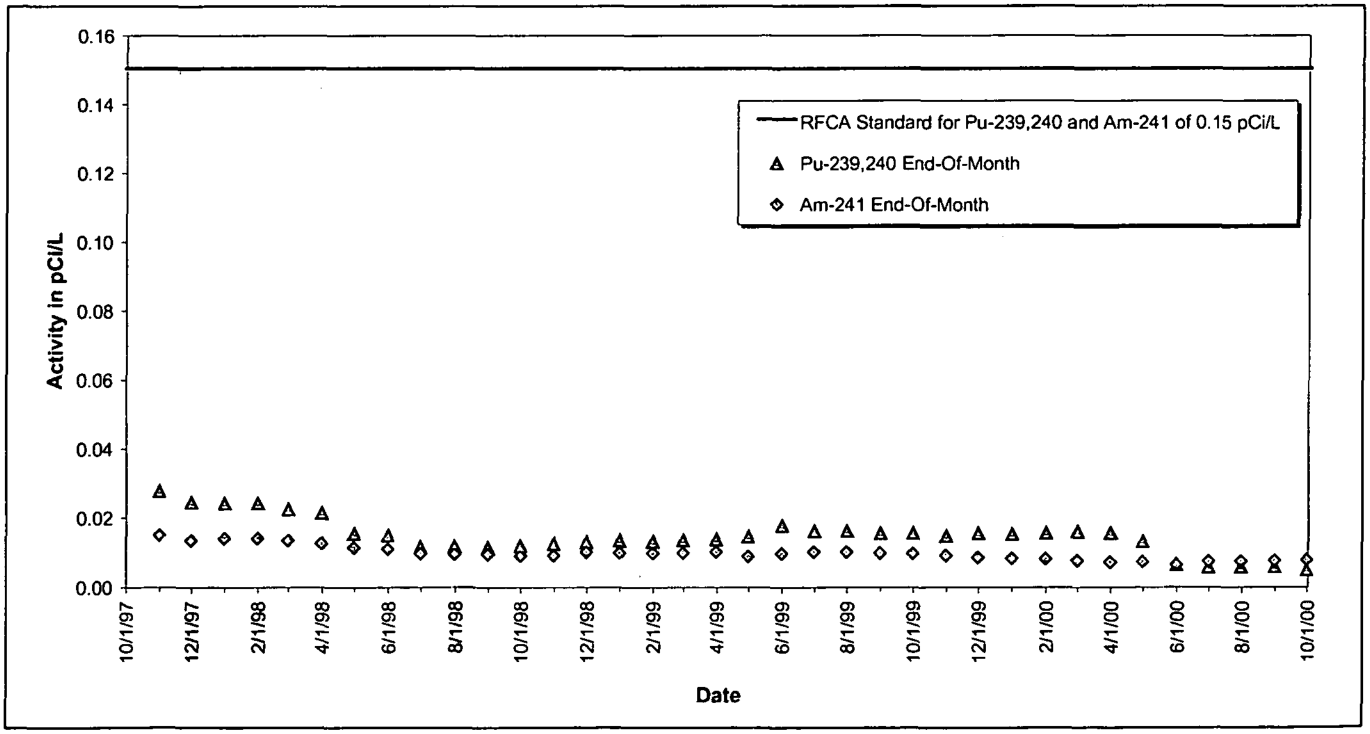


Figure 13-10. Annual Volume-Weighted Average Tritium Activities at GS03: WY97–00.



Note: The 365 calendar-day average activities are calculated for the last day of each month for the previous 365 days.

Figure 13-11. Volume-Weighted 365 Calendar-Day Average Pu and Am Activities at GS03: WY97–00.

13.3.3 Location GS08

Monitoring location GS08 is located on S. Walnut Cr. at the outlet of Pond B-5. Figure 3-20 shows the drainage area for GS08. The central portion of the IA contributes flow to GS08.

Table 13-11 shows that all of the annual average Pu and Am activities were below 0.15 pCi/L. Additionally, the long-term Pu and Am averages (WY97-00) are well below 0.15 pCi/l. The average uranium activities are all well below 10 pCi/L.

Figure 13-12 and Figure 13-13 show no occurrences of reportable 30-day averages. However, between 9/14/00 and 11/24/00 five values of 0.15 pCi/L Pu were calculated. Although not required to perform a source evaluation, the Site did produce a report. A summary of the extensive investigations is given in Section 6.3.

Figure 13-16 shows the 365 calendar-day averages using the proposed post-Closure calculation method (see Appendix B.1: Data Evaluation Methods). It can be seen that by using this method the variability is 'dampened' by the longer evaluation period, and no values would be reportable using the current 0.15 pCi/L Action Level.

Table 13-11. Annual Volume-Weighted Average Radionuclide Activities at GS08 in WY97-00.

Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	*Pu-239,-240*	*Total Uranium*
1997	0.007	0.006	1.740
1998	0.007	0.008	2.263
1999	0.020	0.061	1.451
2000	0.025	0.041	1.002
Total	0.018	0.036	1.462

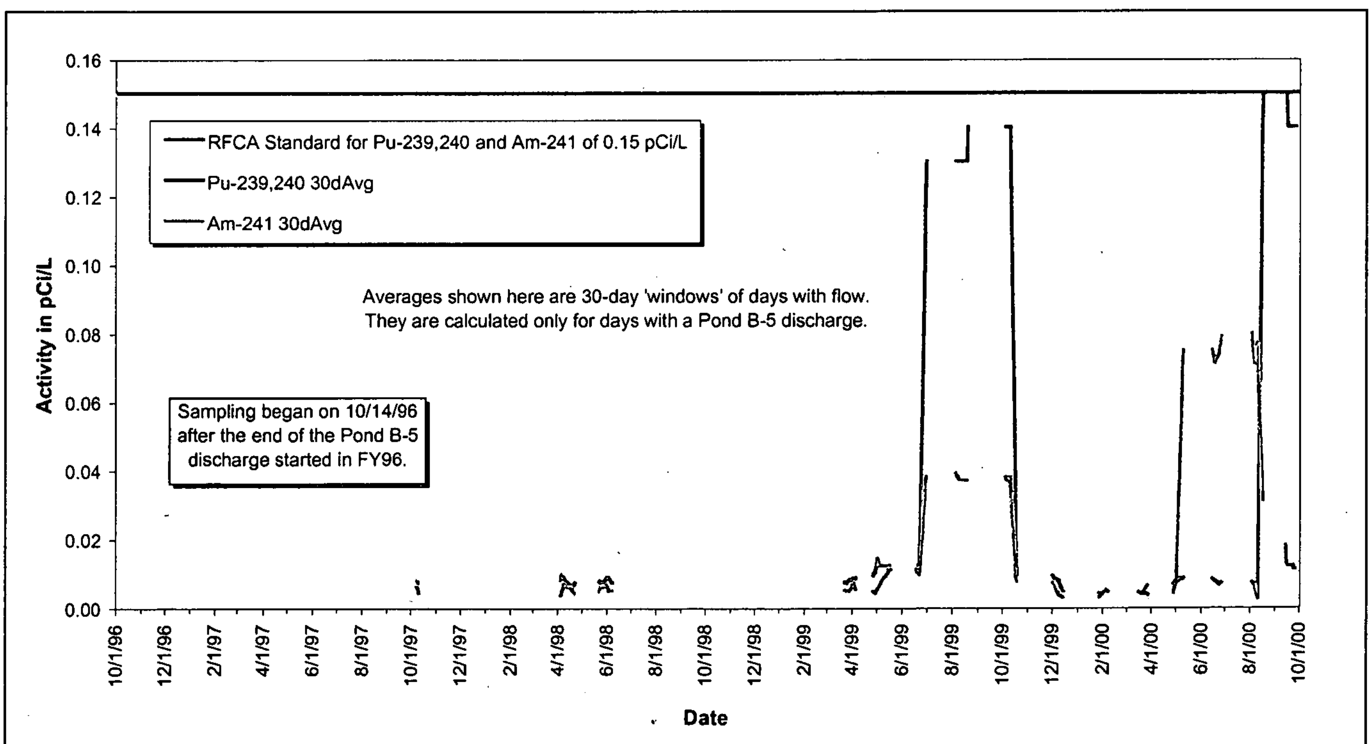


Figure 13-12. Volume-Weighted 30-Day Average Pu and Am Activities at GS08: WY97–00.

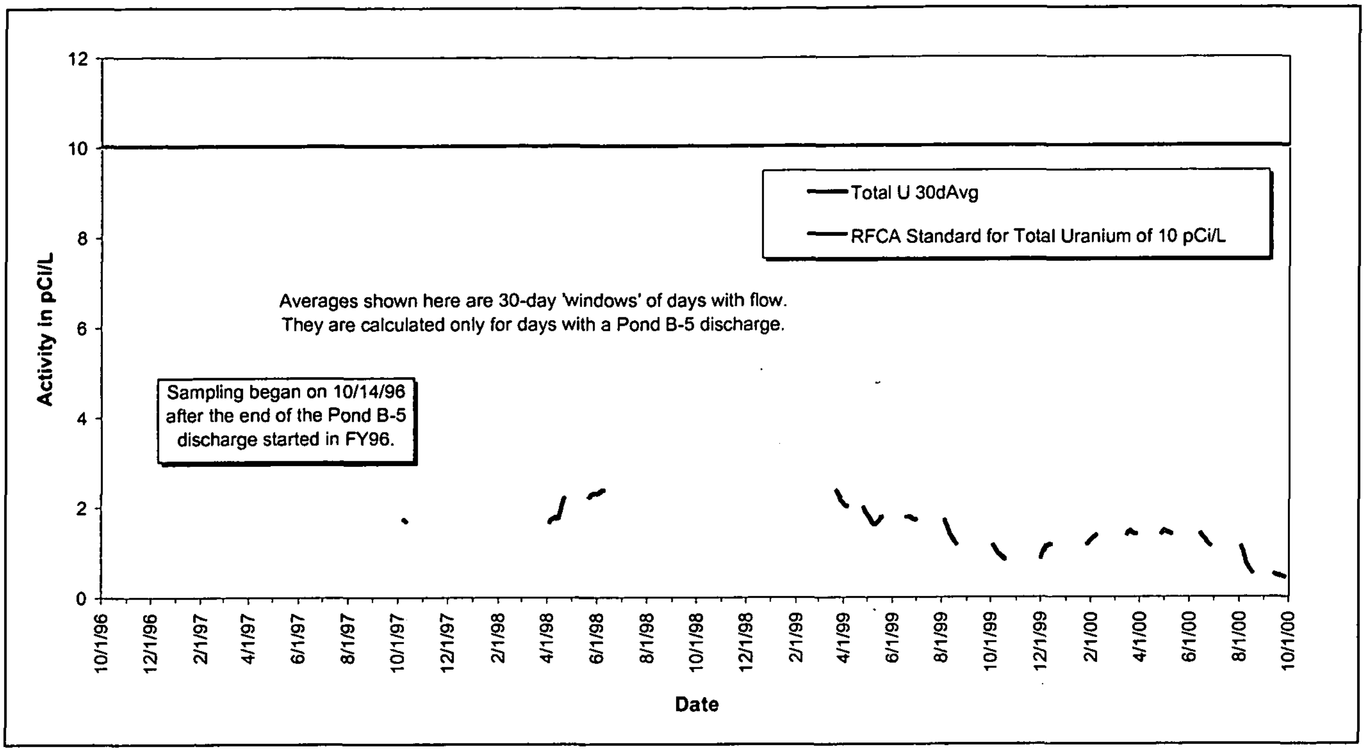


Figure 13-13. Volume-Weighted 30-Day Average Total Uranium Activities at GS08: WY97–00.

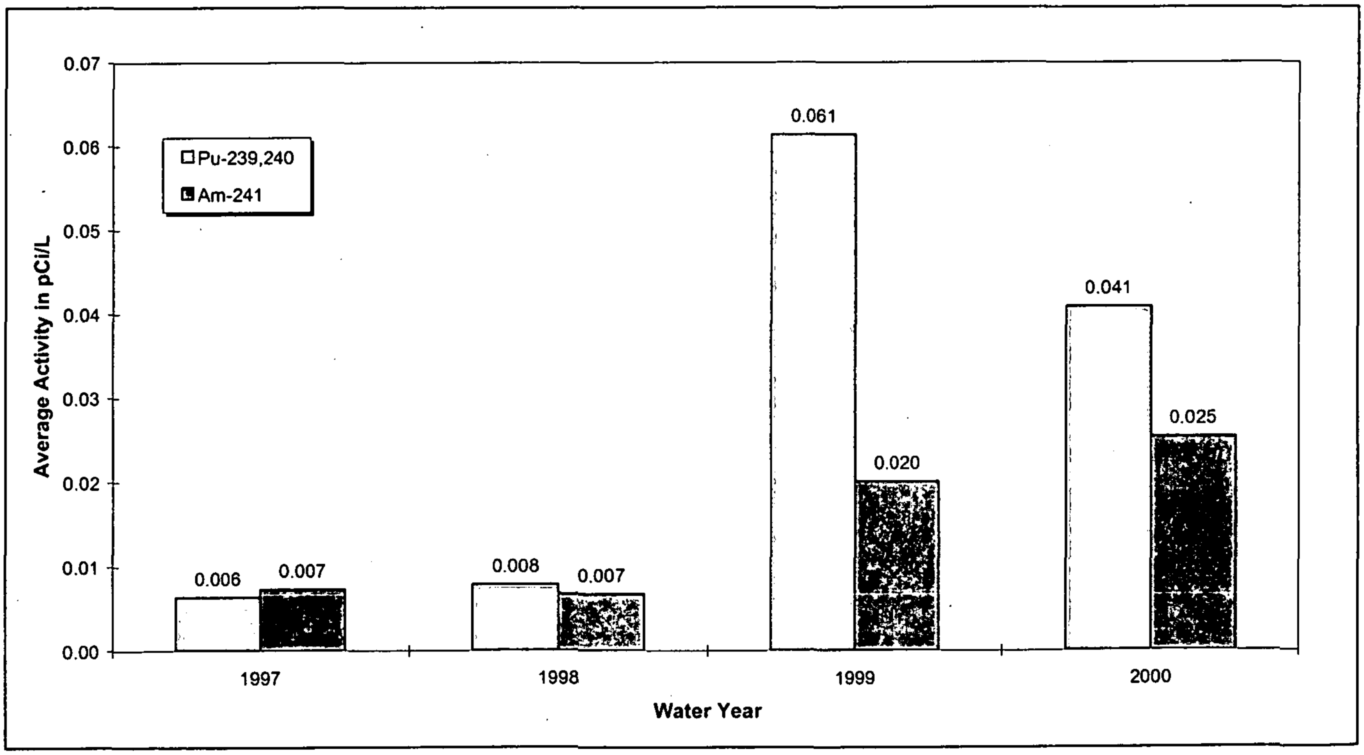


Figure 13-14. Annual Volume-Weighted Average Pu and Am Activities at GS08: WY97–00.

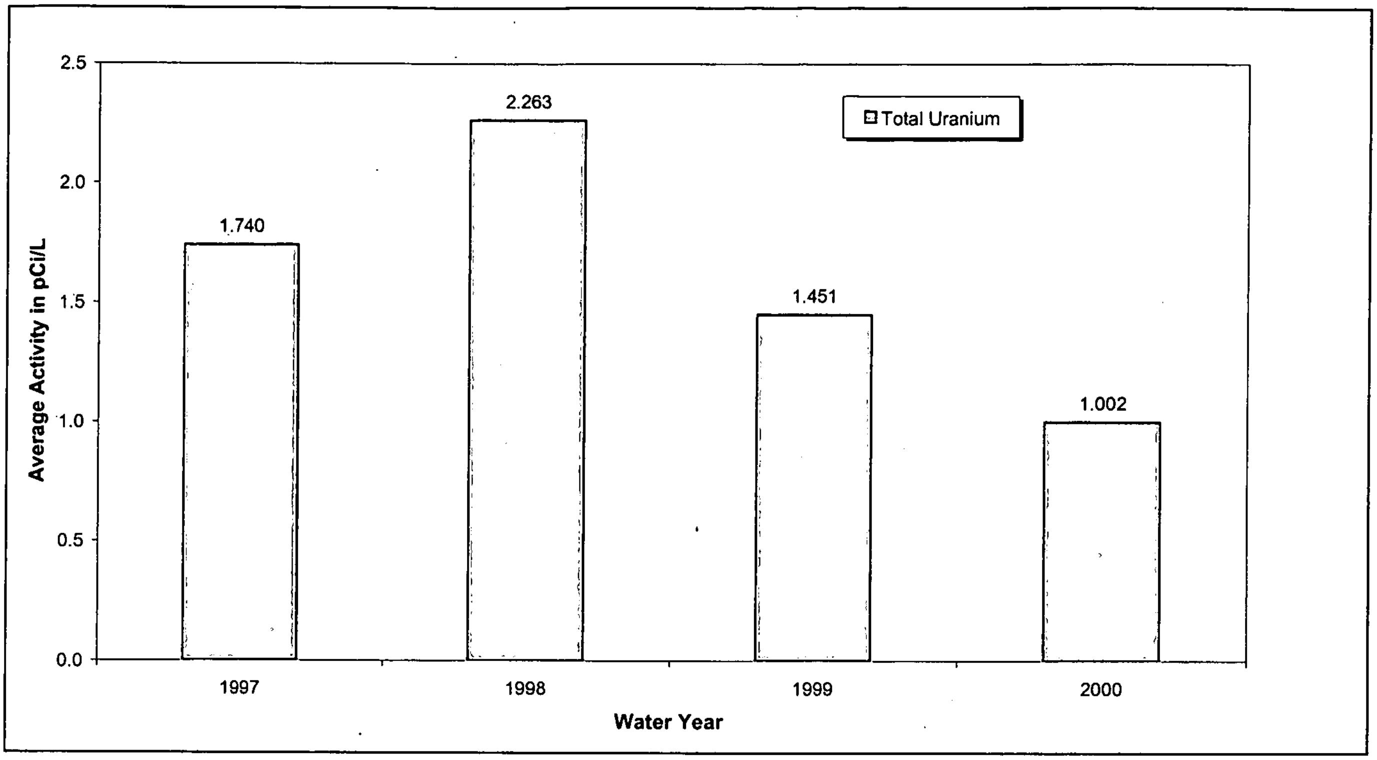
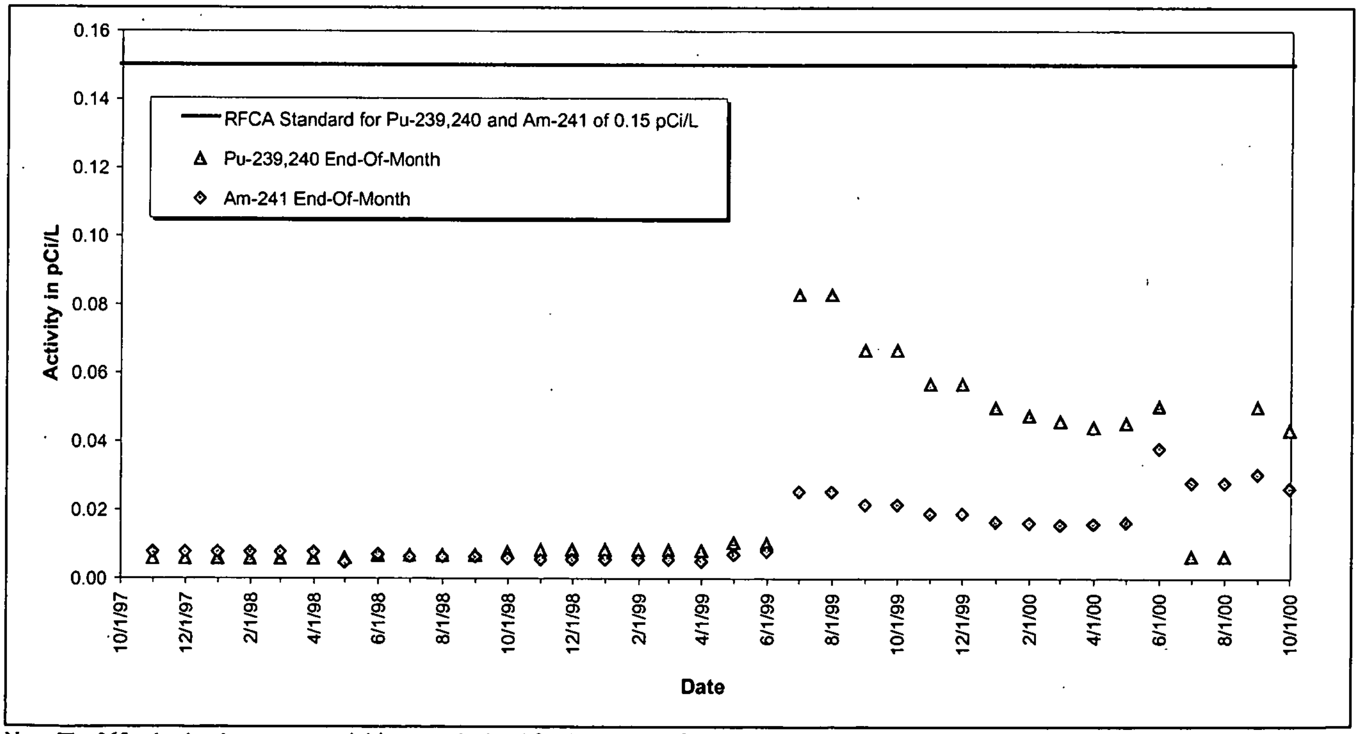


Figure 13-15. Annual Volume-Weighted Average Total Uranium Activities at GS08: WY97–00.



Note: The 365 calendar-day average activities are calculated for the last day of each month for the previous 365 days.

Figure 13-16. Volume-Weighted 365 Calendar-Day Average Pu and Am Activities at GS08: WY97–00.

Mean daily water-quality parameter data are plotted in Figure 13-17 through Figure 13-20 along with the mean daily flow rate. Figure 13-17 shows the expected annual variation in water temperature. Figure 13-18 shows elevated conductivities during the winter months, most likely a result of road and walkway deicing operations.

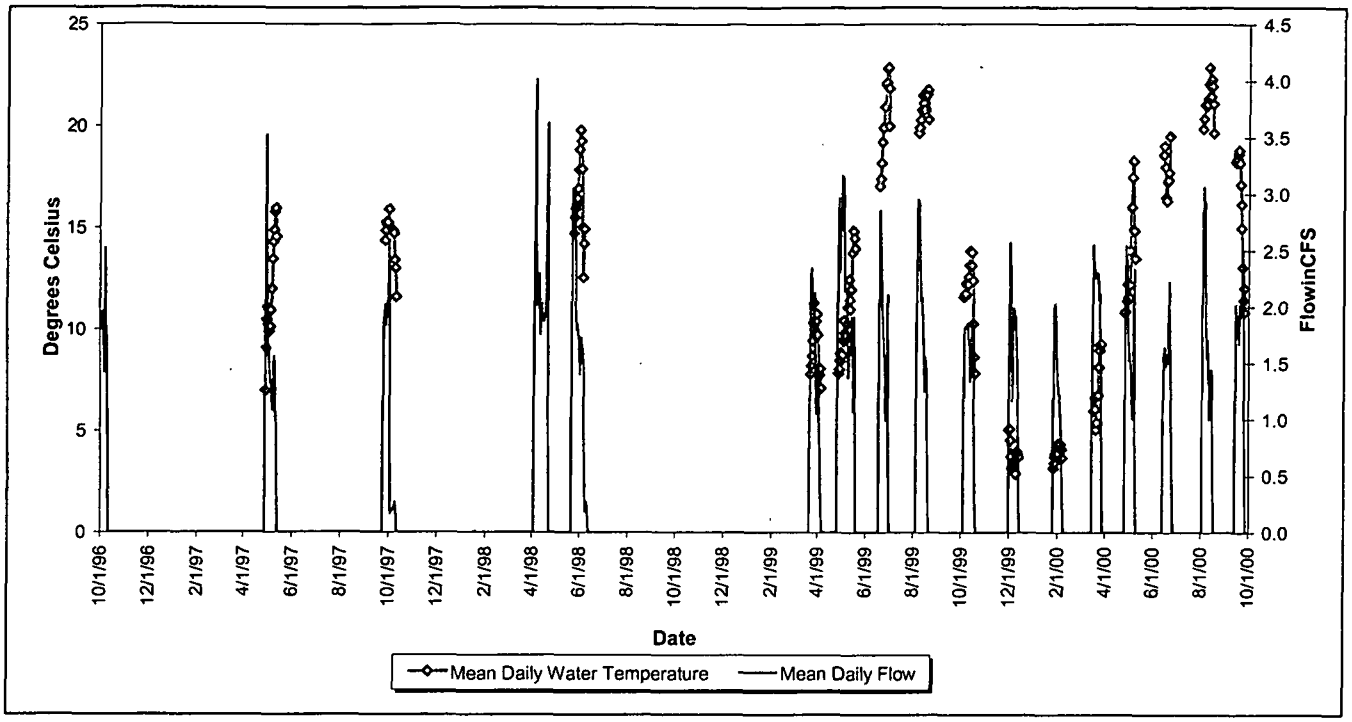


Figure 13-17. Mean Daily Water Temperature at GS08: Water Years 1997 – 2000.

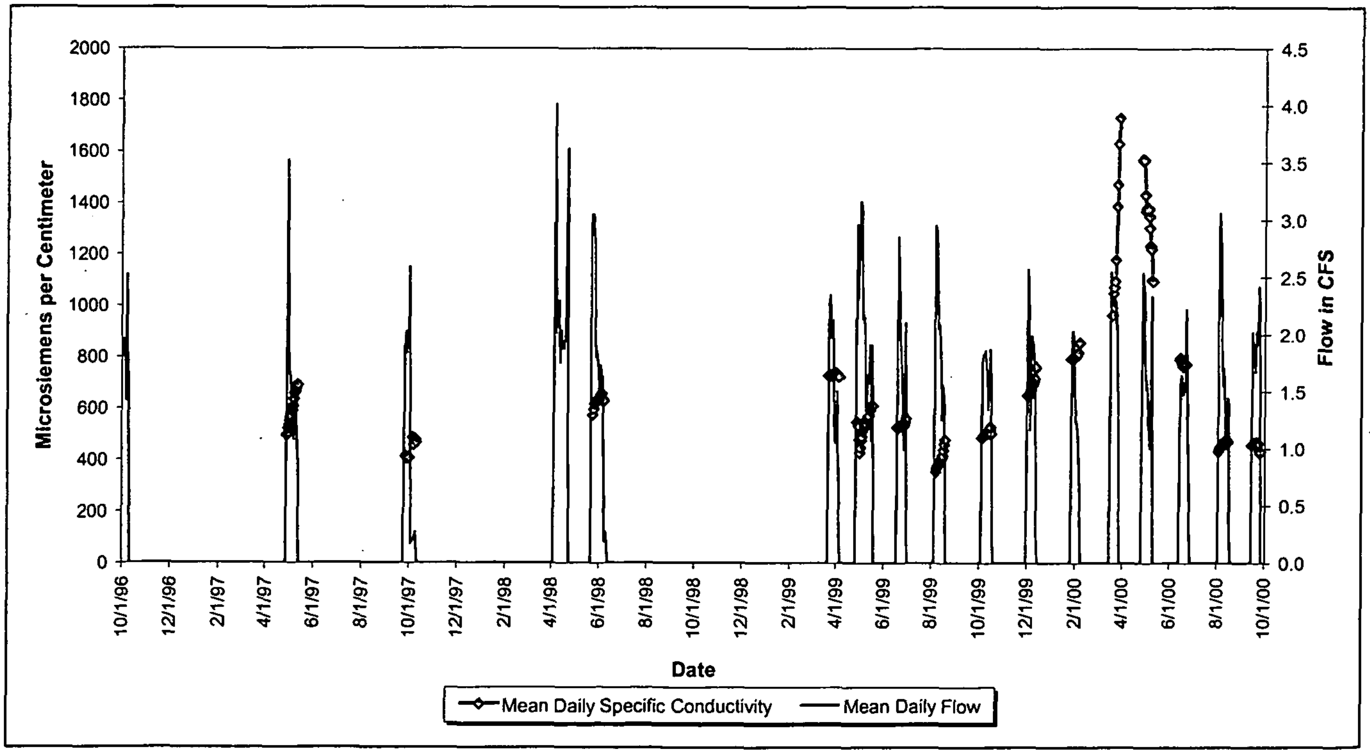


Figure 13-18. Mean Daily Specific Conductivity at GS08: Water Years 1997 – 2000.

Figure 13-19 shows the mean daily pH varying between 7.5 and 10.5. The somewhat higher pH values are due to algae growth affecting the CO_2 buffering capacity. Finally, Figure 13-20 shows variable turbidity measurements. These variations are likely the result of biological growth in the pond and turbidity from recent pond inflows.

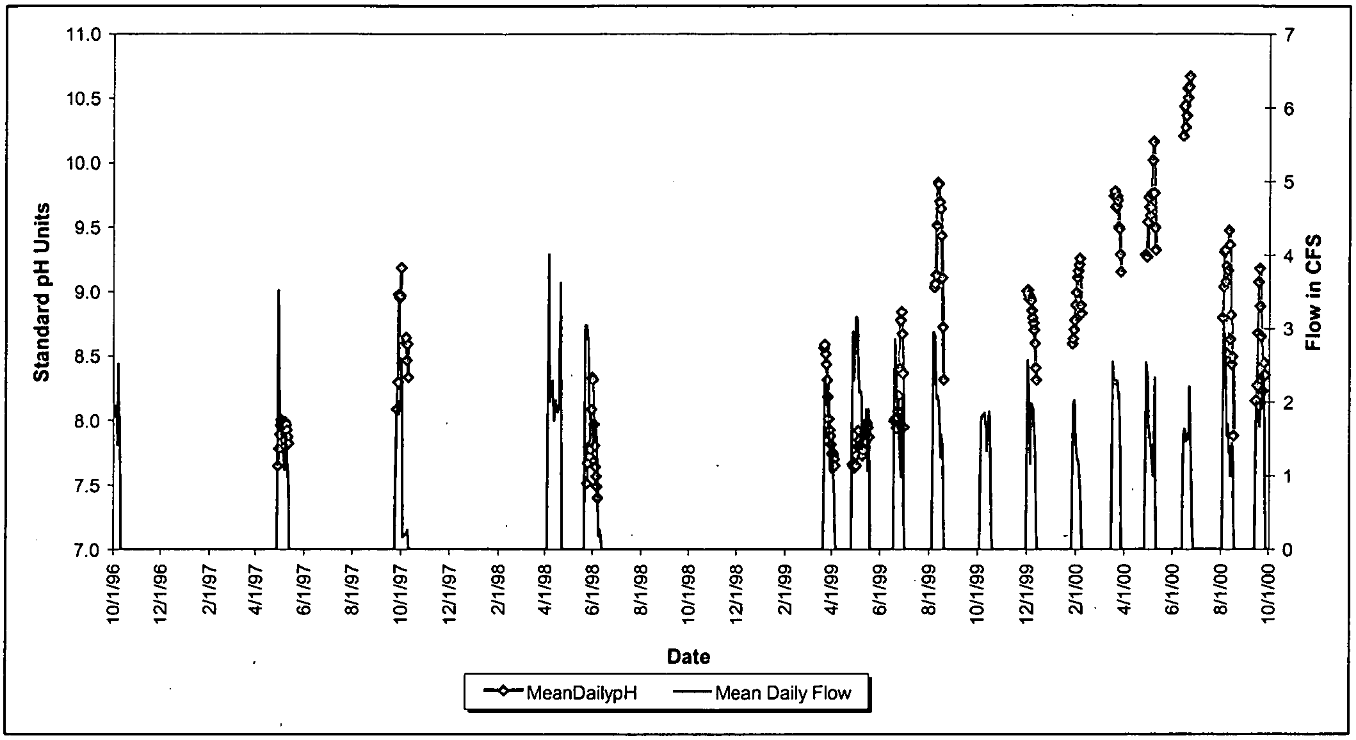


Figure 13-19. Mean Daily pH at GS08: Water Years 1997 – 2000.

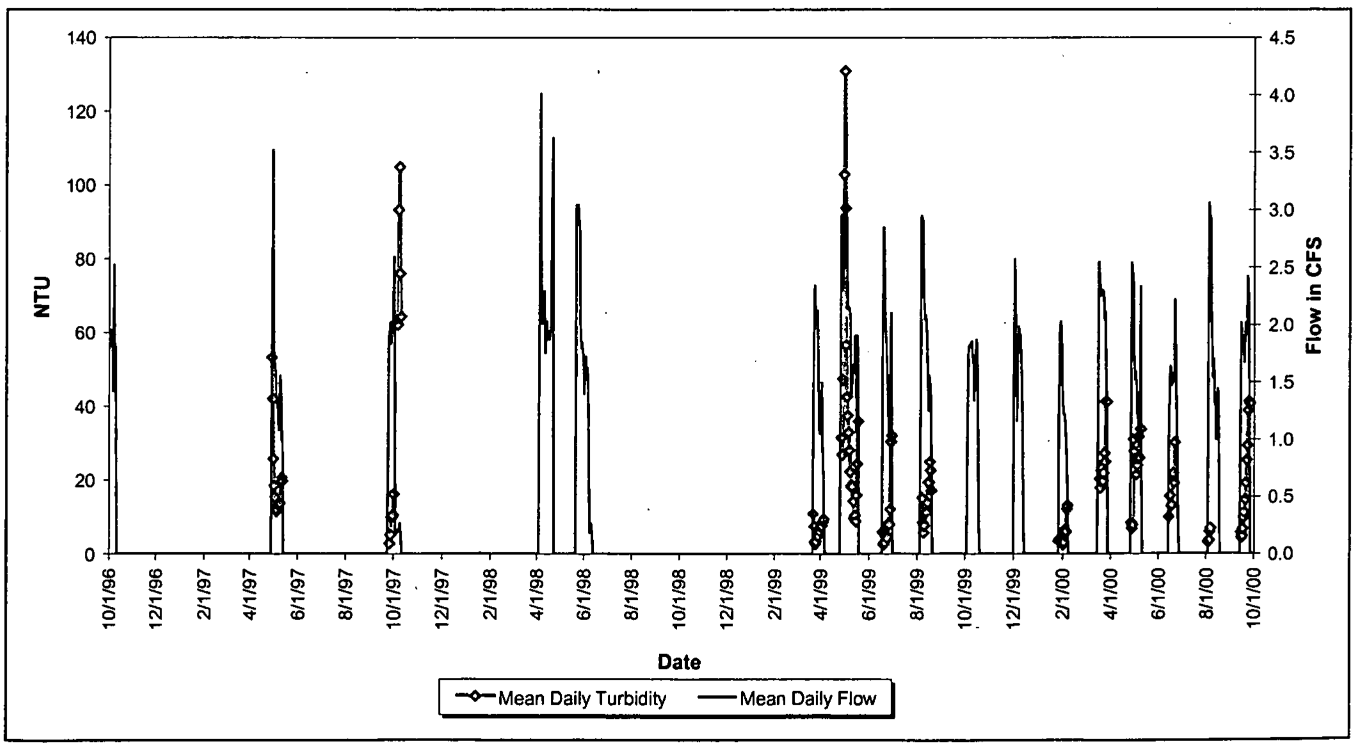


Figure 13-20. Mean Daily Turbidity at GS08: Water Years 1997 – 2000.

13.3.4 Location GS11

Monitoring location GS11 is located on N. Walnut Cr. at the outlet of Pond A-4. Figure 3-26 shows the drainage area for GS11. The northern portion of the IA contributes flow to GS11.

Table 13-12 shows that all of the annual average Pu and Am activities were well below 0.15 pCi/L. Additionally, the long-term Pu and Am averages (WY97-00) are well below 0.15 pCi/l. The average uranium activities are all well below 10 pCi/L.

Figure 13-21 and Figure 13-22 show no occurrences of reportable 30-day averages.

Figure 13-25 shows the 365 calendar-day averages using the proposed post-Closure calculation method (see Appendix B.1: Data Evaluation Methods). It can be seen that by using this method the variability is 'dampened' by the longer evaluation period, and no values would be reportable using the current 0.15 pCi/L Action Level.

Table 13-12. Annual Volume-Weighted Average Radionuclide Activities at GS11 in WY97-00.

Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	*Pu-239,-240*	*Total Uranium*
1997	0.005	0.009	1.890
1998	0.009	0.004	2.072
1999	0.004	0.006	1.735
2000	0.001	0.029	3.229
Total	0.006	0.007	2.000

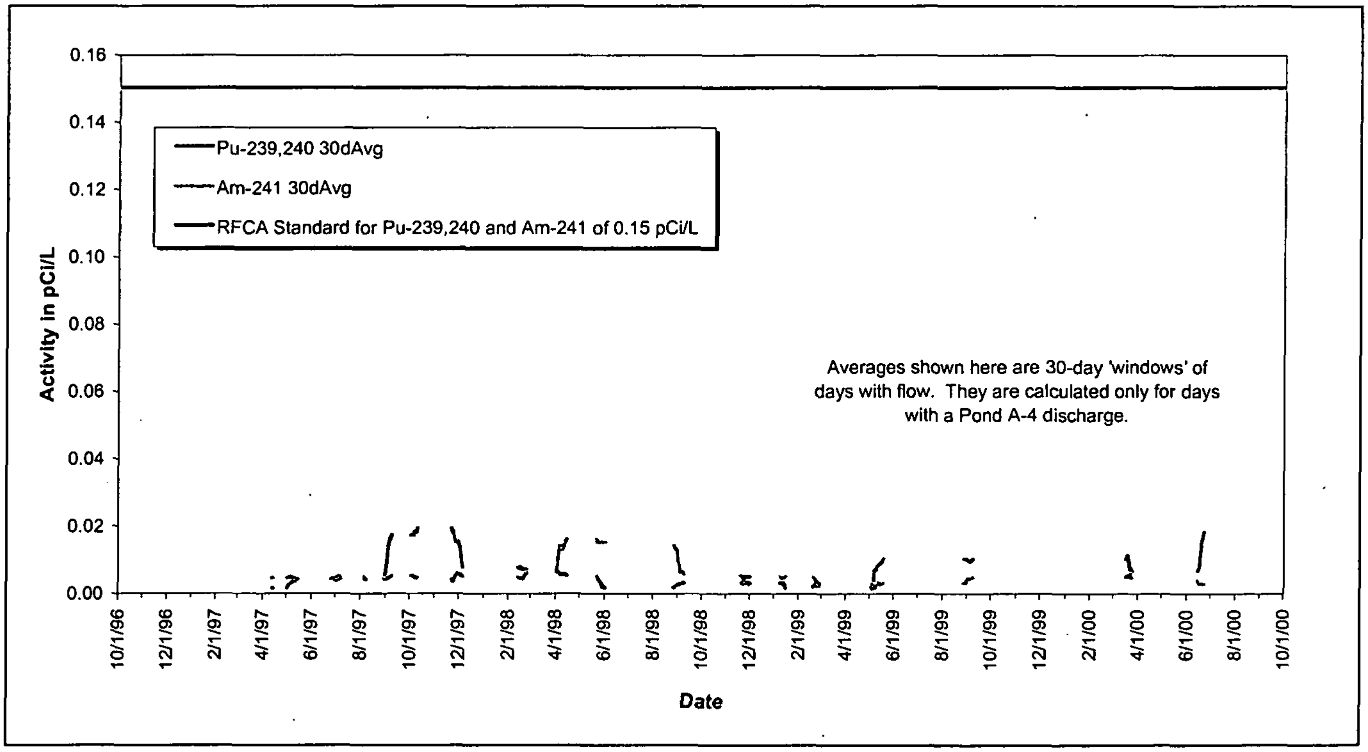


Figure 13-21. Volume-Weighted 30-Day Average Pu and Am Activities at GS11: WY97–00.

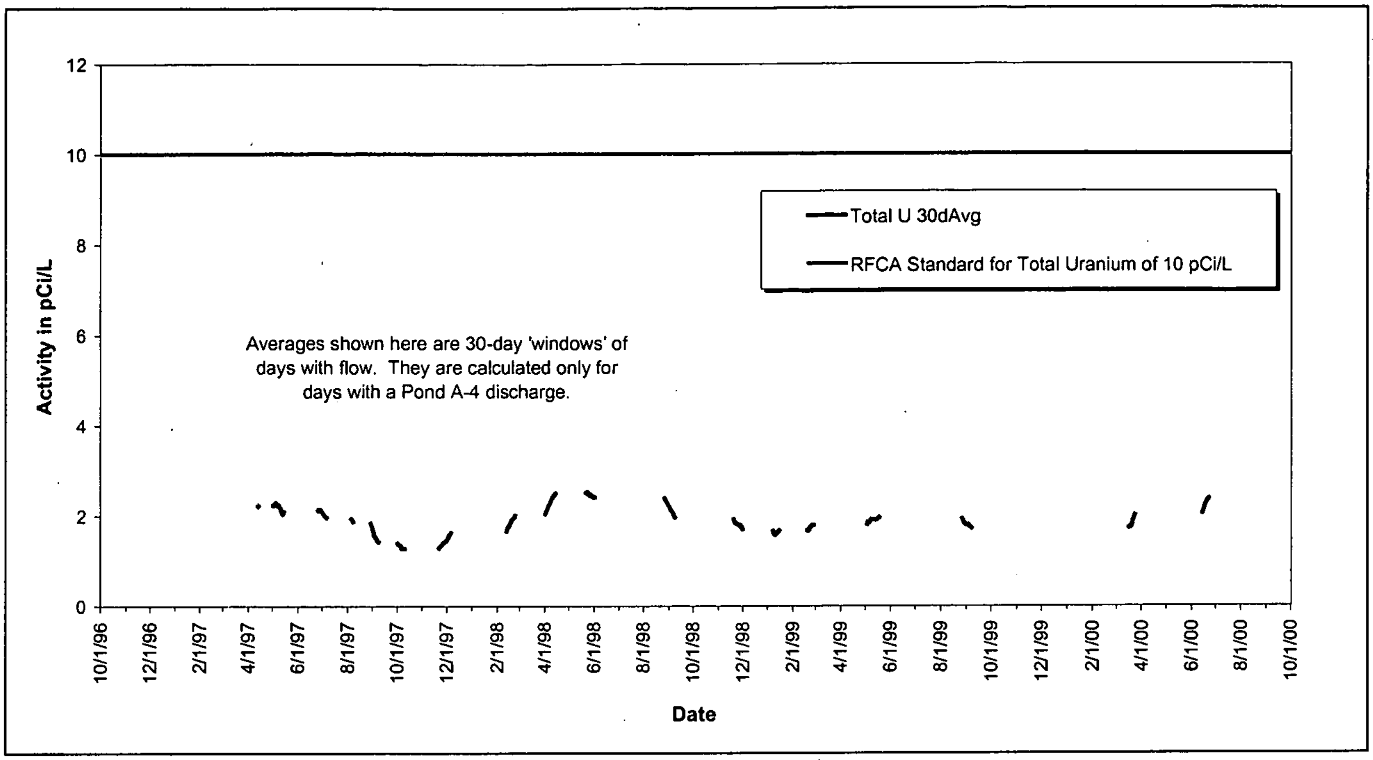


Figure 13-22. Volume-Weighted 30-Day Average Total Uranium Activities at GS11: WY97–00.

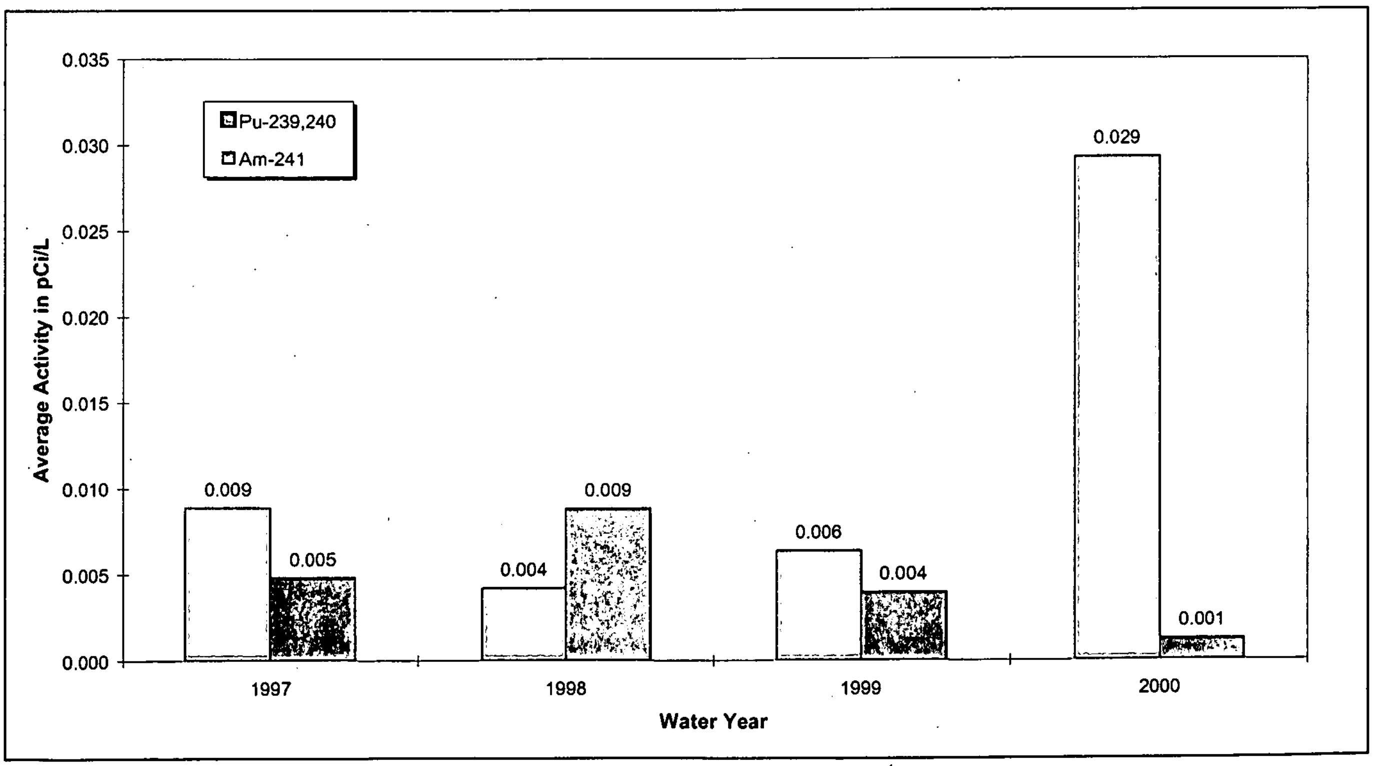


Figure 13-23. Annual Volume-Weighted Average Pu and Am Activities at GS11: WY97–00.

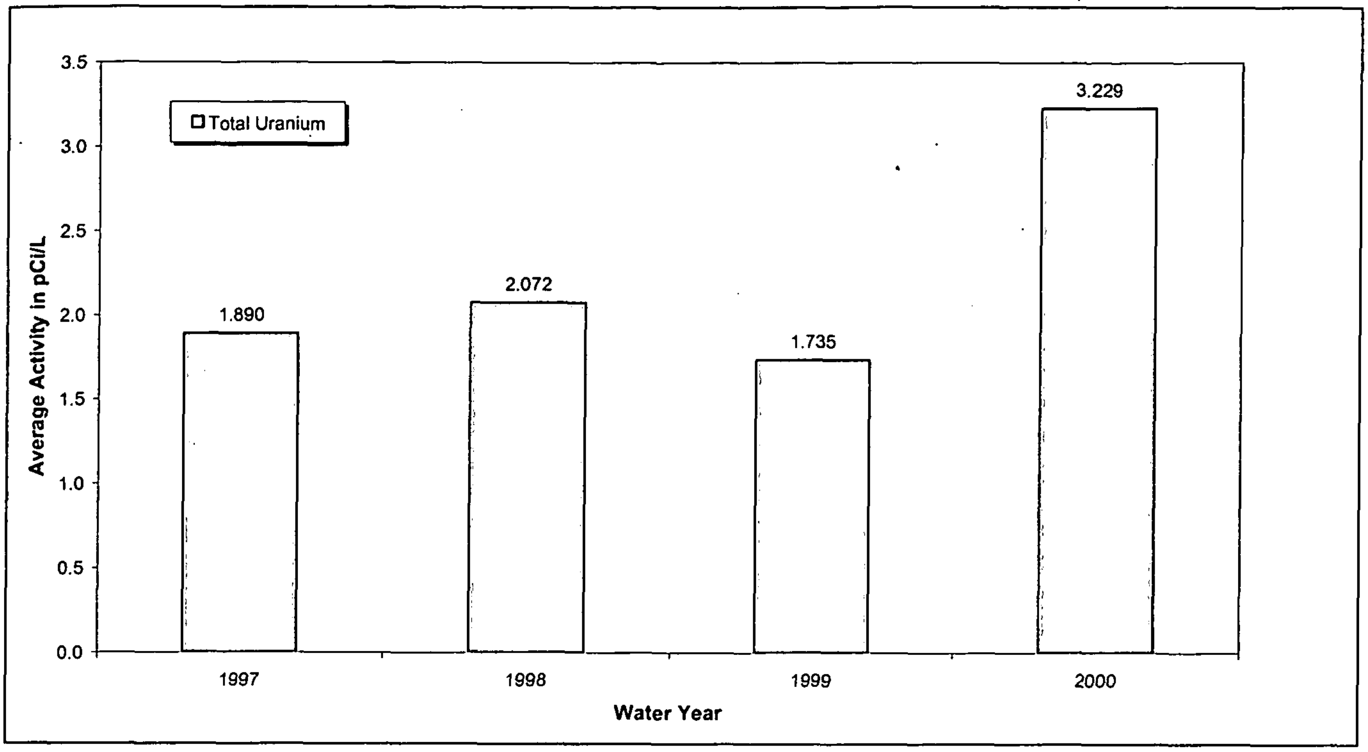
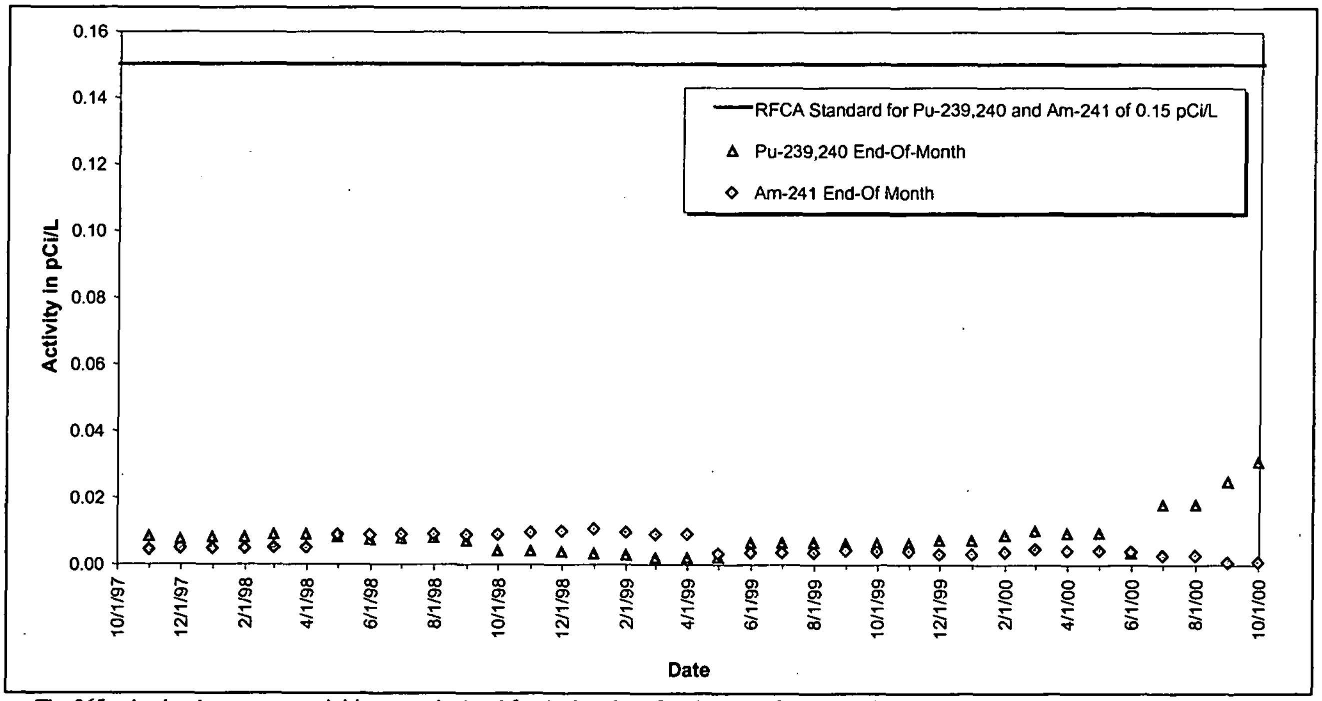


Figure 13-24. Annual Volume-Weighted Average Total Uranium Activities at GS11: WY97–00.



Note: The 365 calendar-day average activities are calculated for the last day of each month for the previous 365 days.

Figure 13-25. Volume-Weighted 365 Calendar-Day Average Pu and Am Activities at GS11: WY97–00.

Mean daily water-quality parameter data are plotted in Figure 13-26 through Figure 13-29 along with the mean daily flow rate. Figure 13-26 shows the expected annual variation in water temperature. Figure 13-27 shows elevated conductivities during the winter months, most likely a result of road and walkway deicing operations. The higher June 2000 conductivities are also likely caused by runoff that entered A-4 during previous winter months.

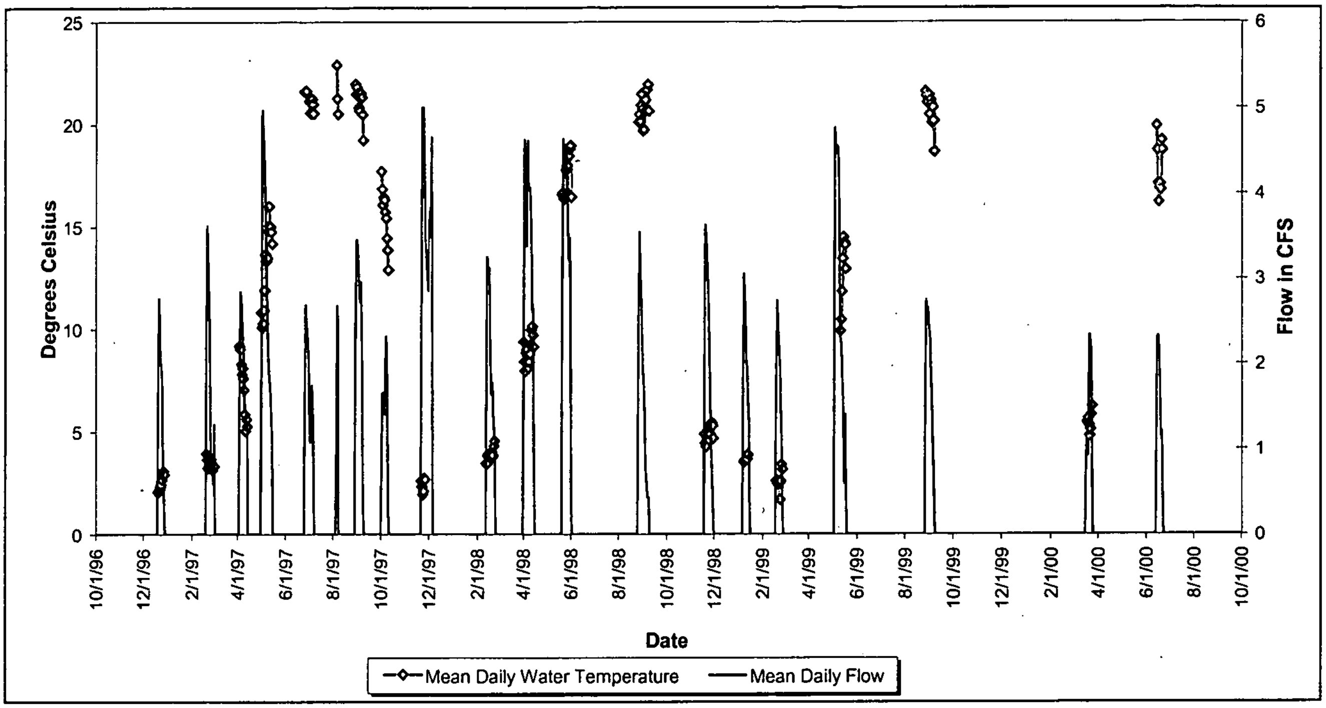


Figure 13-26. Mean Daily Water Temperature at GS11: Water Years 1997 – 2000.

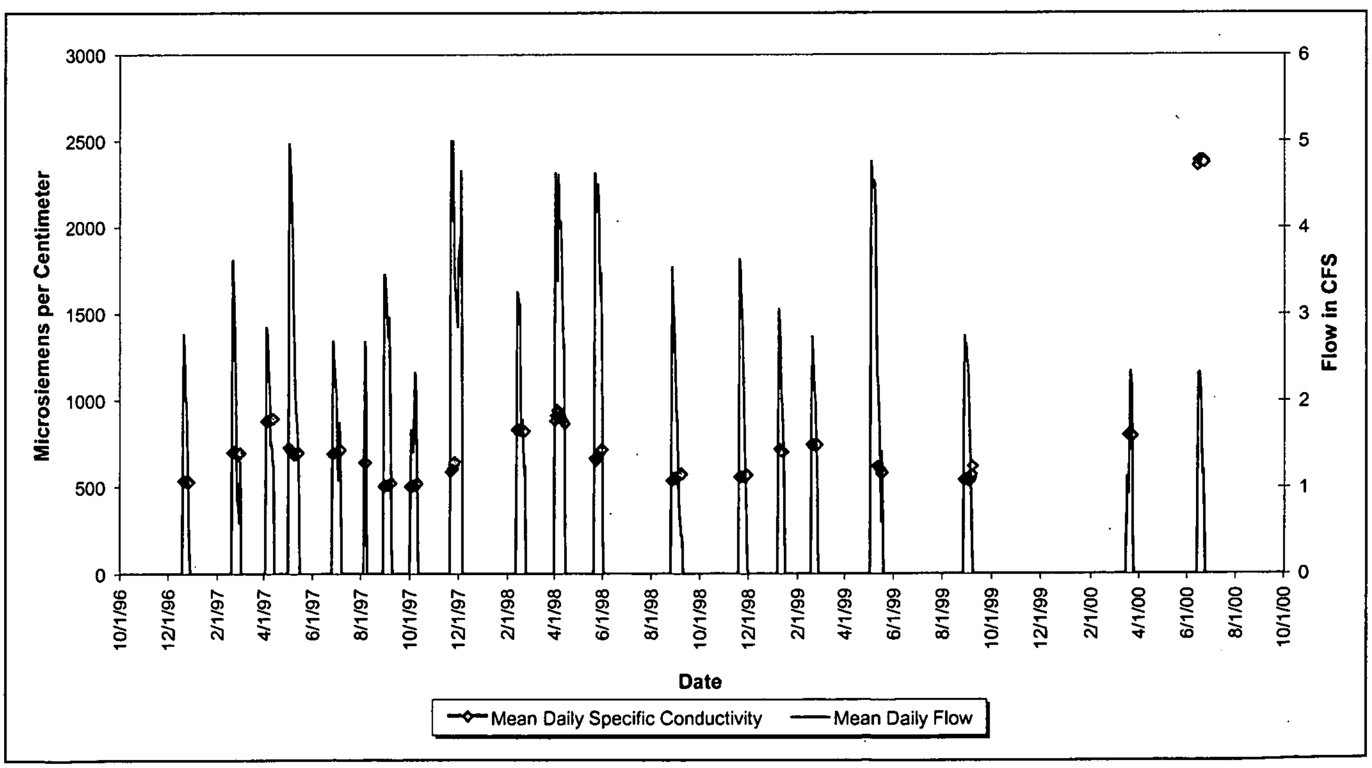


Figure 13-27. Mean Daily Specific Conductivity at GS11: Water Years 1997 – 2000.

Figure 13-28 shows the mean daily pH varying between 7.5 and 10.5. The somewhat higher pH values are due to algae growth affecting the CO_2 buffering capacity. Finally, Figure 13-29 shows variable turbidity measurements. These variations are likely the result of biological growth in the pond and turbidity from recent pond inflows.

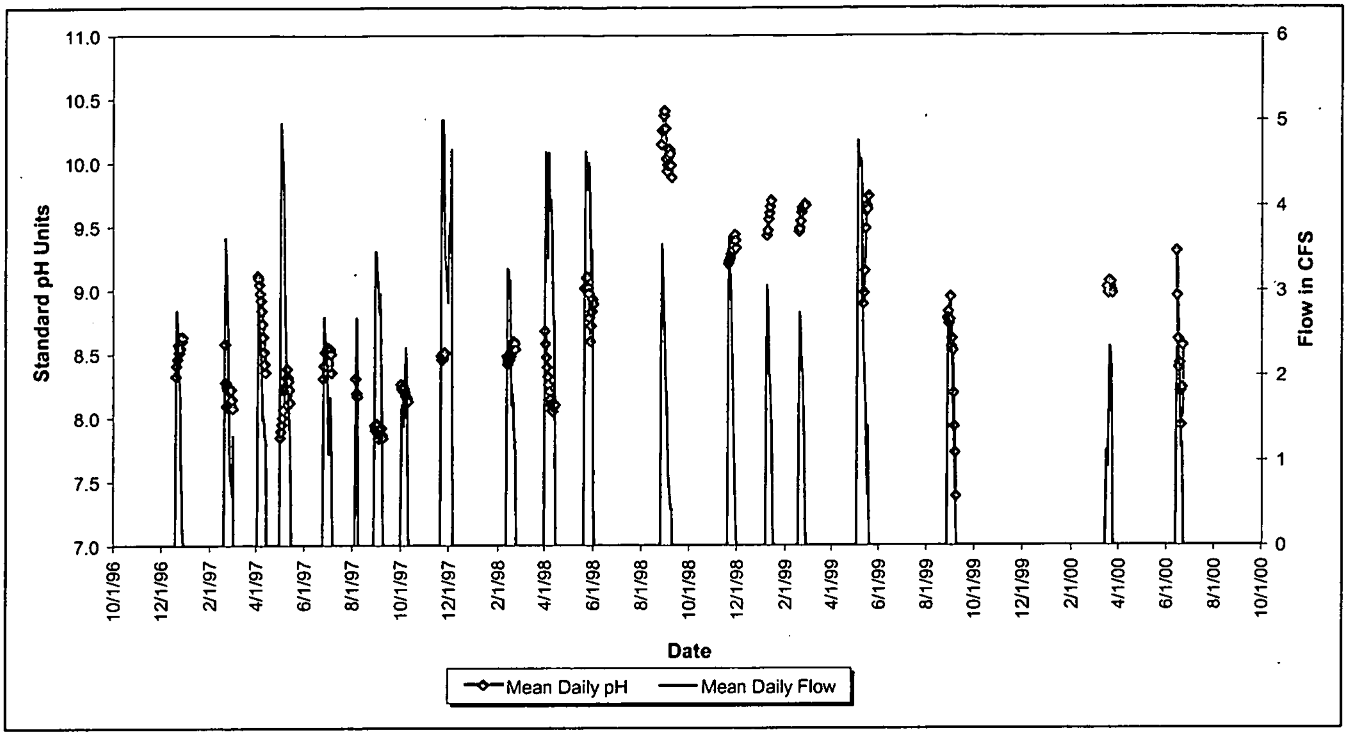


Figure 13-28. Mean Daily pH at GS11: Water Years 1997 – 2000.

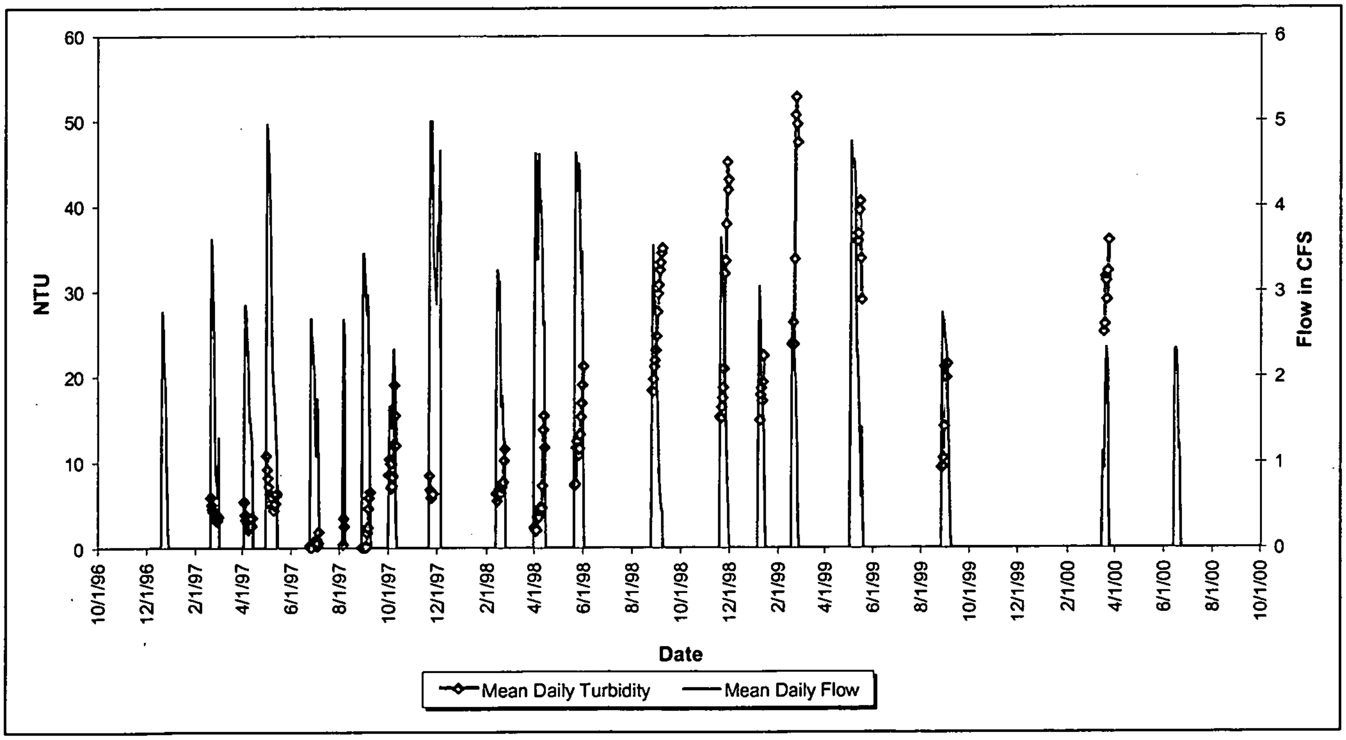


Figure 13-29. Mean Daily Turbidity at GS11: Water Years 1997 – 2000.

13.3.5 Location GS31

Monitoring location GS31 is located on Woman Cr. at the outlet of Pond C-2. Figure 3-38 shows the drainage area for GS31. The southern portion of the IA contributes flow to GS31.

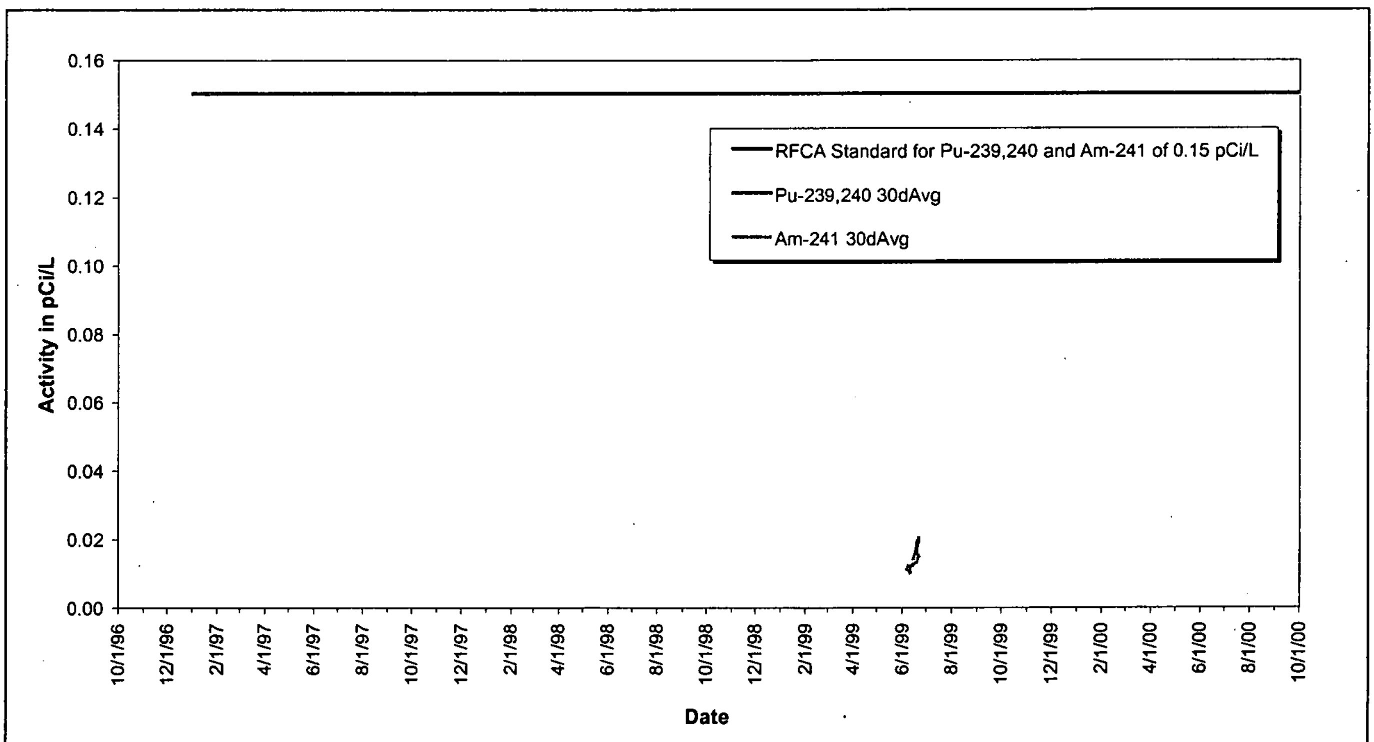
Table 13-13 shows that all of the annual average Pu and Am activities were below 0.15 pCi/L. Additionally, the long-term Pu and Am averages (WY97-00) are well below 0.15 pCi/l. The average uranium activities are all well below 11 pCi/L.

Figure 13-30 and Figure 13-31 show no occurrences of reportable 30-day averages.

Figure 13-34 shows the 365 calendar-day averages using the proposed post-Closure calculation method (see Appendix B.1: Data Evaluation Methods). It can be seen that by using this method the variability is 'dampened' by the longer evaluation period, more values are calculated using a calendar window, and no values would be reportable using the current 0.15 pCi/L Action Level.

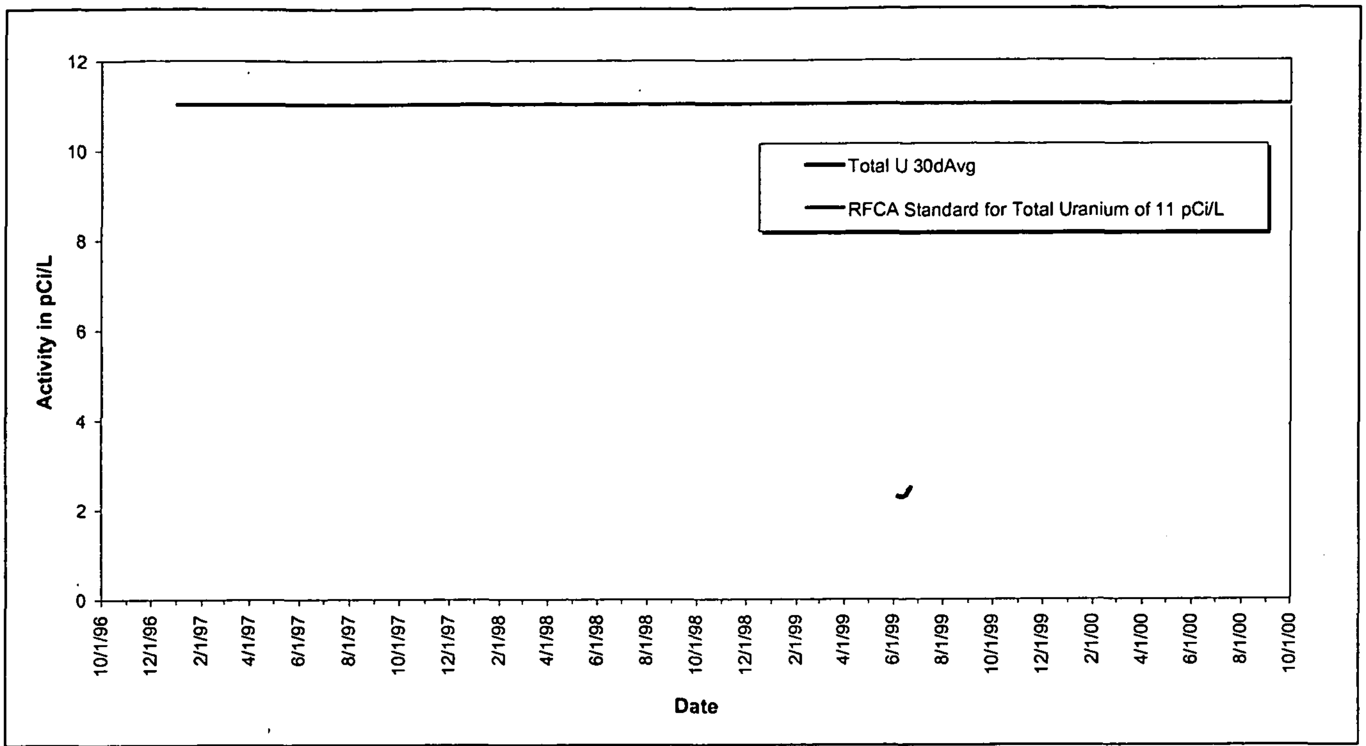
Table 13-13. Annual Volume-Weighted Average Radionuclide Activities at GS31 in WY97-00.

Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	*Pu-239,-240*	*Total Uranium*
1997	0.005	0.018	2.475
1998	0.015	0.009	2.223
1999	0.010	0.043	2.699
2000	No C-2 Discharge	No C-2 Discharge	No C-2 Discharge
Total	0.012	0.02	2.395



Note: 30 days of flow were not available for use in calculation until during (6/6/99) the 4th C-2 discharge after the start of RFCA monitoring.

Figure 13-30. Volume-Weighted 30-Day Average Pu and Am Activities at GS31: WY97–00.



Note: 30 days of flow were not available for use in calculation until during (6/6/99) the 4th C-2 discharge after the start of RFCA monitoring.

Figure 13-31. Volume-Weighted 30-Day Average Total Uranium Activities at GS31: WY97–00.

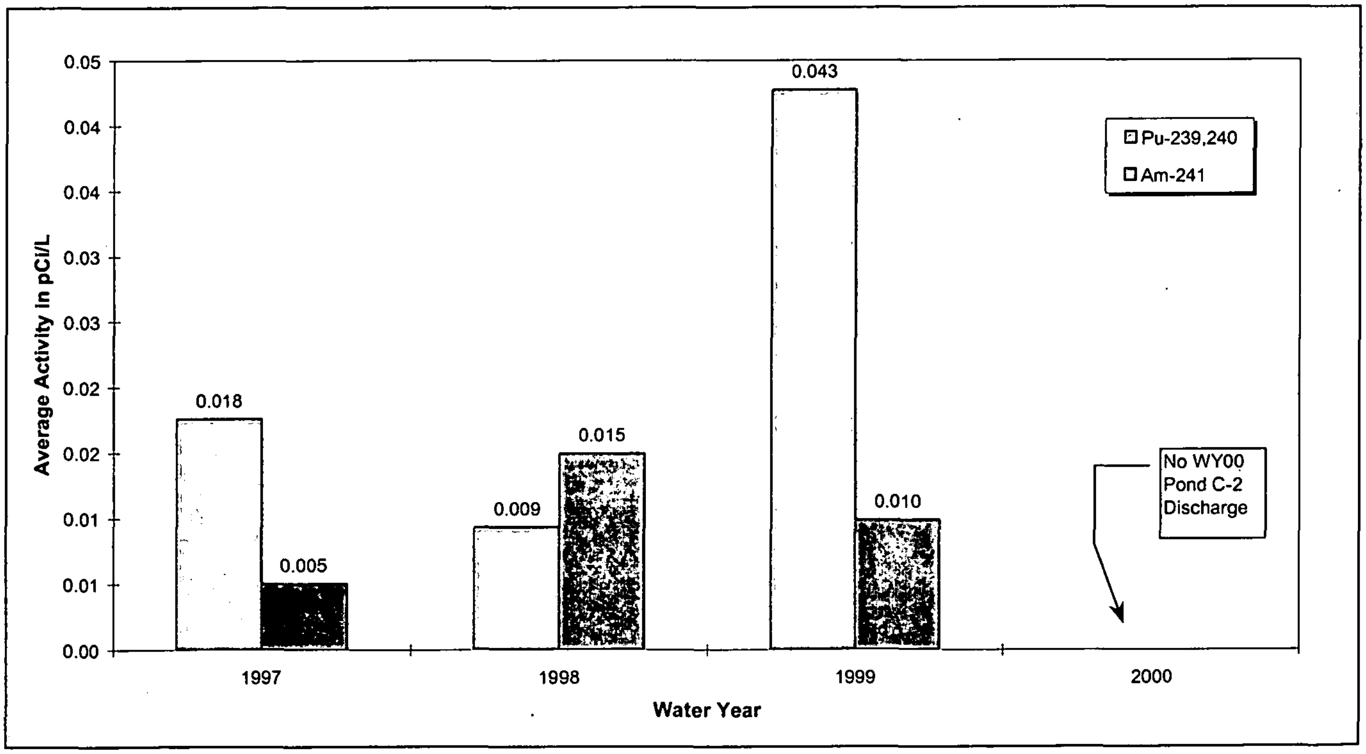


Figure 13-32. Annual Volume-Weighted Average Pu and Am Activities at GS31: WY97–00.

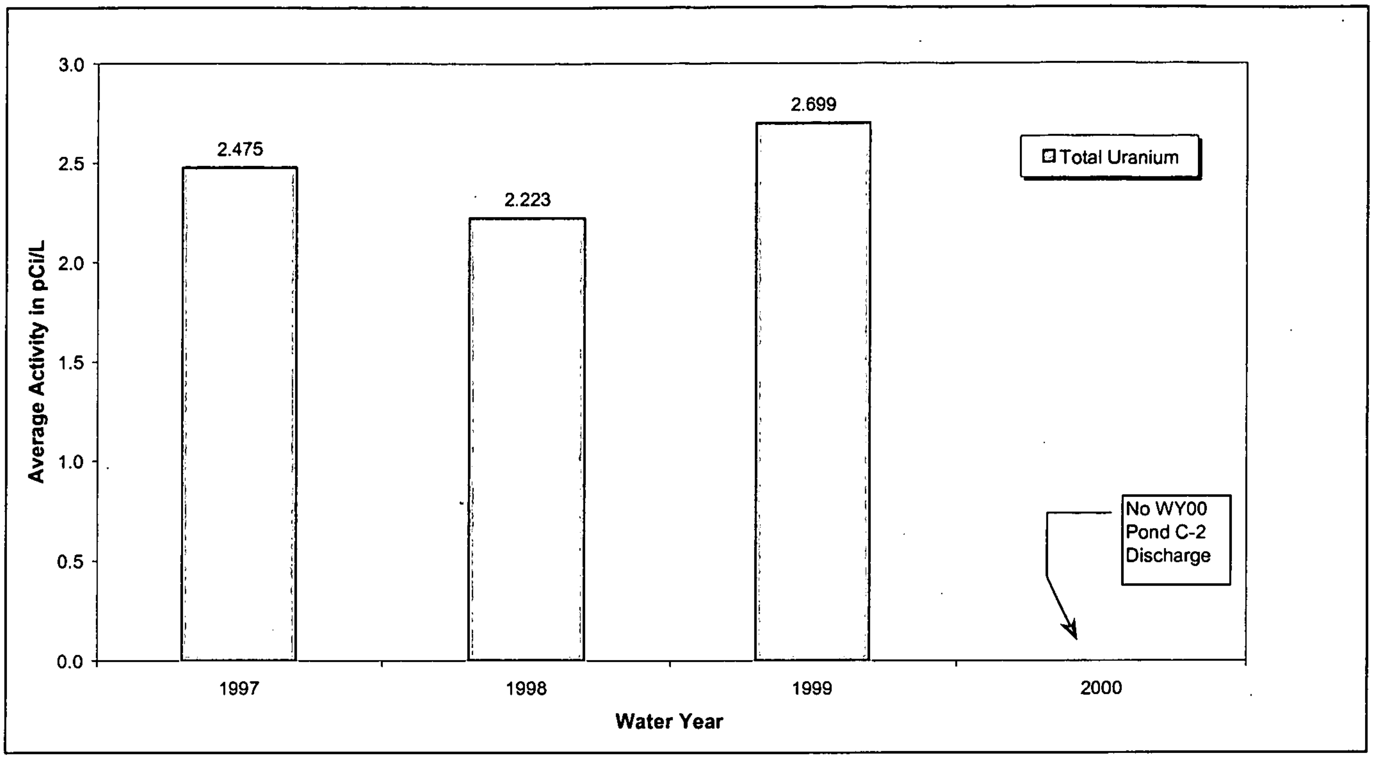
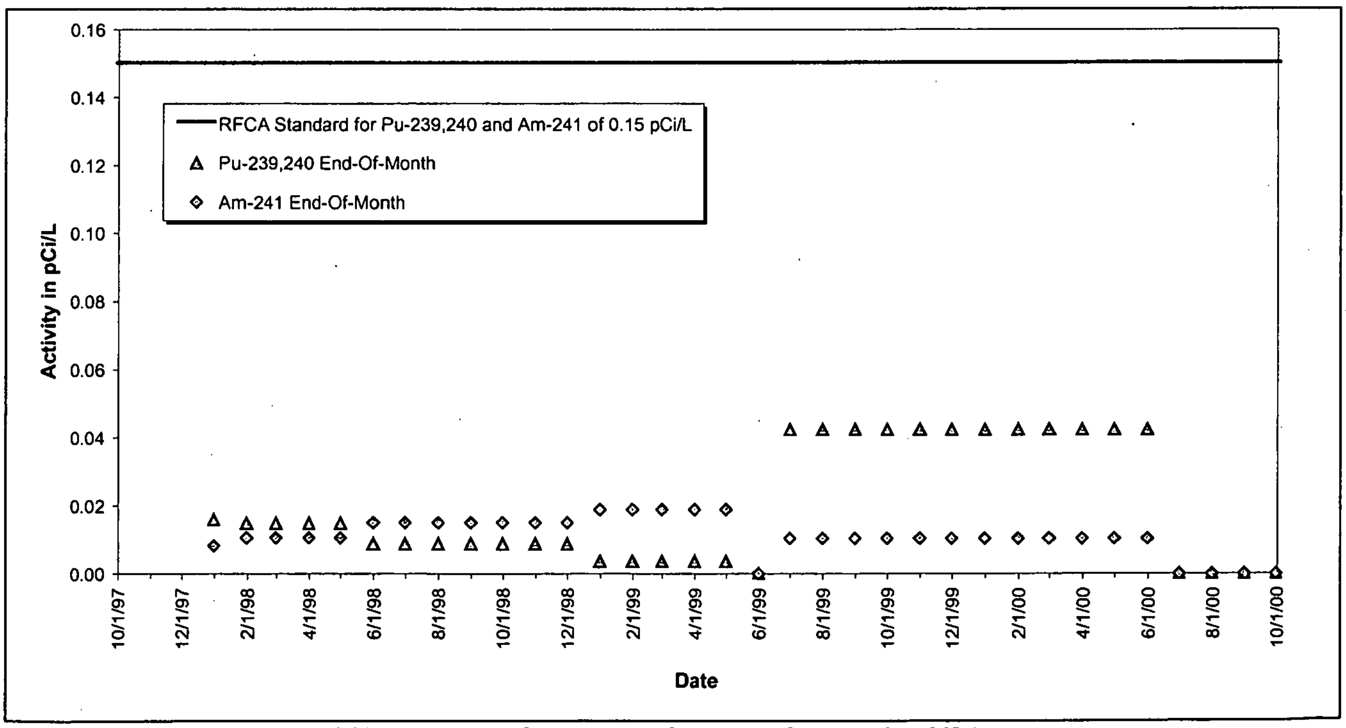


Figure 13-33. Annual Volume-Weighted Average Total Uranium Activities at GS31: WY97–00.



Note: The 365 calendar-day average activities are calculated for the last day of each month for the previous 365 days.

Figure 13-34. Volume-Weighted 365 Calendar-Day Average Pu and Am Activities at GS31: WY97–00.

Mean daily water-quality parameter data are plotted in Figure 13-35 through Figure 13-38 along with the mean daily flow rate. Figure 13-35 shows the expected annual variation in water temperature. Figure 13-36 shows elevated conductivities during June 1999, most likely a result of road and walkway deicing operations affecting runoff that entered C-2 during previous winter months.

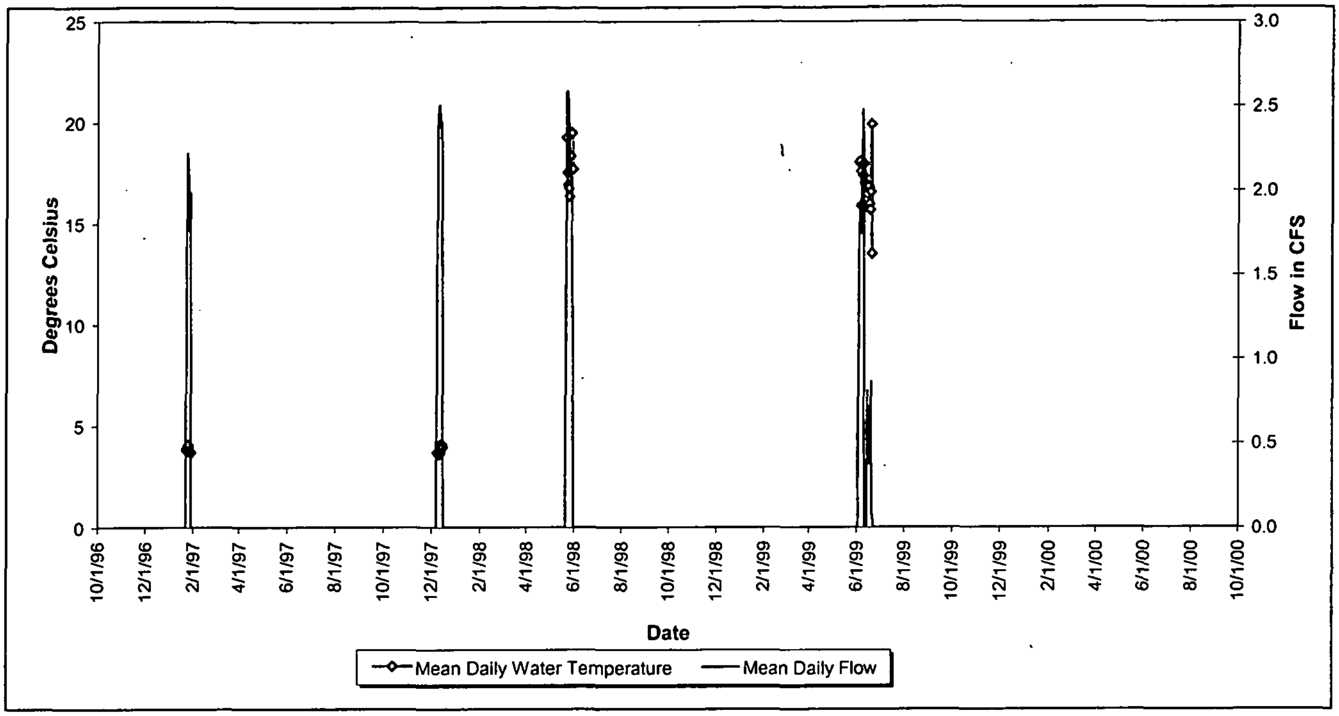


Figure 13-35. Mean Daily Water Temperature at GS31: Water Years 1997 – 2000.

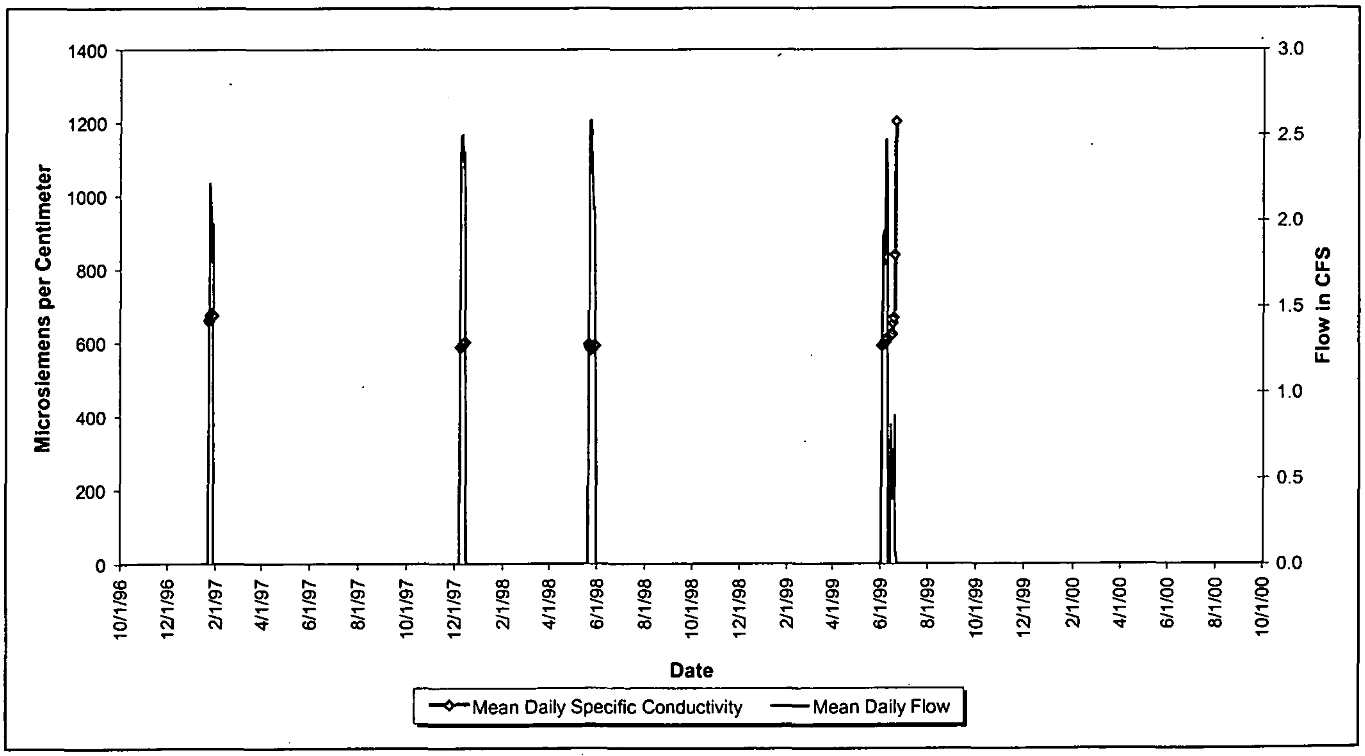


Figure 13-36. Mean Daily Specific Conductivity at GS31: Water Years 1997 – 2000.

Figure 13-37 shows the mean daily pH varying between 6.5 and 8.0. Finally, Figure 13-38 shows variable turbidity measurements. These variations are likely the result of biological growth in the pond and turbidity from recent pond inflows.

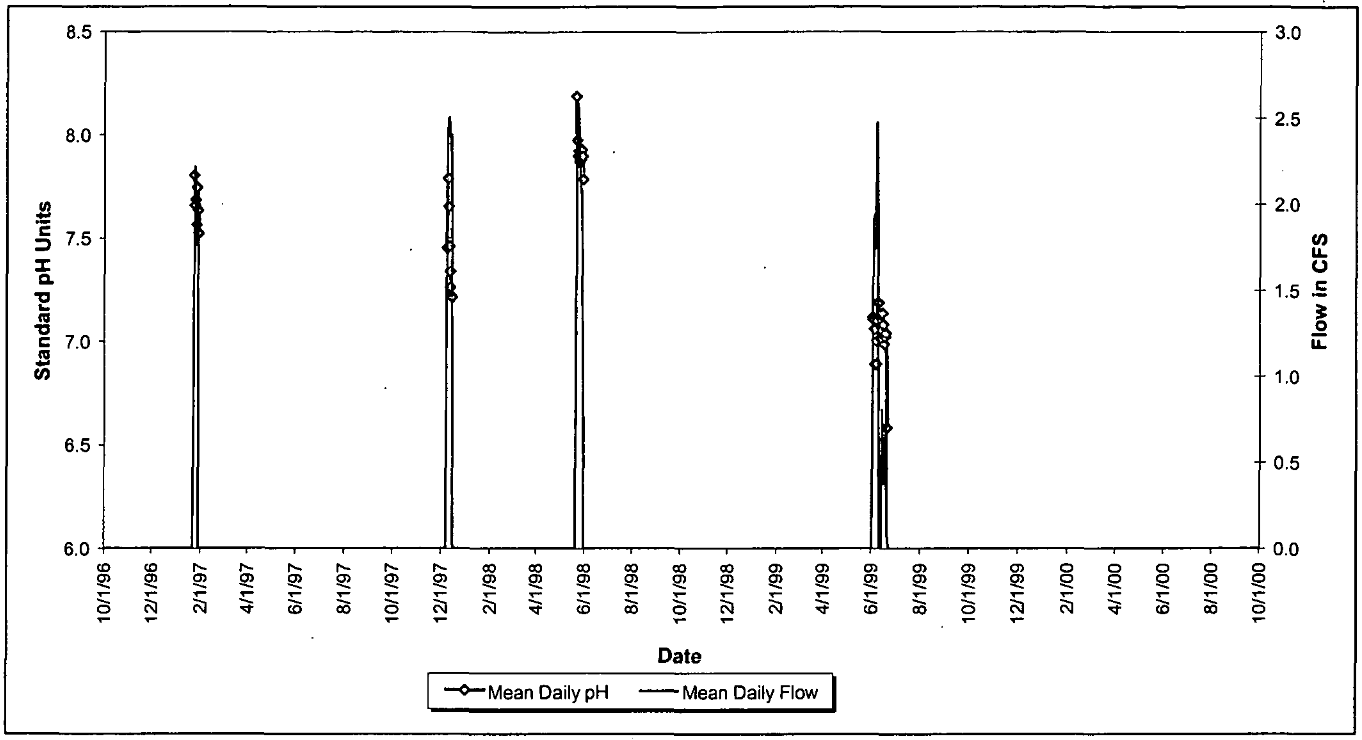


Figure 13-37. Mean Daily pH at GS31: Water Years 1997 – 2000.

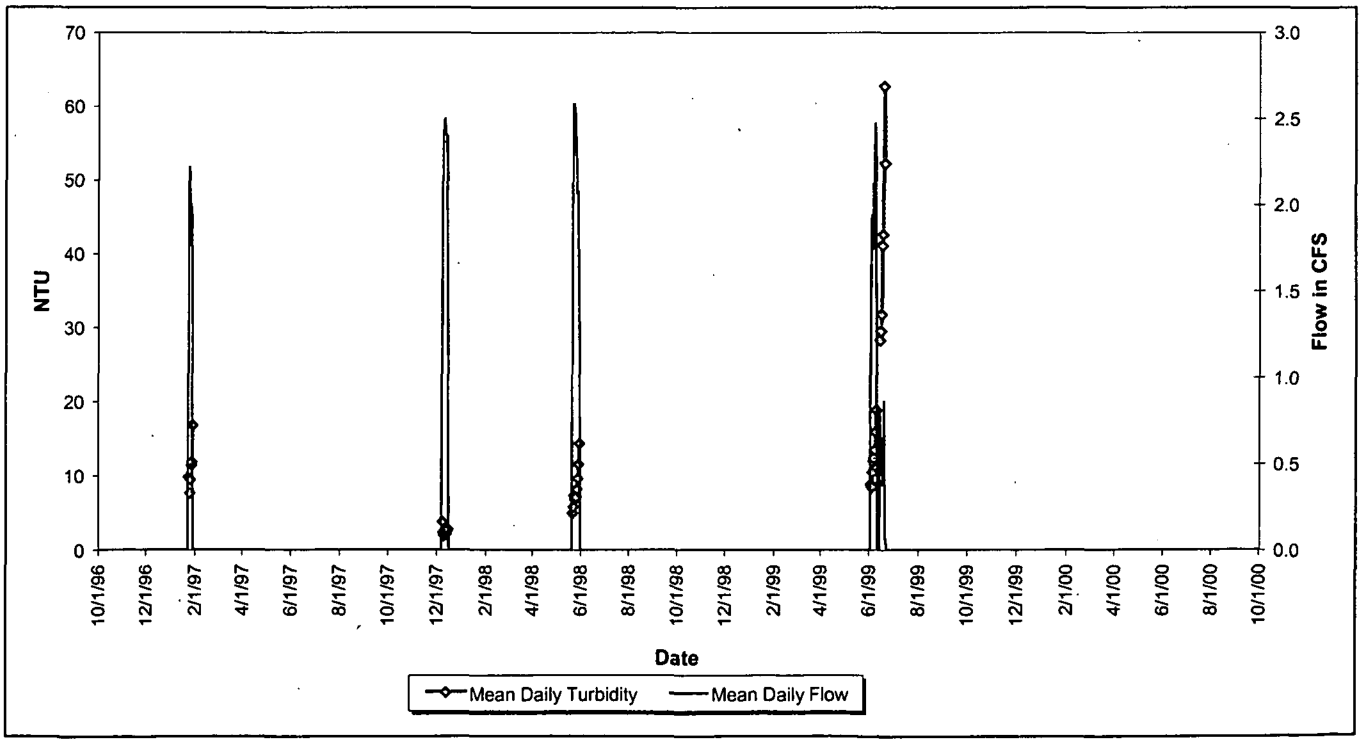


Figure 13-38. Mean Daily Turbidity at GS31: Water Years 1997 – 2000.

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14. NON-POC MONITORING AT INDIANA STREET

Non-POC monitoring is conducted as a prudent management action, and it is the intent of the RFCA parties that no enforcement action will be taken based on this monitoring. There are several reasons to monitor for certain contaminants and nutrients in the water leaving the Site in both drainages. The actions to be taken based on this monitoring are variable and may not be known until the monitoring results are available.

The Colorado Water Quality Control Commission (CWQCC) is moving toward waste load allocations for all segments of the Big Dry Creek drainage. Nutrient loadings generated by the Site are carried offsite via Walnut Creek, which can either bypass Great Western Reservoir or be directed into the reservoir. Water bypassing the reservoir enters Segment 1 of Big Dry Creek, which then flows into the South Platte River. For these reasons, it will be necessary to monitor nutrient loads leaving the Site under all three of these conditions:

- Water leaving the Site via Walnut Creek is 100% Site discharge (used and potentially contaminated by the Site before discharge from terminal ponds).
- Water leaving the Site via Walnut Creek is 100% natural stream flow (no pond discharge included).
- Water leaving the Site via Walnut Creek is a mixture of Site pond discharge and natural stream flow.

With the changes in flow configuration in the Woman Creek drainage, there is a need to monitor to determine new ambient levels for various analytes at monitoring station GS01. The results of these analyses will be used to determine what changes in water quality, if any, have occurred as a result of the new flow configuration.

14.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

The complete list of parameters and analytes (analytes collected by CDPHE) is given in Table 14-1. Only the continuously-measured water-quality parameters pH and conductivity are collected by the Site.

Table 14-1. Non-POC Monitoring Analytes and Parameters.

Total ammonia
Nitrite
Nitrate
Total phosphate as P
Orthophosphate
Be, Cd, Ag, Cr
Isotopic uranium
pH
Temperature
Conductivity
Flow

Non-POC monitoring is limited to Stream Segment 4, as represented by samples taken from Walnut Creek at Indiana Street and Woman Creek at Indiana Street (GS03 and GS01 respectively, see Figure 13-1).

14.2 WY97-00 MONITORING SCOPE

Table 14-2. Non POC Monitoring Locations.

ID Code	Location	Primary Flow Measurement Device	Telemetry
GS01	Woman Creek and Indiana St.	9" Parshall Flume	Yes
GS03	Walnut Creek and Indiana St.	6" and 36" Parallel Parshall Flumes	Yes

Table 14-3. Non POC Field Data Collection: Parameters and Frequency.

ID Code	Parameters		
	Discharge	Real-Time pH and Conductivity	Precipitation
GS01	15-min continuous	15-min continuous	5-min continuous
GS03	15-min continuous	15-min continuous	5-min continuous

Notes: Parameters are measured opportunistically when continuous flow is present and freezing conditions will not damage the probes.

14.3 DATA EVALUATION

No specific data evaluations are required of the Site for this monitoring objective.

Plots of mean daily water temperature, specific conductivity, and pH for the Indiana Street POCs (GS01 and GS03) are given below.[45] More detailed data for all parameters are presented in Appendix B.5.2. The methods used for the water-quality parameter evaluations are given in Appendix B.5: Real-Time Water-Quality Parameters.

14.3.1 Location GS01

No real-time water-quality data were collected at GS01 during WY00.

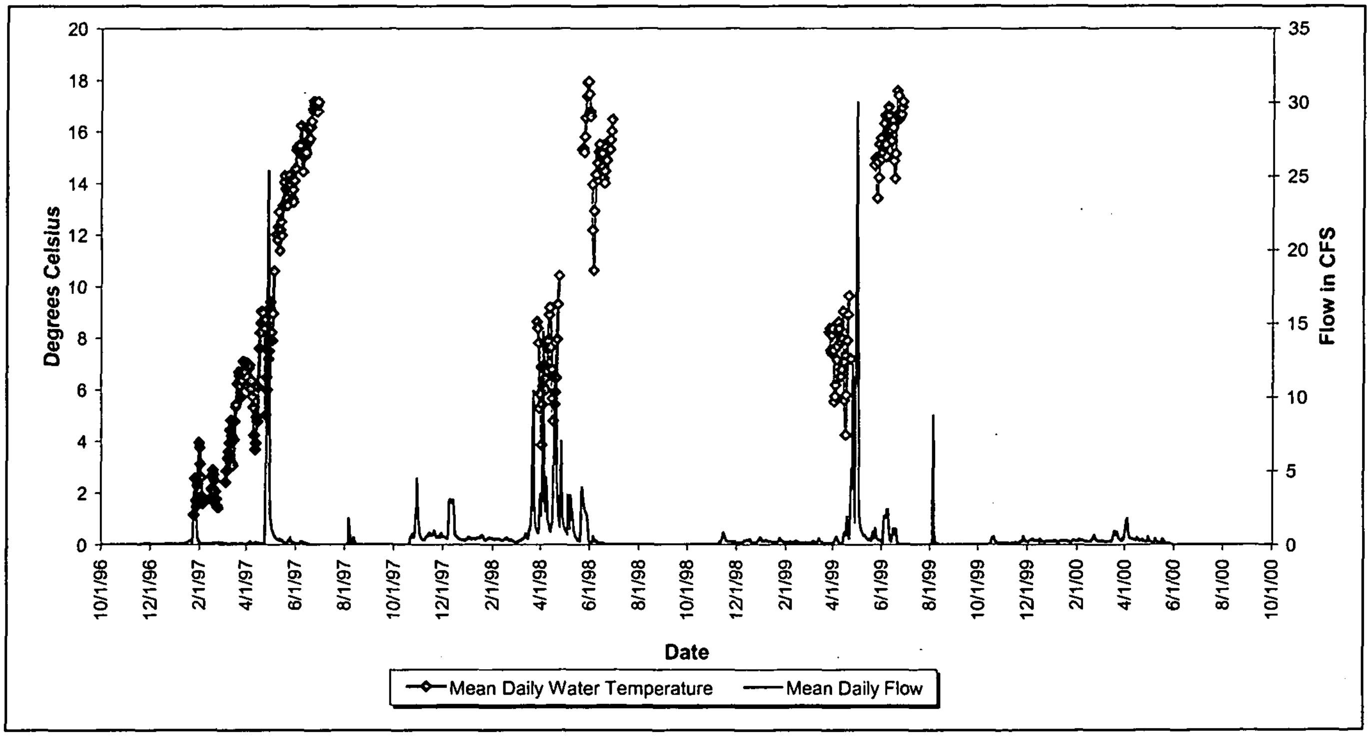

Figure 14-1. Mean Daily Water Temperature at GS01: Water Years 1997 – 2000.

[45] Mean daily water-quality values are given for days of measurable flow. Some data may be missing due to equipment failures and removal for calibration.

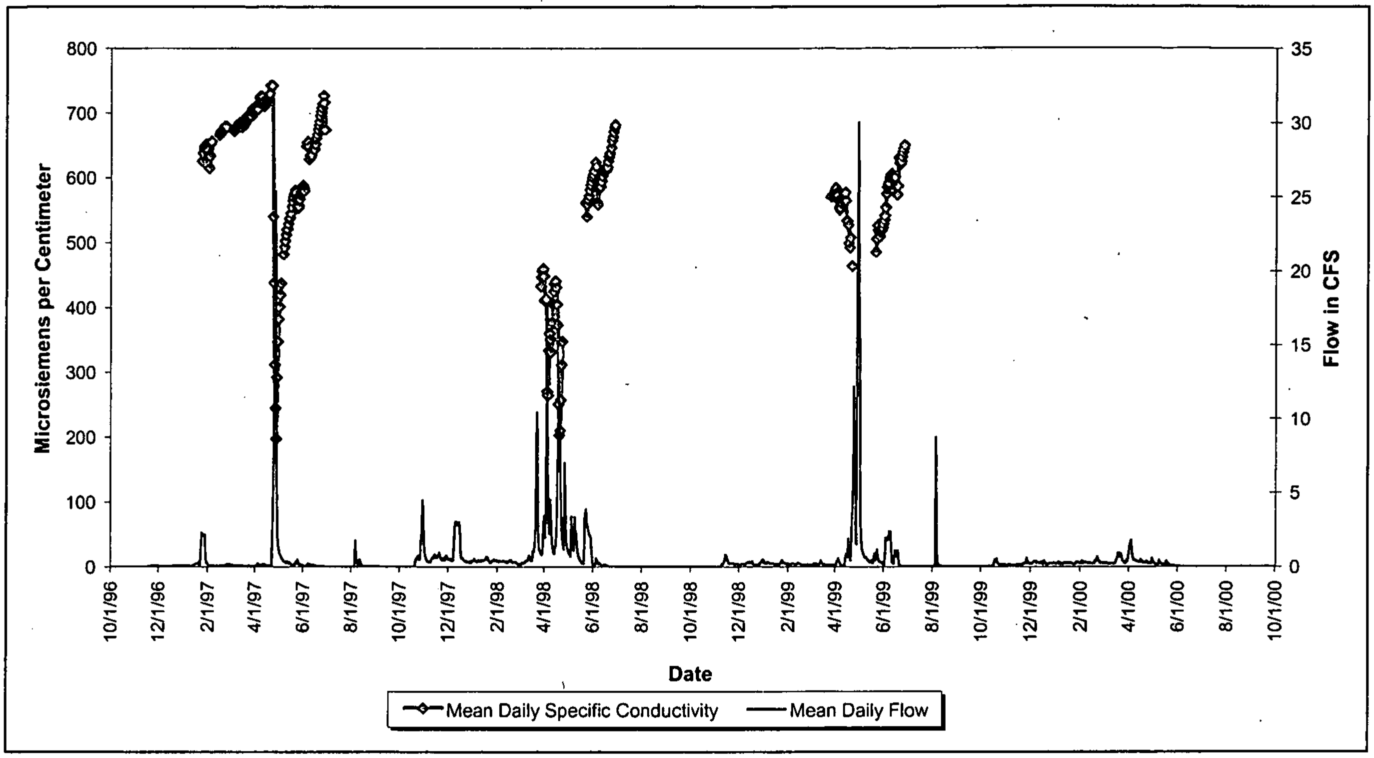

Figure 14-2. Mean Daily Specific Conductivity at GS01: Water Years 1997 – 2000.

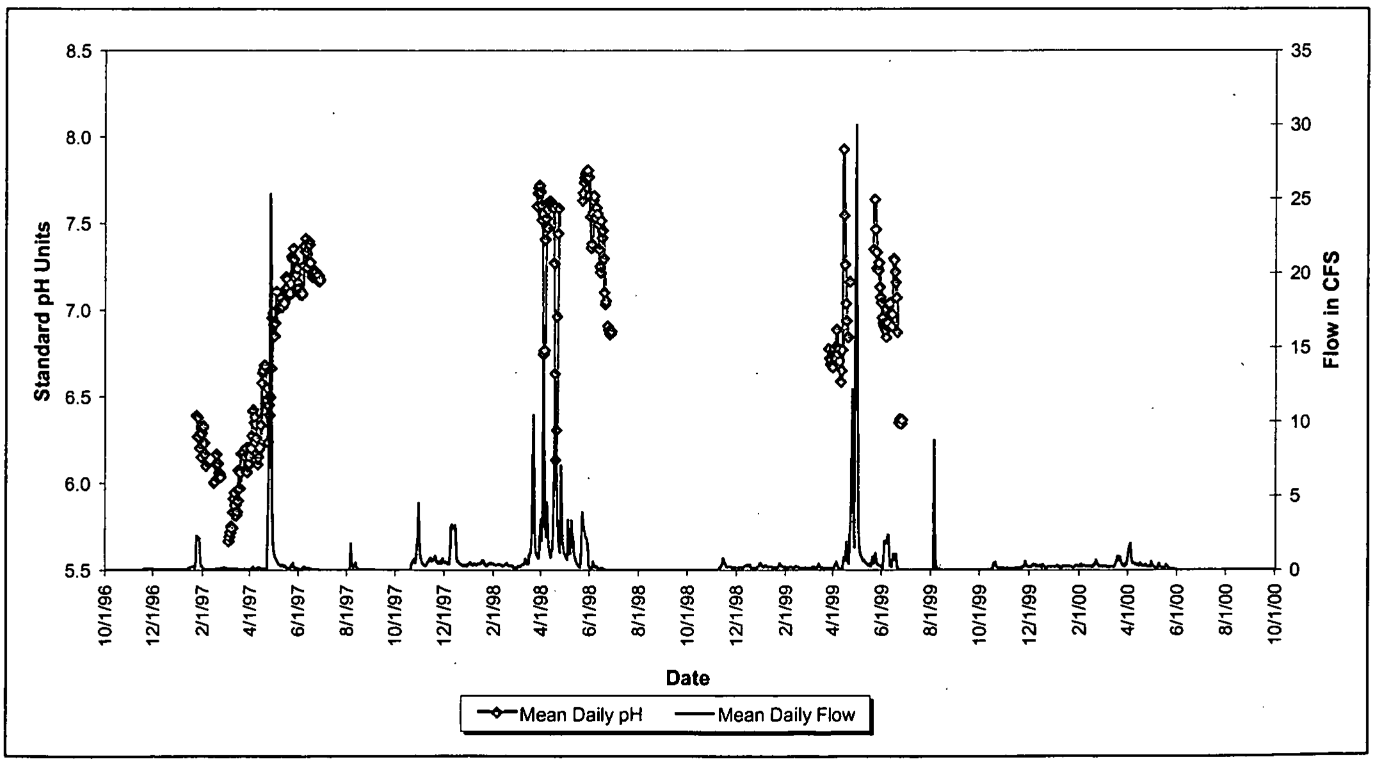

Figure 14-3. Mean Daily pH at GS01: Water Years 1997 – 2000.

14.3.2 Location GS03

No real-time water-quality data were collected at GS03 during WY99.

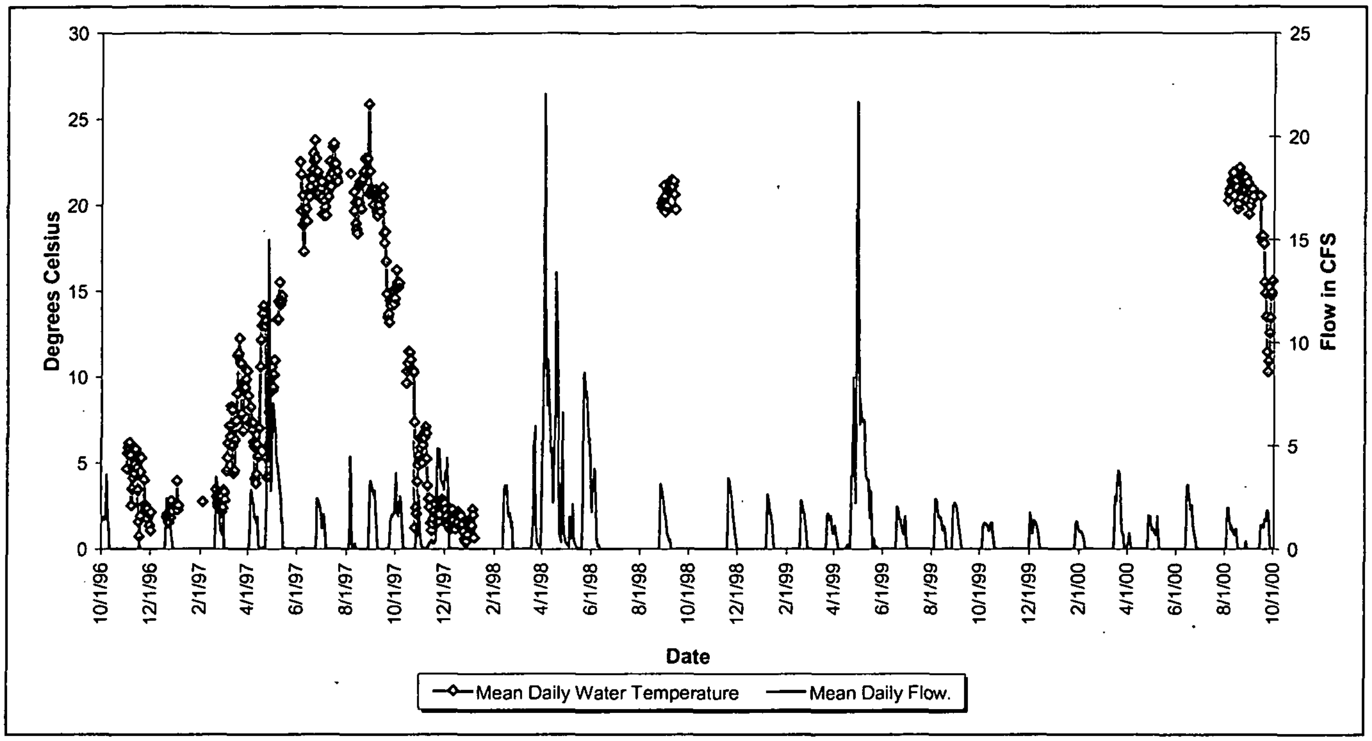

Figure 14-4. Mean Daily Water Temperature at GS03: Water Years 1997 – 2000.

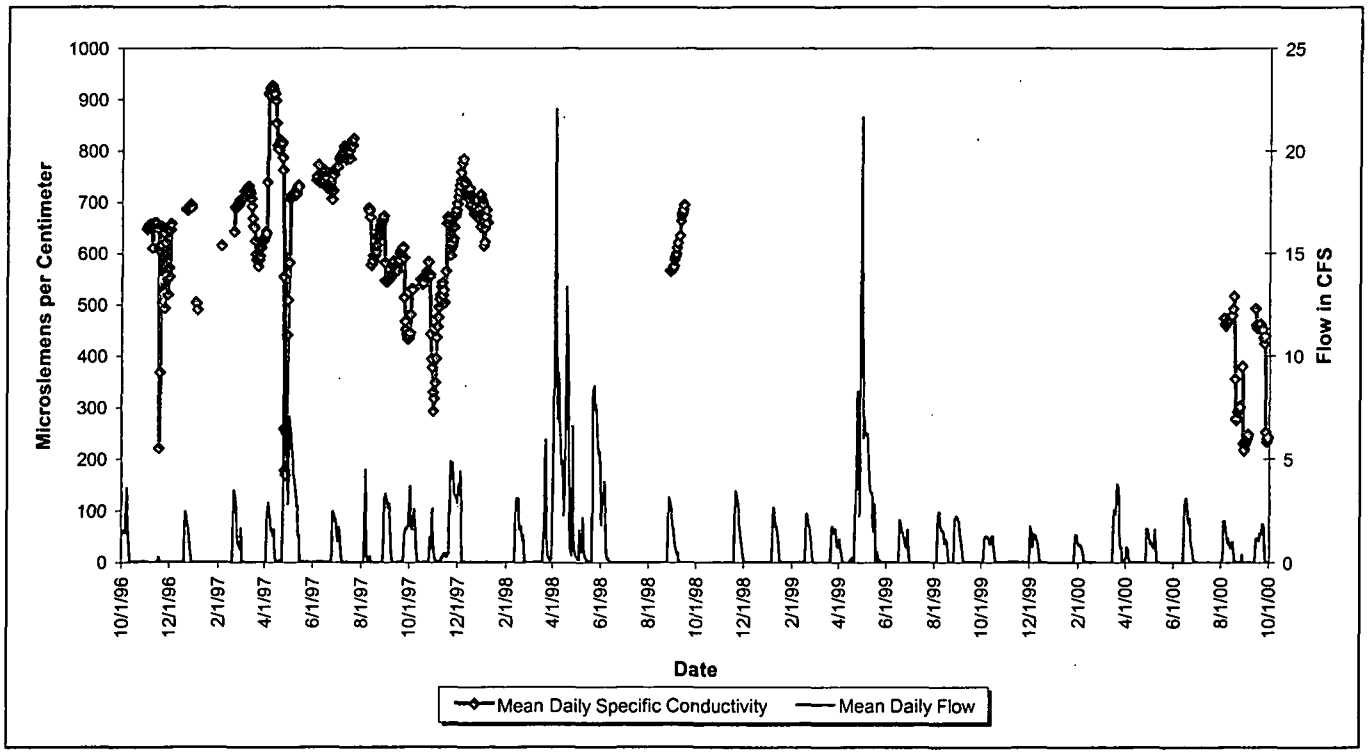

Figure 14-5. Mean Daily Specific Conductivity at GS03: Water Years 1997 – 2000.

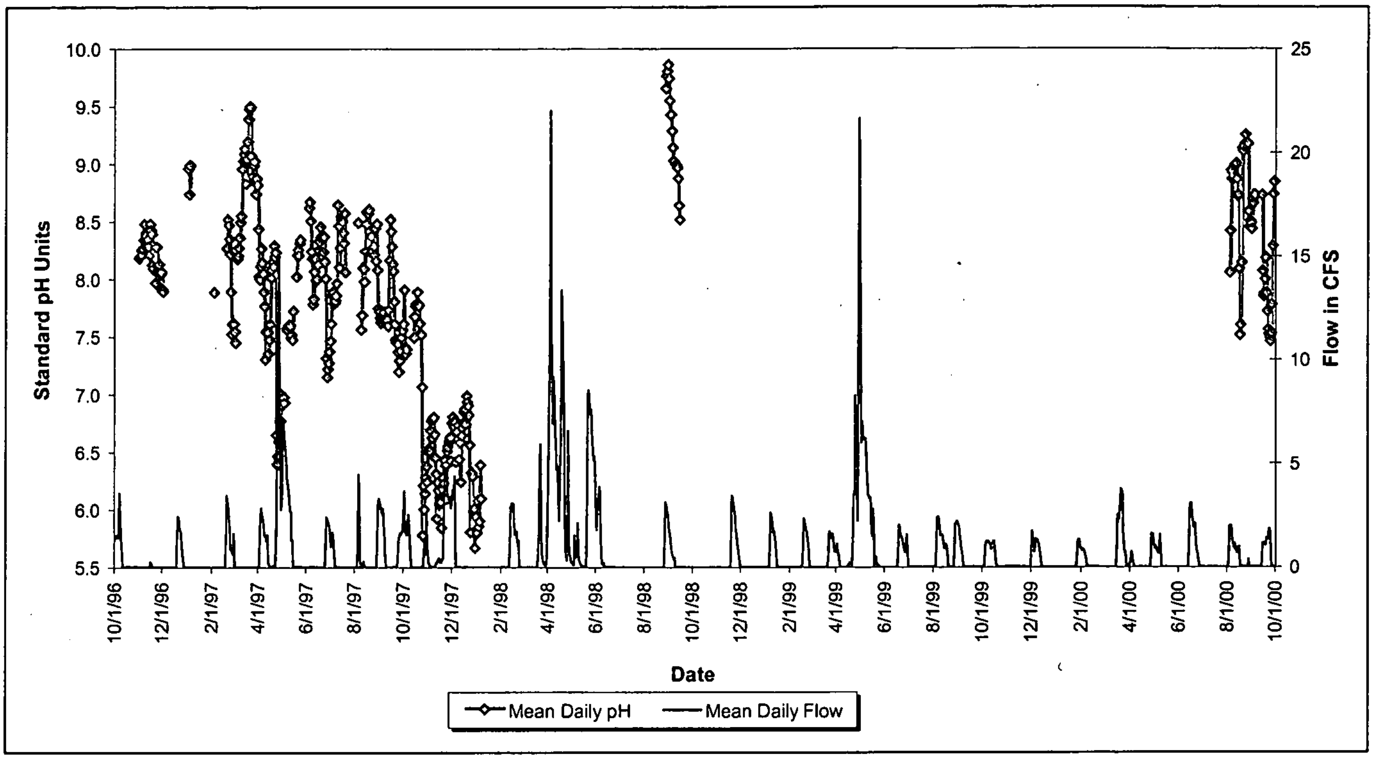

Figure 14-6. Mean Daily pH at GS03: Water Years 1997 – 2000.

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15. BUFFER ZONE HYDROLOGIC MONITORING

Buffer Zone (BZ) hydrologic monitoring is performed to characterize interactions between the various environmental media. Possible interactions are presented in Table 15-1, which represents a conceptual model of integrated monitoring at the Site

As indicated in Table 15-1, there are interactions between surface water, air, groundwater, and the flora and fauna of the Site. Concerns have been expressed that changes in flow into and out of the Site could impact habitat and species of concern both onsite and downstream (e.g., the Prebles meadow jumping mouse onsite, and whooping cranes in Nebraska). For example, aggregate mining activities west of the Site may alter surface water flowing onto the Site and could impact species of concern on Site and downstream. The Department of Energy, Rocky Flats Field Office (DOE, RFFO) could be held responsible for these impacts. Also, Site closure activities (e.g., closure of the Building 995 wastewater treatment plant and modification of the Interceptor Trench System) could significantly alter drainage and flow patterns. In fact, water is one of the key abiotic components structuring some of the significant habitats. Should the availability or quality of water be affected by upgradient off-Site activities or upgradient on-Site activities, significant habitats could be adversely affected.

Table 15-1. Interactions Between Media, Significance at RFETS, and Monitoring to Evaluate Interactions.

Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
Surface Water to Ecology	Potentially significant; surface water flow and contamination could impact local ecology. However, the local ecology has remained healthy during a variety of climatic and flow conditions.	Data from existing Site-wide surface water monitoring may be used to assess potential ecological impacts. The ecological monitoring program is also designed to detect ecological changes and assess general ecological health. In addition, project-specific evaluations are conducted to assess potential impacts.
Surface Water to Groundwater	Not significant; groundwater recharge from surface water is not significant.	No monitoring is necessary to characterize or assess groundwater impacts.
Surface Water to Air	Not significant; surface water quality will not significantly impact air quality (i.e., cause exceedances of air quality standards).	Any significant impacts on air or water quality will be detected by existing DOE, CDPHE, and project-specific monitoring.
Surface Water to Soil	Potentially significant; water in drainages and ponds will not significantly increase contaminant concentrations in soil; however, runoff could spread contaminants on surface soils and increase sediment concentrations.	Soil monitoring is conducted to determine the impacts of surface water runoff and the extent of required soil removal before, during, and after individual remediation projects. Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded.
Groundwater to Surface Water	Significant; most of the Site groundwater flows into Site surface water drainages.	Existing surface water monitoring will detect any impacts from groundwater. Data from Site-wide groundwater monitoring (Site-wide and project-specific) are also used to assess and predict potential surface water impacts.

Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
Air to Surface Water	Potentially significant; point source and fugitive emission sources could degrade surface water quality.	Surface water monitoring (Site-wide and project-specific) will detect increases in contaminant concentrations. Also, any significant impacts on air quality will be detected by existing DOE, CDPHE, and project-specific air monitoring.
Soil to Surface Water	Significant; contaminants in soils are transported to surface water via runoff and surface water quality is degraded.	Site-wide and project-specific surface water monitoring will detect increases in contaminant concentrations. Soil monitoring is also conducted to determine the impacts of runoff and the extent of required soil removal before, during, and after individual remediation projects. Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded.

In consideration of these potential impacts, watershed-level information is collected regarding water availability in the Buffer Zone. Current flow monitoring in the Buffer Zone, in addition to that performed under RFCA, is shown in Table 15-2. The flow data are collected at 15-minute intervals, downloaded, and compiled monthly (presented in Section 3). However, data-quality objectives (DQOs) for this monitoring have not yet been developed, and data evaluation to assess ecological impacts is not included in this report

15.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

BZ hydrologic monitoring will be performed only as represented by GS01, GS02, GS03, GS04, GS05, GS06, GS16, SW118, and SW134 (see Figure 15-1).

Sampling at selected BZ stations is performed by collecting storm-event, rising-limb, flow-paced composites. The recommended monitoring design detailed in the IMP was to take samples for WY97-00 as specified in Table 15-4.

15.2 WY97-00 MONITORING SCOPE

Table 15-2. BZ Hydrologic Monitoring Locations.

ID Code	Location	Primary Flow Measurement Device	Telemetry
GS01	Woman Creek and Indiana St.	9" Parshall Flume	Yes
GS02	Mower Ditch and Indiana St.	9" Parshall Flume	No
GS03	Walnut Creek and Indiana St.	6" and 36" Parallel Parshall Flumes	Yes
GS04	Rock Creek at Rte. 128	9" Parshall Flume	Yes
GS05	North Woman Creek at West Site Boundary	9" Parshall Flume	Yes
GS06	South Woman Creek at West Site Boundary	6" Parshall Flume	Yes
GS16	Antelope Springs	6" Parshall Flume	No
SW118	N. Walnut Creek W of Portal 3	169.5° V-Notch Weir	Yes
SW134	Gravel Pits on Rock Creek Near West Site Boundary	6" Parshall Flume	Yes

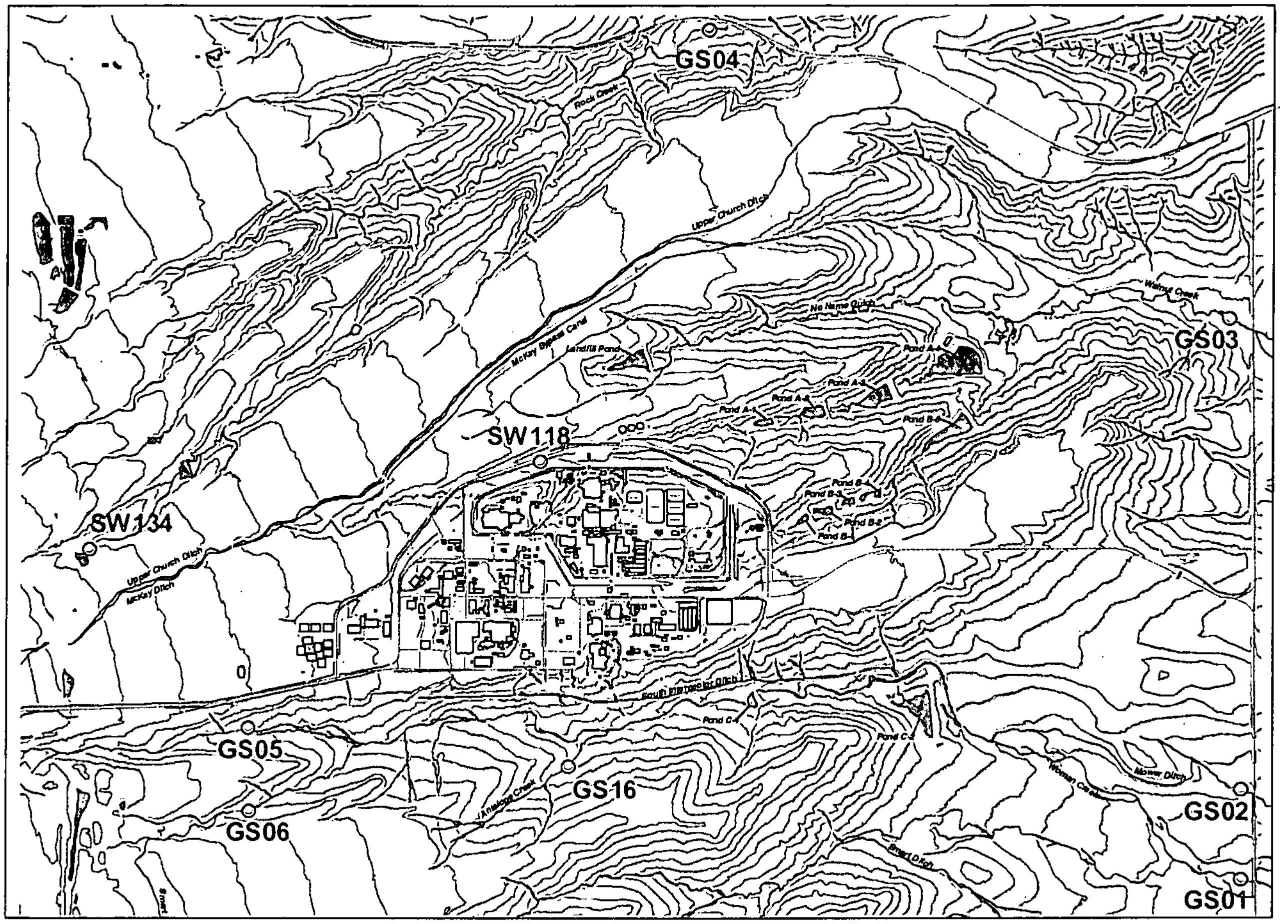

Figure 15-1. Water Year 1997-2000 Buffer Zone Hydrologic Monitoring Locations.

Table 15-3. BZ Hydrologic Field Data Collection: Parameters and Frequency.

ID Code	Parameter	
	Discharge	**Precipitation**
GS01	15-min continuous	15-min continuous
GS02	15-min continuous	NA
GS03	15-min continuous	15-min continuous
GS04	15-min continuous	15-min continuous
GS05	15-min continuous	15-min continuous
GS06	15-min continuous	NA
GS16	15-min continuous	NA
SW118	15-min continuous	15-min continuous
SW134	15-min continuous	NA

All locations collect 5- and 15-minute flow data.

Table 15-4. BZ Hydrologic Sample Collection Protocols.

ID Code	Frequency	Type[a]
GS01	Quarterly with an additional TSS in spring	Storm-event, flow-paced composites
GS02	Quarterly with an additional TSS in spring	Storm-event, flow-paced composites
GS03	Quarterly with an additional TSS in spring	Storm-event, flow-paced composites
GS04	Quarterly with an additional TSS in spring	Storm-event, flow-paced composites
GS05	Quarterly with an additional TSS in spring	Storm-event, flow-paced composites
GS06	Quarterly with an additional TSS in spring	Storm-event, flow-paced composites
GS16	NA	NA
SW118	NA	NA
SW134	Quarterly	Storm-event, flow-paced composites

Notes: [a] Sample types are defined in The Automated Surface-Water Monitoring Work Plan.

Table 15-5. BZ Hydrologic Analytical Targets (Analyses per Year).

ID Code	TSS	Sed/Sand	Ca,Mg,Na,K,Cl,F,SO_4,HCO_3
GS01	5	4	4
GS02	5	4	4
GS03	5	4	4
GS04	5	4	4
GS05	5	4	4
GS06	5	4	4
SW134	4	4	4

15.3 DATA EVALUATION

Although no routine data evaluations are required, the following preliminary decision rules have been proposed by the IMP:

IF The seasonal average or yearly average water availability or quality entering Rock Creek, Walnut Creek, or Woman Creek drainages diminishes below baseline due to off-Site activities,

THEN The Site will notify Jefferson County and the U.S. Fish and Wildlife Service (USFWS) to determine what actions, if any, should be taken to restore availability and/or quality to historical levels.

IF Activities occurring within Site boundaries result in a depletion of the seasonal or yearly average natural flow greater than the historic baseline, or at rates that are determined to have a negative impact on downstream habitats or individual species,

THEN The Site will determine what management actions should be taken to ameliorate this problem.

IF Significant changes to alluvial groundwater availability in a wetlands habitat are determined,

THEN Notify parties of potential impacts to the wetlands habitat and continue groundwater and ecological monitoring.

IF A proposed action could adversely affect a listed species or its critical habitat,

THEN The Site will consult with the USFWS.

Secondary Data Uses Could Include:

- Determining the impact of mining on Rock Creek water quality and availability;
- Interpreting potential causes of declines in any of the valued habitats on Site;
- Supporting water management planning;
- Evaluating cumulative impacts of all actions (on and off Site);
- Validating any predicted impacts of the selected alternative to downstream resources; and
- Supporting the Site's biological assessment and USFWS's biological opinion.

Flow summaries for the BZ locations are given in Section 3: Hydrologic Data. More detailed hydrologic data are given in Appendix A.1: Hydrologic Data.

The following sections present the Buffer Zone Hydrologic data on a location-specific basis. Each section includes a table of summary statistics for the location-specific analytes of interest and box-whisker plots.

The following evaluations include all results that were not rejected through the verification/validation process. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' value and the 'duplicate'. When a sample has multiple 'real' analyses (Site requested 're-runs'), the value used in calculations is the arithmetic average of the multiple 'real' analyses.

For the summary tables, when metals and TSS results are returned from the laboratory as 'undetect', ½ of the detection limit is used for calculation purposes.

Box-whisker plots were calculated using S-Plus statistical evaluation software. For these plots, when metals and TSS results are returned from the laboratory as 'undetect', ½ of the detection limit is used for calculation purposes. A key describing the components of the box-whisker plots is given in Appendix B.1: Data Evaluation Methods.

No discussion of the BZ Hydro data is provided below. The tables and box plots are intended to summarize the collected data.

15.3.1 Location GS01

Monitoring location GS01 is located on Woman Cr. at Indiana Street. Figure 3-8 shows the drainage area for GS01. Table 15-6 presents the analyte-specific summary statistics for BZ samples collected at GS01. Figure 15-2 through Figure 15-7 show the analyte-specific box plots for BZ samples collected at GS01. The southern portion of the IA and Pond C-2 contribute flow to GS01.

Table 15-6. BZ Summary Statistics for Analytical Results from GS01 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median	85th Percentile	Maximum
TSS [mg/L]	14	43%	3.75	25.1	85.0
CHLORIDE [mg/L]	14	0%	40.7	49.9	82.0
FLUORIDE [mg/L]	14	0%	0.40	0.50	0.69
SULFATE [mg/L]	14	0%	37.0	54.1	100
TOTAL ALKALINITY [mg/L]	14	0%	170	189	230
TDS [mg/L]	13	0%	330	416	510
ALUMINUM [µg/L]	14	0%	96.6	1460	5010
ANTIMONY [µg/L]	14	64%	0.41	1.68	11.2
ARSENIC [µg/L]	14	50%	0.89	1.96	2.65
BARIUM [µg/L]	14	0%	100	113	158
BERYLLIUM [µg/L]	14	71%	0.17	0.28	0.75
CADMIUM [µg/L]	14	79%	0.05	0.24	2.50
CALCIUM [µg/L]	14	0%	53050	65340	80600
CHROMIUM [µg/L]	14	36%	0.51	2.46	4.60
COBALT [µg/L]	14	71%	0.27	0.89	2.65
COPPER [µg/L]	14	29%	1.28	4.71	5.80
IRON [µg/L]	14	7%	142	1050	3570
LEAD [µg/L]	14	50%	0.84	2.71	3.10
LITHIUM [µg/L]	12	0%	11.7	15.3	38.5
MAGNESIUM [µg/L]	14	0%	13650	18283	23300
MANGANESE [µg/L]	14	7%	8.60	21.7	56.4
MERCURY [µg/L]	14	100%	0.05	0.05	0.10
MOLYBDENUM [µg/L]	12	25%	0.98	3.17	6.45
NICKEL [µg/L]	14	29%	1.45	4.03	6.60
POTASSIUM [µg/L]	14	0%	2450	4204	7700
SELENIUM [µg/L]	14	64%	0.95	2.41	6.30
SILVER [µg/L]	14	93%	0.12	0.44	1.35
SODIUM [µg/L]	14	0%	33000	50058	64400
STRONTIUM [µg/L]	12	0%	367	430	565
THALLIUM [µg/L]	14	86%	0.45	1.02	7.80
TIN [µg/L]	12	92%	0.36	3.44	7.60
VANADIUM [µg/L]	14	21%	1.50	4.30	10.6
ZINC [µg/L]	14	7%	8.85	13.6	26.7

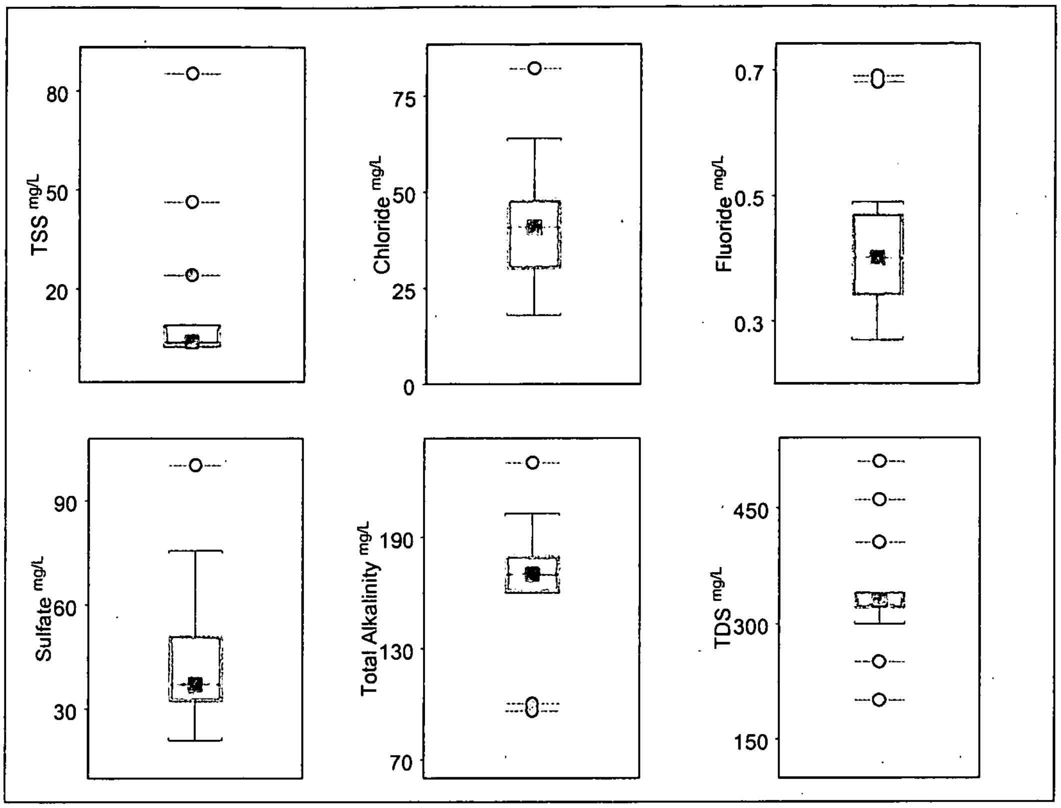

Figure 15-2. Water-Quality Parameter Box Plots for Location GS01.

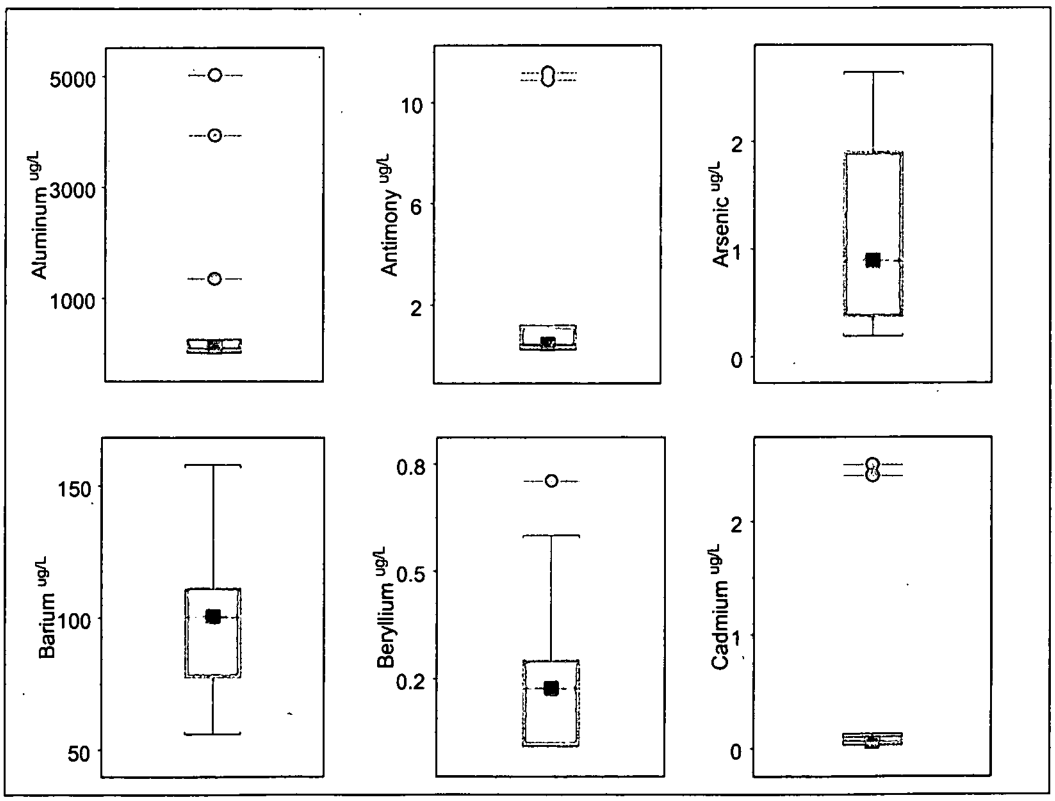

Figure 15-3. Total Metals Box Plots for Location GS01: Aluminum through Cadmium.

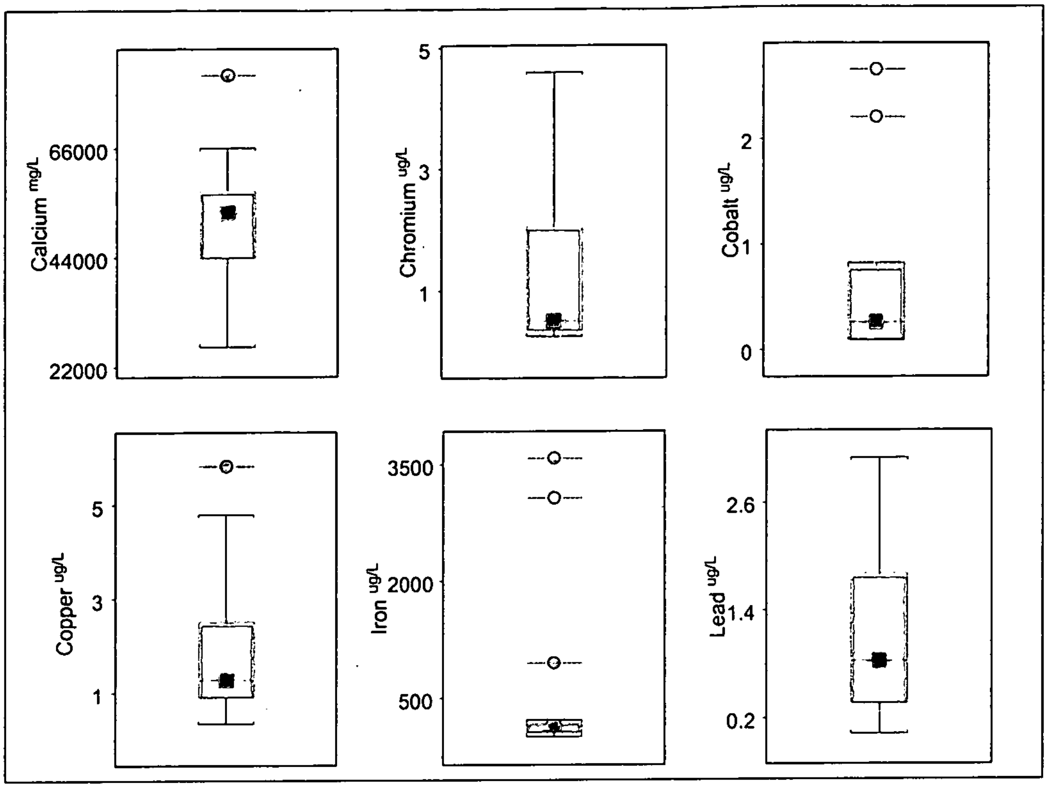

Figure 15-4. Total Metals Box Plots for Location GS01: Calcium through Lead.

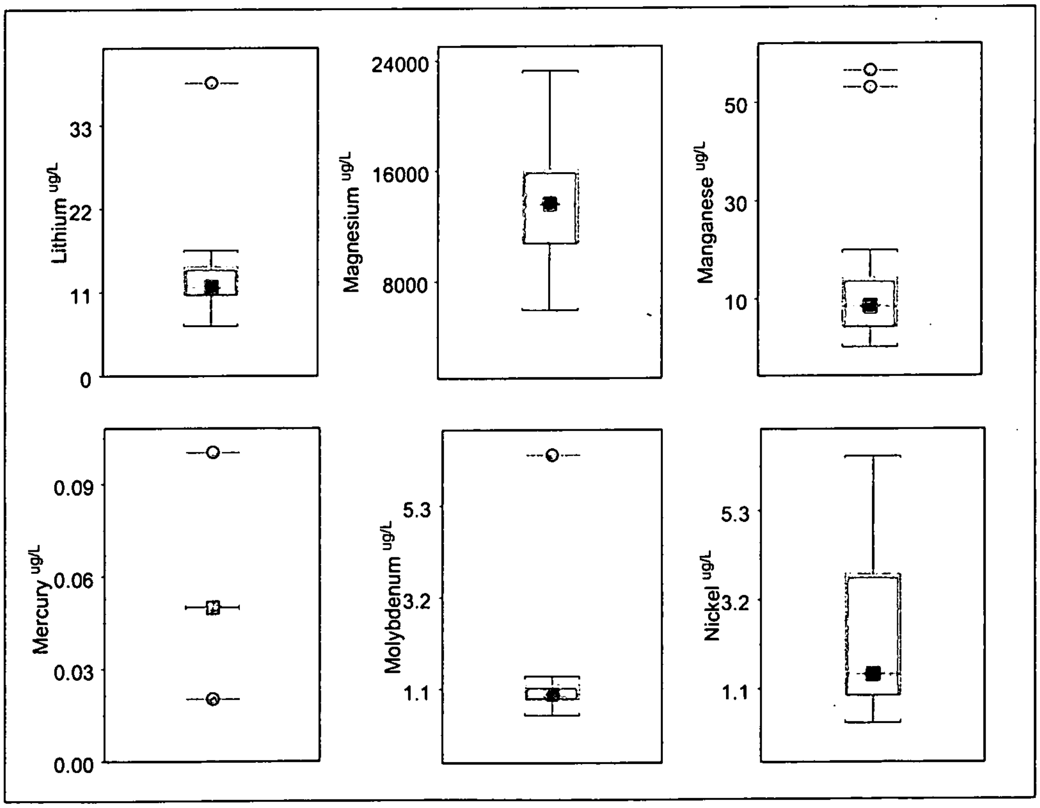

Figure 15-5. Total Metals Box Plots for Location GS01: Lithium through Nickel.

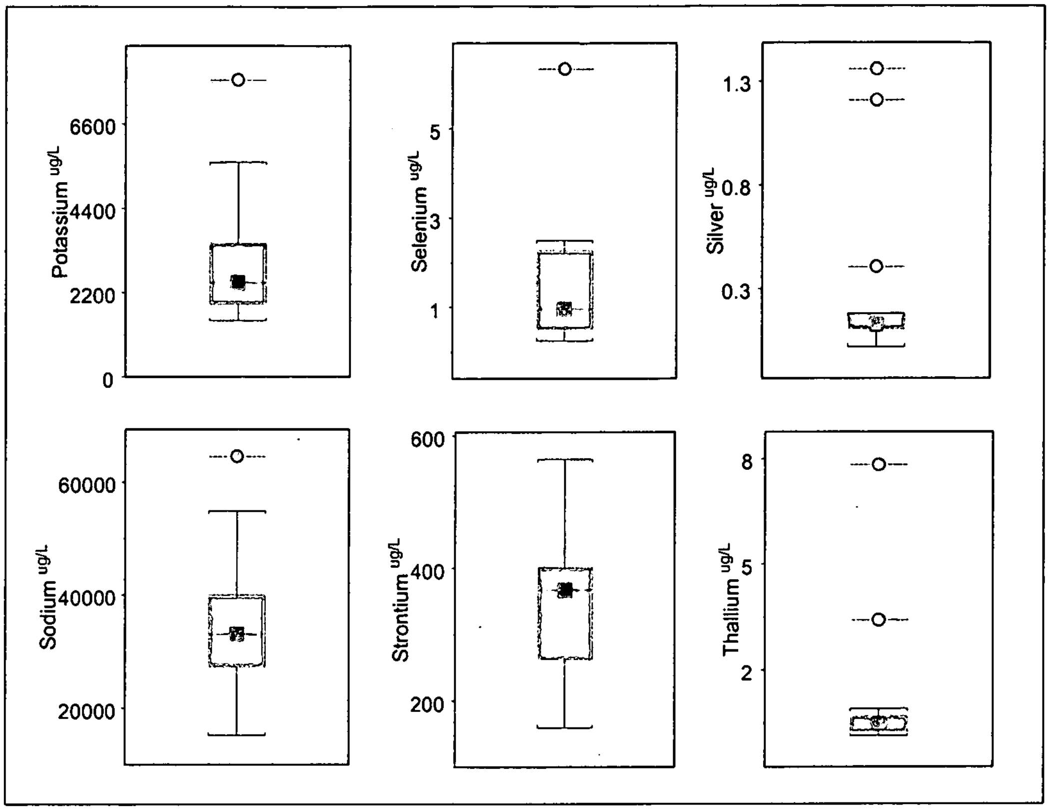

Figure 15-6. Total Metals Box Plots for Location GS01: Potassium through Thallium.

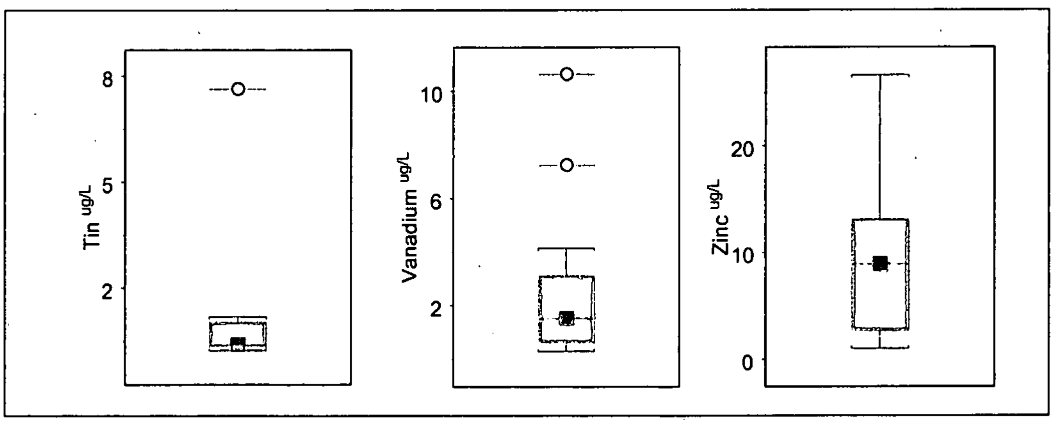

Figure 15-7. Total Metals Box Plots for Location GS01: Tin through Zinc.

15.3.2 Location GS02

Monitoring location GS02 is located on Mower Ditch at Indiana Street. Table 15-7 presents the analyte-specific summary statistics for BZ samples collected at GS02. Figure 15-8 through Figure 15-13 show the analyte-specific box plots for BZ samples collected at GS02. Figure 3-10 shows the drainage area for GS01. The splitter box at Woman Creek is normally configured so no Woman Cr. water enters Mower Ditch..

Table 15-7. BZ Summary Statistics for Analytical Results from GS02 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median	85th Percentile	Maximum
TSS [mg/L]	5	0%	5.00	9.40	16.0
CHLORIDE [mg/L]	5	0%	44.0	62.3	86.0
FLUORIDE [mg/L]	5	0%	0.39	0.43	0.47
SULFATE [mg/L]	5	0%	28.7	74.8	140
TOTAL ALKALINITY [mg/L]	5	0%	153	170	170
TDS [mg/L]	5	0%	300	445	660
ALUMINUM [µg/L]	5	0%	330	656	837
ANTIMONY [µg/L]	5	100%	0.43	10.9	10.9
ARSENIC [µg/L]	5	60%	1.50	1.95	1.95
BARIUM [µg/L]	5	0%	89.8	122	151
BERYLLIUM [µg/L]	4	75%	0.58	0.75	0.75
CADMIUM [µg/L]	5	60%	0.10	2.50	2.50
CALCIUM [µg/L]	5	0%	54500	61980	66900
CHROMIUM [µg/L]	5	60%	1.90	2.40	2.40
COBALT [µg/L]	5	100%	0.45	2.65	2.65
COPPER [µg/L]	5	60%	1.10	1.22	1.40
IRON [µg/L]	5	0%	223	433	569
LEAD [µg/L]	5	60%	1.50	1.94	2.60
LITHIUM [µg/L]	3	0%	14.3	18.9	20.8
MAGNESIUM [µg/L]	5	0%	11500	14320	16000
MANGANESE [µg/L]	5	40%	3.30	6.86	7.40
MERCURY [µg/L]	5	100%	0.05	0.10	0.10
MOLYBDENUM [µg/L]	3	33%	1.10	4.85	6.45
NICKEL [µg/L]	5	60%	2.10	6.60	6.60
POTASSIUM [µg/L]	5	0%	3410	5594	8270
SELENIUM [µg/L]	5	40%	1.40	1.85	1.85
SILVER [µg/L]	5	40%	0.32	1.97	2.90
SODIUM [µg/L]	5	0%	30800	41100	56100
STRONTIUM [µg/L]	3	0%	337	410	441
THALLIUM [µg/L]	5	100%	0.23	2.25	2.25
TIN [µg/L]	3	100%	1.05	5.64	7.60
VANADIUM [µg/L]	5	20%	2.80	3.58	4.00
ZINC [µg/L]	5	40%	4.50	7.66	10.9

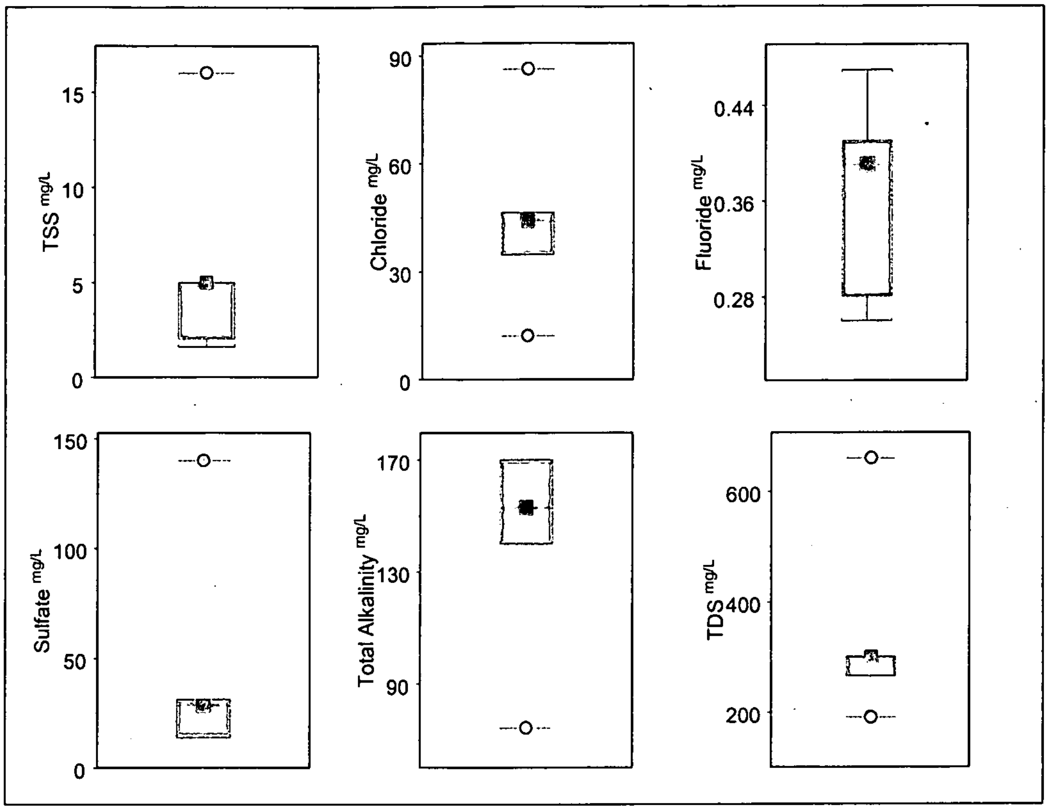

Figure 15-8. Water-Quality Parameter Box Plots for Location GS02.

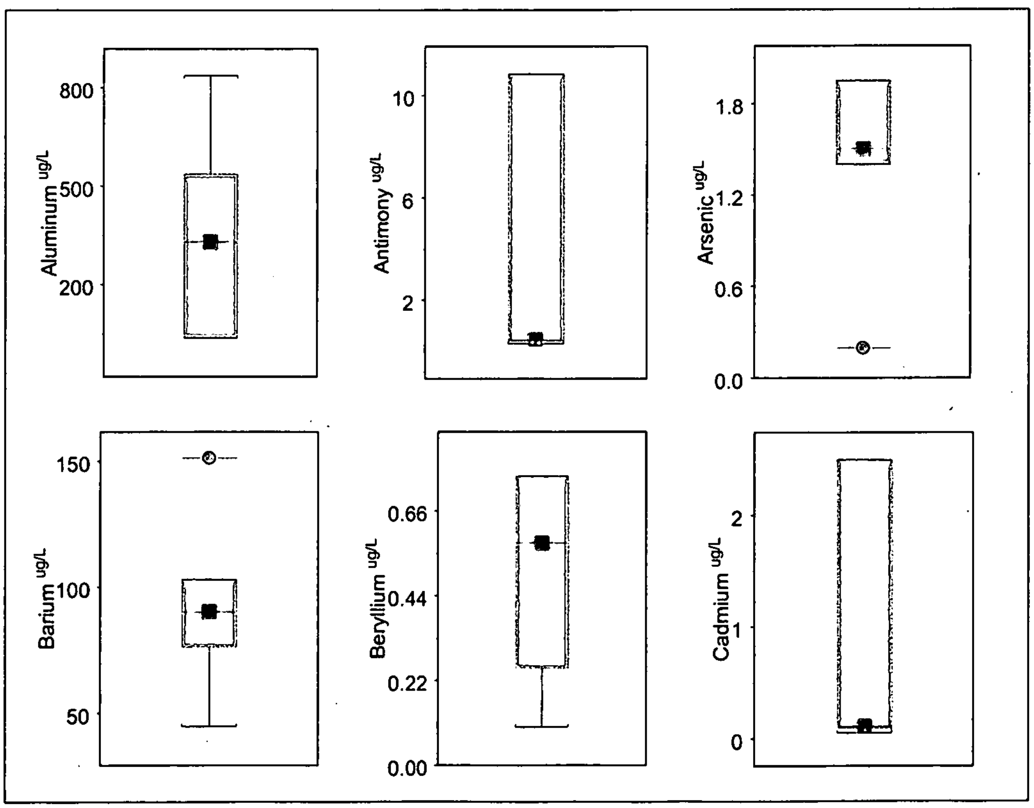

Figure 15-9. Total Metals Box Plots for Location GS02: Aluminum through Cadmium.

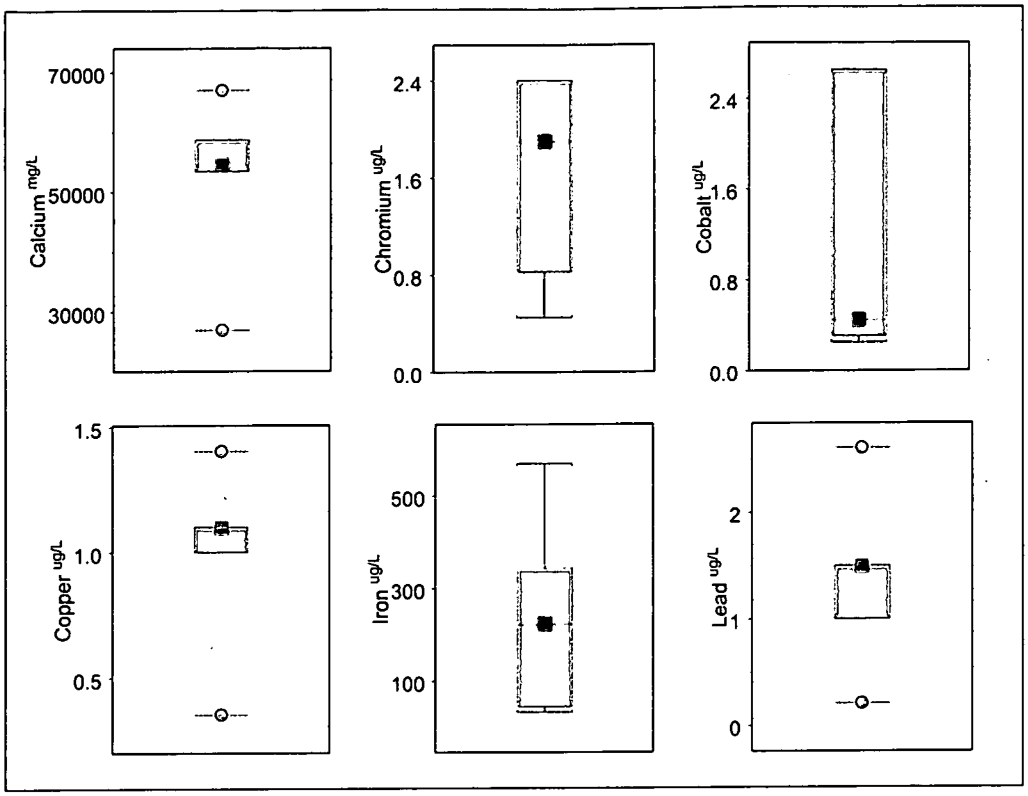

Figure 15-10. Total Metals Box Plots for Location GS02: Calcium through Lead.

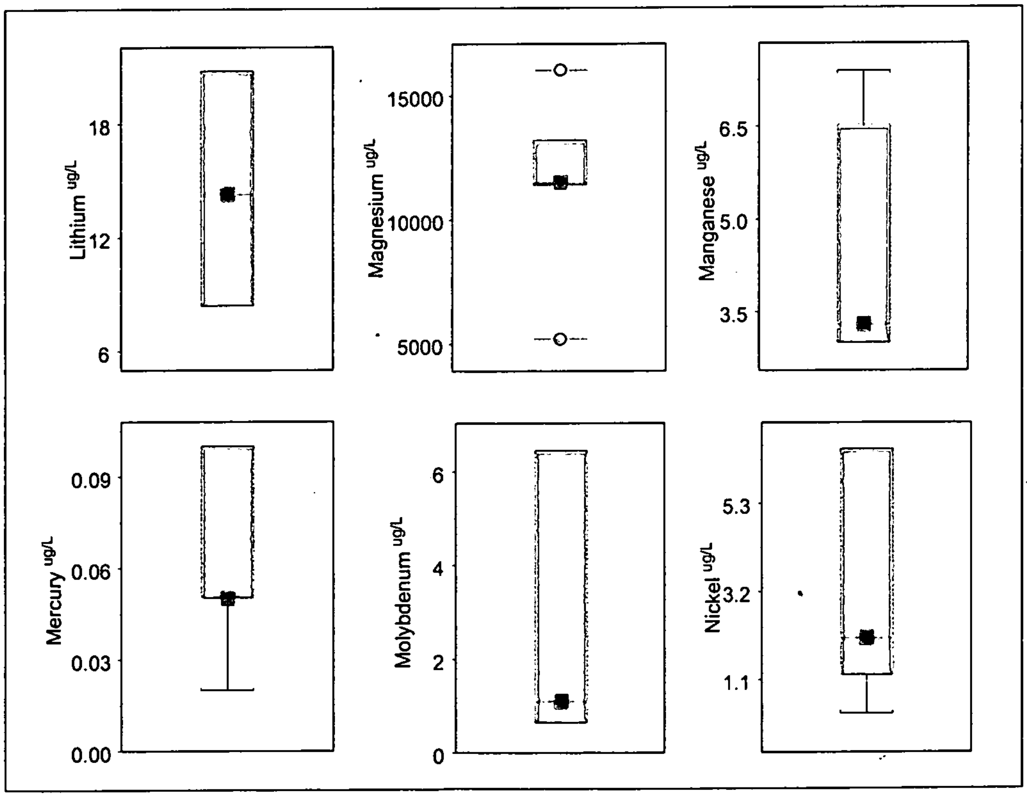

Figure 15-11. Total Metals Box Plots for Location GS02: Lithium through Nickel.

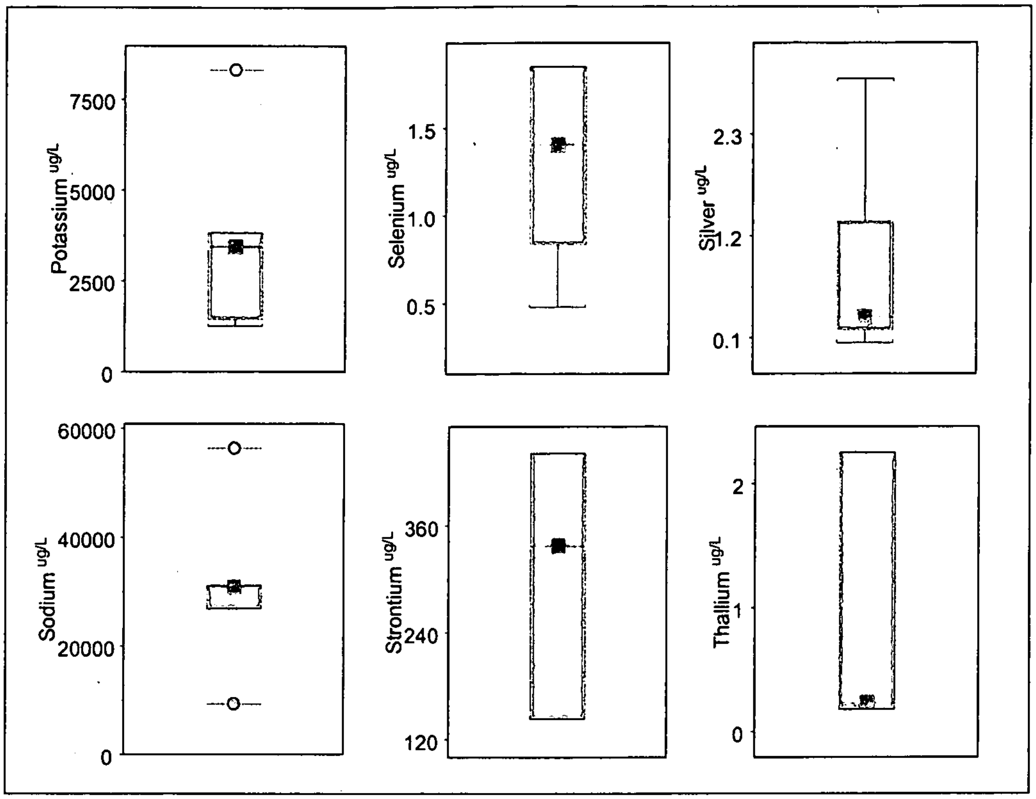

Figure 15-12. Total Metals Box Plots for Location GS02: Potassium through Thallium.

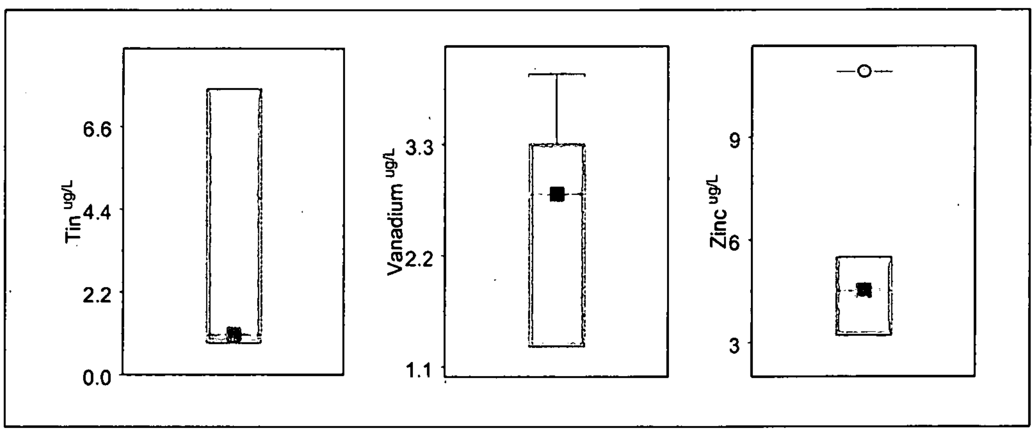

Figure 15-13. Total Metals Box Plots for Location GS02: Tin through Zinc.

15.3.3 Location GS03

Monitoring location GS03 is located on Walnut Cr. at Indiana Street. Table 15-8 presents the analyte-specific summary statistics for BZ samples collected at GS03. Figure 15-14 through Figure 15-19 show the analyte-specific box plots for BZ samples collected at GS03. Figure 3-12 shows the drainage area for GS03. The majority of the IA, Pond A-4, and Pond B-5 contribute flow to GS03.

Table 15-8. BZ Summary Statistics for Analytical Results from GS03 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median	85th Percentile	Maximum
TSS [mg/L]	11	0%	25.0	46.0	61.0
CHLORIDE [mg/L]	10	0%	80.0	99.0	240
FLUORIDE [mg/L]	10	0%	0.39	0.44	0.64
SULFATE [mg/L]	10	0%	41.0	63.3	67.0
TOTAL ALKALINITY [mg/L]	9	0%	150	180	200
TDS [mg/L]	10	0%	399	450	680
ALUMINUM [μg/L]	10	0%	514	1371	1890
ANTIMONY [μg/L]	10	40%	0.86	1.59	11.2
ARSENIC [μg/L]	10	10%	1.40	3.19	8.50
BARIUM [μg/L]	10	0%	79.4	94.8	97.7
BERYLLIUM [μg/L]	10	60%	0.10	0.18	0.60
CADMIUM [μg/L]	10	70%	0.05	0.14	2.40
CALCIUM [μg/L]	10	0%	45150	58845	73100
CHROMIUM [μg/L]	10	10%	0.98	2.03	2.10
COBALT [μg/L]	10	40%	0.89	2.00	2.20
COPPER [μg/L]	10	40%	1.85	2.99	4.60
IRON [μg/L]	10	0%	647	1007	1950
LEAD [μg/L]	10	20%	1.60	2.50	3.50
LITHIUM [μg/L]	9	0%	25.5	27.8	31.3
MAGNESIUM [μg/L]	10	0%	11550	14975	16000
MANGANESE [μg/L]	10	0%	86.1	393	526
MERCURY [μg/L]	10	100%	0.05	0.05	0.10
MOLYBDENUM [μg/L]	9	11%	3.60	7.05	8.60
NICKEL [μg/L]	10	20%	2.80	4.25	6.45
POTASSIUM [μg/L]	10	0%	6245	7475	9250
SELENIUM [μg/L]	10	80%	0.51	1.12	2.25
SILVER [μg/L]	10	70%	0.18	0.31	2.80
SODIUM [μg/L]	10	0%	42750	63630	125000
STRONTIUM [μg/L]	9	0%	289	366	444
THALLIUM [μg/L]	10	100%	0.45	0.81	2.60
TIN [μg/L]	9	100%	0.85	1.17	7.60
VANADIUM [μg/L]	10	0%	2.80	7.50	7.70
ZINC [μg/L]	10	0%	8.70	11.8	15.5

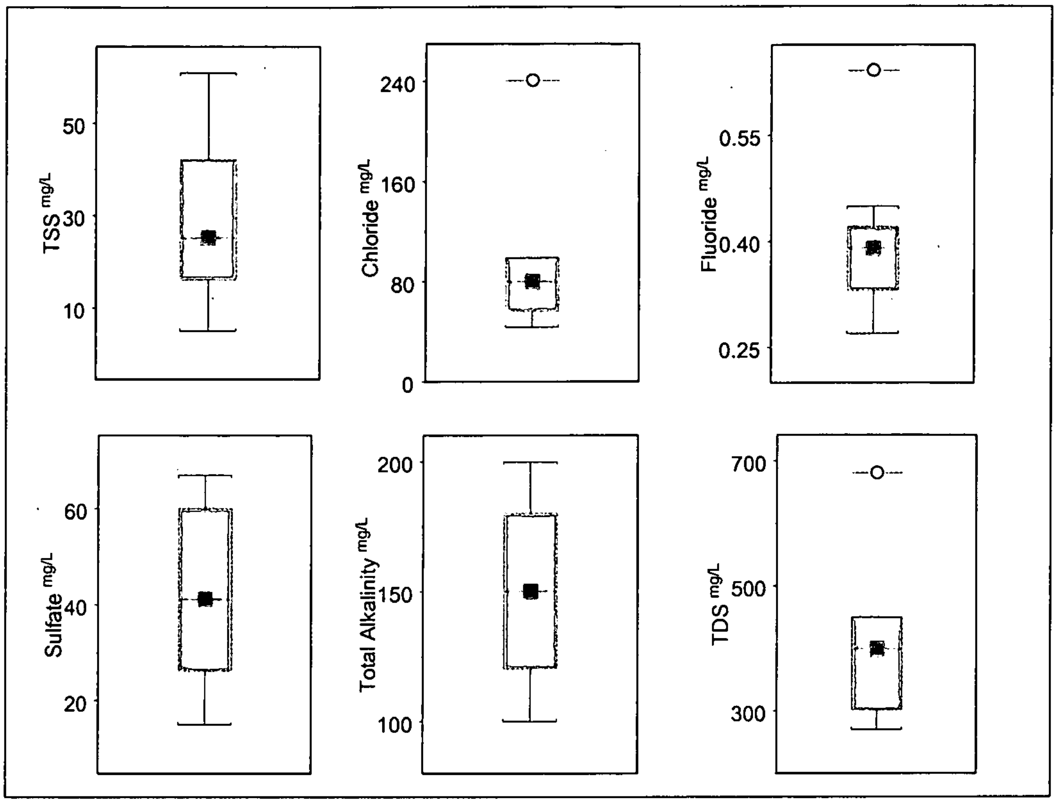

Figure 15-14. Water-Quality Parameter Box Plots for Location GS03.

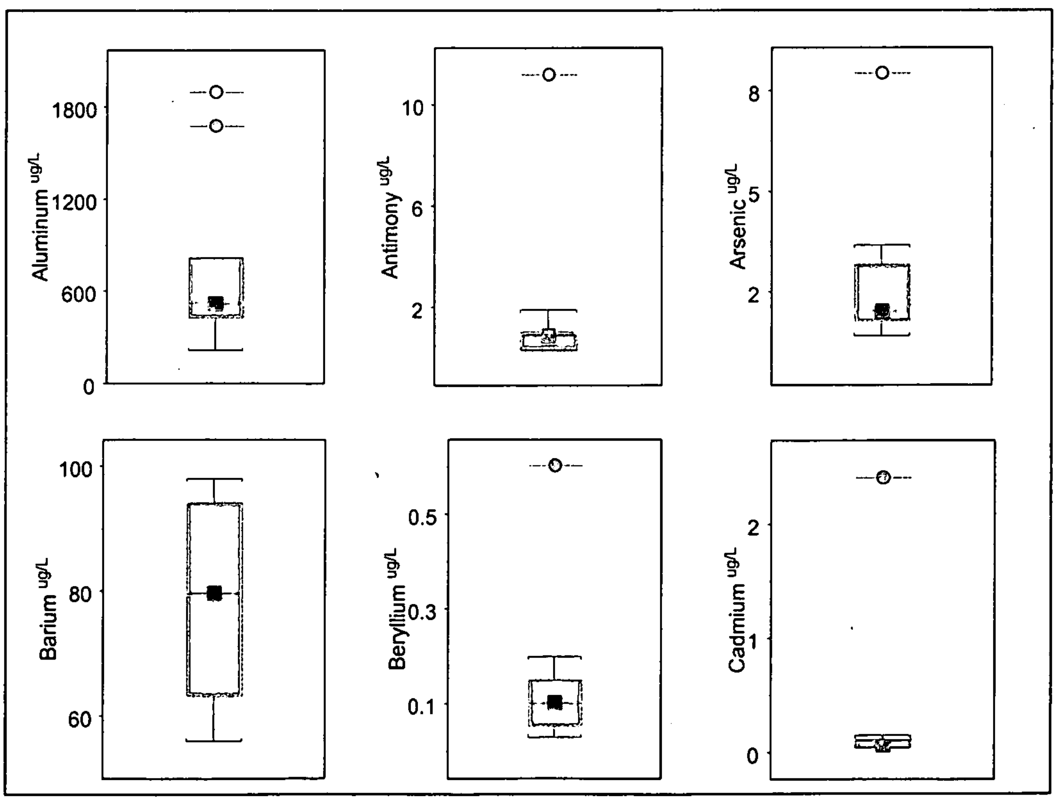

Figure 15-15. Total Metals Box Plots for Location GS03: Aluminum through Cadmium.

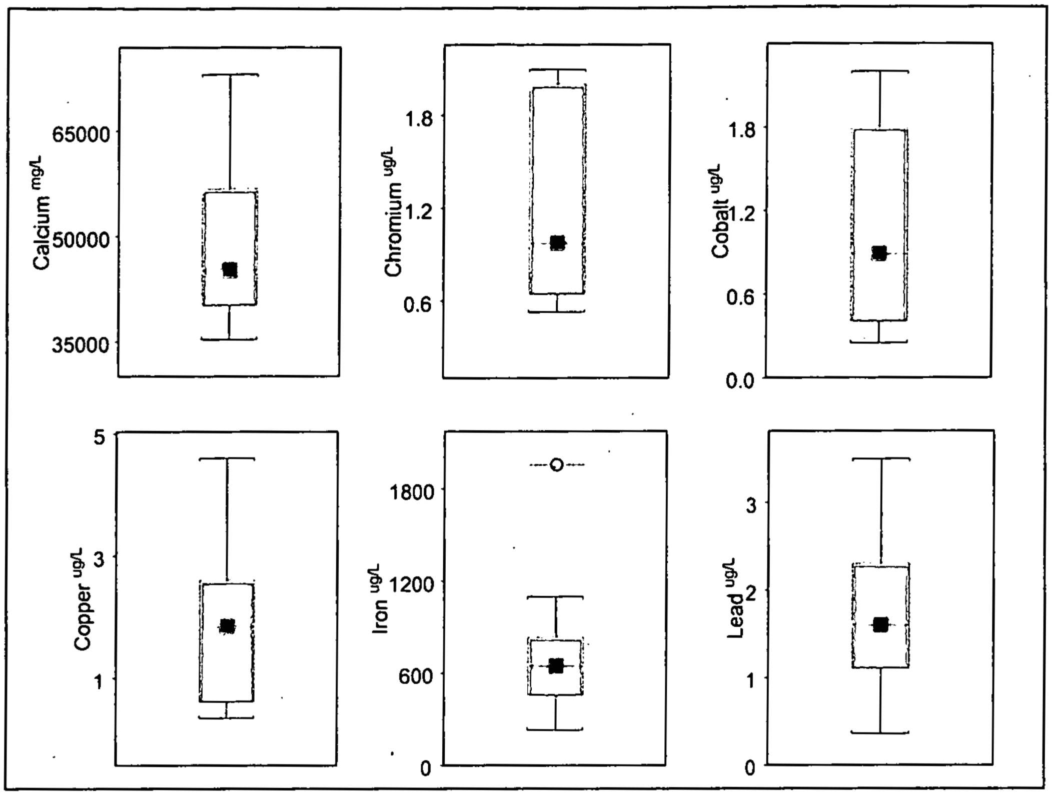

Figure 15-16. Total Metals Box Plots for Location GS03: Calcium through Lead.

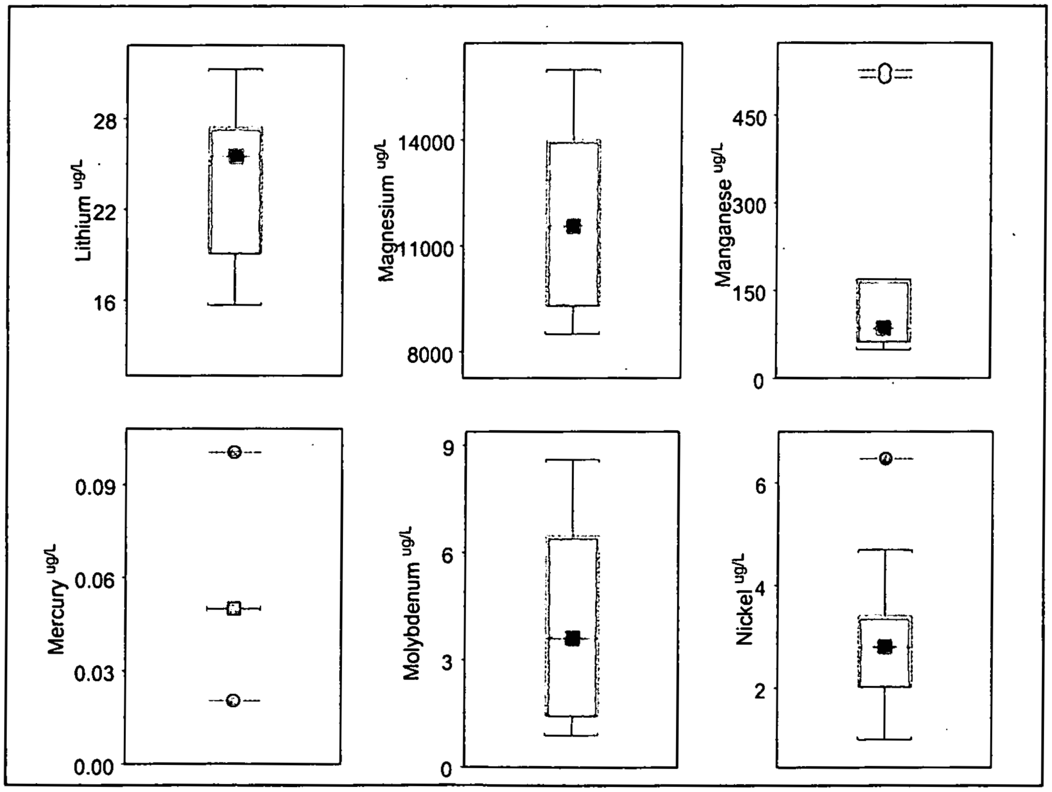

Figure 15-17. Total Metals Box Plots for Location GS03: Lithium through Nickel.

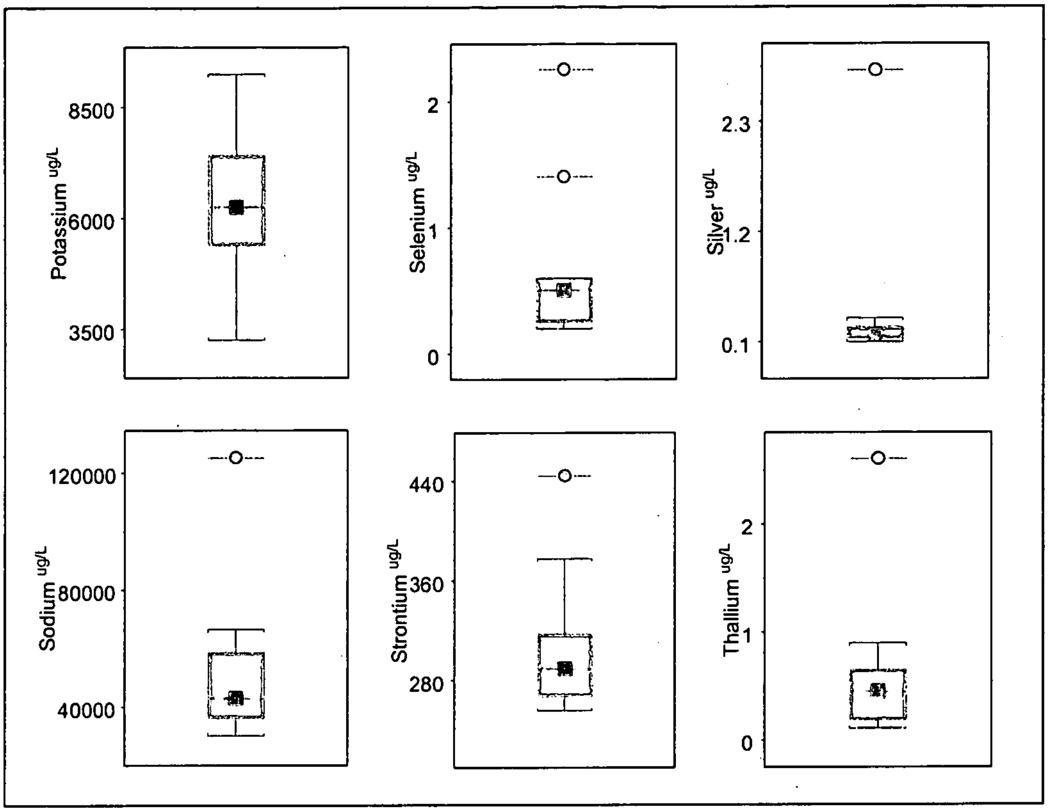

Figure 15-18. Total Metals Box Plots for Location GS03: Potassium through Thallium.

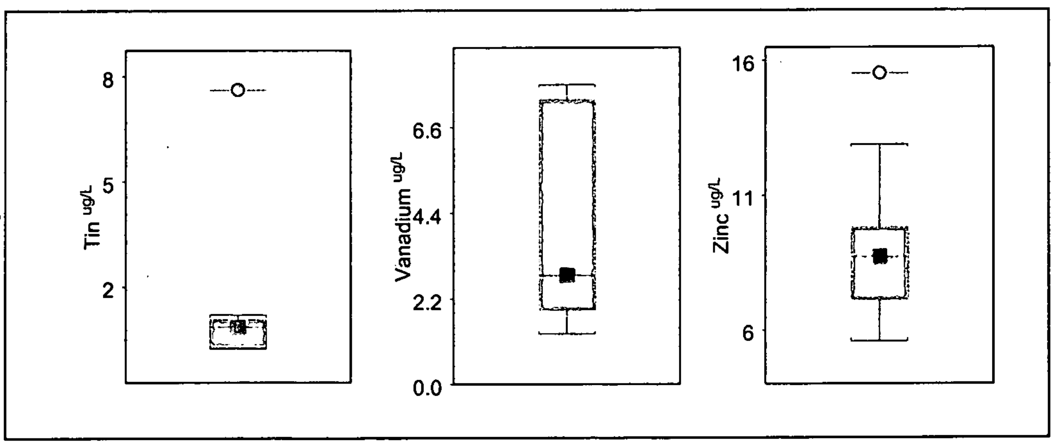

Figure 15-19. Total Metals Box Plots for Location GS03: Tin through Zinc.

15.3.4 Location GS04

Monitoring location GS04 is located on Rock Cr. at Route 128. Table 15-9 presents the analyte-specific summary statistics for BZ samples collected at GS04. Figure 15-20 through Figure 15-25 show the analyte-specific box plots for BZ samples collected at GS04. Figure 3-14 shows the drainage area for GS04.

Table 15-9. BZ Summary Statistics for Analytical Results from GS04 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median	85th Percentile	Maximum
TSS [mg/L]	14	43%	7.20	42.8	210.0
CHLORIDE [mg/L]	14	0%	13.5	20.0	21.0
FLUORIDE [mg/L]	14	0%	0.36	0.39	0.52
SULFATE [mg/L]	14	0%	31.1	38.1	40.0
TOTAL ALKALINITY [mg/L]	11	0%	120	140	170
TDS [mg/L]	14	0%	240	271	290
ALUMINUM [µg/L]	14	0%	227	3502	5560
ANTIMONY [µg/L]	14	64%	0.65	10.9	11.2
ARSENIC [µg/L]	14	50%	1.70	2.65	3.90
BARIUM [µg/L]	14	0%	82.8	105	132
BERYLLIUM [µg/L]	14	50%	0.10	0.61	0.75
CADMIUM [µg/L]	14	79%	0.06	2.41	2.50
CALCIUM [µg/L]	14	0%	35800	45255	48100
CHROMIUM [µg/L]	14	43%	2.23	4.25	6.10
COBALT [µg/L]	14	57%	0.52	2.65	3.20
COPPER [µg/L]	14	36%	2.15	4.40	5.60
IRON [µg/L]	14	0%	265	2578	6410
LEAD [µg/L]	14	36%	1.65	2.13	7.30
LITHIUM [µg/L]	10	0%	12.5	14.2	113
MAGNESIUM [µg/L]	14	0%	8195	10130	10800
MANGANESE [µg/L]	14	14%	15.0	38.5	103
MERCURY [µg/L]	14	100%	0.05	0.10	0.10
MOLYBDENUM [µg/L]	10	40%	0.70	1.53	6.45
NICKEL [µg/L]	14	36%	3.10	6.46	6.60
POTASSIUM [µg/L]	14	0%	1985	3261	7800
SELENIUM [µg/L]	14	71%	0.60	2.25	3.10
SILVER [µg/L]	14	71%	0.19	1.21	1.35
SODIUM [µg/L]	14	0%	20050	28135	29400
STRONTIUM [µg/L]	10	0%	194	270	294
THALLIUM [µg/L]	14	79%	0.44	2.73	8.00
TIN [µg/L]	10	90%	0.63	2.18	7.60
VANADIUM [µg/L]	14	36%	2.50	7.20	15.5
ZINC [µg/L]	14	14%	7.85	14.2	30.7

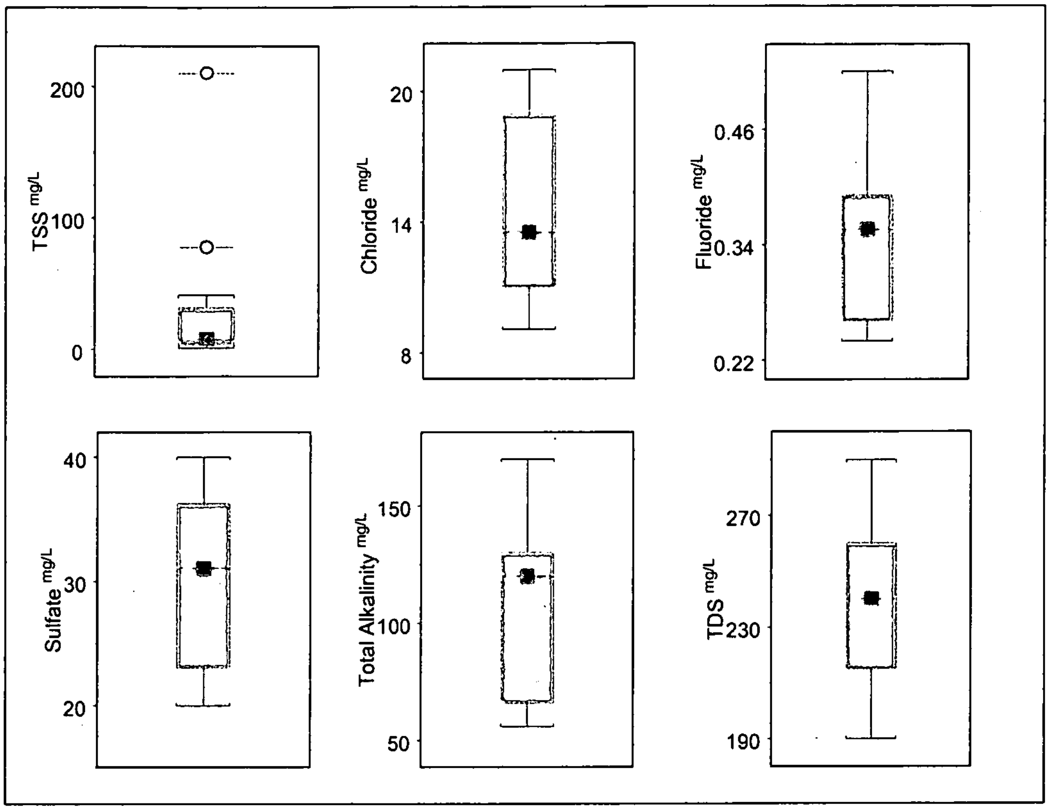

Figure 15-20. Water-Quality Parameter Box Plots for Location GS04.

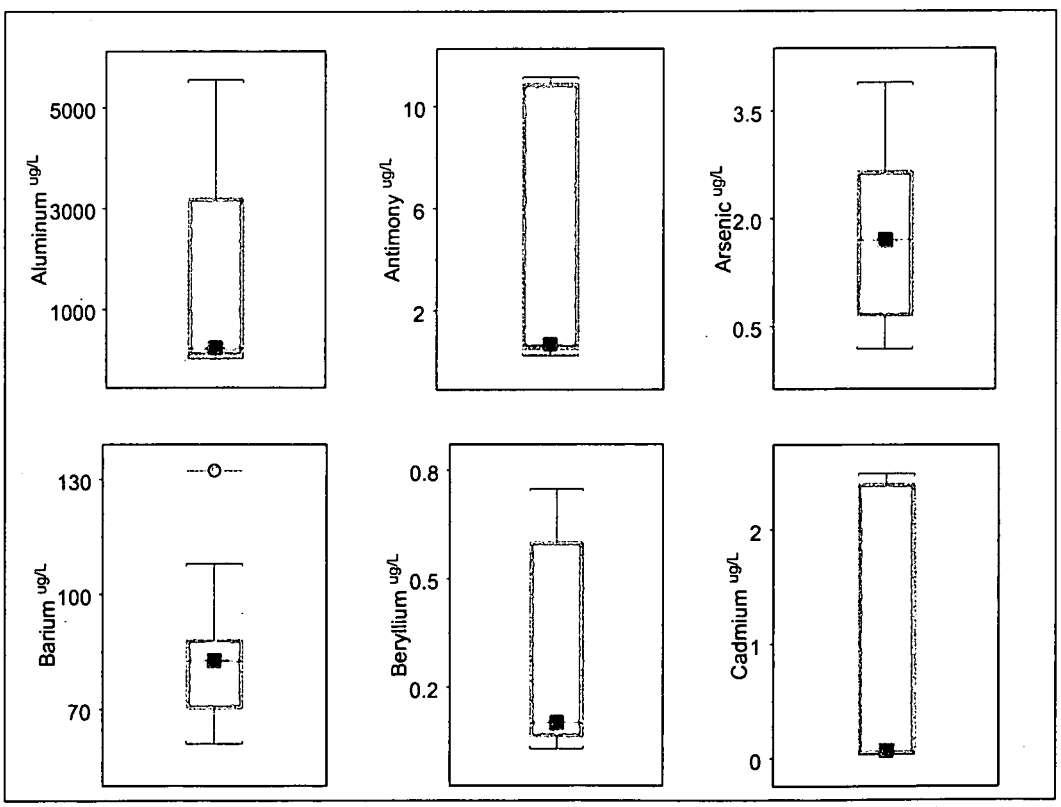

Figure 15-21. Total Metals Box Plots for Location GS04: Aluminum through Cadmium.

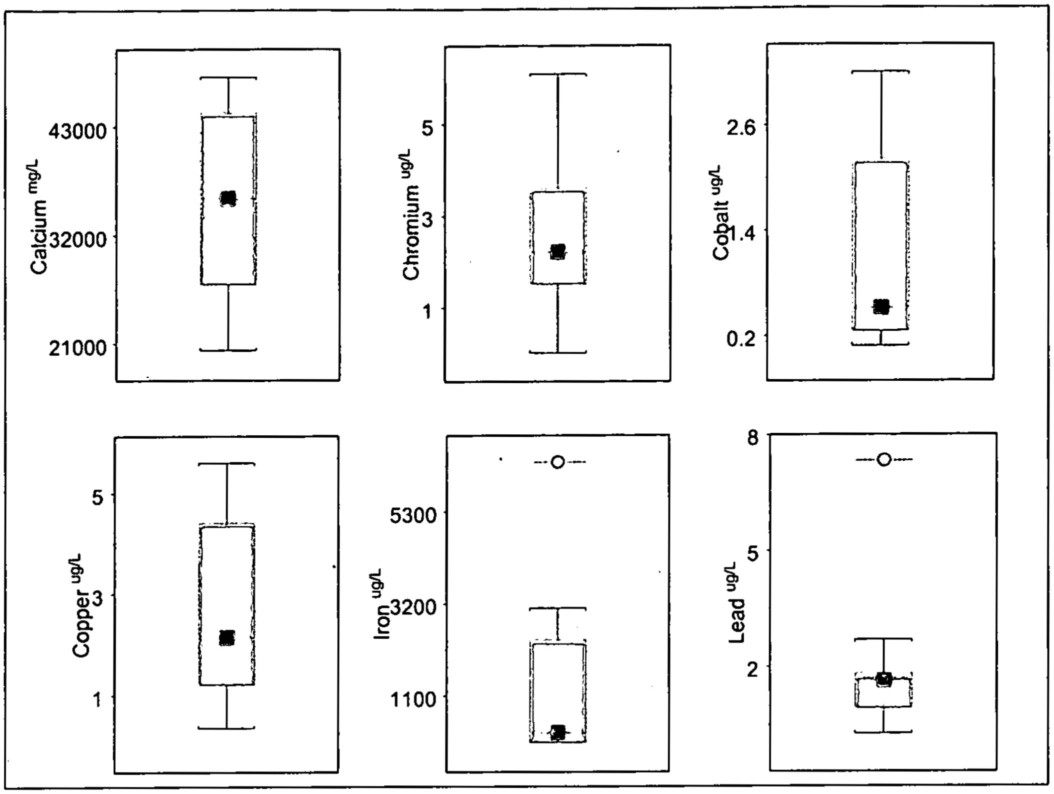

Figure 15-22. Total Metals Box Plots for Location GS04: Calcium through Lead.

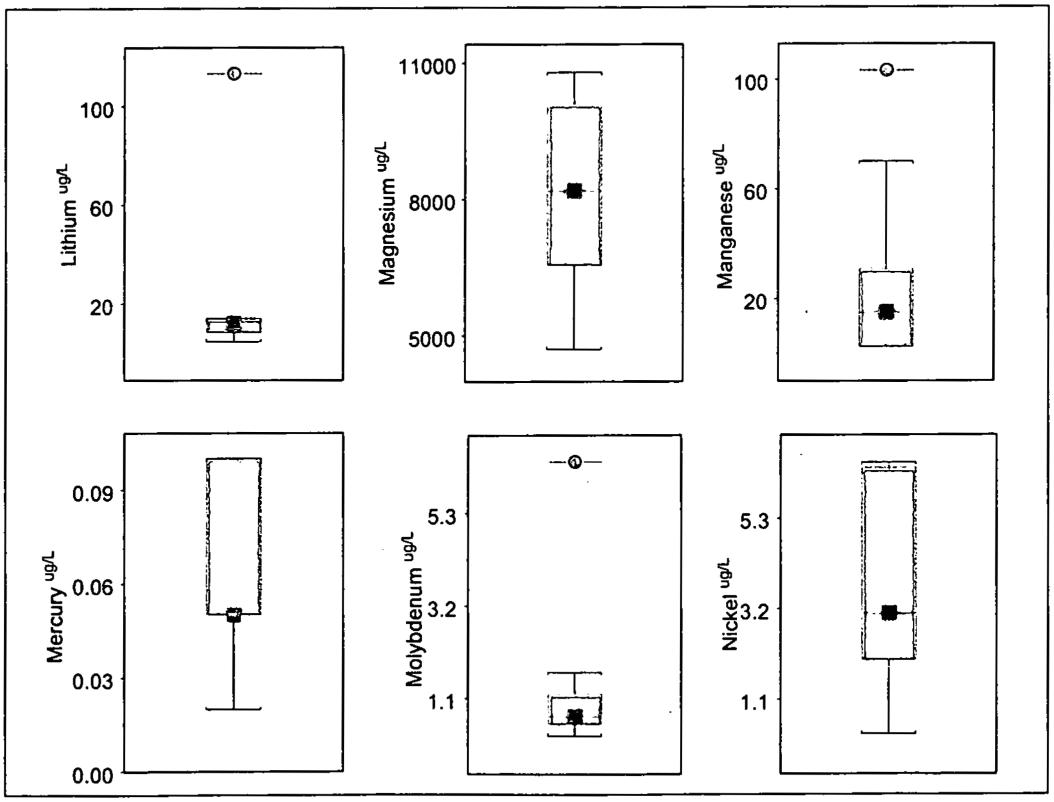

Figure 15-23. Total Metals Box Plots for Location GS04: Lithium through Nickel.

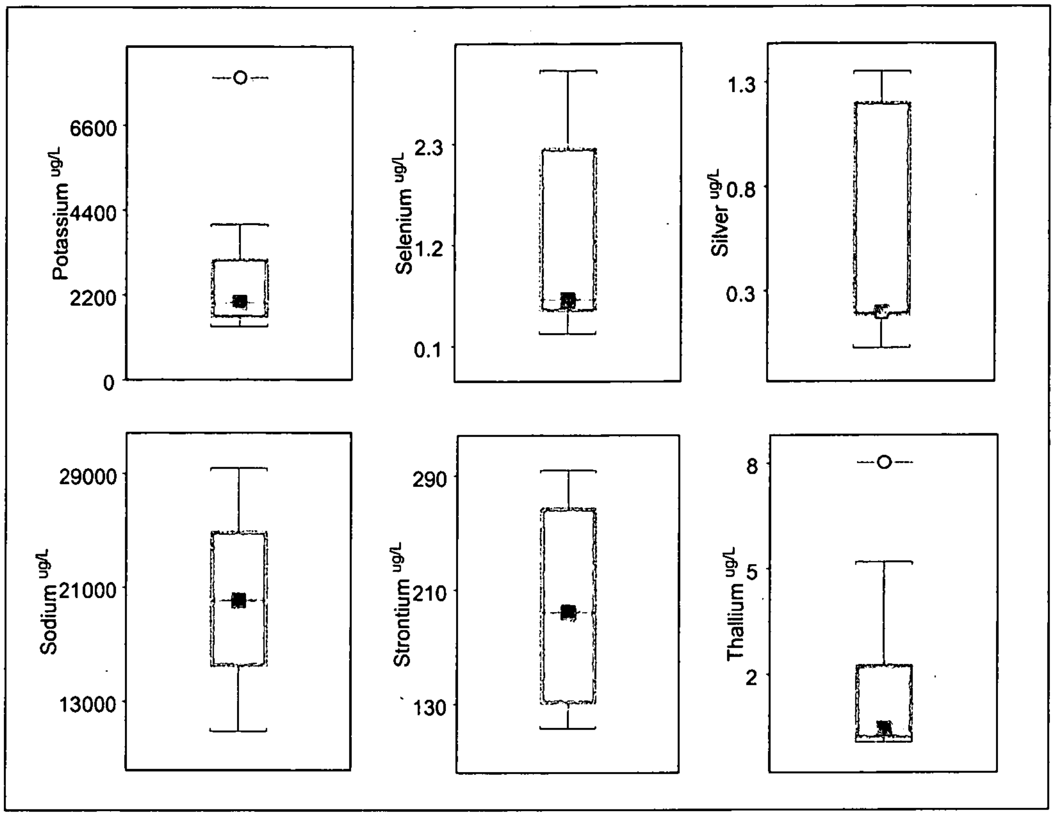

Figure 15-24. Total Metals Box Plots for Location GS04: Potassium through Thallium.

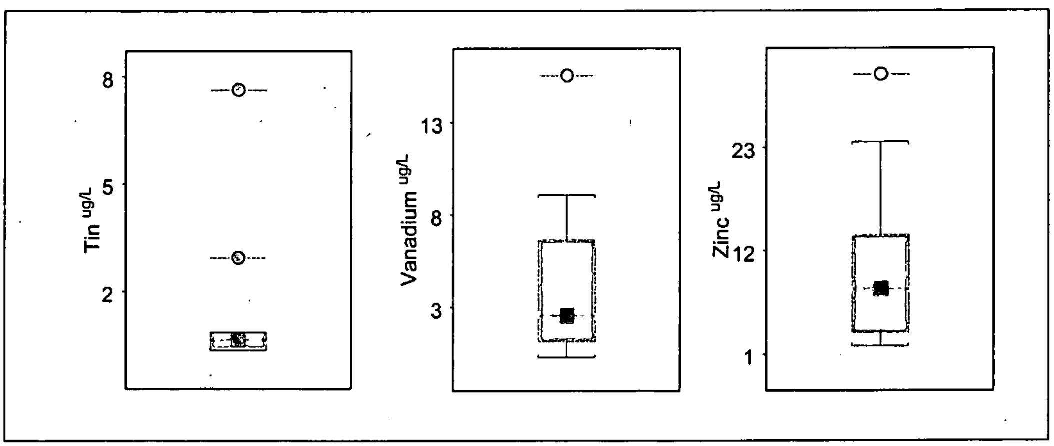

Figure 15-25. Total Metals Box Plots for Location GS04: Tin through Zinc.

15.3.5 Location GS05

Monitoring location GS05 is located on Woman Cr. at the west Site fenceline. Table 15-10 presents the analyte-specific summary statistics for BZ samples collected at GS05. Figure 15-26 through Figure 15-31 show the analyte-specific box plots for BZ samples collected at GS05. Figure 3-16 shows the drainage area for GS05.

Table 15-10. BZ Summary Statistics for Analytical Results from GS05 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median	85th Percentile	Maximum
TSS [mg/L]	19	0%	106.0	2010	7900
CHLORIDE [mg/L]	19	0%	19.0	42.8	170
FLUORIDE [mg/L]	19	5%	0.20	0.28	0.37
SULFATE [mg/L]	19	0%	8.00	22.3	28.1
TOTAL ALKALINITY [mg/L]	18	0%	67.0	85.5	95.0
TDS [mg/L]	19	0%	230	442	690
ALUMINUM [µg/L]	19	0%	2840	102370	296000
ANTIMONY [µg/L]	18	56%	0.72	10.9	11.2
ARSENIC [µg/L]	19	26%	2.65	33.9	90.8
BARIUM [µg/L]	19	0%	101	457	1210
BERYLLIUM [µg/L]	18	33%	0.75	6.76	17.9
CADMIUM [µg/L]	19	58%	0.20	2.43	2.50
CALCIUM [µg/L]	19	0%	26400	39390	45000
CHROMIUM [µg/L]	19	16%	2.60	79.0	215
COBALT [µg/L]	19	21%	2.65	18.8	51.0
COPPER [µg/L]	19	16%	4.00	46.3	128
IRON [µg/L]	19	0%	2570	80590	228000
LEAD [µg/L]	19	21%	3.00	40.8	137
LITHIUM [µg/L]	15	0%	11.5	60.5	138
MAGNESIUM [µg/L]	19	0%	8500	13450	29400
MANGANESE [µg/L]	19	0%	171	1040	1480
MERCURY [µg/L]	19	68%	0.05	0.21	1.20
MOLYBDENUM [µg/L]	15	7%	1.00	2.27	6.45
NICKEL [µg/L]	19	21%	6.60	63.6	167
POTASSIUM [µg/L]	19	0%	2230	12670	23900
SELENIUM [µg/L]	19	53%	0.77	3.87	18.4
SILVER [µg/L]	19	63%	0.18	1.35	7.00
SODIUM [µg/L]	19	0%	16200	23740	62600
STRONTIUM [µg/L]	15	0%	169	304	315
THALLIUM [µg/L]	18	78%	0.65	2.60	2.60
TIN [µg/L]	15	53%	0.85	6.34	22.6
VANADIUM [µg/L]	19	11%	5.80	182	484
ZINC [µg/L]	19	5%	28.6	122	335

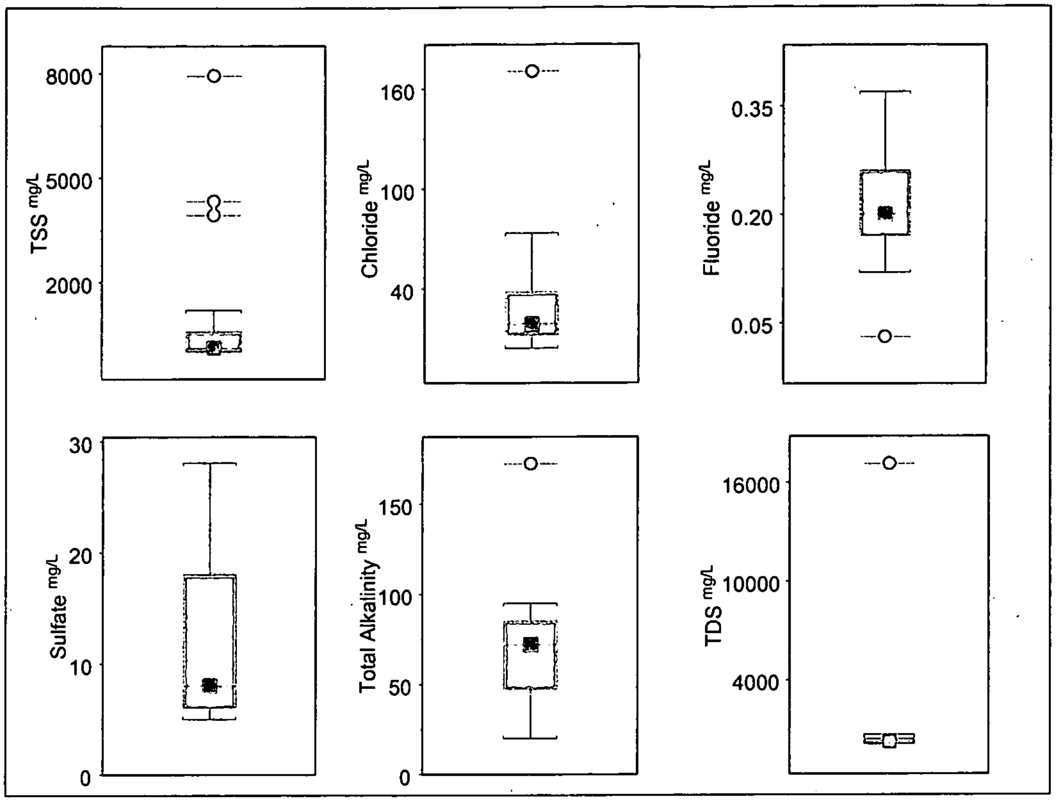

Figure 15-26. Water-Quality Parameter Box Plots for Location GS05.

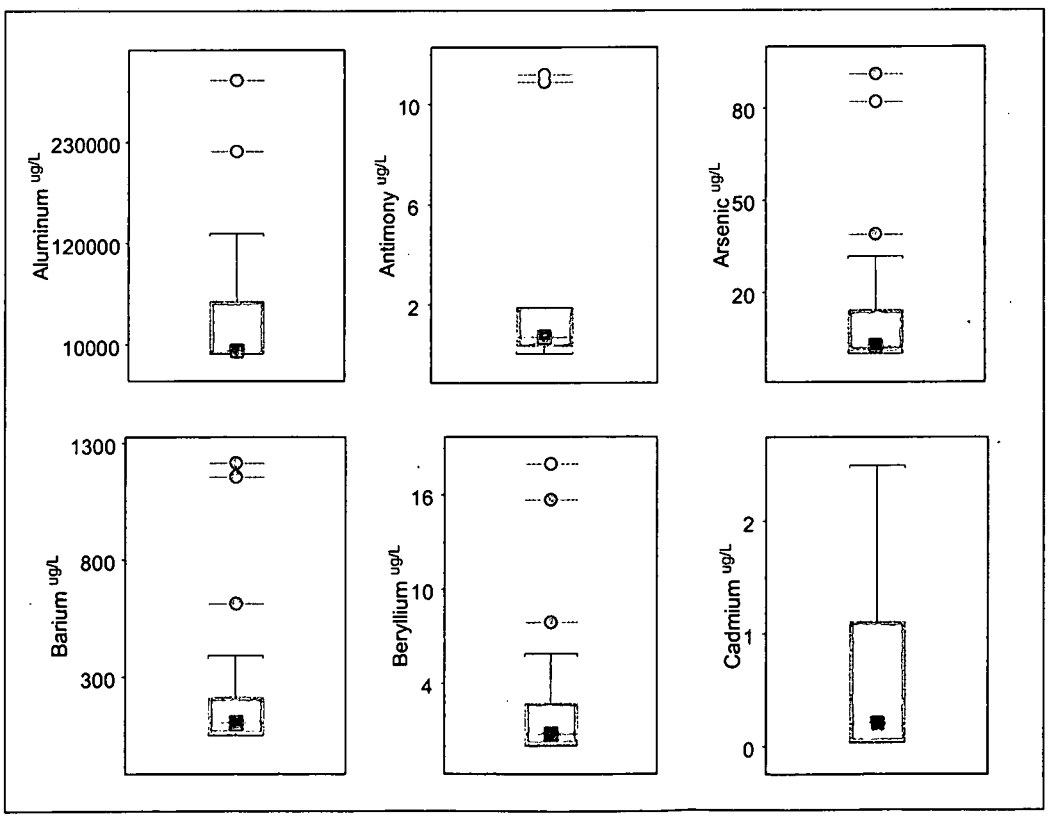

Figure 15-27. Total Metals Box Plots for Location GS05: Aluminum through Cadmium.

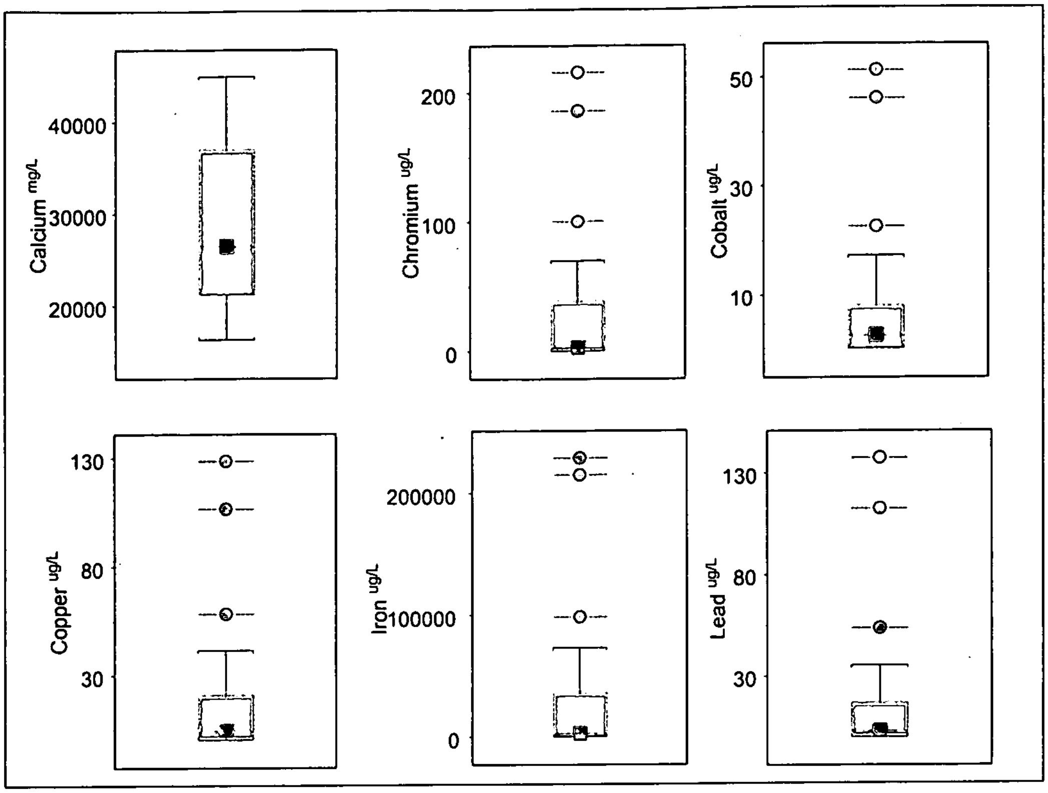

Figure 15-28. Total Metals Box Plots for Location GS05: Calcium through Lead.

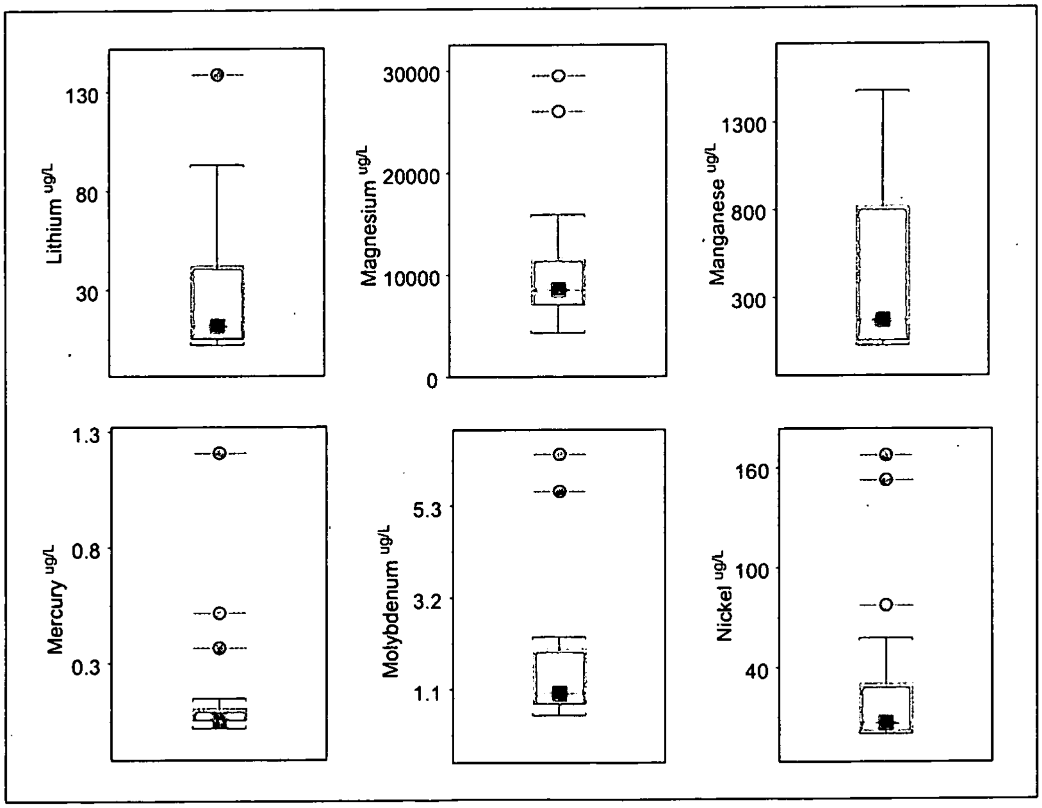

Figure 15-29. Total Metals Box Plots for Location GS05: Lithium through Nickel.

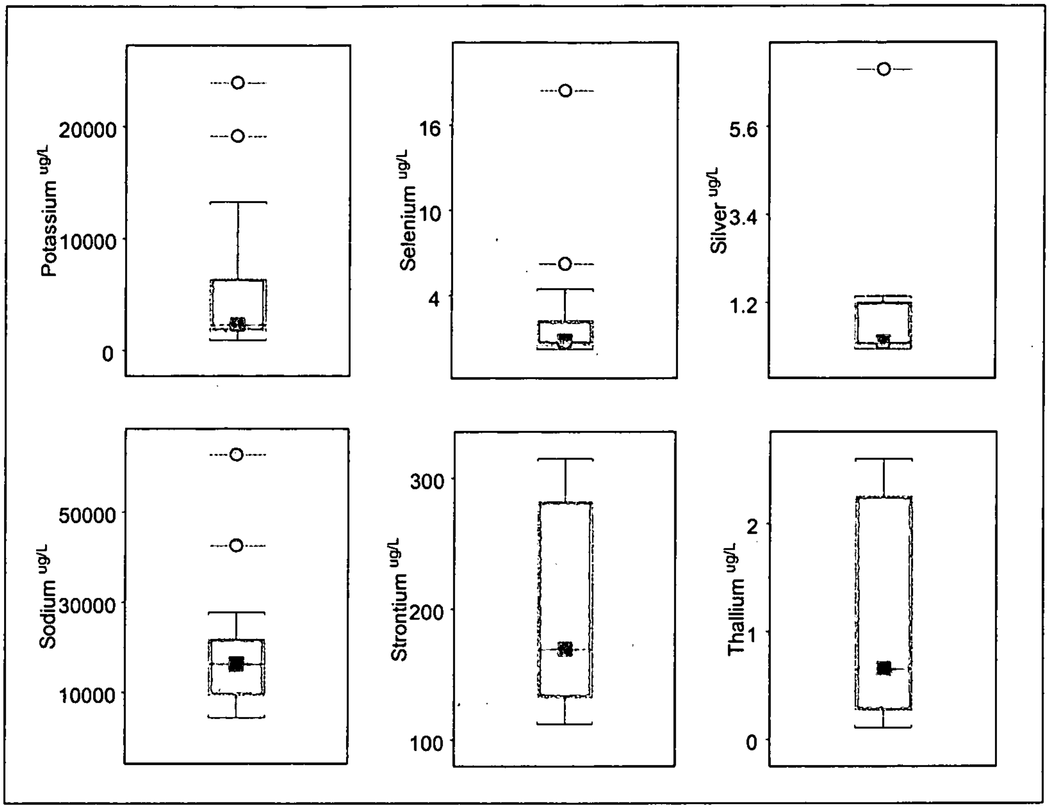

Figure 15-30. Total Metals Box Plots for Location GS05: Potassium through Thallium.

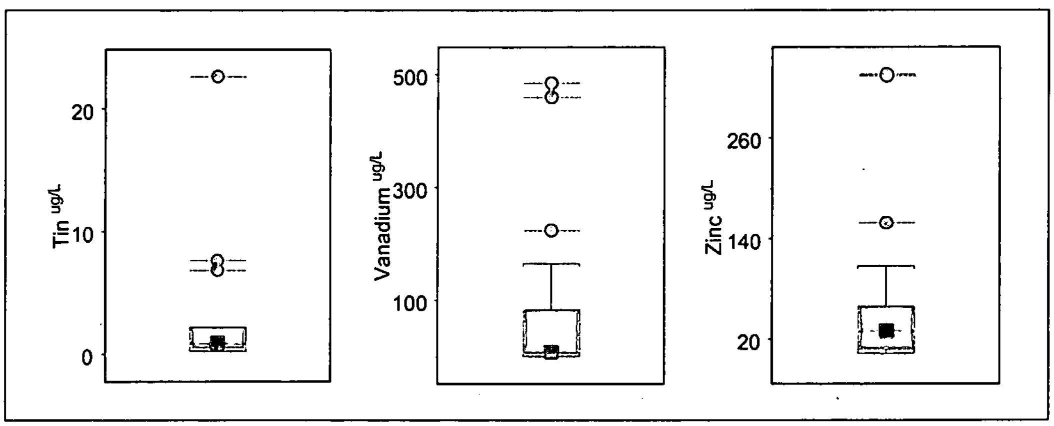

Figure 15-31. Total Metals Box Plots for Location GS05: Tin through Zinc.

15.3.6 Location GS06

Monitoring location GS06 is located on the Owl Branch to Woman Cr. at the west Site fenceline. Table 15-11 presents the analyte-specific summary statistics for BZ samples collected at GS06. Figure 15-32 through Figure 15-37 show the analyte-specific box plots for BZ samples collected at GS06. Figure 3-18 shows the drainage area for GS06.

Table 15-11. BZ Summary Statistics for Analytical Results from GS06 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median	85th Percentile	Maximum
TSS [mg/L]	16	0%	540	7725	11000
CHLORIDE [mg/L]	16	0%	10.2	21.5	34.3
FLUORIDE [mg/L]	16	6%	0.13	0.24	0.46
SULFATE [mg/L]	16	0%	7.50	10.5	15.7
TOTAL ALKALINITY [mg/L]	16	0%	56.5	70.8	74.0
TDS [mg/L]	16	0%	190	250	320
ALUMINUM [µg/L]	16	0%	31900	149500	415000
ANTIMONY [µg/L]	15	53%	0.85	3.49	11.2
ARSENIC [µg/L]	16	6%	13.1	60.0	147
BARIUM [µg/L]	16	0%	249	985	2560
BERYLLIUM [µg/L]	16	25%	1.90	10.8	25.5
CADMIUM [µg/L]	15	33%	0.46	2.40	4.90
CALCIUM [µg/L]	16	0%	25150	33025	63900
CHROMIUM [µg/L]	16	0%	29.0	133	348
COBALT [µg/L]	16	6%	10.8	46.1	112
COPPER [µg/L]	16	6%	23.4	86.1	259
IRON [µg/L]	16	0%	31400	166000	398000
LEAD [µg/L]	16	6%	23.7	99.2	262
LITHIUM [µg/L]	14	7%	53.0	95.2	277
MAGNESIUM [µg/L]	16	0%	7935	21250	51900
MANGANESE [µg/L]	16	0%	1036	3008	7770
MERCURY [µg/L]	16	56%	0.10	0.57	1.60
MOLYBDENUM [µg/L]	14	36%	3.10	6.45	6.45
NICKEL [µg/L]	16	13%	23.9	104	272
POTASSIUM [µg/L]	16	0%	8345	20650	50000
SELENIUM [µg/L]	16	44%	2.38	5.05	10.1
SILVER [µg/L]	16	75%	0.18	1.08	30.9
SODIUM [µg/L]	16	0%	8220	10648	16100
STRONTIUM [µg/L]	14	0%	144	236	494
THALLIUM [µg/L]	16	75%	0.65	2.23	2.90
TIN [µg/L]	14	57%	1.70	7.60	7.60
VANADIUM [µg/L]	16	0%	62.7	314	747
ZINC [µg/L]	16	0%	118	347	684

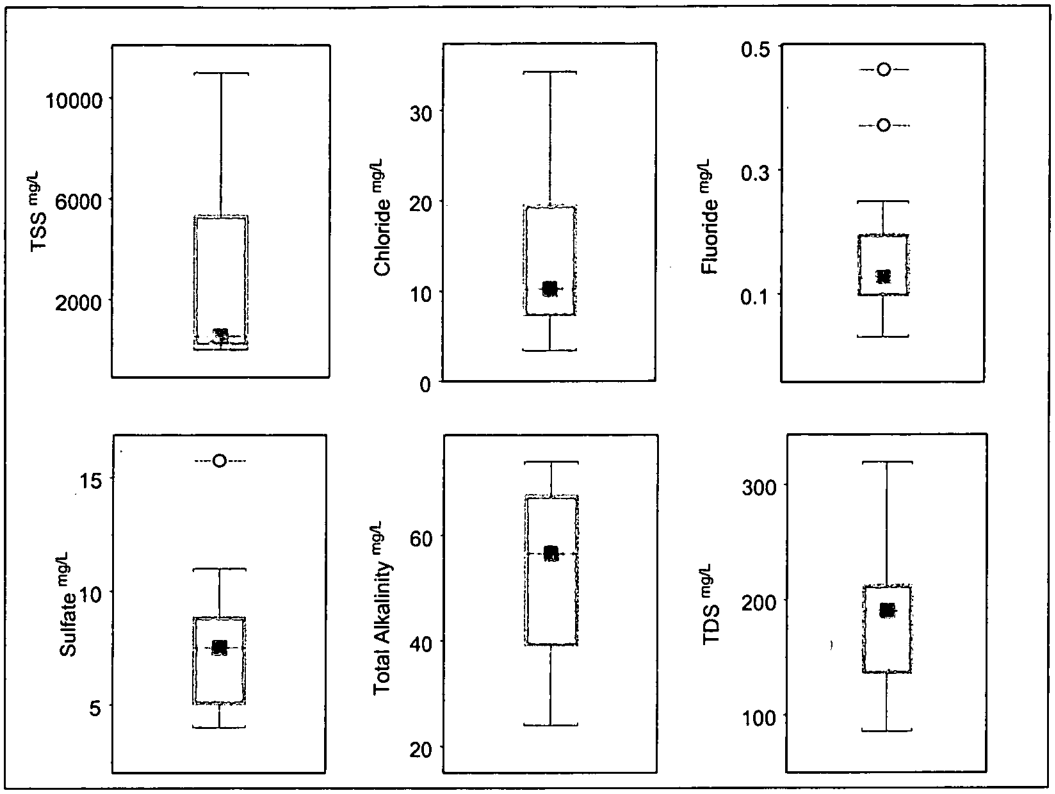

Figure 15-32. Water-Quality Parameter Box Plots for Location GS06.

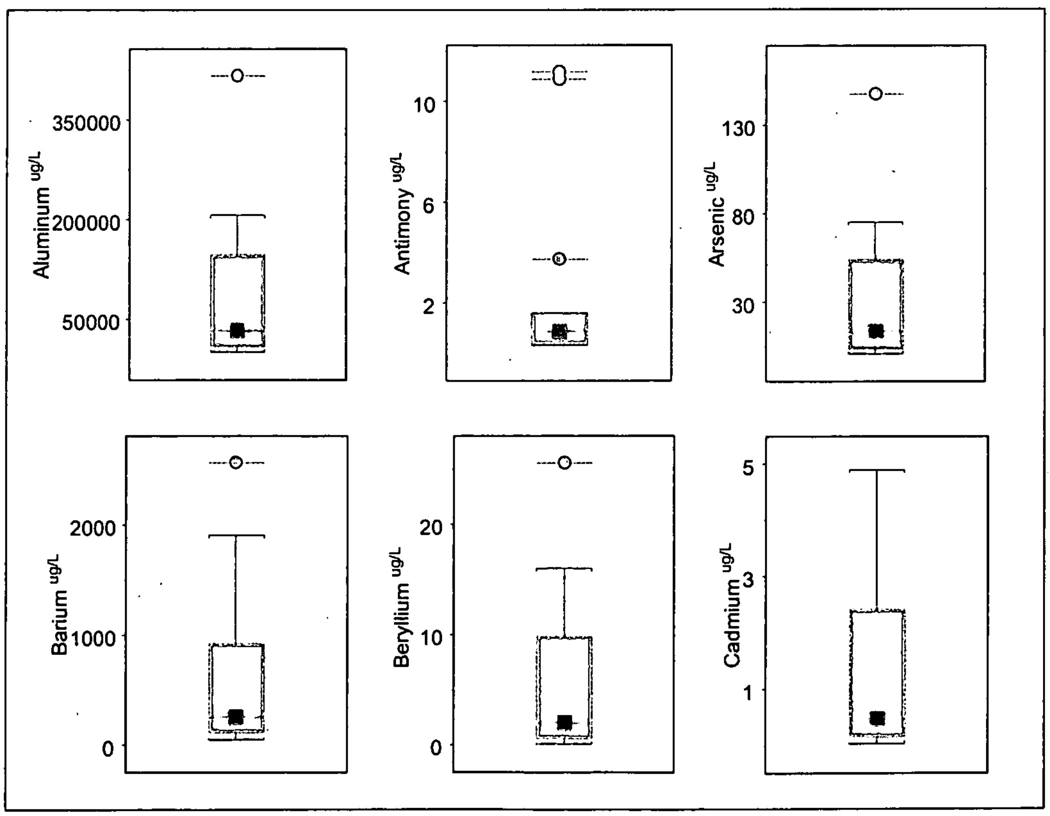

Figure 15-33. Total Metals Box Plots for Location GS06: Aluminum through Cadmium.

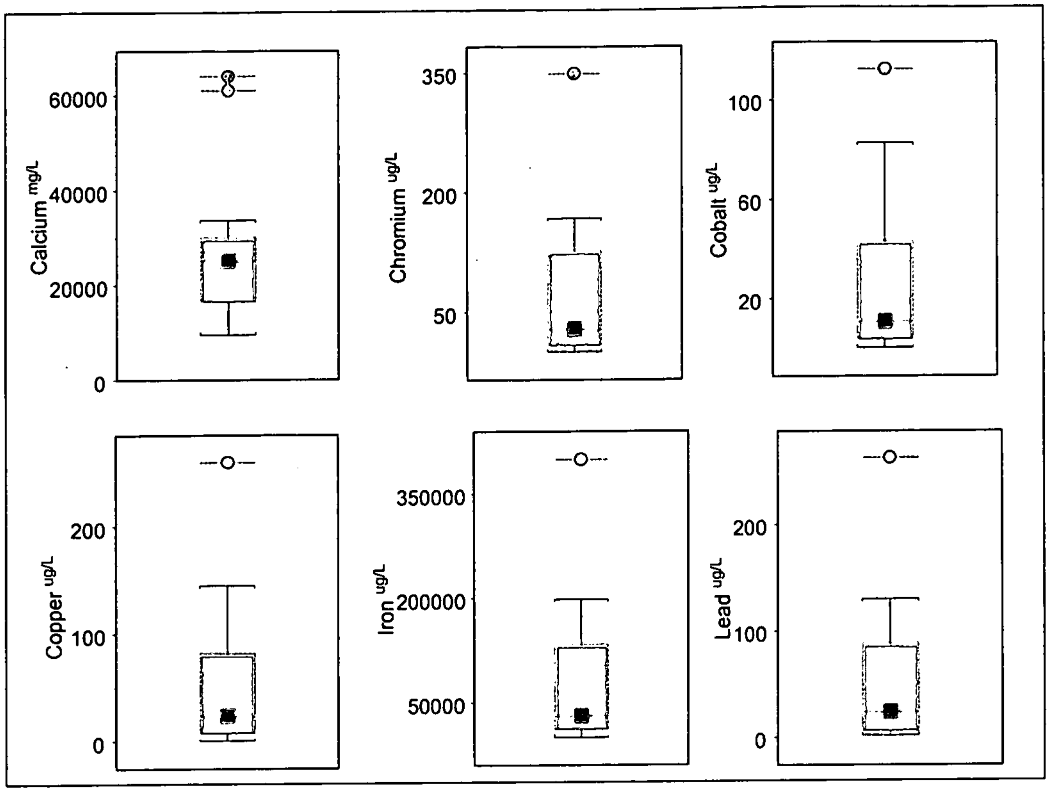

Figure 15-34. Total Metals Box Plots for Location GS06: Calcium through Lead.

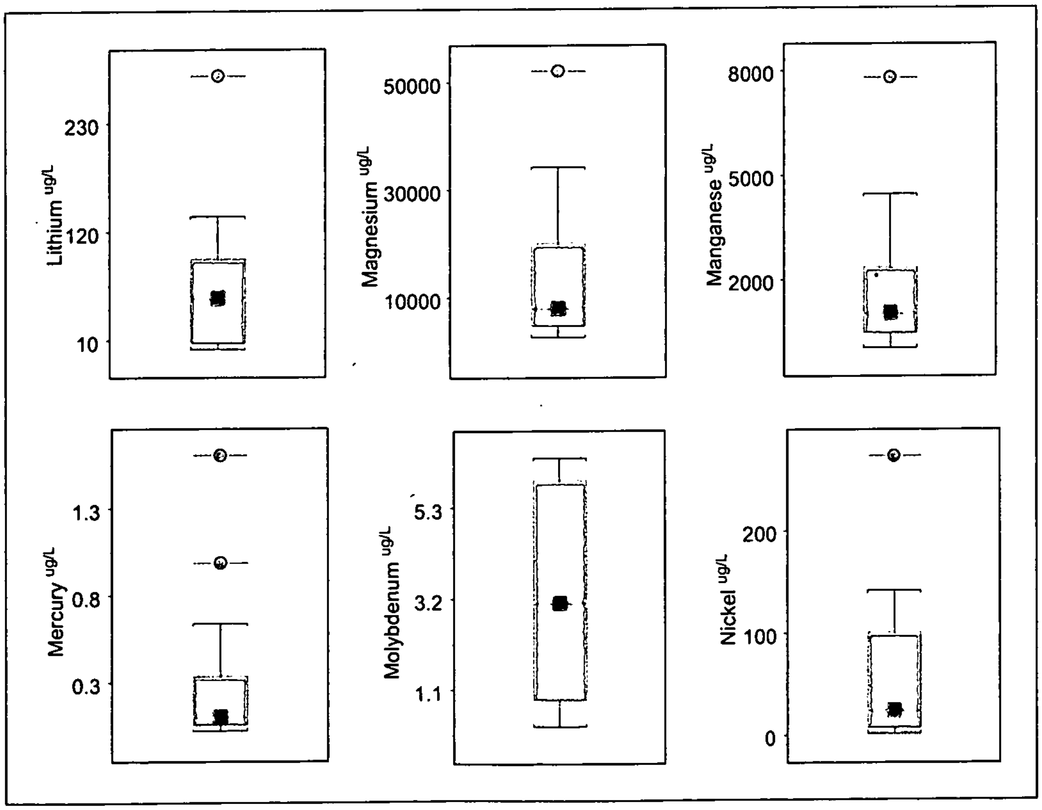

Figure 15-35. Total Metals Box Plots for Location GS06: Lithium through Nickel.

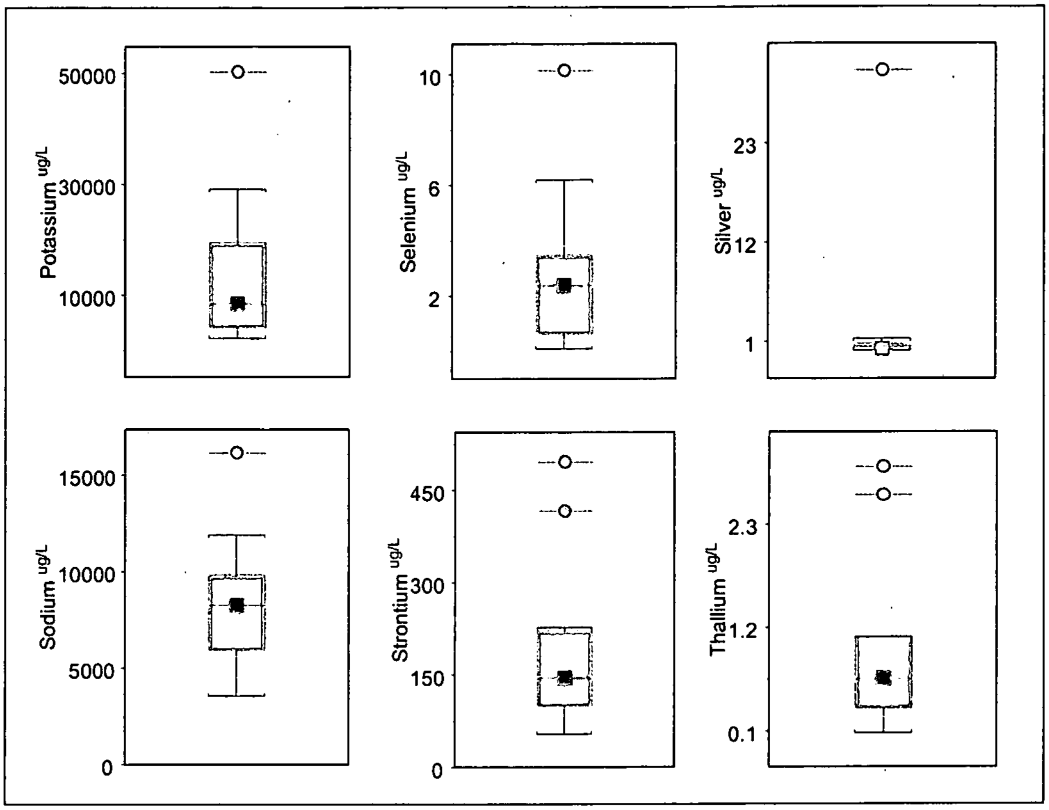

Figure 15-36. Total Metals Box Plots for Location GS06: Potassium through Thallium.

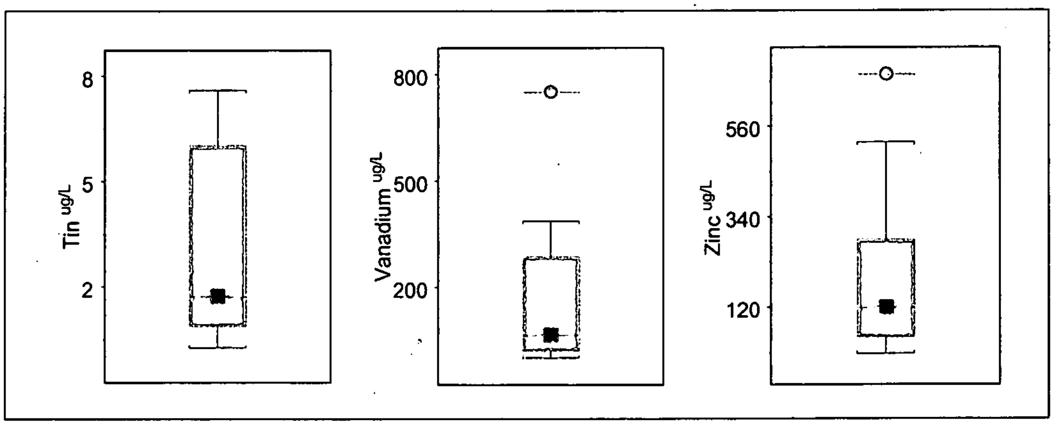

Figure 15-37. Total Metals Box Plots for Location GS06: Tin through Zinc.

15.3.7 Location SW134

Monitoring location SW134 is located north of the gravel pits north of the West Access Road. Table 15-12 presents the analyte-specific summary statistics for BZ samples collected at SW134. Figure 15-38 through Figure 15-43 show the analyte-specific box plots for BZ samples collected at SW134. Figure 3-84 shows the location of SW134. SW134 receives water pumped from the pits; the drainage area is undetermined.

Table 15-12. BZ Summary Statistics for Analytical Results from SW134 in WY97-00.

Analyte	Samples [N]	Percent Undetect	Median	85th Percentile	Maximum
TSS [mg/L]	16	0%	40.0	99.9	1400
CHLORIDE [mg/L]	16	0%	9.80	10.8	12.0
FLUORIDE [mg/L]	16	0%	0.35	0.43	0.52
SULFATE [mg/L]	16	0%	38.0	43.8	48.2
TOTAL ALKALINITY [mg/L]	15	0%	80.0	89.2	120
TDS [mg/L]	16	0%	210	260	440
ALUMINUM [μg/L]	16	0%	2080	6071	26800
ANTIMONY [μg/L]	16	75%	0.48	6.13	11.2
ARSENIC [μg/L]	16	44%	1.20	2.14	9.30
BARIUM [μg/L]	16	0%	94.0	125	265
BERYLLIUM [μg/L]	16	44%	0.21	0.64	2.10
CADMIUM [μg/L]	16	88%	0.05	1.75	2.50
CALCIUM [μg/L]	16	0%	27100	30700	39050
CHROMIUM [μg/L]	16	25%	3.05	10.1	35.9
COBALT [μg/L]	16	31%	0.74	2.54	6.60
COPPER [μg/L]	16	19%	3.60	6.30	27.9
IRON [μg/L]	16	0%	1060	4118	16200
LEAD [μg/L]	16	31%	1.75	2.80	27.0
LITHIUM [μg/L]	13	0%	5.40	12.4	18.3
MAGNESIUM [μg/L]	16	0%	6208	7480	8510
MANGANESE [μg/L]	16	0%	25.3	57.4	181
MERCURY [μg/L]	12	92%	0.05	0.10	0.12
MOLYBDENUM [μg/L]	13	15%	1.20	1.64	6.45
NICKEL [μg/L]	16	25%	2.50	6.83	16.8
POTASSIUM [μg/L]	16	0%	1475	1983	5550
SELENIUM [μg/L]	16	63%	0.79	2.11	7.10
SILVER [μg/L]	16	88%	0.11	0.98	1.70
SODIUM [μg/L]	16	0%	14250	17225	19300
STRONTIUM [μg/L]	13	0%	168	184	218
THALLIUM [μg/L]	16	75%	0.46	1.08	6.80
TIN [μg/L]	13	77%	0.50	1.88	7.60
VANADIUM [μg/L]	16	6%	5.90	14.3	77.1
ZINC [μg/L]	15	0%	12.8	17.4	52.7

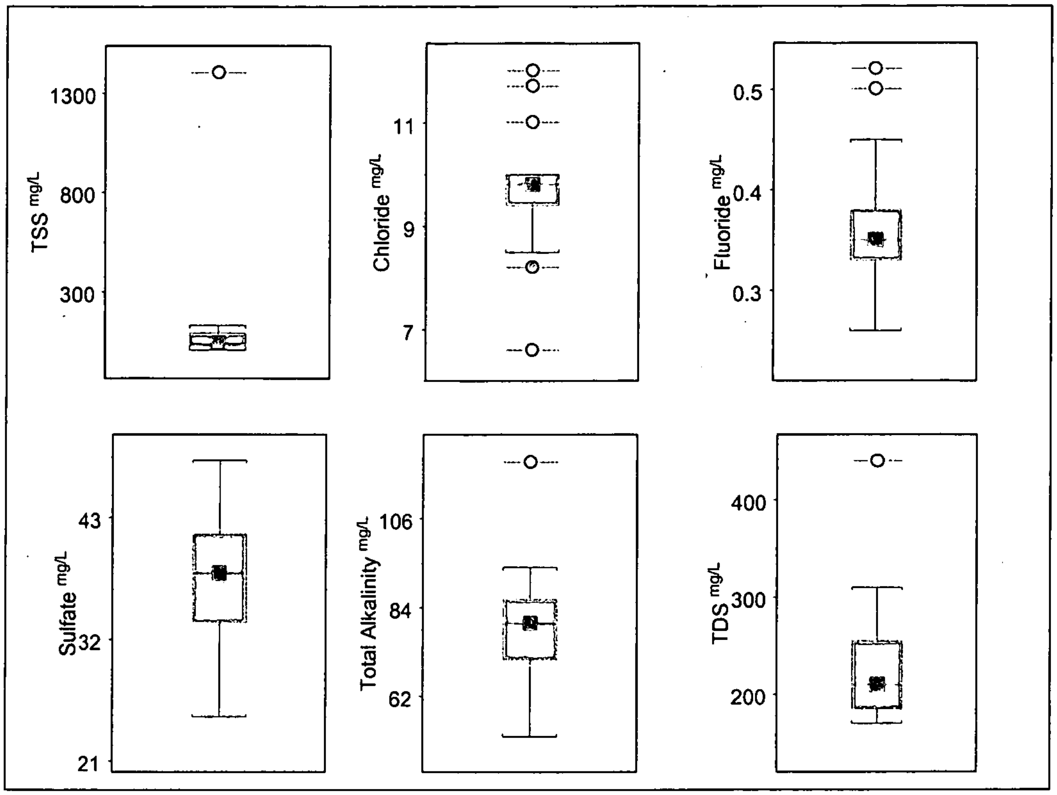

Figure 15-38. Water-Quality Parameter Box Plots for Location SW134.

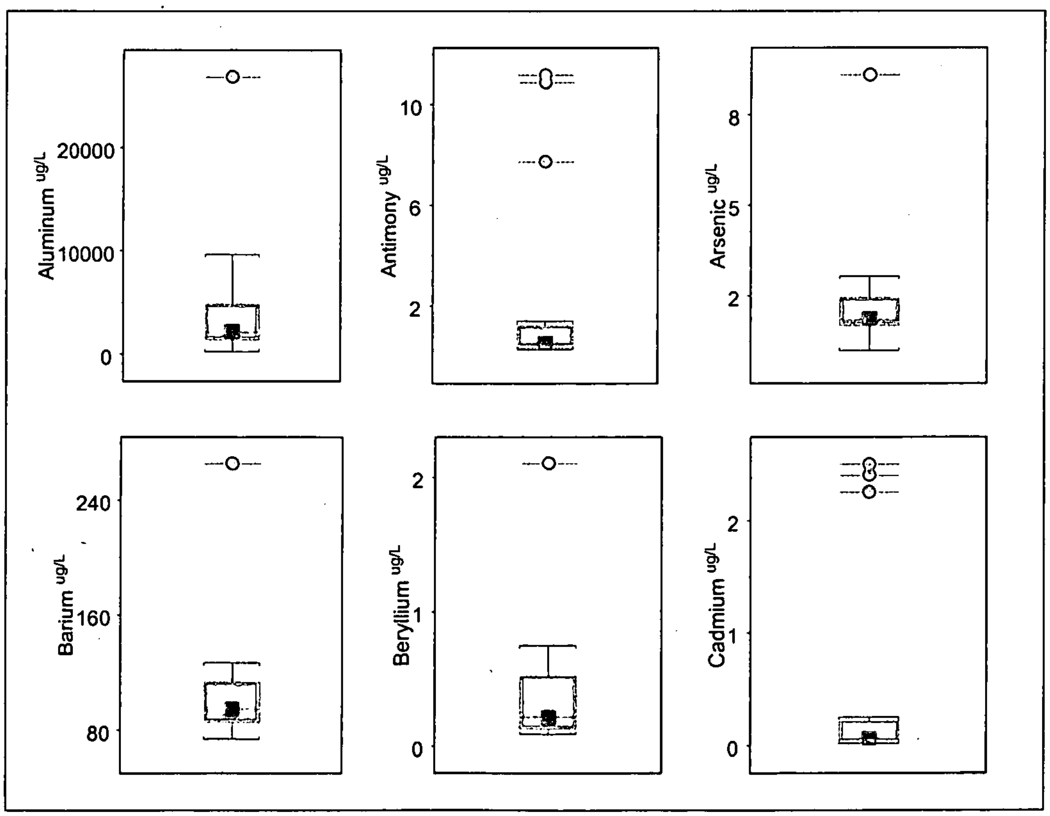

Figure 15-39. Total Metals Box Plots for Location SW134: Aluminum through Cadmium.

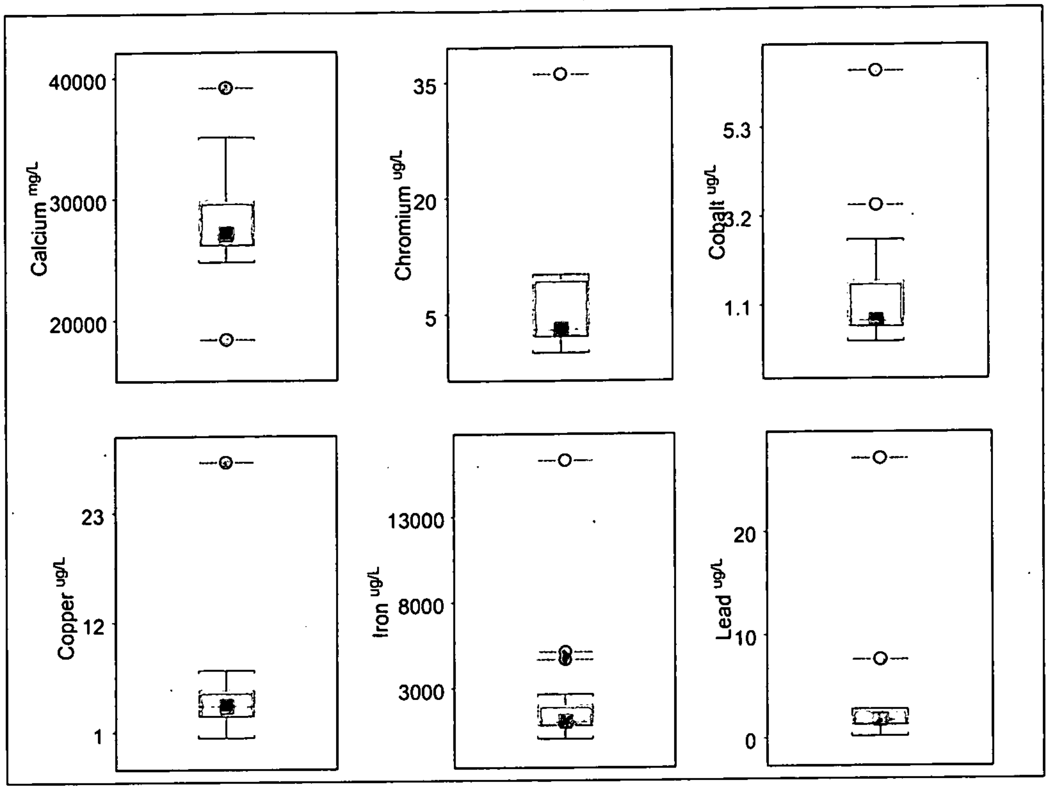

Figure 15-40. Total Metals Box Plots for Location SW134: Calcium through Lead.

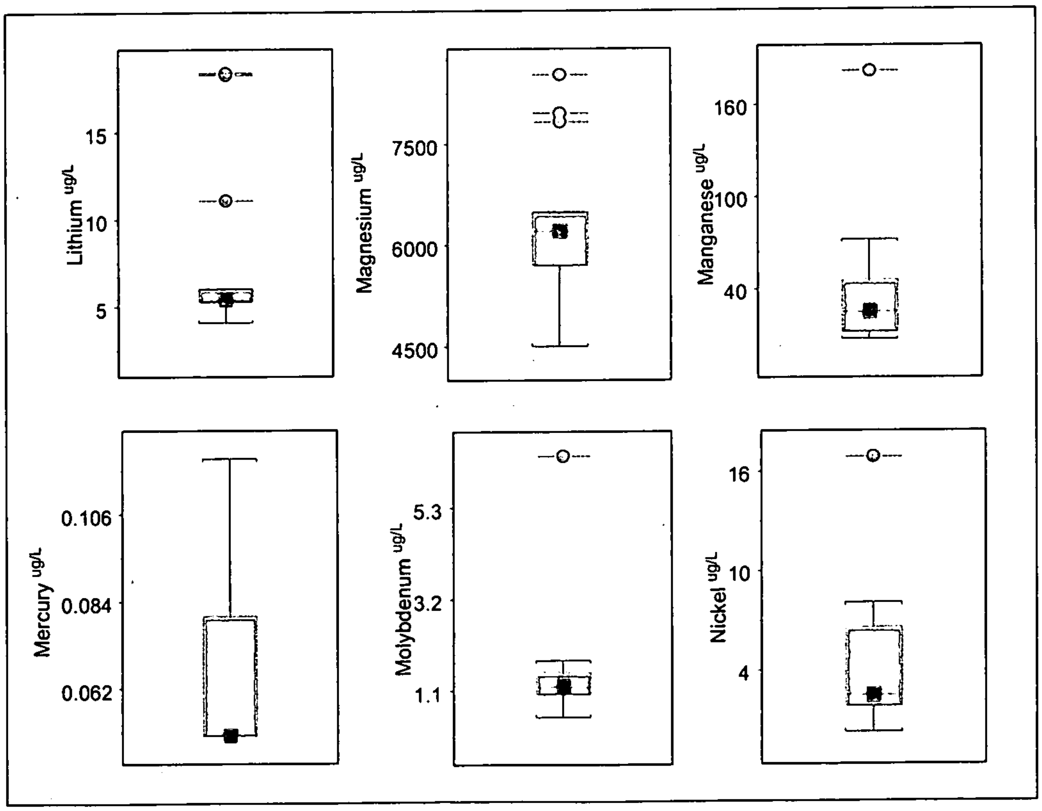

Figure 15-41. Total Metals Box Plots for Location SW134: Lithium through Nickel.

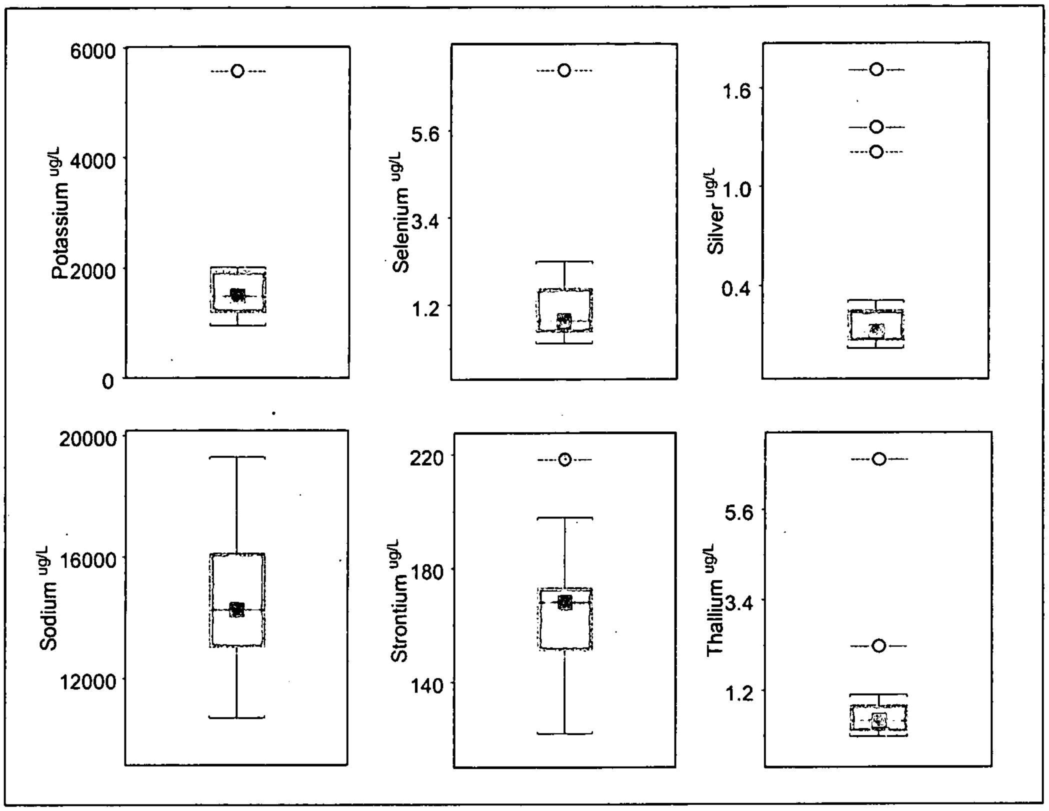

Figure 15-42. Total Metals Box Plots for Location SW134: Potassium through Thallium.

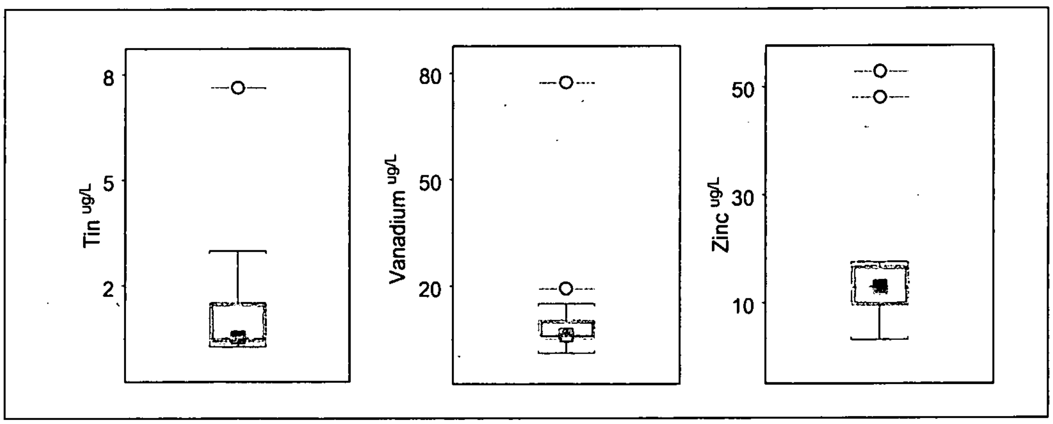

Figure 15-43. Total Metals Box Plots for Location SW134: Tin through Zinc.

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16. ANALYTICAL DATA QUALITY ASSESSMENT

The quality of surface-water monitoring data is assessed in terms of five data quality parameters. These parameters include precision, accuracy, representativeness, completeness, and comparability (PARCC) as described in the *Quality Assurance Program Plan for the Automated Surface-Water Monitoring Program*, RF/RMRS-2000-013, Revision 0, March 2000. This section summarizes the types of data available to assess the PARCC parameters.

With respect to the 46 gaging stations operated during Water Years 1997 through 2000, samples were obtained at 39 of the sites with remaining 7 used to monitor only flow. Samples results were evaluated from 37 of the sites. Nineteen of the sampled sites were selected for the collection of field real/duplicate samples. At 10 of the 37 sites, field rinsate samples were collected. On a per sample basis the overall frequency for field QC sampling is 1 sample in 19.4 (5.2% of the total) during the period under evaluation. Duplicates were collected at a ratio of 1 in 23.7 (4.2%) and rinsates at a ratio of 1 in 107.5 (0.9%).

16.1 PARCC PARAMETERS

Precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters are indicators of data quality. Analytical data that is collected in support of the Surface Water Program will be evaluated using the guidance developed in RMRS procedure *Evaluation of Data for Usability in Final Reports*, RF/RMRS-98-200. This procedure establishes the guidelines for evaluating analytical data with respect to the PARCC parameters that are indicators of data quality. The following paragraphs define these PARCC parameters in conjunction with this program.

16.1.1 Precision

The precision of a measurement is an expression of mutual agreement among duplicate measurements of the same property taken under prescribed similar conditions. Precision is a measure of the reproducibility of results and is evaluated by comparing results from field duplicate samples with results from associated real samples. Precision will be evaluated quantitatively by using two functions. The most typical measure for non-radiological analyses is the relative percent difference (RPD) term. However, because of the stochastic nature of radioactivity, a statistical measure is better suited for evaluating radiological reproducibility. This statistical measure is referred to as the duplicate error ratio (DER)[46]. The equations defining these two measures is provided below:

$$RPD = \left[\frac{|C_1 - C_2|}{(C_1 + C_2)/2}\right]100$$

C_1 = first sample result (in terms of concentration)
C_2 = duplicate sample result (in terms of concentration)

$$DER = \left[\frac{|C_1 - C_2|}{\sqrt{(TPU_{c1}^2 + TPU_{c2}^2)}}\right]100$$

C_1 = first sample result (in terms of concentration)
C_2 = duplicate sample result (in terms of concentration)
TPU = total propagated uncertainty

[46] Because TPU is seldom reported (except for tritium analyses in some cases) in the laboratory analytical data packages, the 2-Sigma Error has been substituted for TPU in the DER formula for precision evaluations of americium, plutonium, uranium, and tritium real-duplicate pairs. Substitution of 2-Sigma Error for TPU results in a more conservative estimate of precision (larger DER value).

The purpose of the field duplicate samples is to evaluate the precision of the field sampling process. The acceptable RPD limit for non-radiological field duplicate measurements is ≤ 30% for water. At least 85% of all quality control samples are required to comply with the established precision, or RPD goals. Duplicate samples exceeding the RPD criteria indicate that samples do not comply with the DQO specifications, and require an explanation of the deficiencies and a determination if additional sampling is required. Duplicate samples exceeding the DER criterion are interpreted as different at the 95% confidence level. The acceptable DER limit for radiological field duplicate measurements is ≤ 1.96.

16.1.2 Accuracy

Accuracy is the degree of agreement of a measurement with an accepted reference or true value and is a measure of the bias in a system. The closer the measurement to the true value, the more accurate the measurement. All analytical data will be compared with the required analytical method and detection limit with the actual method used and its detection limit for each medium and analyte to assess the DQO compliance for accuracy.

16.1.3 Representativeness

Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point. Representativeness is a qualitative term that should be evaluated to determine whether samples are collected in such a manner that the resulting data appropriately reflect the contamination present. Typically the discussion of representativeness is limited to an evaluation of whether analytical results for field samples are truly representative of environmental concentration or whether they may have been influenced by the introduction of contamination during collection and handling. This is assessed by evaluating the results of various blanks specifically equipment rinsates.

16.1.4 Completeness

Completeness is a measure of the amount of valid usable data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions. Usability will be determined by evaluation of the PARCC parameters including completeness. Those data that are validated and need no qualification or are qualified as estimated or undetected are considered usable. Rejected data are not considered usable. Completeness will be calculated following data evaluation. A completeness goal of 90% has been established for the Surface Water program. If this goal is not met, additional sampling may be necessary to adequately achieve project objectives. Completeness is calculated using the following equation:

$$Completeness = DP_u = \left[\frac{DP_t - DP_n}{DP_t}\right]100$$

Where:

Where:	DP_u	=	Percentage of usable data points
	DP_n	=	Non usable data points
	DP_t	=	Total number of data points

16.1.5 Comparability

Comparability is a qualitative parameter. Consistency in the acquisition, handling, and analysis of samples is necessary for comparing results. Data developed under this investigation will be collected and analyzed using standard EPA or nationally recognized analytical methods and QC procedures to ensure comparability of results with other analyses performed in a similar manner.

16.2 PARCC EVALUATION BY ANALYTE GROUP

16.2.1 Metals Analyte Group

Precision

To evaluate precision for metals analyte group, real and duplicate results are paired and the Relative Percent Difference (RPD) QC criterion is calculated. For Water Years 1997 through 2000, there are 230 paired real/duplicate results out of 7820 real (TR1) sample results. Of the 230 real/duplicate pairs, only 214 were used to calculate RPDs (Appendix B3 Table B-4). Of the 214 RPDs calculated, 147 meet the lab qualifier criteria listed in Appendix B.3 Table B-14 of which 128 were within the QC criterion of ≤ 30% for water. Of the 67 real/duplicate pairs did not meet the QC criteria, 2 of these pairs have "UJ1"/"UJ1" validation qualifiers and 3 pairs have "J1"/"J1" validation qualifiers (these qualifiers indicate that some level of estimation was used to derive the result). Another 47 real/duplicate pairs that were used in precision calculations have a combination of "B"/"B" laboratory qualifiers and had validation qualifiers suggest that the results used to calculate the RPDs are estimates or difficult to replicate. Furthermore, several of the analytes (antimony, copper, sodium, zinc) associated with those real/duplicate pairs that were above the 30% criterion generally are not concerned to be contaminants of concern in RFETS surface-water. With 85.7% of the RPDs in the acceptable range (just above the QC criterion), the overall precision for dissolved metal analysis is near the acceptable goal of 85%.

Accuracy

To evaluate accuracy, reported detection limits are compared with the required methods and contract required detection limits (CRDL). The CRDL for metal analytes are listed in Appendix B.3 Table B-13. The data set was filtered to remove lab duplicates and other non-target records prior to evaluating the detection limits. Results that have DLs that exceeded the CRDL and are "U" qualified were not included in the final summary. Approximately 7.0% of the reported results for 12 out of 28 metal analytes are above the contract required detection limit (Table 16-1). It should be noted that while the CRDLs are exceeded, most of these cases are associated with data from the first water year under review WY97. Detection limits for all other metals analysis are within the CRDL for metal analyses.

Table 16-1 - Summary of Metals Analyses Reported with DLs above the CRDLs

Analyte	CRDL (ug/L)	Number of Results Evaluated	Number of Results with Reported DL Exceeding CRDL	Percentage Above CRDL
Aluminum	17	242	33	13.6%
Antimony	3	247	29	11.7%
Arsenic	5	246	26	10.6%
Barium	100	243	22	9.1%
Cadmium	1	574	64	11.1%
Chromium	2	556	68	12.2%
Copper	3	246	26	10.6%
Nickel	20	246	26	10.6%
Selenium	3	243	26	10.7%
Silver	13	574	72	12.5%
Thallium	4	232	25	10.8%
Vanadium	17	232	22	9.1%

Accuracy can also be assessed using the results from spiked samples. The basic measure of accuracy is the percent recovery (%R). The QC criteria for %R is adopted from the EPA and is 75 to 125 percent for all media. Appendix B.3 Table B-5 lists the 1383 matrix spike recovery results reported for metals analyses for the Water Years 1997 through 2000. Appendix B.3 Table B-6 shows the 130 (9.4 %) matrix spikes were outside the matrix spike criterion of 75-125%. Analytes with recoveries outside the QC criteria include aluminum, antimony, arsenic, barium, cadmium, chromium, nickel, selenium, silver, thallium, and zinc.

Representativeness

To evaluate representativeness, the results of equipment rinsates are compared to the analyte specific detection limits. There are 43 rinsate sample results (Appendix B.3 Table B-7) versus 230 real/duplicate paired results for metals during the Water Years 1997 through 2000 (1 in 5.4). Of the 43 rinsate results, all are lab qualified as either "U" (non-detection) or "B" (detection was less than Contract Required Detection Limit but greater than the Instrument Detection Limit), generally indicating that no metal contamination was introduced during sampling and/or shipping activities. Thirty (30) results have either "V" or "V1" validations, 7 had "J" or "J1" validation qualifiers indicating the results had been verified, and 6 are "UJ" indicating the results are estimated at an elevated detection level. Considering these results, there is little indication that contaminants were introduced during sample collection for Water Quality Parameter analyses.

Completeness

To evaluate completeness, the percent of rejected results is determined. A total of 36 sample results out of a total of 7,820 TR1 real sample results were rejected during validation. Using the completeness formula listed in the previous section, 99.5% of the metals data records are considered acceptable. The completeness goal of 90% was met for WQP analytes s during Water Years 1997 through 2000. Therefore, the WQP analyses are considered to be complete for the period under evaluation.

Comparability

No changes were made to the analytical procedures for metals analyses during the Water Years 1997 through 2000. For each monitoring objective, sampling methodologies (composite sampling, grab sampling) did not change during the period under review. Therefore, analytical results for the period of time under review are assumed to be comparable.

16.2.2 Radionuclide Analyte Group

Precision

To evaluate precision for radionuclide analyte group, real and duplicate results are paired and the Duplicate Error Ratio (DER) QC criterion is calculated. For dissolved radionuclide analyses, there are 159 paired real/duplicate analytical results out of a total 4,496 real (TR1) results. DERs were calculated for 156 duplicate/real pairs (Appendix B.3 Table B-8). Of the 156 DERs calculated, 82 meet the lab qualifier criteria listed in Appendix B.3 Table B-14 of which all (100.0%) are below the 1.96 criterion, thus analytical precision is determined to be acceptable for the radiological analysis completed during Water Years 1997 through 2000.

Accuracy

To evaluate accuracy, reported detection limits are compared with the required methods and contract required detection limits (CRDL). The contract required detection limits for radionuclide analyses of surface water samples performed during Water Years 1997 through 2000 are listed in Appendix B.3 Table B-13. Forty eight (48) radionuclide results (Table 16-2) out of the 4,496 (TR1) radionuclide results did not meet the CRDL (1.1% of the results). In general, the accuracy of radionuclide analyses appears to be acceptable.

Table 16-2 - Summary of Radionuclide Analyses with Reported DLs above the CRDLs

Analyte	CRDL (ug/L)	Number of Results Evaluated	Number Exceeding CRDL	Percentage Above CRDL
Americium	0.5	1072	43	4.0%
Plutonium	0.5	1075	3	0.3%

Representativeness

To evaluate representativeness, the results of equipment rinsates are compared to the analyte specific detection limits. It should be noted that rinsate sampling did not start until WY00. During WY00, 49 rinsate sample results were obtained versus 159 real/duplicate pairs for radionuclide analyses during the Water Years 1997 through 2000 (1 in 3.2; Appendix B.3 Table B-9). Of the 49 rinsate results, all are lab qualified as "U" (non-detection). All 49 results have either "V" or "V1" validations. All rinsate analyses are below the RFCA surface-water Action Level and Standards (ALF) 0.15 pCi/L value. In conclusion, the review of rinsate results and the sample collection program indicate that no radionuclide contamination was introduced during the sampling process for the period under review.

Completeness

To evaluate completeness, the percent of rejected results is determined. Only 15 sample results out of a total of 4,496 results were rejected during validation. Using the completeness formula listed in the previous section, 99.7% of the radiological data records are considered acceptable. The completeness goal of 90% was met for WQP analytes s during Water Years 1997 through 2000. Therefore, the radiological analyses are considered to be complete for the period under evaluation.

Comparability

No changes were made to analytical procedures for the period under review. In all but one case, sampling protocols were also constant. Sampling protocol changes were made at SW022 in October 1999, converting from a storm event sampling methodology (rising limb) to the flow paced methodology to make load calculations possible. With the exception of SW022, radionuclide analyses presented here are assumed to comparable throughout Water Years 1997 through 2000.

16.2.3 Water-Quality Parameters Analyte Group

Precision

To evaluate precision for the water-quality parameter analyte group, real and duplicate results are paired and the Relative Percent Difference (RPD) QC criterion is calculated. For water quality analyses, a total of 62 paired real-duplicate samples results out of a total 1,645 real (TR1) results. Of the 62 duplicate/real pairs, 54 were of sufficient quality to be used for calculating the RPD precision measurements (Appendix B3 Table B-10). Of the 54 calculated, 49 meet the lab qualifier criteria (Appendix B3 Table B-14) of which 48 values (98.0 %) were within the QC criterion of $\leq$ 30% (only 1 failed). These results indicate an acceptable level of precision associated with WQP analyses.

Accuracy

To evaluate accuracy, reported detection limits are compared with the required methods and contract required detection limits (CRDL). The CRDL for water-quality analytes are listed in Appendix B.3 Table B-13. The detection limits for 45 out of 1645 (2.7%) of the water-quality analytes were above the contract required detection limit (Table 16-3). Detection limits for all other water-quality analyses are within the CRDL for those analyses.

Table 16-3. Summary of Water-Quality Parameters with Reported DLs above the CRDLs

Analyte	CRDL (ug/L)	Number of Results Evaluated	Number Exceeding CRDL	Percentage Above CRDL
Chloride	0.5	138	20	18.3%
Sulfate	5.0	138	1	0.7%
Sulfide	0.002	2	2	100.0%
Total Suspended Solids	5.0	490	22	4.5%

Accuracy can also be assessed using the results from spiked samples. The basic measure of accuracy is the percent recovery (%R). The QC criteria for %R is adopted from the EPA and is 75 to 125 percent for all media. Appendix B3 Table B-11 includes the matrix spike results for WQPs for the period under review. In summary, 43 of the 51 results are within the acceptable 75-125% recovery range. Only silicon and one of the total suspended solids results failed to meet the acceptable recovery criteria. Analytical results for water quality parameters are considered to be accurate for Water Years 1997 through 2000.

Representativeness

To evaluate representativeness, the results of equipment rinsates are compared to the analyte specific detection limits. There are 21 rinsate sample results (Appendix B.3 Table B-12) versus 62 real/duplicate pairs for water-quality parameters during the Water Years 1997 through 2000 (1 in 3.3). Of the 21 rinsate results, 19 (90.5%) are lab qualified as either "U" (non-detection) or "B" (detection was less than Contract Required Detection Limit but greater than the Instrument Detection Limit). Sixteen (16) results have either "V" or "V1" validations and 5 results had J1 validation qualifiers indicating the results have been verified. Considering these results, there is little indication of that contaminants were introduced during sample collection for Water-Quality Parameter analyses.

Completeness

To evaluate completeness, the percent of rejected results is determined. None of the 1,645 sample results were rejected during validation. Using the completeness formula listed in the previous section, 100%of the water quality data records are considered acceptable. The completeness goal of 90% was met for WQP analytes s during Water Years 1997 through 2000. Therefore, the WQP analyses are considered to be complete for the period under evaluation.

Comparability

As stated in previous sections, no changes were made to the analytical procedures during the period under review. For location SW022, changes in sample collection methodology from rising-limb to continuous flow-paced limit the comparably of the data after October 1999. For all other locations, WQP analyses performed during Water Years 1997 through 2000 are considered to be comparable.

16.3 PARCC DATA QUALITY EVALUATION SUMMARY

Precision

Precision was evaluated by pairing real and duplicate results and calculating the appropriate analyte group QC criterion. Table 16-4 provides a summary of RPD and DER calculations. Appendix B.3 Table B-15 lists the lab qualifier criteria for screening and reporting of precision calculations. With the exception of metals analyses, analytical data obtained by the surface-water monitoring program exceeded the desired precision criterion.

Table 16-4 – Summary of Calculated RPDs and DERs by Analyte Group

Analyte Group	QC Criterion for RPD or DER Values	Total Number of Real/Duplicate Pairs	Number of RPDs/DERs Calculated	Number of RPDs/DERs Meeting Lab Qualifier Criteria	Number of Acceptable RPDs/DERs Results	Overall Precision (Goal = 85%)
Metals	Less than 30%	230	214	147	126	85.7%
Radionuclides	Less than 1.96	159	156	82	82	100.0%
Water-Quality Parameters	Less than 30%	54	54	49	48	98.0%

Accuracy

Accuracy was evaluated by comparing the reported detection limits were with the required methods and contract required detection limits (CRDL). Based on the review of detection limits for each analyte group, reported detection limit exceeded the CRDL for two of analyte groups. For approximately half of the metal analytes during WY97, 439 out of 7820 (5.6%) of the results that were reported had exceeded the CRDL. Noting the fact that most of these cases occurred during the first water year under review WY97, metals data for WY98 and after are considered to be accurate. For radiological analyses, 48 out of 4,496 (1.1 %) of the results that were reported have detection limits that exceeded the CRDL. For the water quality analytes, 45 out of 1,645 (2.7%) of the analytes were reported with detection limits that exceeded the CRDL.

Based on the review of matrix spike recoveries, approximately 9.4% of the metals evaluated have matrix spike criterion suggesting the results received for metals may not be entirely accurate.

Representativeness

As determined by a review of rinsate results and the sampling program, analytical data for all three analyte groups are representative and that no quantifiable level of contamination was introduced during the sampling process for the period under review. None of the rinsate results were at or above the CRDL.

Completeness

Completeness was evaluated using the completeness formula listed in the previous section, the number of rejected results, and the total number of results. For metals, 36 results out of 7,820 were rejected resulting in a completeness of 99.5%. For radionuclides, 15 results out of 4,4,96 were rejected resulting in a completeness of 99.7%. For water quality parameters, 1 result out of 1645 were rejected resulting in a completeness of 99.9%. Almost 100% of all the results received for all 3 analyte groups are considered acceptable. The completeness goal of 90% was met for all three analyte groups and the analytical results are considered to be complete for the period under evaluation.

Comparability

No changes were made to analytical procedures for the period under review. In all but one case, sampling protocols also were constant. Changes were sampling protocol were made at SW022 in October 1999, converting from a storm event sampling methodology (rising limb) to the flow paced methodology to make load calculations possible. With the exception of SW022, analytical results are assumed to comparable throughout Water Years 1997 through 2000.

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