Surface-Water Quality Data, Permanente and Saratoga Creeks, Santa Clara Valley, California, Water Year 1997

By Seth H. Myhre and Kenneth E. Bencala

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CONVERSION FACTORS

Multiply	By	To Obtain
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
gallon (gal)	0.003785	cubic meter (m^3)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.59	square kilometer (km^2)
gram (g)	0.035	ounce (oz)
inch (in)	2.54	centimeter (cm)

Degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) by using the following equation:
$°F = 9/5\ (°C) + 32$

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ABSTRACT

The U.S. Geological Survey (USGS) monitored selected water quality characteristics at three sites along Permanente Creek and six sites along Saratoga Creek from October 1, 1996 through September 18, 1997. Water samples were collected one to three times per month, depending on rainfall. Samples were measured in the laboratory for alkalinity, specific conductance, total suspended solids, and chloride, sulfate, calcium, magnesium and sodium concentrations. Temperature and pH were measured directly in the creeks. This report presents tabulated data from these measurements. This report also presents a description of the data and a graphical presentation of the constituents and discharge.

INTRODUCTION

This study was designed to monitor spatial and temporal variability of selected water quality characteristics in Permanente and Saratoga Creeks during the 1997 water year (October 1, 1996 through September 30, 1997). The chemical and physical data presented in this report will be used to determine the applicability of Permanente and Saratoga Creeks for future studies. This report presents physical and chemical data, figures which display spatial and temporal variability of the data, a description of the study area and of the methods used in the field and in the laboratory. This report also presents discharge data for Permanente and Saratoga Creeks, however these data were measured independently of this study.

Acknowledgments

Many people helped in the prepartaration of this report. Permanente Creek discharge data were provided by Santa Clara Valley Water District (SCVWD) (gaging station number 32A). Saratoga Creek discharge was provided by the California District of the USGS Water Resources Division (gaging station number 11169500). The USGS and SCVWD gaging stations were set up independently, prior to this study, and are currently in operation. Larry Schemel designed and supervised the experiment, provided the necessary training for sample collection and processing, laboratory procedures, computer skills, and writing of the data report. Ron Avanzino provided training on the Dionex Ion Chromatograph and general laboratory protocol.

DESCRIPTION OF STUDY AREA

Permanente and Saratoga Creeks are located in the northwestern (NW) section of Santa Clara County California (fig. 1). Santa Clara County is located approximately forty miles south of San Francisco on the east side of the Santa Cruz Mountains. Drainage basins for Permanente and Saratoga Creeks are oriented west to east. Permanente and Saratoga Creeks drain to the San Francisco Bay. See figure 1 for site locations.

Permanente Creek water samples were collected at three sites: two along Permanente

Creek and one along West Fork Permanente Creek. A cement plant and limestone quarrying operation heavily impacted Permanente Creek upstream from the sampling sites (Nolan and Hill, 1989). Permanente Creek was impacted by channelization and suburbanization downstream from the sampling sites. West Fork Permanente Creek was unimpacted upstream from its sampling site.

Permanente Creek sites are identified with a "PR" prefix. Site numbers descend downstream. PR3 was on West Fork Permanente Creek, upstream from the confluence with Permanente Creek. PR2 was on Permanente Creek, upstream from the confluence with West Fork Permanente Creek. PR1 was on Permanente Creek, downstream from the confluence with West Fork Permanente Creek.

Saratoga Creek water samples were collected at six sites: four along Saratoga Creek, one along Mc Elroy Creek (tributary), and one along San Andreas Creek (tributary). Saratoga Creek was impacted by a sparse residential population upstream from the sampling sites, and by suburbanization downstream from the sampling sites. Mc Elroy and San Andreas Creeks were unimpacted upstream from their sampling sites.

Saratoga Creek sites are identified with a "SA" prefix. Suffixes descend downstream. SA6 was on Saratoga Creek downstream from the confluence of Booker Creek. SA5 was on Mc Elroy Creek upstream from the confluence with San Andreas. SA4 was on San Andreas Creek upstream from the confluence with Mc Elroy. SA3 was on Saratoga Creek, downstream from the confluence of Mc Elroy Creek with Saratoga Creek. SA2 was on Saratoga Creek, in the town of Saratoga. SA1 was the furthest downstream site on Saratoga Creek. SA1 was located in the city of San Jose, on the north side of Prospect Avenue. Saratoga Creek enters a cement channel between SA2 and SA1, and remains channelized untill discharging into the San Francisco Bay.

EXPERIMENTAL METHODS

One water sample was collected at each site. Collection frequency varied from one to three times per month depending on rainfall. Each water sample was collected in a 1,000 ml Nalgene polyethylene bottle using the single-vertical method (Ward and Harr, 1990). Collection bottles were rinsed in the laboratory with deionized water (DIW), field rinsed with stream water, and marked with their corresponding sites before each use.

Water temperature and pH were measured directly in the creeks during sample collection with a Cole-Parmer pH/mV/°C meter (model 59002-00). The meter was calibrated before each measurement with pH 7 and pH 4 buffers. Buffer solutions were made the evening prior to use. The pH 4 buffer solution was made by dissolving 5.1 g of Beckman potassium biphthalate in DIW to a solution volume of 500 ml. The pH 7 buffer was made by dissolving 3.3 g of Beckman Phosphate Buffer in DIW to a solution volume of 500 ml.

Samples were processed and preserved as described by Ward and Harr (1990). Samples to be measured for selected ion concentrations, alkalinity, and total suspended solids concentrations (TSS) were filtered in the laboratory on collection day through 47 mm diameter, 0.45 micron pore size Gelman polycarbonate membrane filters. The filters were placed in an acid-washed Sartorious filter holder which was attached to a hand vacuum pump. The filter, filter holder, and storage bottles were rinsed several times with filtrate before receiving a final aliquot. Specific conductance samples were not filtered prior to analysis. All samples were refrigerated after processing.

Water samples were analyzed in the laboratory for major cations: magnesium (Mg^{2+}), calcium (Ca^{2+}) and sodium (Na^{+}), anions: chloride (Cl^{-}) and sulfate (SO_4^{2-}), and alkalinity, specific conductance and total suspended solids concentration. The laboratory analyses usually were done several weeks after collection.

Chemical Analysis for Cations

The water samples to be analyzed for sodium, magnesium and calcium were preserved immediately after processing by adding 1 ml of concentrated nitric acid (HNO_3) to approximately 100 ml of sample (Ward and Harr 1990; Shelton, 1994). On the day of analyses lanthanum chloride ($LaCl_3$) was added to sample aliquots to be measured for calcium and magnesium. Lanthanum chloride was added to mask possible interferences of phosphate, sulfate, and aluminum (Fishman and Friedman, 1989).

The analyses were executed by direct aspiration of a sample to a Perkin Elmer Atomic Absorption Spectrophotometer model 603. Most samples were left undiluted. Occasionally samples analyzed for sodium and calcium were diluted with a 2 percent hydrochloric acid (HCl) solution. Samples were diluted in order to bring their cation concentrations within the linear dynamic range for the wavelength at which they were measured. Instrumental drift was corrected for by analyzing blanks and standards between sample sets.

Chemical Analysis for Anions

Analyses were performed on a Dionex DX 500 Ion Chromatograph using the Fishman and Friedman analytical method (1989). All samples were undiluted. Instrumental drift was corrected for by analyzing blanks and standards between sample sets.

Alkalinity by Gran Titration

Alkalinity was determined by an HCl titration, as outlined by Gran (1952). The titration was done in a reaction flask with a stopper. The stopper contained an inlet line for HCl, a vent, and a glass reference electrode. During the titration, the contents of the reaction flask were kept at 25 °C in a water bath and agitated by a magnetic stir bar. HCl (0.5 M) was added to a known volume of sample in the vented reaction flask. The amount of acid added and the change in potential from the glass reference electrode were entered in a calculator program. The program "Alkreg" written by Larry Schemel calculated the end point of the titration. The end point corresponds to the stoichiometric equivalence point for the neutralization of all bases present, primarily carbonate species.

Specific Conductance

Conductivity was measured with a Cole-Parmer model 19820-00 conductivity meter. Samples were kept at 25 °C in a water bath during measurement. Instrumental drift was corrected for by analyzing blanks and standards between sample sets. Specific conductance was calculated by adjusting conductivity measurements taken at 25 °C with the results of a standard curve (Shelton, 1994).

Total Suspended Solids Concentration

The total suspended solids concentration was determined in the laboratory. During the collection-day processing the first filter used for each site was preweighed, this filter received 300 ml of water sample. The filter was then stored in a desiccator and weighed biweekly to a constant weight. The TSS concentration was calculated by dividing the increased weight of the filter by 300 ml. Values are reported to +/- 0.1 mg/L, based on the accuracy of the analytical balance.

DATA DESCRIPTION

Temporal and spatial variability was documented in the data collected from Permanente and Saratoga Creeks. Table 1 and figure 2 display discharge variability. Temporal variability is displayed in figures 3 through 11. Spatial variability is displayed in figures 12 through 20. Water quality data are presented in tables 2 through 18. Ion and total suspended solids concentrations are presented in milligrams per liter (mg/L), alkalinity in milliequivalents per liter (meq/L), pH in pH units, specific conductance in microsemens per centimeter (us/cm), and temperature in degrees celsius (°C). The appropriate number of significant digits used to present data throughout this report were based on the precision and reliability of the methods used for analyses.

Discharge Variability

Discharge varied throughout the water year, often changing quickly during storms (fig. 2). Table 1 and figure 2 illustrate discharge level as samples were taken. Peak flow in Permanente Creek was 162 cubic feet per second (ft^3/s) while the median was 6.95 ft^3/s. Peak flow in Saratoga Creek was 543 ft^3/s while the median was 1.7 ft^3/s.

Surface flow was present in the creeks during each sampling period at all sites, except for at PR2 on October 1, 1996, August 15, 1997, and September 19, 1997. Discharge was zero at the Permanente gage on these dates. The stage at PR3 was noted to usually be lower and to not fluctuate as much between site visits as at PR2 or PR1.

Temporal Variability

Analyte concentrations at SA3 and PR1 varied throughout the water year. Figures 3 through 11 display a generally negative relationship between discharge and analyte concentration. PR1 data was used for these plots because the site is downstream from the confluence of Permanente and West Fork Permanente Creek and nearest to the Permanente Creek gaging station. SA3 data was used for these plots because the site is downstream from the confluence of Booker and Mc Elroy Creek with Saratoga Creek, upstream from the impact of urbanization on Saratoga Creek (fig. 1), and nearest to the Saratoga Creek gaging station.

Spatial Variability

Figures 12 through 20 display points for all water year 1997 water quality data at each site, with lines of: median data values for the water year, median data values for the high flow periods of the water year (November 20, 1996 through March 3, 1997), and median data values for the base flow periods of the water year (October 1, 1996 through November 19, 1996 and March 4, 1997 through September 30, 1997).

In Saratoga Creek the median values for specific conductance, alkalinity, sulfate, calcium and magnesium concentrations increase from SA6 to SA5, decrease from SA5 to SA4, increase from SA4 downstream through SA2, then sharply drop by SA1. Median values for sodium and chloride follow a spatial pattern similar to the other constituents in Saratoga Creek; however, values increase in concentration from SA2 downstream to SA1. High-flow median values tend to be lower and change less between sites than water year median values. Low-flow median values tend to be higher and change more between sites than water year median values.

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Ward, J.R. and Harr, C.A., 1990, Methods for collection and processing of surface-water and bed-material samples for physical and chemical analysis: U.S. Geological Survey Open-File Report 90-140, 71 p.

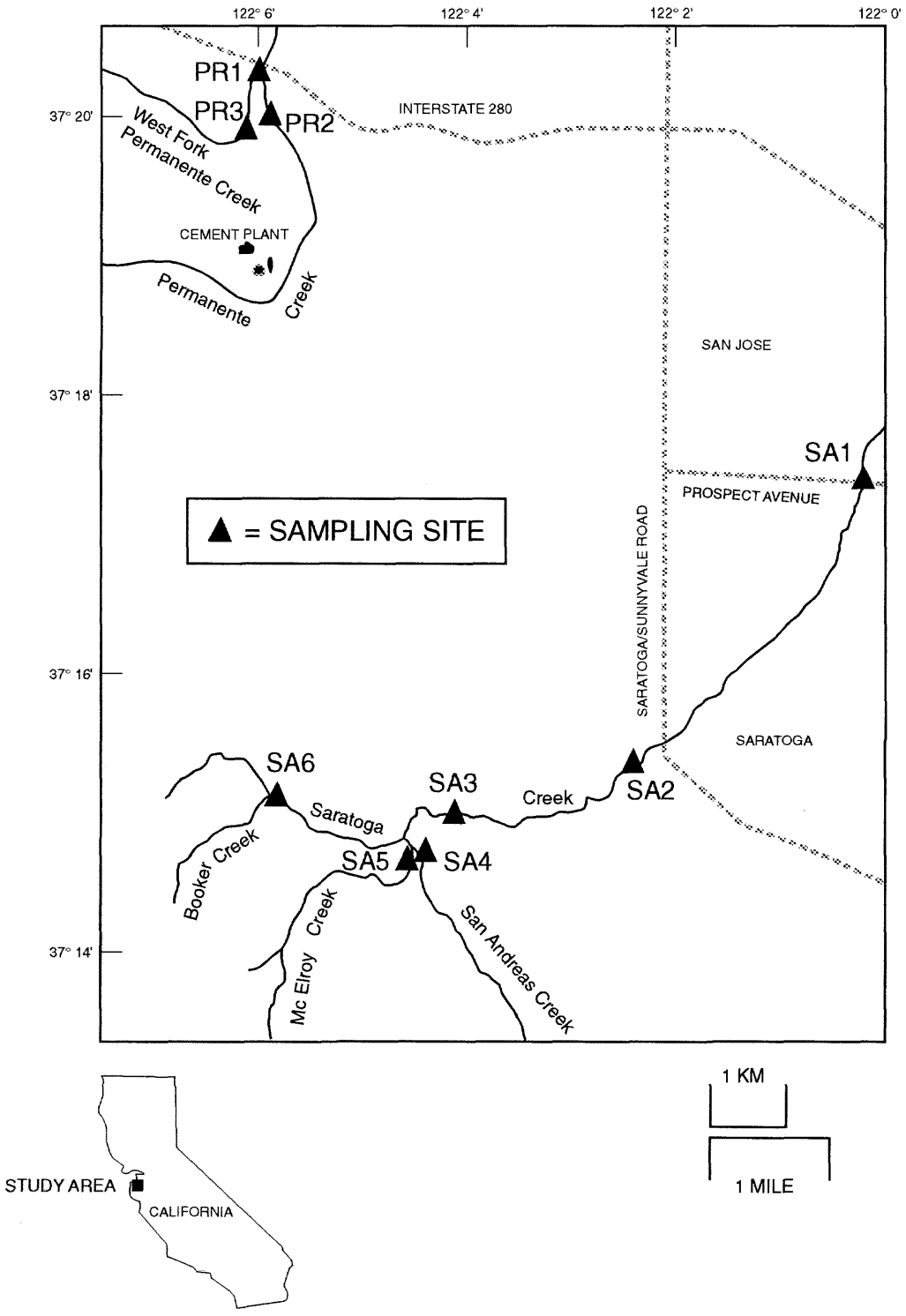

Figure 1. Location of study area

Table 1. Permanente and Saratoga Creek discharge on sampling dates [ft^3/s, cubic feet per second]

Date	Permanente Creek Discharge (ft^3/s)	Saratoga Creek Discharge (ft^3/s)
10/1/96	0	1.5
10/24/96	0	1.6
11/5/96	0	1.6
11/20/96	2.2	6.5
12/3/96	0.28	0.47
12/12/96	9.8	32
1/2/97	142	349
1/13/97	16	17
1/27/97	86	139
2/5/97	29	33
3/3/97	12	8.3
4/1/97	9.4	2.8
5/2/97	13	1.6
6/10/97	0.15	3.2
7/8/97	0	0.61
8/15/97	0	0.49
9/18/97	0	0.16

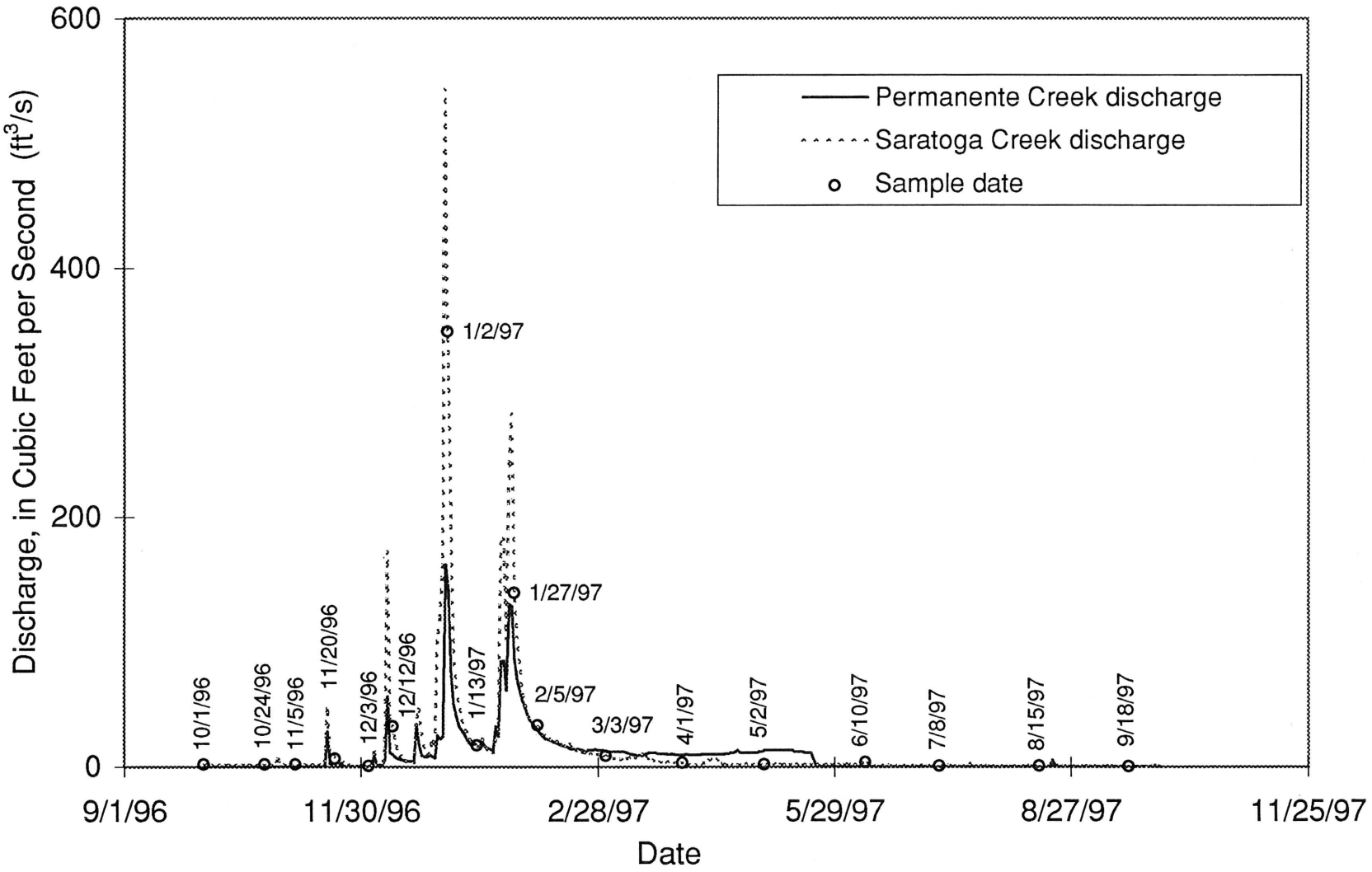

Figure 2. Permanente and Saratoga Creek hydrograph for water year 1997

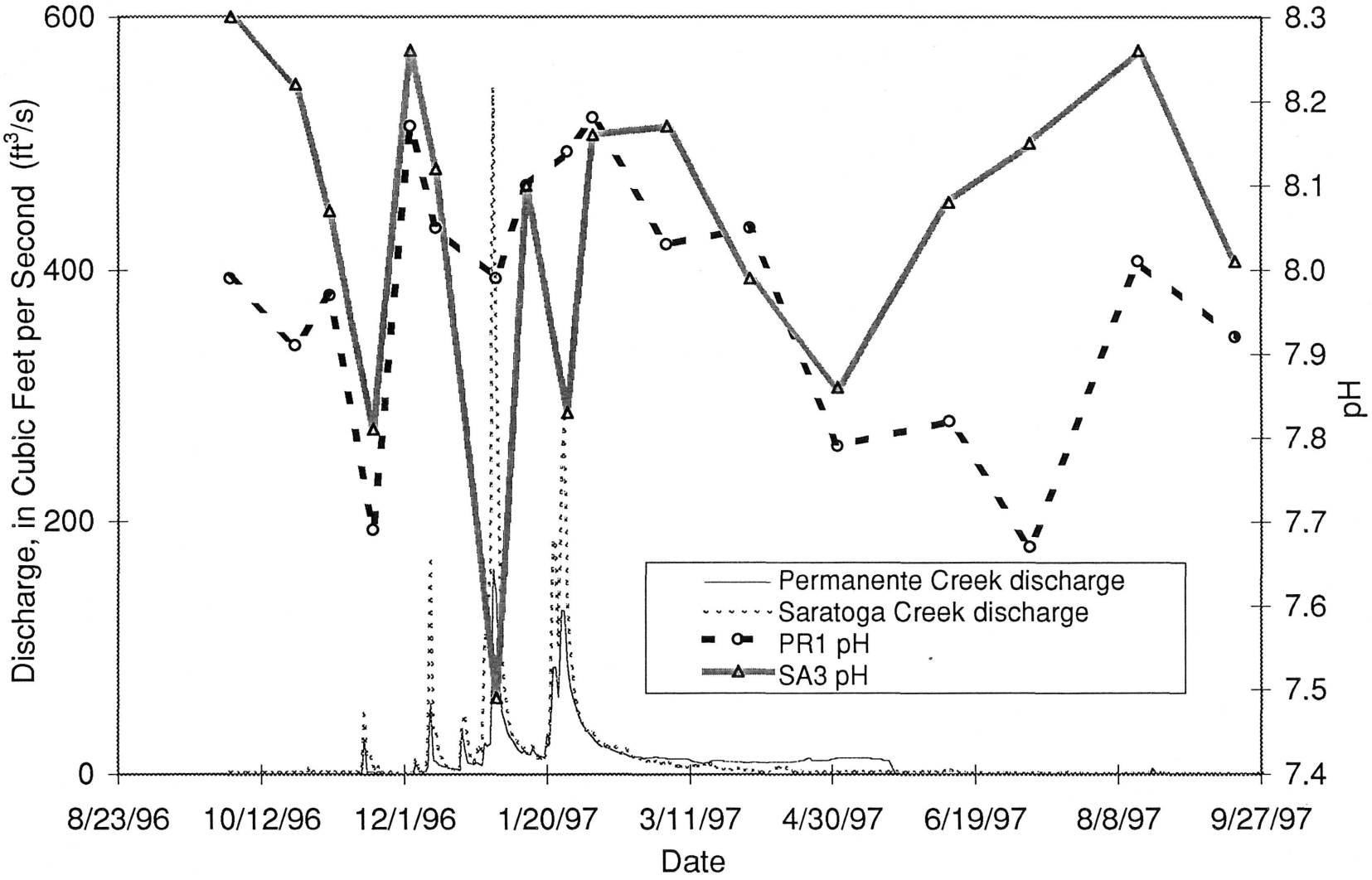

Figure 3. Temporal variability of pH at PR1 and SA3, hydrograph of Permanente and Saratoga Creeks

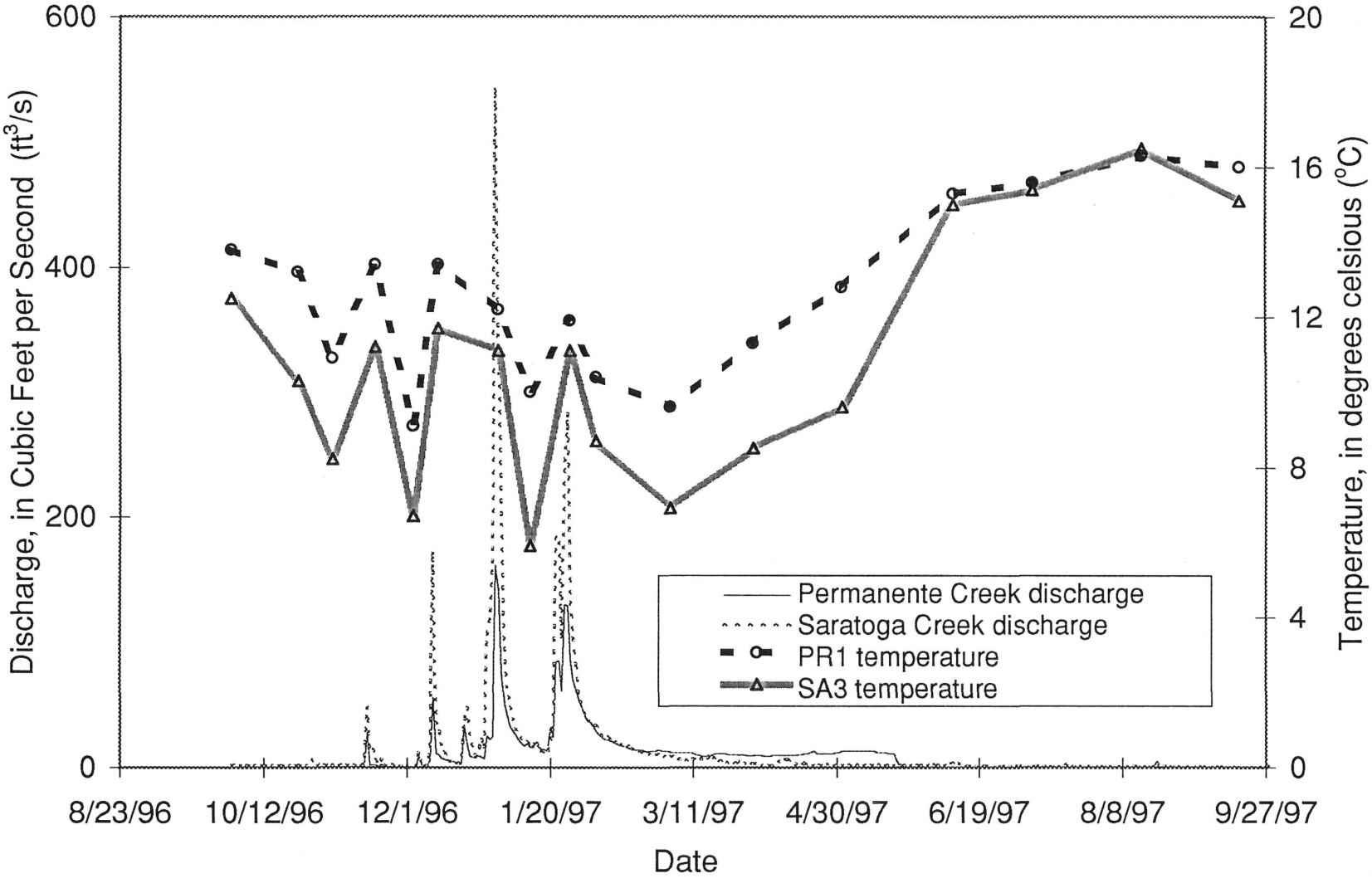

Figure 4. Temporal variability of temperature at PR1 and SA3, hydrograph of Permanente and Saratoga Creeks

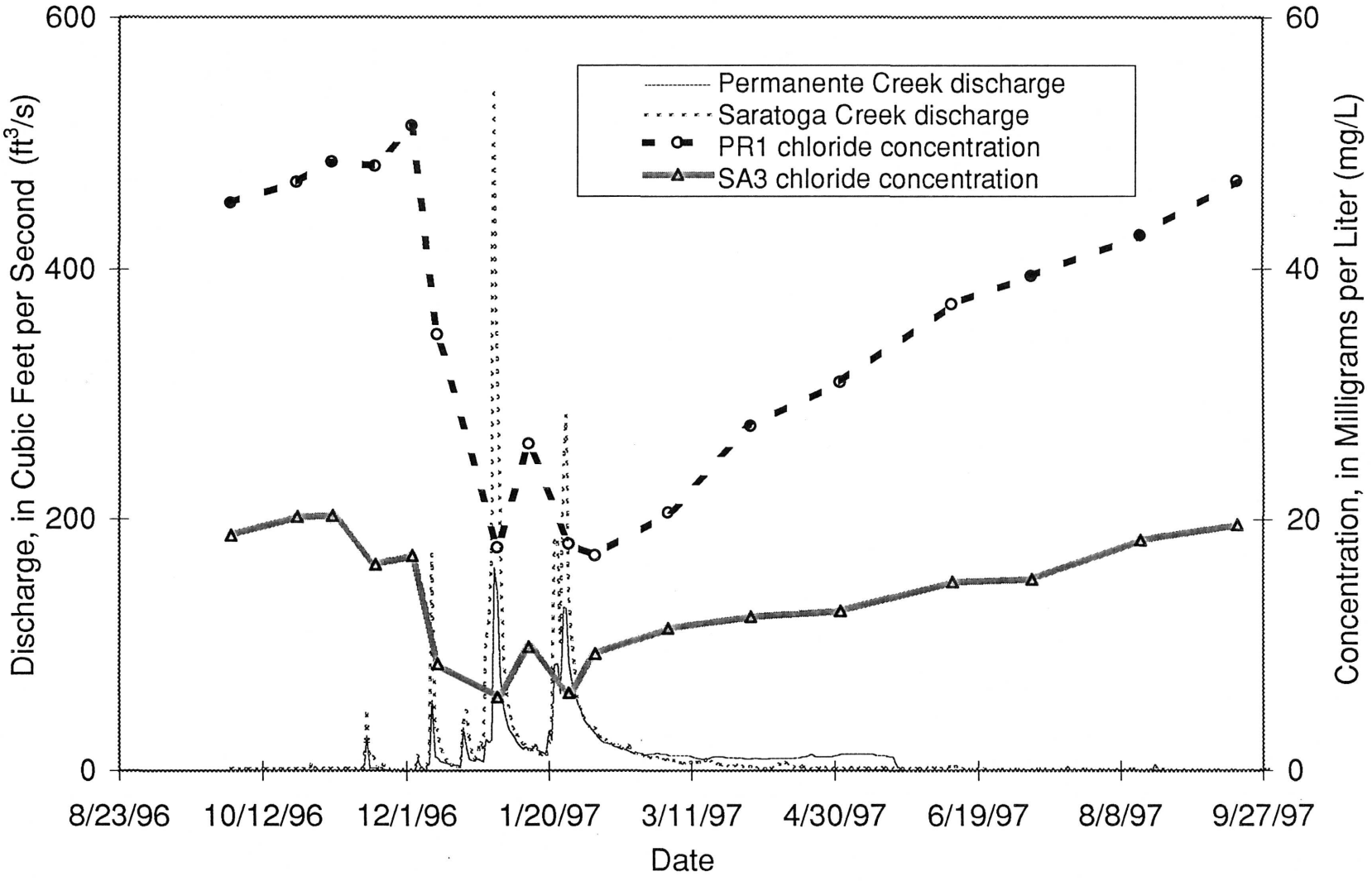

Figure 5. Temporal variability of chloride concentration at PR1 and SA3, hydrograph of Permanente and Saratoga Creeks

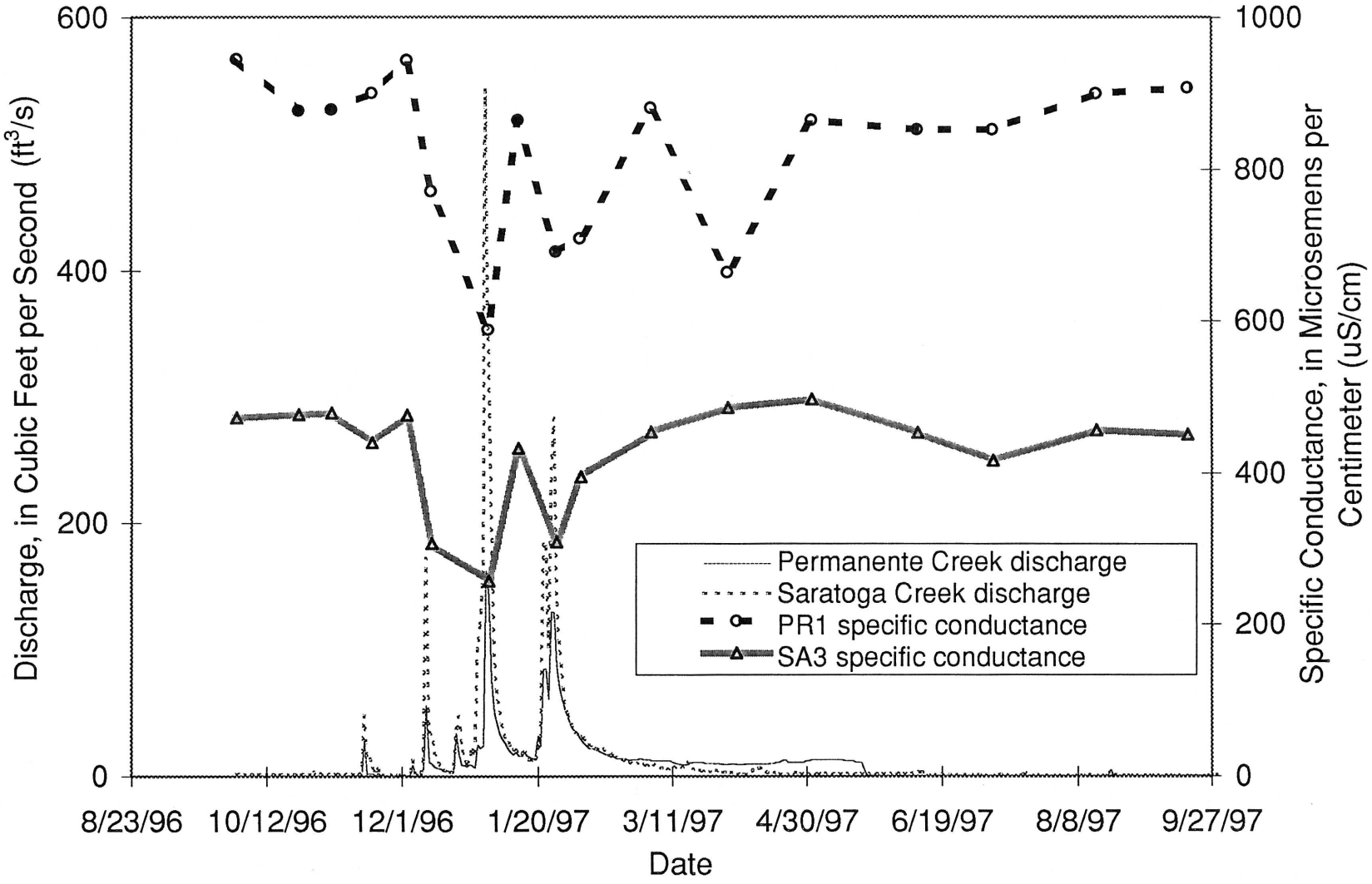

Figure 6. Temporal variability of specific conductance at PR1 and SA3, hydrograph of Permanente and Saratoga Creeks

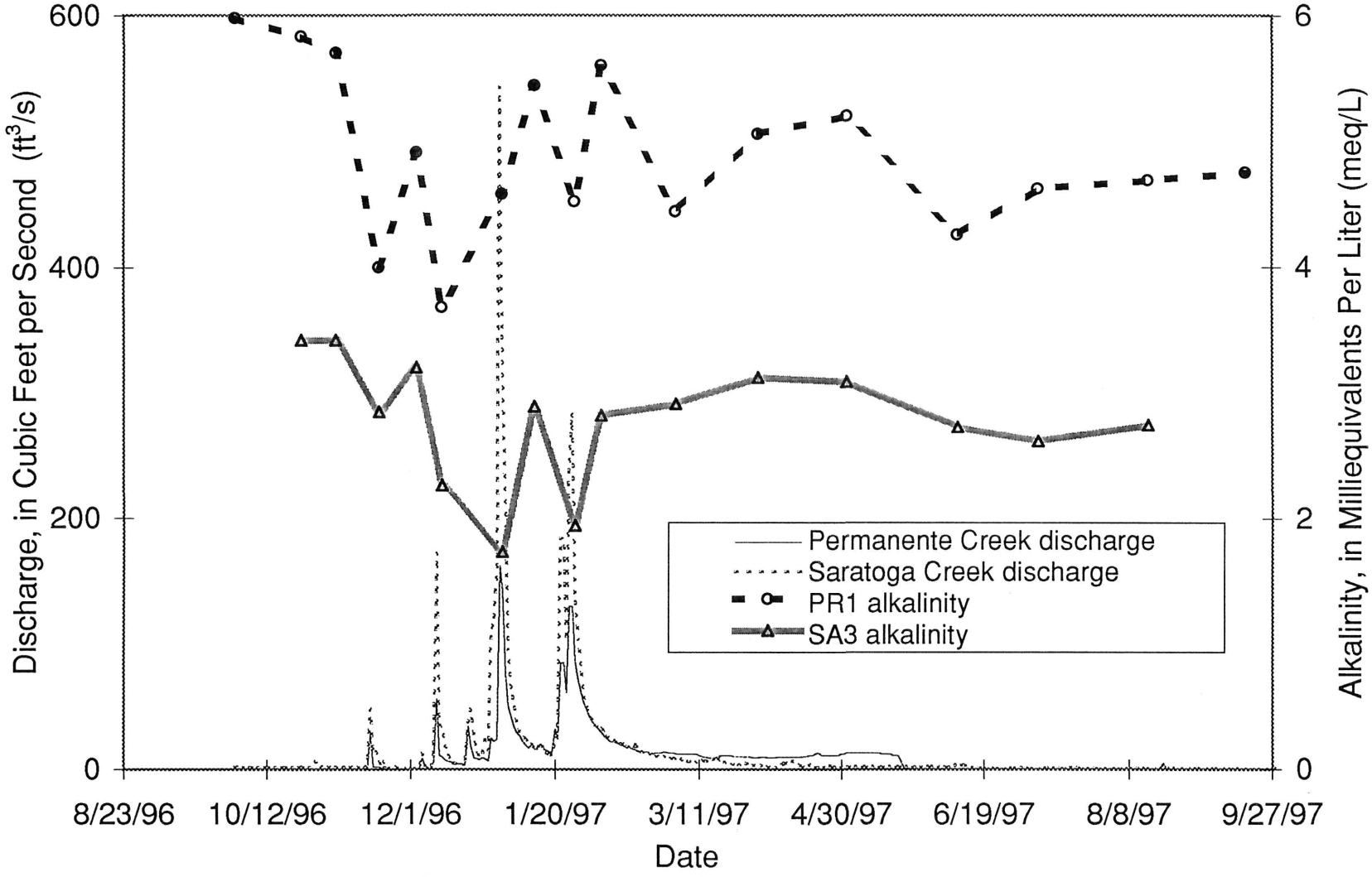

Figure 7. Temporal variability of alkalinity at PR1 and SA3, hydrograph of Permanente and Saratoga Creeks

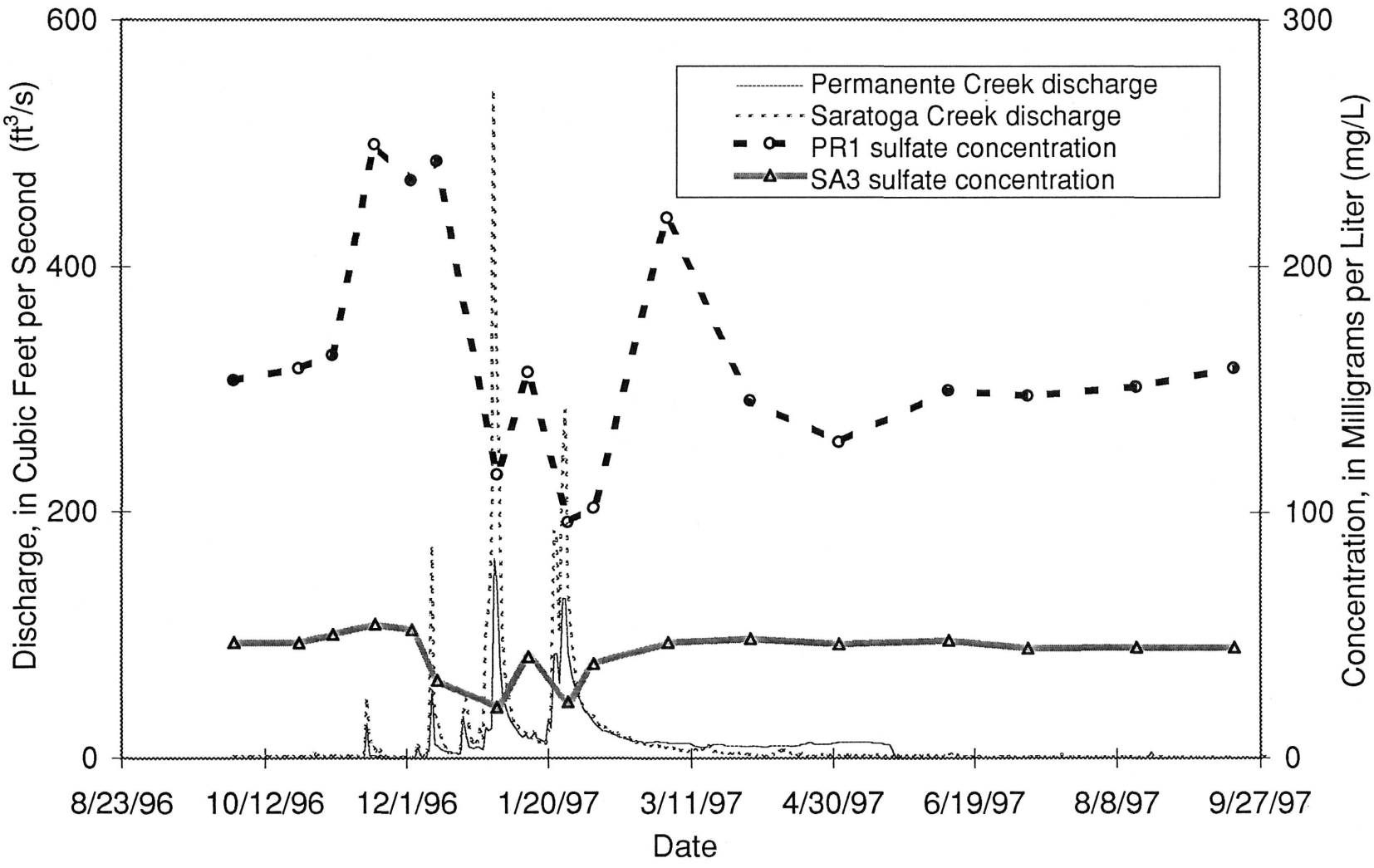

Figure 8. Temporal variability of sulfate concentration at PR1 and SA3, hydrograph of Permanente and Saratoga Creeks

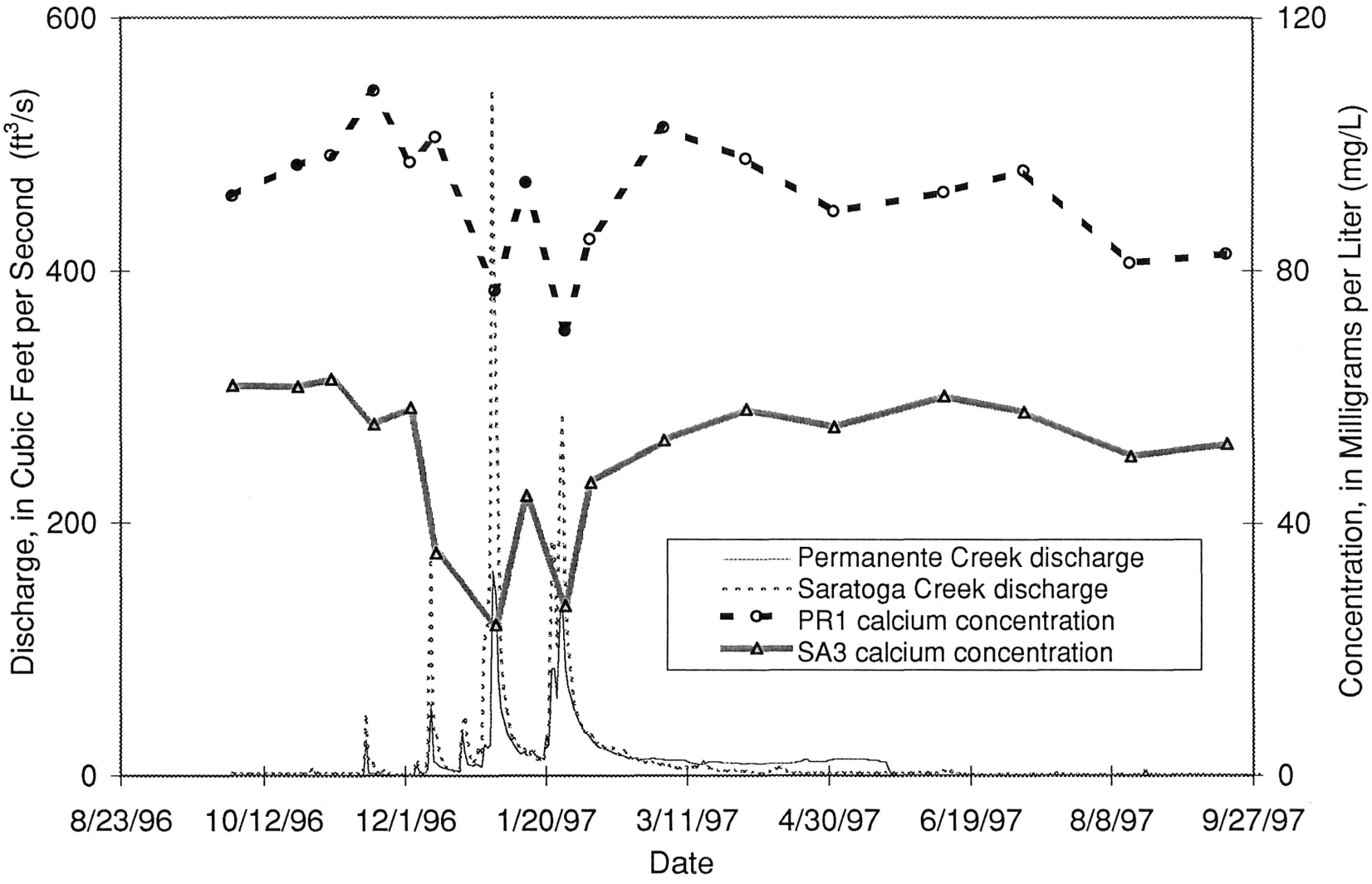

Figure 9. Temporal variability of calcium concentration at PR1 and SA3, hydrograph of Permanente and Saratoga Creeks

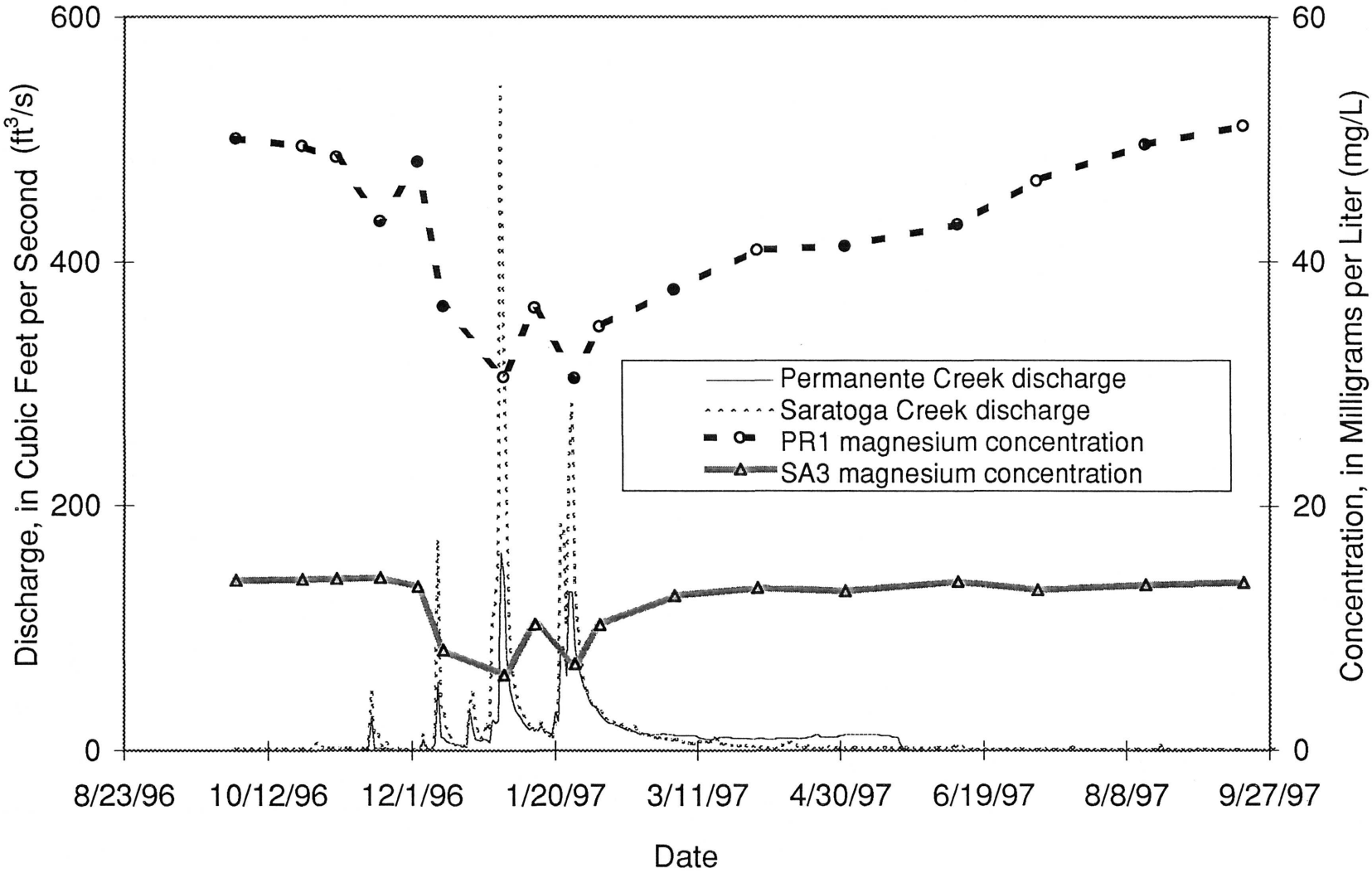

Figure 10. Temporal variability of magnesium concentration at PR1 and SA3, hydrograph of Permanente and Saratoga Creeks

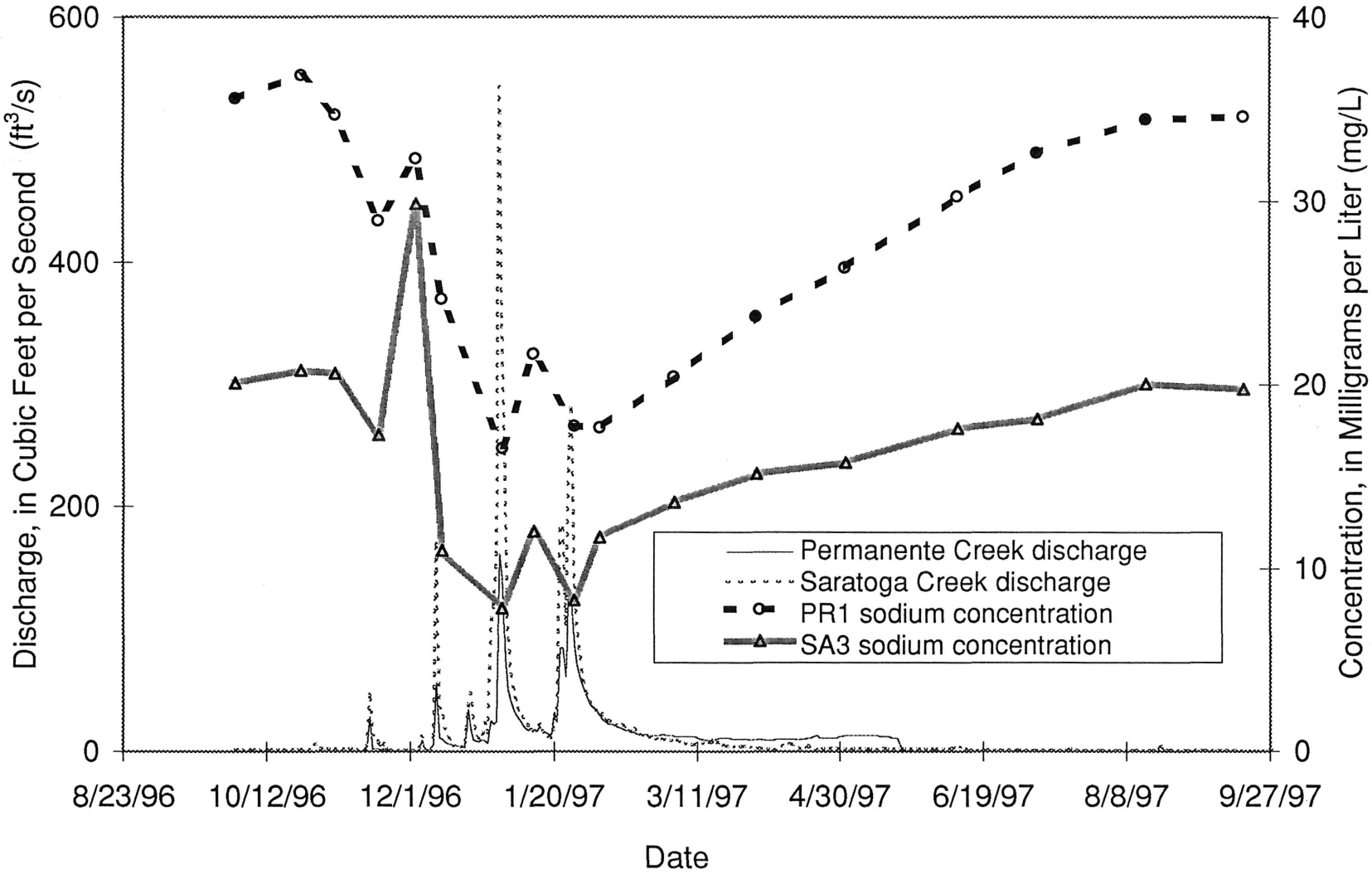

Figure 11. Temporal variability of sodium concentration at PR1 and SA3, hydrograph of Permanente and Saratoga Creeks

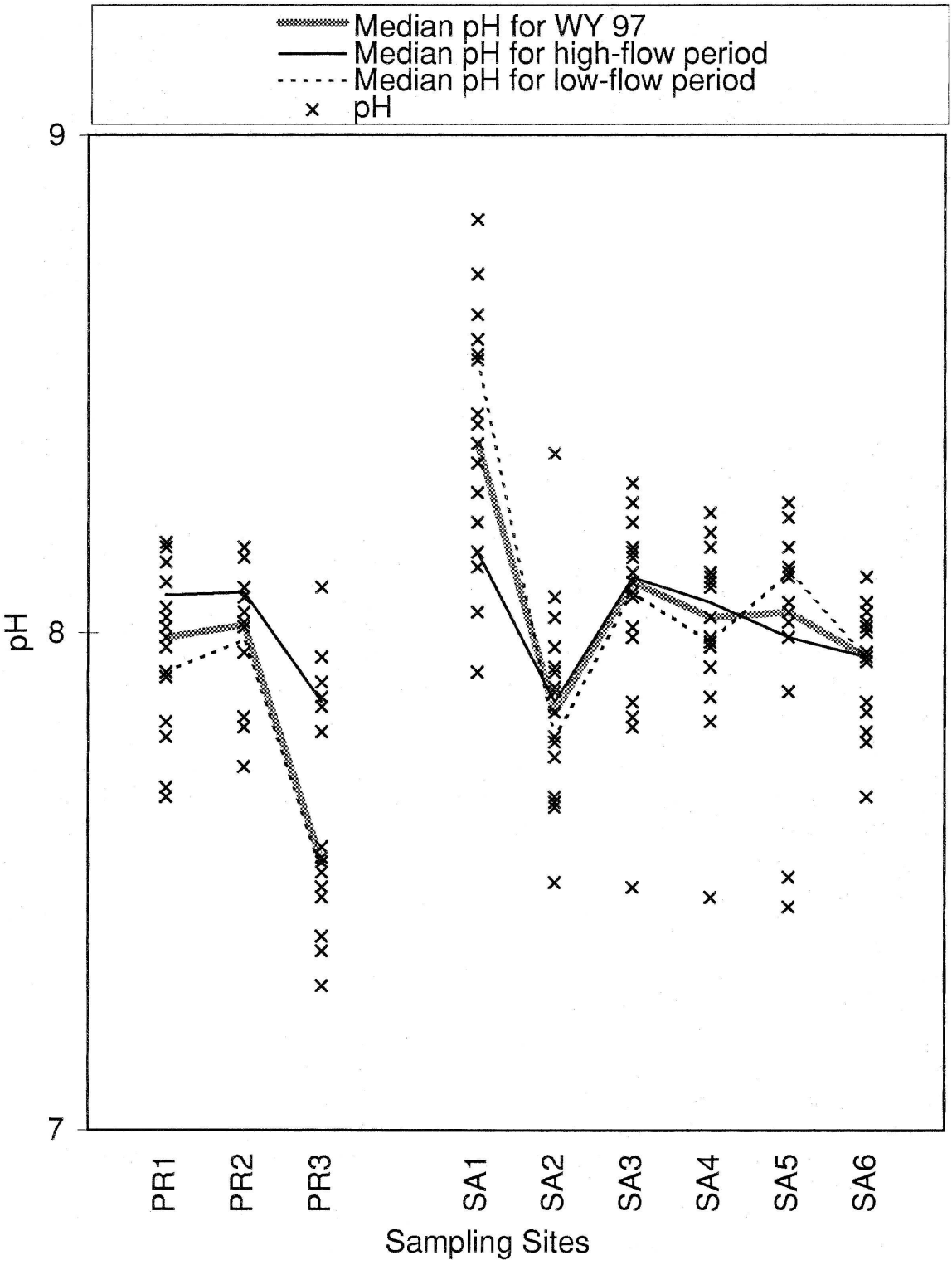

Figure 12. Spatial variability of pH

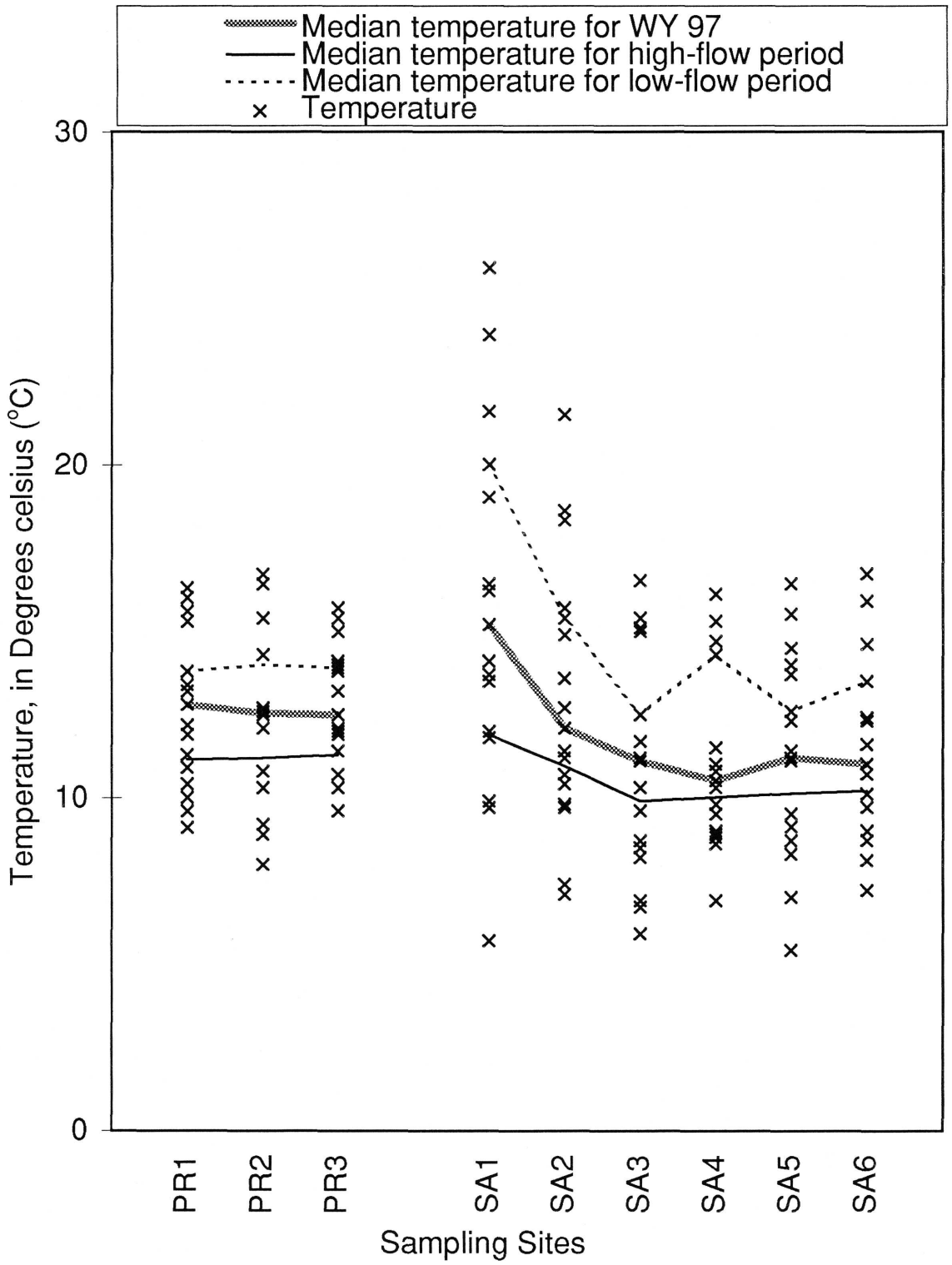

Figure 13. Spatial variability of Temperature

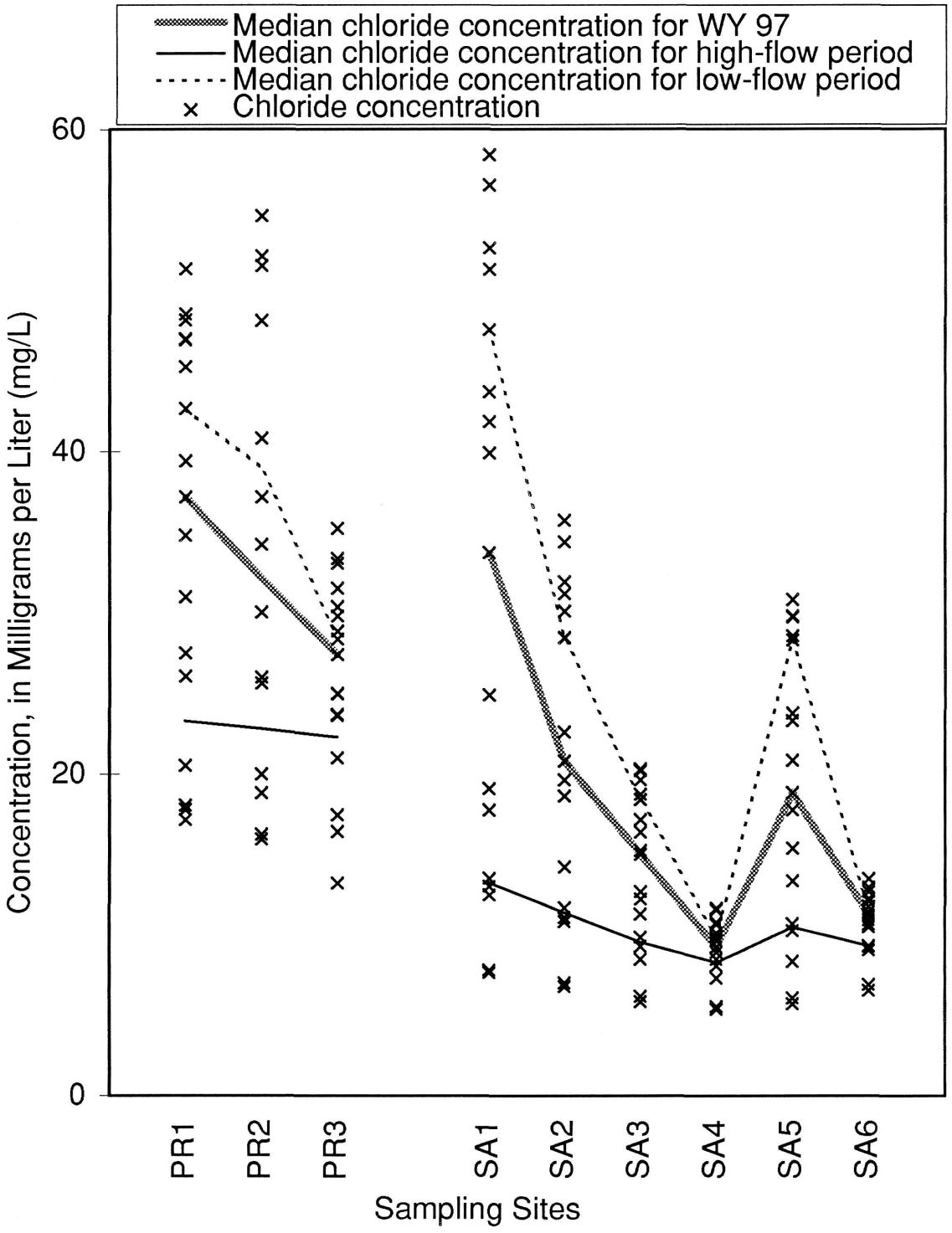

Figure 14. Spatial variability of chloride concentration

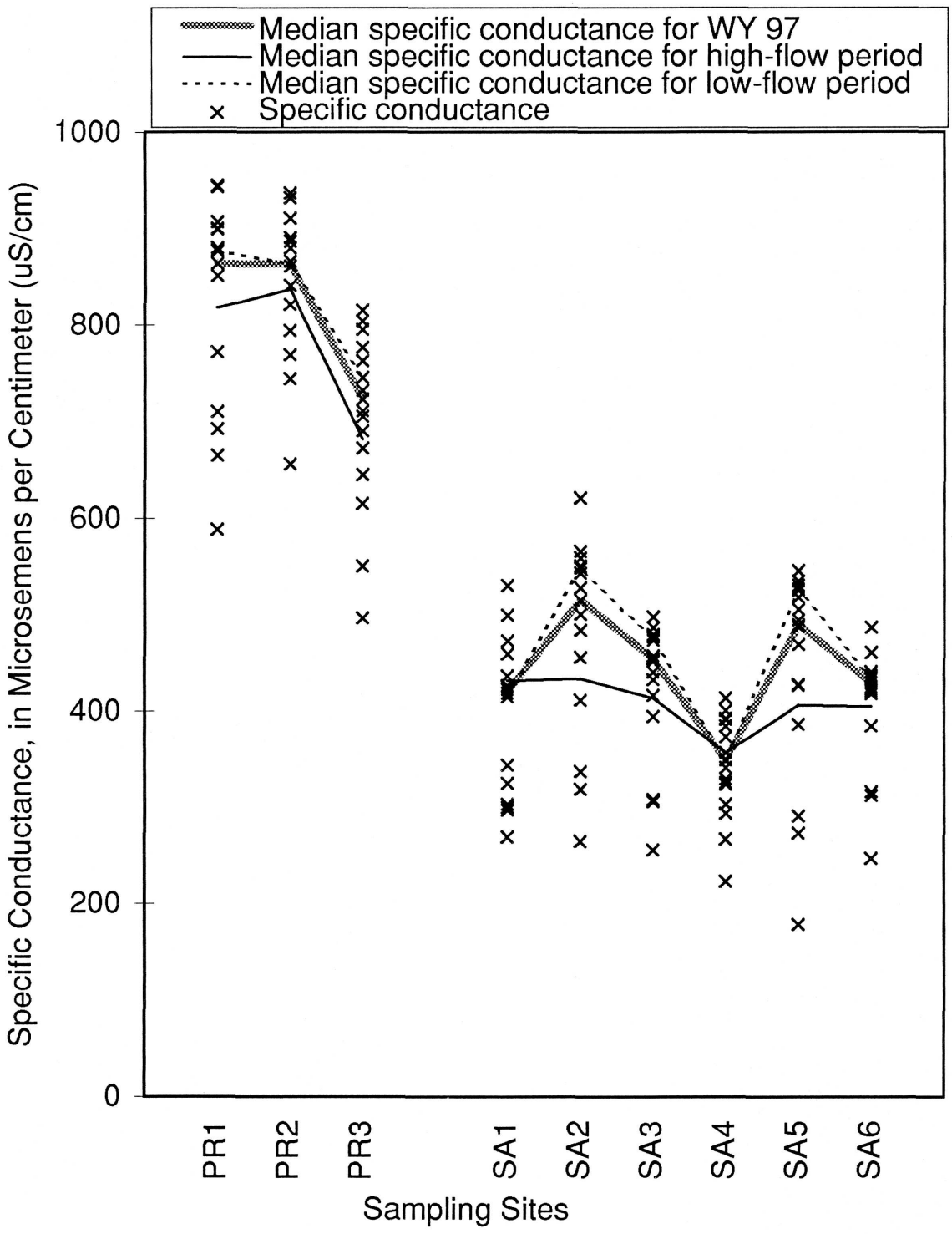

Figure 15. Spatial variability of specific conductance

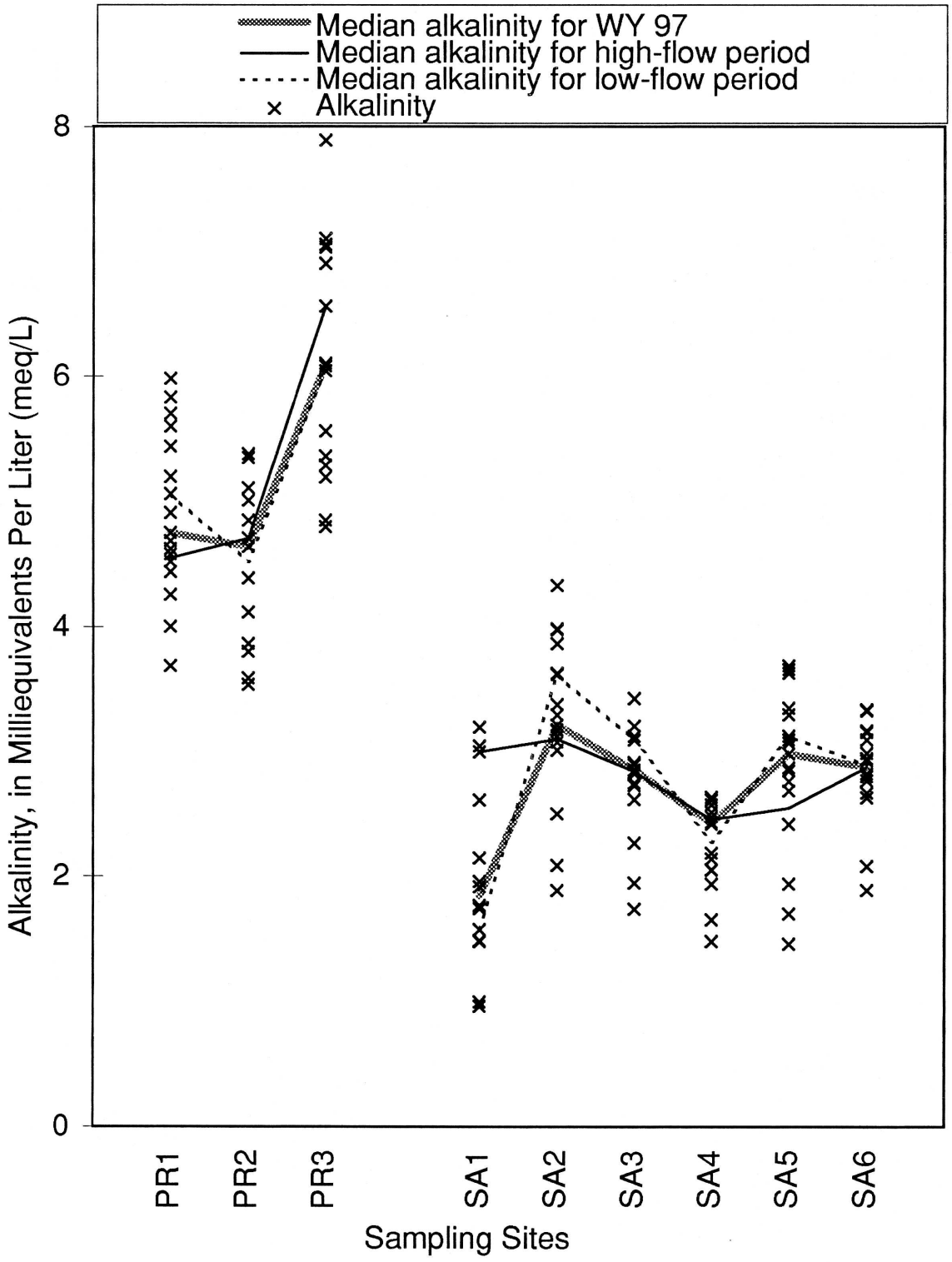

Figure 16. Spatial variability of alkalinity

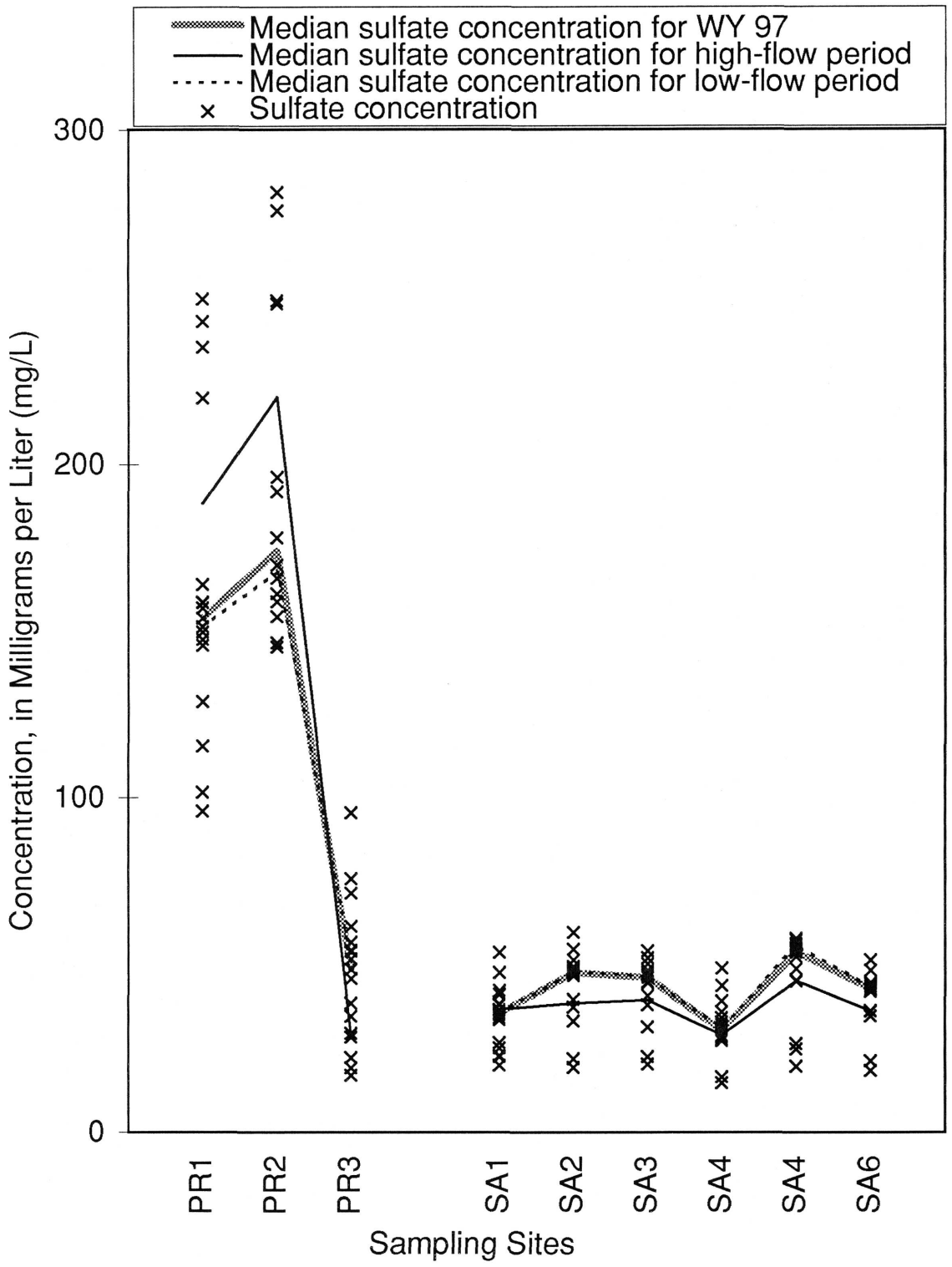

Figure 17. Spatial variability of sulfate concentration

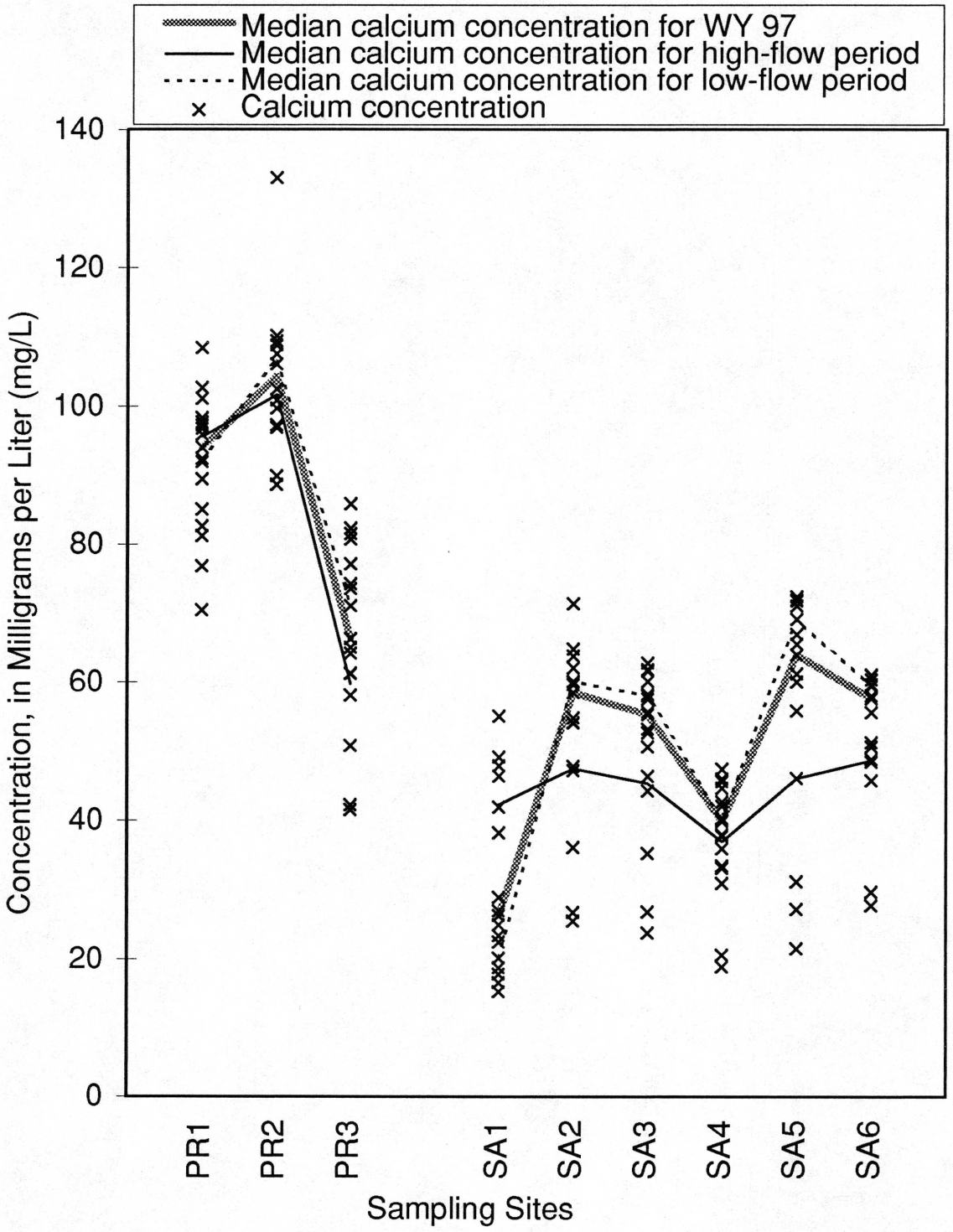

Figure 18. Spatial variability of calcium concentration

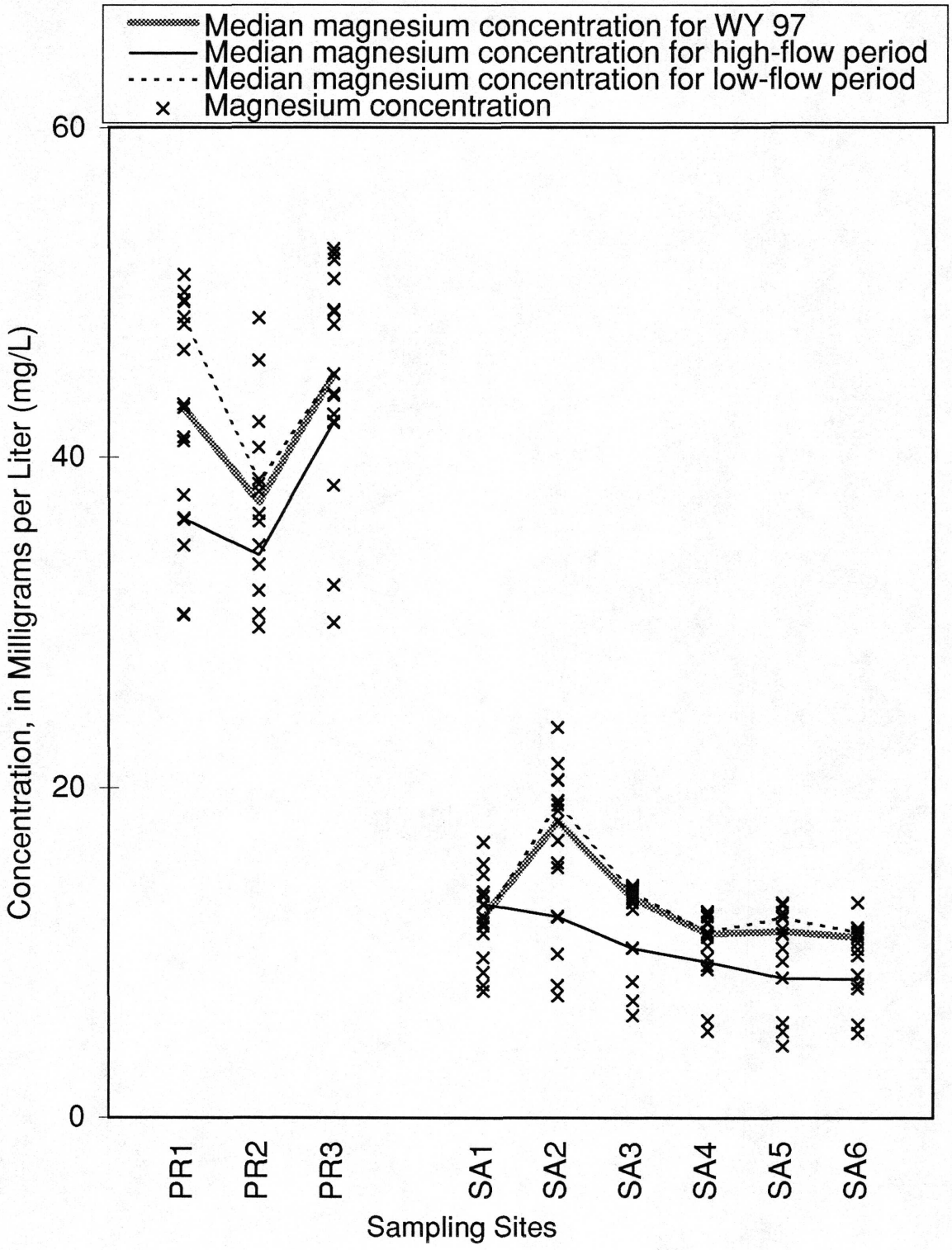

Figure 19. Spatial variability of magnesium concentration

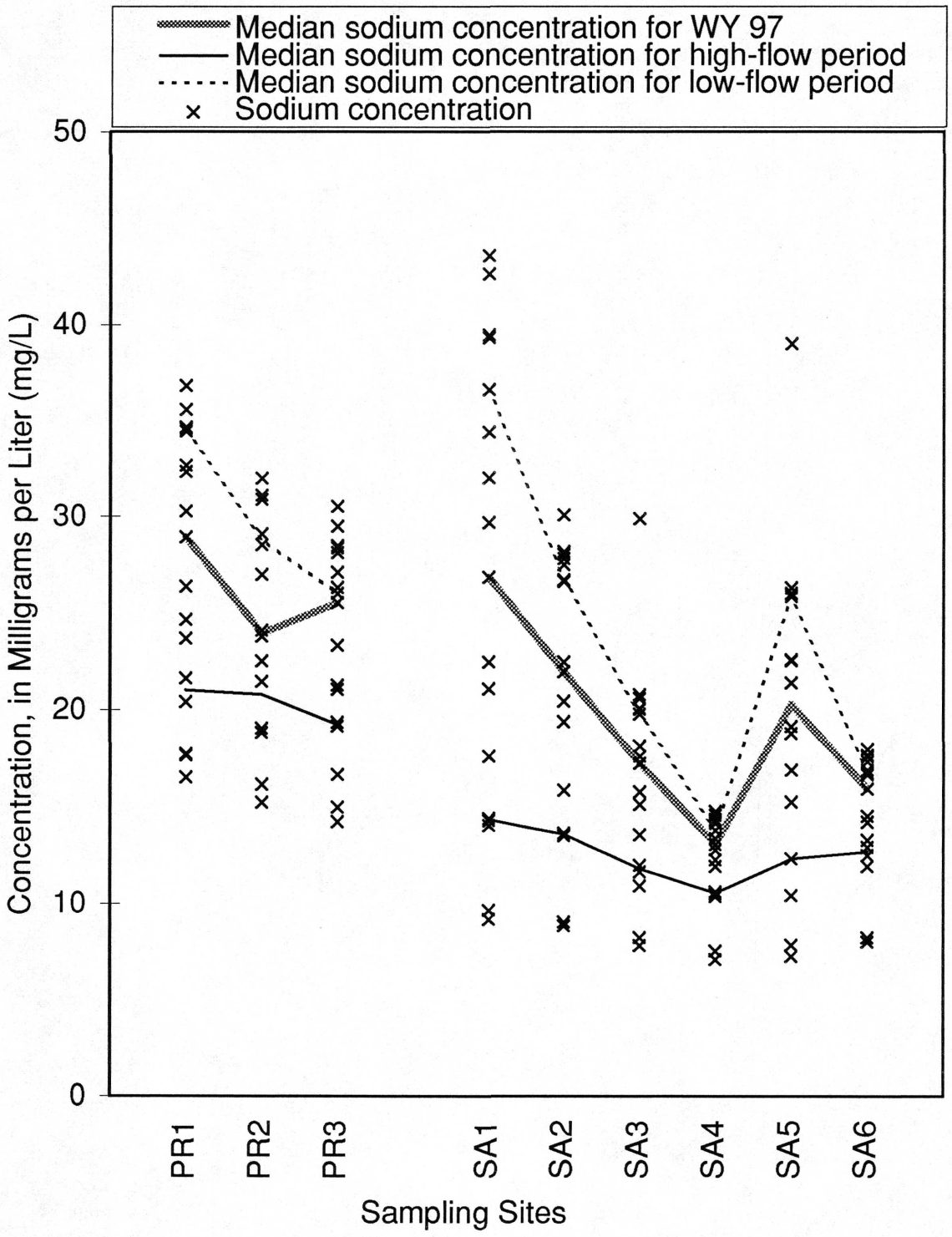

Figure 20. Spatial variability of sodium concentration

Table 2. Measurements from Permanente and Saratoga Creek
October 1, 1996
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2*	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	7.99	---	7.54	8.72	8.03	8.30	8.24	8.04	8.11
TEMP (C)	13.8	---	13.9	20.0	13.6	12.5	14.3	12.6	13.5
COND (uS/cm)	950	---	800	420	550	470	360	540	430
TSS (mg/L)	0.0	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALK (meq/L)	5.98	---	6.90	1.75	3.86	---	2.57	3.65	---
Cl (mg/L)	45	---	30	51	28	19	11	29	11
SO4 (mg/L)	154	---	54	37	49	47	33	54	43
Ca (mg/L)	92	---	77	23	64	62	40	72	60
Mg (mg/L)	50	---	49	13	19	14	12	12	11
Na (mg/L)	36	---	27	40	27	20	14	26	17

* AT PR2 PERMANENTE CREEK WAS FLOWING ONLY THROUGH THE STREAMBED, NO SAMPLE TAKEN

Table 3. Measurements from Permanente and Saratoga Creek
October 24, 1996
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	7.91	8.02	7.52	8.44	7.67	8.22	8.11	8.26	8.11
TEMP (C)	13.2	15.4	13.8	19.0	15.4	10.3	10.3	11.2	12.3
COND (uS/cm)	880	870	760	420	530	480	320	530	430
TSS (mg/L)	3.0	0.7	0.0	2.7	0.0	0.0	0.0	0.0	0.0
ALK (meq/L)	5.83	5.38	7.03	1.48	3.98	3.42	---	3.68	3.33
Cl (mg/L)	47	52	30	58	30	20	11	30	12
SO4 (mg/L)	158	166	57	37	48	47	31	54	43
Ca (mg/L)	97	108	81	19	65	62	40	72	59
Mg (mg/L)	49	41	49	12	19	14	11	12	11
Na (mg/L)	37	31	29	44	28	21	14	26	18

Table 4. Measurements from Permanente and Saratoga Creek
November 5, 1996
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	7.97	8.01	7.57	8.28	7.89	8.07	7.82	8.17	7.84
TEMP (C)	10.9	12.5	11.4	16.4	9.8	8.2	8.9	8.7	9.0
COND (uS/cm)	880	890	780	410	550	480	380	520	440
TSS (mg/L)	0.0	0.0	0.0	3.3	1.0	0.0	0.0	0.0	0.0
ALK (meq/L)	5.70	5.35	7.10	1.47	3.97	3.42	2.63	3.62	3.32
Cl (mg/L)	49	55	32	57	32	20	12	30	12
SO4 (mg/L)	160	180	61	34	51	50	39	55	45
Ca (mg/L)	98	110	81	18	65	63	46	71	61
Mg (mg/L)	49	49	51	11	19	14	13	12	11
Na (mg/L)	35	31	28	43	28	21	15	26	17

Table 5. Measurements from Permanente and Saratoga Creek
November 20, 1996
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	7.69	7.83	7.39	8.22	7.84	7.81	8.03	8.23	8.02
TEMP (C)	13.4	12.7	12.5	13.5	14.9	11.2	11.0	12.3	11.6
COND (uS/cm)	900	910	820	470	480	440	390	430	440
TSS (mg/L)	2.3	5.0	0.0	4.3	2.0	3.0	0	9.7	3.0
ALK (meq/L)	4.00	3.53	7.05	3.04	3.16	2.85	2.57	2.76	3.15
Cl (mg/L)	48	48	33	25	23	16	12	19	13
SO4 (mg/L)	250	280	76	54	55	54	49	49	51
Ca (mg/L)	110	110	74	55	58	56	47	56	61
Mg (mg/L)	43	42	53	15	15	14	12	9.5	13
Na (mg/L)	29	27	30	23	23	17	14	19	17

Table 6. Measurements from Permanente and Saratoga Creek
December 3, 1996
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	8.17	8.07	7.80	8.38	7.65	8.26	8.20	8.02	8.04
TEMP (C)	9.1	8.9	9.6	14.1	10.7	6.7	9.0	9.1	8.1
COND (uS/cm)	940	940	690	430	620	480	390	490	430
TSS (mg/L)	2.0	2.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0
ALK (meq/L)	4.91	4.71	7.05	1.95	4.33	3.20	2.63	3.34	3.16
Cl (mg/L)	51	52	33	44	36	17	12	23	13
SO4 (mg/L)	230	250	71	35	60	52	44	52	48
Ca (mg/L)	97	110	82	23	71	58	46	67	58
Mg (mg/L)	48	46	52	14	24	13	13	11	11
Na (mg/L)	32	32	28	34	30	30	15	23	17

Table 7. Measurements from Permanente and Saratoga Creek
December 12, 1996
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	8.05	8.01	7.47	8.16	7.88	8.12	8.09	7.99	7.96
TEMP (C)	13.4	14.3	14.0	13.7	12.7	11.7	11.5	11.4	12.4
COND (uS/cm)	770	790	800	340	340	310	290	270	310
TSS (mg/L)	340	300	0.0	40	34	30	14	27	9.0
ALK (meq/L)	3.68	3.58	7.89	3.00	2.50	2.26	2.18	1.93	2.92
Cl (mg/L)	35	34	35	12	11	8.5	7.3	8.3	9.3
SO4 (mg/L)	240	250	95	34	33	32	27	27	36
Ca (mg/L)	100	100	86	38	36	35	31	31	48
Mg (mg/L)	36	36	52	12	9.9	8.2	9.7	5.7	8.6
Na (mg/L)	25	24	31	14	14	11	11	10	13

Table 8. Measurements from Permanente and Saratoga Creek
January 2, 1997
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	7.99	8.04	7.85	8.04	7.78	7.49	7.87	7.45	6.94
TEMP (C)	12.2	16.7	13.2	12.0	12.1	11.1	10.5	13.7	10.7
COND (uS/cm)	590	660	500	270	270	260	220	180	250
TSS (mg/L)	500	750	76	510	320	250	160	130	45
ALK (meq/L)	4.58	---	4.85	1.91	1.88	1.73	1.47	1.45	1.88
Cl (mg/L)	18	16	17	7.6	6.8	5.8	5.4	5.7	6.5
SO4 (mg/L)	120	160	19	20	19	21	15	20	19
Ca (mg/L)	77	90	42	25	26	24	19	22	28
Mg (mg/L)	31	31	30	7.6	7.3	6.2	5.2	4.3	5.1
Na (mg/L)	17	15	15	9.2	8.8	7.8	7.1	7.2	8.0

Table 9. Measurements from Permanente and Saratoga Creek
January 13, 1997
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	8.1	8.15	7.87	8.13	7.92	8.10	7.99	7.99	7.94
TEMP (C)	10.0	8.0	10.7	5.7	7.1	5.9	9.5	5.4	7.2
COND (uS/cm)	860	880	700	460	460	430	370	430	420
TSS (mg/L)	17	36	2.3	6.7	9.0	0.0	2.0	2.0	0.0
ALK (meq/L)	5.44	4.85	6.56	3.19	3.12	2.89	2.51	2.68	2.94
Cl (mg/L)	26	26	24	14	12	9.8	8.5	11	9.3
SO4 (mg/L)	160	190	28	41	40	41	30	45	36
Ca (mg/L)	94	100	58	48	48	44	36	46	46
Mg (mg/L)	36	34	42	13	12	10	9.2	8.5	8.1
Na (mg/L)	22	23	19	14	14	12	10	12	12

Table 10. Measurements from Permanente and Saratoga Creek
January 27, 1997
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	8.14	8.17	7.90	7.92	7.78	7.83	7.47	7.51	7.67
TEMP (C)	11.9	12.1	11.9	11.8	11.2	11.1	10.8	11.1	11.0
COND (uS/cm)	690	770	550	330	320	310	270	290	320
TSS (mg/L)	270	270	140	210	130	68	110	27	30
ALK (meq/L)	4.52	5.11	4.80	2.14	2.08	1.94	1.64	1.69	2.07
Cl (mg/L)	18	20	13	7.8	7.0	6.2	5.5	6.1	6.9
SO4 (mg/L)	96	150	17	23	22	23	17	25	22
Ca (mg/L)	70	89	42	27	27	27	21	27	30
Mg (mg/L)	30	30	32	8.0	8.0	7.1	5.9	5.2	5.6
Na (mg/L)	18	19	14	9.6	9.0	8.2	7.5	7.8	8.2

Table 11. Measurements from Permanente and Saratoga Creek
February 5, 1997
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	8.18	8.17	8.09	8.16	8.07	8.16	8.17	8.06	8.06
TEMP (C)	10.4	10.3	10.7	9.9	9.7	8.7	8.6	8.7	9.7
COND (uS/cm)	710	740	610	440	410	390	340	390	380
TSS (mg/L)	34	63	16	38	130	260	9.3	1100	6.0
ALK (meq/L)	5.60	5.01	6.10	3.19	3.07	2.82	2.43	2.41	2.82
Cl (mg/L)	17	16	16	13	11	9.3	8.1	10	9.0
SO4 (mg/L)	100	150	22	38	38	38	28	45	35
Ca (mg/L)	85	100	51	49	47	46	38	---	49
Mg (mg/L)	35	32	38	13	12	10	9.0	---	7.8
Na (mg/L)	18	16	17	14	14	12	11	---	13

Table 12. Measurements from Permanente and Saratoga Creek
March 3, 1997
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	8.03	8.09	7.95	8.64	8.36	8.17	8.12	7.88	7.80
TEMP (C)	9.6	9.2	10.3	9.7	7.4	6.9	6.9	7.0	8.1
COND (uS/cm)	880	930	670	500	480	450	390	470	440
TSS (mg/L)	2.0	3.7	2.3	2.7	2.3	2.7	0.0	2.7	2.7
ALK (meq/L)	4.44	3.86	---	---	3.17	2.91	2.47	2.84	2.82
Cl (mg/L)	21	19	21	18	14	11	9.2	13	11
SO4 (mg/L)	220	280	30	48	47	47	34	56	43
Ca (mg/L)	103	133	61	46	55	53	43	60	56
Mg (mg/L)	38	35	42	17	15	13	11	10	9.8
Na (mg/L)	20	19	19	18	16	14	12	15	13

Table 13. Measurements from Permanente and Saratoga Creek
April 1, 1997
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	8.05	8.01	7.52	8.56	7.97	7.99	7.98	8.12	7.86
TEMP (C)	11.3	10.8	12.0	15.2	10.4	8.5	8.8	8.3	8.7
COND (uS/cm)	660	890	640	530	540	490	410	510	460
TSS (mg/L)	2.3	3.3	1.7	2.3	2.3	2.7	0.0	3.3	2.7
ALK (meq/L)	5.06	4.39	6.04	2.61	3.61	3.12	2.61	3.09	2.98
Cl (mg/L)	28	26	24	42	19	12	9.2	15	11
SO4 (mg/L)	150	200	35	42	49	48	36	58	44
Ca (mg/L)	98	108	64	42	60	58	45	64	58
Mg (mg/L)	41	37	44	15	18	13	12	11	10
Na (mg/L)	24	22	21	32	19	15	13	17	14

Table 14. Measurements from Permanente and Saratoga Creek
May 2, 1997
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	7.79	7.81	7.55	8.34	7.79	7.86	7.93	8.11	8.01
TEMP (C)	12.8	12.6	12.1	16.2	11.4	9.6	9.8	9.5	10.1
COND (uS/cm)	860	860	730	---	570	500	400	550	490
TSS (mg/L)	---	2.3	2.3	0.0	0.0	1.3	1.7	---	2.0
ALK (meq/L)	5.20	4.64	6.08	1.76	3.62	3.09	2.41	3.29	3.09
Cl (mg/L)	31	30	25	53	20	13	9.0	18	11
SO4 (mg/L)	130	150	39	36	48	46	32	57	45
Ca (mg/L)	89	97	66	26	60	55	40	65	58
Mg (mg/L)	41	38	43	12	18	13	11	11	11
Na (mg/L)	26	24	21	39	20	16	12	19	15

Table 15. Measurements from Permanente and Saratoga Creek
June 10, 1997
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	7.82	7.73	7.47	8.83	7.93	8.08	8.10	8.04	8.00
TEMP (C)	15.3	16.4	14.1	20.0	15.7	15.0	14.3	14.0	13.5
COND (uS/cm)	850	840	720	420	500	450	350	490	420
TSS (mg/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALK (meq/L)	4.25	3.80	5.19	1.57	3.01	2.73	2.13	2.87	2.63
Cl (mg/L)	37	37	25	48	21	15	10	21	11
SO4 (mg/L)	150	170	46	38	48	48	31	56	44
Ca (mg/L)	92	97	71	29	60	60	42	69	60
Mg (mg/L)	43	39	44	12	17	14	12	12	11
Na (mg/L)	30	29	23	37	22	18	13	21	16

Table 16. Measurements from Permanente and Saratoga Creek
July 8, 1997
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	7.67	7.96	7.36	8.59	7.66	8.15	8.03	8.13	7.94
TEMP (C)	15.6	16.4	15.0	25.9	18.6	15.4	15.3	15.5	15.9
COND (uS/cm)	850	820	710	300	520	420	300	490	420
TSS (mg/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALK (meq/L)	4.62	4.11	5.29	0.99	3.21	2.61	1.93	2.98	2.67
Cl (mg/L)	39	41	27	40	28	15	9.2	24	11
SO4 (mg/L)	150	160	49	25	48	45	29	56	44
Ca (mg/L)	96	110	74	17	62	58	38	72	60
Mg (mg/L)	47	38	45	8.8	20	13	10	12	11
Na (mg/L)	33	29	26	30	27	18	13	23	17

Table 17. Measurements from Permanente and Saratoga Creek
August 15, 1997
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	8.01	---	7.49	8.42	7.75	8.26	7.97	8.23	7.95
TEMP (C)	16.3	---	15.7	23.9	21.5	16.5	16.1	16.4	16.7
COND (uS/cm)	900	---	740	300	550	460	330	530	430
TSS (mg/L)	0.0	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALK (meq/L)	4.69	---	5.36	0.96	3.29	2.74	2.04	3.06	2.76
Cl (mg/L)	43	---	28	34	31	18	9.8	28	12
SO4 (mg/L)	150	---	52	23	47	45	29	56	42
Ca (mg/L)	81	---	61	15	54	51	33	61	51
Mg (mg/L)	50	---	45	9.7	20	14	11	13	11
Na (mg/L)	34	---	26	27	28	20	14	26	18

* AT PR2 PERMANENTE CREEK WAS FLOWING ONLY THROUGH THE STREAMBED, NO SAMPLE TAKEN

Table 18. Measurements from Permanente and Saratoga Creek
September 19, 1997
Site locations.-- See Figure 1. and Description of Study Area

	SITE								
MEASUREMENT	PR1	PR2	PR3	SA1	SA2	SA3	SA4	SA5	SA6
pH	7.92	---	7.29	8.55	7.50	8.01	7.82	8.04	7.78
TEMP (C)	16.0	---	15.4	21.6	18.3	15.1	14.7	14.5	14.6
COND (uS/cm)	910	---	760	300	560	450	330	530	420
TSS (meq/L)	0.0	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALK (mg/L)	4.75	---	5.56	1.73	3.37	---	2.05	3.12	2.80
Cl (mg/L)	47	---	29	19	34	20	10	31	13
SO4 (mg/L)	160	---	54	27	47	45	29	55	42
Ca (mg/L)	83	---	65	20	54	53	34	64	51
Mg (mg/L)	51	---	48	14	21	14	11	13	12
Na (mg/L)	35	---	26	21	28	20	14	39	18

* AT PR2 PERMANENTE CREEK WAS FLOWING ONLY THROUGH THE STREAMBED, NO SAMPLE TAKEN