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NATIONAL PERFORMANCE AUDIT PROGRAM
AMBIENT AIR AUDITS OF ANALYTICAL PROFICIENCY
-1986-

by

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ABSTRACT

This report presents the results of the U.S. Environmental Protection Agency's 1986 National Ambient Air Performance Audit Program by pollutant and by analytical method. Semiannual audits were conducted for Pb, NO_3^- and $SO_4^=$ on filter strips and acid rain. Annual audits were conducted for CO and high-volume sampler flow rate. Continuous SO_2 monitors were audited throughout the year, with no monitor being audited more than once. The results for each 1986 audit are presented in tabular form for each concentration level. The overall performance for all participants for each audit conducted since the beginning of the program is also shown graphically. For the most part the results of the 1986 audits are essentially unchanged from previous audits.

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SECTION 1

INTRODUCTION

The audits of proficiency in analyzing ambient air are managed by the Environmental Monitoring Systems Laboratory (EMSL), of the U.S. Environmental Protection Agency (EPA). These audits are a part of a continuing program entitled the National Performance Audit Program. This program allows EPA to monitor the performance of laboratories (agencies) making air pollution measurements to assist EPA in assessing the quality of air monitoring data. It also allows participating agencies to assess their performance with respect to other agencies making similar measurements. The audits are conducted by the Quality Assurance Division (QAD) of EMSL. Inquiries and applications to participate should be directed to: U.S. Environmental Protection Agency, Quality Assurance Division, Environmental Monitoring Systems Laboratory, MD-77B, Research Triangle Park, North Carolina 27711.

Most agencies participating in the audits are solicited by the EPA Regional Quality Control Coordinator in each of EPA's 10 regions. Agencies performing ambient air monitoring of criteria pollutants are required by Federal regulation to participate. Once a laboratory enrolls in a particular audit, it is assigned a permanent identifying code number and automatically notified of subsequent audits. Federal, state, local, industrial and foreign air pollution monitoring agencies participate in the surveys.

Sample materials furnished for the audits simulate the several types of collected air pollution samples as closely as possible. The materials for the manual methods evaluate only the analytical portion of the total air measurement process; i.e., they do not determine errors in sample collection, transportation, handling, storage, and data processing. For the high volume method for total suspended particulate (TSP), the audit evaluates only the flow measurement portion of the method.

Throughout this report, reference is made to "assigned values." These values are the standards against which reported results are evaluated and have been so designated after consideration of the analytical results of the referee laboratory, the QAD/EMSL Standards Laboratory, and the manufacturer of the audit material.

In 1986, audits were conducted twice for lead, sulfate, nitrate and acid rain and once for carbon monoxide and the high-volume flow rate. Audits were conducted throughout the year on sulfur dioxide continuous monitors.

Each laboratory participating in an audit received an evaluation of its performance shortly after the audit was completed. When practical, laboratories submitting abnormally high or low results were offered an opportunity to analyze another set of samples. However, the retest results are not included in this summary report. In any case, laboratories having excessively deviant values can investigate their operations to identify and correct the cause of the large errors.

SECTION 2

SUMMARY AND CONCLUSIONS

Approximately 425 laboratories participated in this audit program in 1986. The category and number of participants in each audit are presented in Table 1. Compared to the 1985 audits, participation decreased in the following audits (percentage decline in parentheses): CO (26%), high volume flow rate (6%), Pb (17%), $SO_4^=$ (20%), NO_3^- (7%), and SO_2 continuous monitor (4%). A 24% increase occurred in the acid rain audits -- the only audit to show an increase. The performance of the participants as measured by the percent accuracy and precision (% coefficient of variation) continued to improve compared to the earlier audits (1,2,3).

Approximately 680 laboratories are registered in the National Ambient Air Performance Audit Program. This report presents the results of approximately 425 laboratories that participated in the 1986 audits. The category and number of participants in each audit are presented in Table 1. Compared to the 1985 audits participation decreased in the following audits (percentage decline in parentheses): CO (26%), high volume flow rate (6%), Pb (17%), $SO_4^=$ (20%), NO_3^- (7%), and SO_2 continuous monitor (4%). A 24% increase occurred in the acid rain audits -- the only audit to show an increase.

SECTION 3

AUDIT MATERIALS

The audit sample concentrations spanned the wide range of pollutant concentrations measured in ambient air monitoring. This is achieved directly with the CO samples, which are prepared in cylinders. Dilution is necessary for the acid rain samples to obtain desired concentrations. Lead, NO_3^-, and $SO_4^=$ filter strip samples required extraction with water and then dilution to a specified volume before analysis. The SO_2 continuous monitor audit samples required dilution of the SO_2 with zero air.

Although many air monitoring sites rarely encounter pollutant concentrations at the higher audit sample levels, these concentrations were included to assure that monitoring methods were verified at the higher levels.

The following paragraphs describe each sample type used in the 1986 audits.

CARBON MONOXIDE

These audit materials consist of a mixture of CO, CO_2 and CH_4 and zero air in a disposable pressurized gas cylinder that simulates an ambient air sample. The concentrations of the three CO samples used in the 1986 audits were 6, 21 and 43 ppm. Directions specify that the gas sample be introduced into a continuous analyzer in the "sample" mode, which permits the analyzer to draw the sample in the same fashion and at the same flow rate as during ambient air monitoring.

SULFATE, NITRATE, AND LEAD ON FILTER STRIPS

The filter strip samples used in sulfate, nitrate and lead audits are each 1.9 cm wide by 20 cm long. They were cut from 20- by 24-centimeter glass fiber filters, spiked with an aqueous solution of the appropriate solution and then oven dried. After analysis, pollutant concentrations were computed by assuming that the samples were collected on the prescribed high-volume filter with a sample air volume of 2,000 m^3. Six sample strips comprised a set.

Sulfate and nitrate audit samples were prepared from sodium sulfate and potassium nitrate. Calculated nitrate concentrations ranged from 0.62 to 13.3 $\mu g/m^3$ and sulfate from 1.6 to 28.0 $\mu g/m^3$. Lead samples, which are prepared from lead nitrate ranged in concentration from 0.39 to 8.4 $\mu g/m^3$ of lead.

HIGH-VOLUME FLOW RATE (ReF DEVICE)

The reference flow (ReF) device used for audits of high-volume flow rates consisted of a modified orifice, a wind deflector, a manometer, and a series of resistance plates. A single ReF device was supplied to each participating agency with instructions to check samplers at as many sampling sites as feasible.

Before use in the audit each ReF device is calibrated with a positive displacement meter traceable to NBS. During the audit, the device was mounted on top of the sampler, replacing the filter faceplate. A wind deflector was used to prevent fluctuations in the measurements due to wind blowing across the orifice.

SULFUR DIOXIDE CONTINUOUS MONITORS

The auditing device for the SO_2 continuous ambient air monitors was a porous plug dilution system that provided a mechanism whereby controlled quantities of SO_2 and diluent air were continuously combined in a mixing chamber and passed into the monitor. The flow rate of each gas was controlled by maintaining a predetermined pressure drop across the porous plug flow restrictor. Variable SO_2 concentrations were obtained by using different combinations of the flow restrictors.

The audit device, which was housed in a compact, lightweight, impact-resistant case, was constructed so that only those controls required for system operation were exposed. By opening and closing different toggle valves, it was possible to generate up to seven preset pollutant concentrations. Five were used for the audit. Two compressed gas cylinders were supplied with each unit, one as the SO_2 source and the other as the dilution air source.

Each audit device was calibrated for flow at all the settings used in the audit. Flow calibrations were referenced to laminar flow elements traceable to National Bureau of Standards flow standards. Sulfur dioxide concentrations ranging from 0.0 to 0.8 ppm were used in the 1986 audits.

ACID RAIN

Five aqueous solutions in polyethylene bottles containing the anions and cations found in rain water were shipped to each of the participating laboratories. All samples were to be diluted 1:50 by the participant. Three samples were then analyzed for pH, conductivity, acidity and the major cations and anions normally measured in precipitation samples and the other two samples were analyzed for heavy metals. The latter two samples were acid stabilized in the concentrate form to prevent loss of metals from the solution.

The chemical composition of these samples was certified by using a National Bureau of Standards SRM. The participants analyzed the samples using the analytical procedures they normally employ when analyzing their precipitation samples. The results were reported on the basis of the sample concentration after the 1:50 dilution.

SECTION 4

AUDIT RESULTS

The results of the 1986 audit are presented in Tables 2 through 24. The term "audit mean" in these tables denotes the average of all values reported by the participants for that sample after elimination of outliers. Elimination of outliers was accomplished in a two step procedure. First, results from laboratories/sites whose values for all samples exceeded ± 20 percent of the assigned value were removed from the data base. The excluded values represented approximately 5% of the total number of laboratories/sites reporting results which is approximately the same as for 1983 through 1985 (1, 2, 3). Then, individual sample results were rejected as outliers based on Chauvenet's Criterion (4). After outliers were eliminated, the results from all participants were normally distributed about the mean which was expected from the earlier audits (1, 2, 3).

At each audit level, the percent accuracy (% Acc.) and the precision, as measured by the percent coefficient of variation (%CV), were calculated using Equations 1 and 2, respectively. The percent accuracy measures how well the average of all participants agrees with assigned values. The percent coefficient of variation measures the variability among participants.

$$\% \text{ Acc.} = \frac{\text{audit mean} - \text{EPA assigned value}}{\text{EPA assigned value}} \times 100 \qquad (1)$$

$$\% \text{ CV} = \frac{\text{audit standard deviation}}{\text{audit mean}} \times 100 \qquad (2)$$

Overall accuracy and precision values for each audit were also calculated and plotted (Figures 1 through 23) to show the historical record of performance for each type of audit. All of the figures present the results of the performance audits <u>after</u> elimination of the outliers. Also, for each audit in which the % CV remained approximately constant over the range of audit levels, the average % Acc. can be considered a measure of the percent shift from an ideal slope of 1.00 for a regression line (with an intercept of zero) between the audit level means and the EPA assigned value.

CARBON MONOXIDE

In 1986, only 246 monitors were audited -- this 24% decrease from 1985 resulted because a second audit was cancelled due to budget cuts. Eighty-four percent of the monitors audited were NDIR compared to 86% in 1985 (1) and 95% in 1984 (2). The remaining monitors were gas filter correlation CO

monitors. The 246 monitors represent only 53% of the CO monitors in the SLAMS network in 1986.

As shown in Figure 1, both precision and accuracy have stayed at approximately the same level for the last six years. Also, the number of measurements falling within 20% of the assigned value (Table 4) closely parallels the 1983 through 1985 results (1, 2, 3). Also, as shown in Figure 1, the accuracy has oscillated back and forth across the zero-axis for the last seven years.

SULFATE ON FILTER STRIPS

Approximately 47 laboratories participated in each audit. The audit mean, percent accuracy and precision are given in Table 5. Over the years accuracy has varied quite a bit, but now it seems to have stabilized (Figure 2). Precision has also stabilized after improving continually for several years.

As in 1985, there also is no apparent relationship between concentration and either precision or accuracy for the manual and for the automated methods (Tables 6 and 7).

Except for the lowest sample concentration, between 70 and 100% of the laboratories reported results within ± 20% of the assigned values (Table 8) -- about the same as in 1983-1985 (1, 2, 3).

NITRATE ON FILTER STRIPS

Approximately 42 laboratories participated in each 1986 audit. Participation was down approximately 7% from 1984. As in the sulfate audits, the number of participants has been fairly constant since 1979. Both accuracy and precision seem to have reached a plateau because no improvement is evident over the last couple of years (Figure 3).

The results from the 1986 nitrate audits show only a slight decrease in both precision and accuracy with respect to the 1985 audits (Figure 3).

The percentage of values (90%) that fell within ± 20% of the assigned values (Table 11) is similar to that for the 1983-1985 audits.

LEAD ON FILTER STRIPS

Eighty laboratories participated in the 0186 audit and 93 in the 0786 audit which represent 25% and 12% decreases, respectively, from the 1985 audits. This decrease was primarily due to a 10% decrease in participation by state agency laboratories.

The audit mean, percent accuracy and percent CV (precision) are shown in Table 12. Accuracy has continued to show the negative bias present since the audits were initiated in 1977 (Figure 4). Precision has remained at the same level since 1982 (Figure 4) as has the number of measurements

within ± 20% of the assigned value (98%) (Table 13). This year all participants used atomic absorption spectrometry for sample analysis.

SULFUR DIOXIDE (CONTINUOUS MONITORS)

The number of monitors audited totaled 246 (Table 14) -- a 4% decrease from 1985. This decrease resulted mainly from a decrease in participation by state agencies. This contrasts with 1985 when a 16% increase occurred (from 1984) due to a 10% increase in state agency participitation. Overall, approximately 48% of the monitors in the SLAMS network were audited in 1986.

The accuracy for each of the methods is shown in Table 15. The methods most commonly used were: fluorescence (236), flame photometric (6) and coulometric (2). In relation to 1985, these numbers represent a 2% decrease, 14% decrease and 50% decrease, respectively. The decrease in the number of flame photometric and coulometric analyzers continues the shift in user preference for the fluorescence monitor observed earlier (1, 2, 3). The accuracy of the fluorescent monitors improved compared to 1985 and 1984, but the accuracy of the other two types decreased slightly when compared to this same period.

HIGH VOLUME

The number of monitors audited in 1986 was 1251 -- a 6% decrease from 1985 (1). The pressure transducer continued to be the most widely used method of measurement (38%), the rotameter was next (19%), followed by the flow controller (13%). Other methods which accounted for the remaining 30 percent of the results, included: orifice manometer, manometer, flow gauge, and pressure transducer/non-continuous. Table 16 shows the percentage of the flow measurements within ± 10, 20, 30 and 50% of the assigned value for each resistance plate used in the ReF (audit) device. These results are similar to the 1985, 1984 and 1983 results (1, 2, 3).

ACID RAIN

Forty-four laboratories participated in the 0486 audit and thirty-six participated in the 1086 audit. Overall this represents a 20% increase in participation compared to 1985 and it primarily resulted from an increase in state agency participants.

Because of the short history of this audit, only general observations can be made concerning time trends. Also, because of the low concentrations present in some of the samplers, the relative precision sometimes appears poor, when in absolute terms (e.g., mg/l) the precision is reasonably good.

Results for pH, Conductivity and Acidity

The results are presented in Table 17 (all data), Table 18 (outliers removed) and in Figures 5 (pH), 6 (conductivity) and 7 (acidity). As in the earlier audits (1, 2, 3), there is only a weak correlation apparent

between sample concentration and precision and accuracy. In contrast, the ambient air audits reported earlier reflect precision and accuracy that generally decreased as concentration increased. For all three parameters, precision and accuracy have varied erratically over the life of the audit program.

Major Anions Results (SO_4, NO_3, Cl, F)

The results for these four parameters are presented in Table 19 (all data), Table 20 (outliers removed) and in Figures 8 (SO_4), 9 (NO_3), 10 (Cl) and 11 (F). As in the past, precision continued to exceed 10% in all audits and also remained erratic. As shown by comparing the precision in Tables 19 and 20, however, removal of only a few results yields a large improvement in precision. Thus, the precision results are not as poor as they appear on the surface. Accuracy has also been erratic, but overall quite good.

Major Cations (NH_4, Ca, K, Mg, Na)

The results for these five major ions are presented in Table 21 (all data), Table 22 (outliers removed) and in Figures 12 (NH_4), 13 (Ca), 14 (K), 15 (Mg) and 16 (Na). As in the case for the major anions, the precision has been erratic for all five anions over the history of the audit. But, also as in the case for the major anions, removing just one or two values yields a dramatic improvement in precision.

Trace Metals Results (Mn, Fe, Cd, Cu, Ni, Pb, Zn)

The results for these seven metals are presented in Table 23 (all data), Table 24 (outliers removed) and in Figures 17 (Mn), 18 (Fe), 19 (Cd), 20 (Cu), 21 (Ni), 22 (Pb), and 23 (Zn). As in the case of both the anions and cations, the precision has varied in an erratic manner for most of these metals (Zn and Cd continue to be the exception). It should be borne in mind, however, that because the concentrations of these metals are low, a small absolute difference appears as a large relative difference. Also, most participants report only one significant figure for the metals analyses.

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TABLE 1. AGENCY PARTICIPATION

Survey	Distribution (%)					No. of Laboratories[a]	No. of Monitors[a]
	States	Local	Industry	Federal	Foreign		
CO -- April 1986	56.7	37.4	4.2	1.7	0.0	--	238 (3)
SO_4 -- February 1986	58.1	14.0	18.6	2.3	7.0	43 (3)	--
SO_4 -- August 1986	51.0	19.6	19.6	3.9	5.9	51 (0)	--
NO_3 -- February 1986	56.4	12.8	17.9	2.6	10.3	39 (2)	--
NO_3 -- August 1986	48.9	20.0	22.2	2.2	6.7	45 (4)	--
Pb -- January 1986	49.9	25.0	20.0	1.3	3.8	80 (5)	--
Pb -- July 1986	47.7	28.0	19.4	1.1	3.8	93 (1)	--
SO_2 (continuous)	51.6	38.2	8.9	1.2	0.0	--	246 (4)
High-Volume Flow-Rate -- May 1986	41.0	44.2	13.7	0.5	0.6	--	1251 (100)
Acid Rain -- April 1986	55.6	11.1	24.4	8.9	0.0	45	--
Acid Rain -- October 1986	54.1	13.5	21.6	10.8	0.0	37	--

[a]Value in parentheses is the number of laboratories/monitors that reported all values off by more than ± 20% from the assigned value.

TABLE 2. AUDIT RESULTS FOR CARBON MONOXIDE

Audit	Level	n	Assigned value (ppm)	Mean (ppm)	% Acc.	% CV
			A. ALL DATA			
0486	1	238	5.81	5.74	-1.20	6.45
	2	236	20.70	20.72	0.01	3.09
	3	234	42.80	42.64	-0.37	4.46
			B. OUTLIERS REMOVED			
0486	1	231	5.81	5.76	-0.86	5.56
	2	231	20.70	20.75	0.24	2.60
	3	230	42.80	42.76	-0.09	2.48

TABLE 3. AUDIT RESULTS FOR CARBON MONOXIDE BY THE NDIR AND GFC METHODS

Audit	Level	Assigned value (ppm)	NDIR Method n	NDIR Method Mean (ppm)	NDIR Method % Acc.	NDIR Method % CV	GFC Method n	GFC Method Mean (ppm)	GFC Method % Acc.	GFC Method % CV
					A. ALL DATA					
0486	1	5.81	206	5.73	-1.38	6.81	32	5.79	-0.34	3.45
	2	20.70	204	20.74	0.19	3.13	32	20.57	0.62	2.58
	3	42.80	203	42.61	-0.44	4.74	31	42.81	0.02	1.47
					B. OUTLIERS REMOVED					
0486	1	5.81	201	5.75	-1.03	6.26	31	5.76	-0.86	2.43
	2	20.70	200	20.77	0.34	2.70	31	20.64	-0.29	1.65
	3	42.80	199	42.75	0.17	2.60	30	42.86	1.40	1.31

TABLE 4. PERCENT OF CARBON MONOXIDE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUES

Audit	Level	Assigned value (ppm)	10%	20%	30%	50%
		A. ALL DATA				
0486	1	5.81	89.1	98.3	100.0	100.0
	2	20.70	97.9	100.0	100.0	100.0
	3	42.80	97.9	99.6	99.6	99.6
		B. OUTLIERS REMOVED				
0486	1	5.81	90.2	98.3	100.0	100.0
	2	20.70	99.1	100.0	100.0	100.0
	3	42.80	99.1	99.6	99.6	99.6

TABLE 5. AUDIT RESULTS FOR SULFATE ON FILTER STRIPS

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0286	1	42	1.62	1.62	0.00	30.25
	2	41	3.14	3.39	7.96	83.76
	3	43	9.94	9.51	-4.33	20.40
	4	43	15.43	15.20	-1.49	31.91
	5	43	18.00	18.53	2.94	23.42
	6	43	17.87	18.36	2.67	27.29
0886	1	50	3.27	3.25	0.61	20.92
	2	50	1.87	1.97	5.35	32.99
	3	51	6.01	5.88	2.16	9.52
	4	51	7.92	7.87	-0.63	7.12
	5	51	24.39	23.46	-3.81	8.91
	6	50	21.45	20.54	-4.24	15.68
			B. OUTLIERS REMOVED			
0286	1	37	1.62	1.66	2.47	19.28
	2	37	3.14	3.00	-4.45	8.67
	3	38	9.94	9.69	-2.52	9.60
	4	39	15.43	15.39	-0.26	7.09
	5	39	18.00	18.34	1.89	6.05
	6	38	17.87	17.86	-0.06	6.72
0886	None removed					

TABLE 6. AUDIT RESULTS FOR SULFATE BY THE MANUAL METHODS

Audit	Level	Assigned value (μg/m³)	$BaCl_2$ n	$BaCl_2$ Mean (μg/m³)	$BaCl_2$ % Acc.	$BaCl_2$ % CV	Sulfa-Ver n	Sulfa-Ver Mean (μg/m³)	Sulfa-Ver % Acc.	Sulfa-Ver % CV
A. ALL DATA										
0286	1	1.62	3	1.99	22.89	71.86	2	1.90	17.28	54.74
	2	3.14	2	3.61	14.97	23.82	2	2.75	-12.42	0.36
	3	9.94	3	10.53	5.94	21.94	2	8.08	-18.71	4.95
	4	15.43	3	15.07	-2.33	4.51	2	13.95	-9.59	1.57
	5	18.00	3	17.37	-3.50	7.31	2	18.56	3.11	8.83
	6	17.87	3	18.87	5.88	11.45	2	17.93	0.34	4.19
0886	1	3.67	7	3.98	8.45	29.14	2	2.88	-11.93	13.19
	2	1.87	7	2.70	44.39	34.44	2	1.43	-23.53	68.53
	3	6.01	7	6.00	-0.17	10.83	2	6.16	1.83	10.95
	4	7.92	7	8.08	2.02	7.18	2	7.53	-4.92	12.48
	5	24.39	7	23.23	-4.76	5.25	2	24.32	-0.29	7.40
	6	21.45	6	20.73	-3.36	8.15	2	21.09	-1.67	0.57
B. OUTLIERS REMOVED										
0286	None removed									
0886	None removed									

TABLE 7. AUDIT RESULTS FOR SULFATE BY THE AUTOMATED METHODS

Audit	Level	Assigned value ($\mu g/m^3$)	Methyl Thymol Blue n	Methyl Thymol Blue Mean ($\mu g/m^3$)	Methyl Thymol Blue % Acc.	Methyl Thymol Blue % CV	Ion Chromatograph n	Ion Chromatograph Mean ($\mu g/m^3$)	Ion Chromatograph % Acc.	Ion Chromatograph % CV
				A. ALL DATA						
0286	1	1.62	18	1.62	0.00	27.70	18	1.61	-0.62	11.60
	2	3.14	18	2.89	-7.96	11.00	18	2.97	-5.41	7.74
	3	9.94	19	9.51	-4.33	26.29	18	9.54	-5.03	8.67
	4	15.43	19	14.03	-9.07	48.00	18	15.20	-1.49	4.93
	5	18.00	19	18.41	2.28	34.00	18	18.07	0.39	9.12
	6	24.09	19	23.74	-1.45	39.50	18	23.29	-3.32	14.00
0886	1	3.27	18	2.98	-8.87	19.80	22	3.27	0.00	11.93
	2	1.87	18	1.78	-4.81	32.58	22	1.94	3.60	22.68
	3	6.01	19	5.66	-5.82	11.31	22	6.01	0.00	7.15
	4	7.92	19	7.86	-0.76	6.87	22	7.84	-0.76	7.27
	5	24.39	19	22.95	-5.90	13.03	22	23.87	-2.13	5.36
	6	21.45	19	20.13	-6.15	23.75	22	20.77	-3.17	9.29
				B. OUTLIERS REMOVED						
0286	1	1.62	14	1.69	4.32	13.50	17	1.63	0.62	9.94
	2	3.14	14	3.07	-2.22	8.28	18	2.97	-0.54	7.74
	3	9.94	15	9.95	0.10	5.33	17	9.54	-4.02	6.07
	4	15.43	15	14.97	-2.98	8.57	18	15.20	-1.49	4.93
	5	18.00	14	18.64	3.56	3.06	17	18.43	2.39	3.98
	6	17.87	15	17.76	-0.61	3.97	16	18.48	3.41	4.02
0886	None removed									

TABLE 8. PERCENT OF SULFATE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
		A. ALL DATA				
0286	1	1.62	42.9	69.8	83.3	90.5
	2	3.14	63.4	85.4	92.7	95.1
	3	9.94	69.7	81.4	88.4	97.7
	4	15.43	86.0	88.4	88.4	93.0
	5	18.00	81.4	90.7	93.0	95.3
	6	17.87	79.1	86.0	90.7	95.3
0886	1	3.27	60.0	84.0	90.0	92.0
	2	1.87	48.0	68.0	80.0	86.0
	3	6.01	70.6	96.1	100.0	100.0
	4	7.92	76.5	100.0	100.0	100.0
	5	24.37	86.3	96.1	96.1	100.0
	6	21.45	86.0	96.0	96.0	98.0
		B. OUTLIERS REMOVED				
0286	1	1.62	46.1	76.9	87.2	92.3
	2	3.14	68.4	92.1	97.4	100.0
	3	9.94	75.0	87.5	95.0	100.0
	4	15.43	92.5	95.0	95.0	97.5
	5	18.00	87.5	95.0	97.5	100.0
	6	17.87	85.0	92.5	95.0	100.0
0886	None removed					

TABLE 9. AUDIT RESULTS FOR NITRATE ON FILTER STRIPS

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0286	1	38	0.85	1.01	18.82	66.30
	2	38	1.93	2.02	4.66	26.71
	3	39	5.35	5.38	0.56	22.52
	4	39	8.89	9.03	1.55	20.41
	5	39	11.17	12.10	8.30	55.52
	6	39	11.96	12.00	0.33	16.51
0886	1	43	1.24	1.30	4.84	31.54
	2	43	0.62	0.70	12.90	44.29
	3	45	4.74	4.64	-2.11	19.40
	4	45	8.46	8.17	-3.43	18.73
	5	45	13.29	12.86	-3.24	23.72
	6	44	12.05	10.90	-9.54	27.61
			B. OUTLIERS REMOVED			
0286	1	34	0.85	0.85	0.00	22.32
	2	35	1.93	1.97	2.07	15.21
	3	36	5.35	5.28	1.33	6.44
	4	36	8.89	8.91	0.22	6.72
	5	36	11.17	11.01	-1.43	7.31
	6	36	11.96	11.90	-0.50	6.72
0886	1	38	1.24	1.30	4.84	15.38
	2	38	0.62	0.67	8.06	26.87
	3	39	4.74	4.81	1.48	6.44
	4	39	8.46	8.33	-1.54	5.40
	5	39	13.29	13.26	-0.23	8.37
	6	38	12.05	10.90	-9.54	6.33

TABLE 10. AUDIT RESULTS FOR NITRATE BY THE AUTOMATED METHODS

Audit	Level	Assigned value ($\mu g/m^3$)	Ion Chromatograph n	Ion Chromatograph Mean ($\mu g/m^3$)	Ion Chromatograph % Acc.	Ion Chromatograph % CV	Cadmium Reduction n	Cadmium Reduction Mean ($\mu g/m^3$)	Cadmium Reduction % Acc.	Cadmium Reduction % CV
				A. ALL DATA						
0286	1	0.85	18	0.86	1.18	15.12	13	0.99	16.47	42.42
	2	1.93	18	1.83	-5.18	20.22	13	2.05	6.22	20.49
	3	5.35	18	5.07	-5.23	17.36	14	5.70	6.54	27.37
	4	8.89	18	8.50	-4.39	18.71	14	9.56	7.00	23.74
	5	11.17	18	10.55	-5.55	16.59	14	11.63	3.96	22.53
	6	11.96	18	11.41	-4.59	16.21	14	12.28	2.68	16.53
0886	1	1.24	20	1.28	3.23	10.16	12	1.32	6.45	55.30
	2	0.62	20	0.71	14.52	35.21	12	0.68	9.68	67.65
	3	4.74	21	4.76	0.42	9.03	13	4.14	-12.66	34.54
	4	8.46	20	8.37	-2.24	7.77	13	7.24	-14.42	32.60
	5	13.29	21	13.01	-2.11	6.15	13	12.22	-8.05	42.47
	6	12.05	21	10.65	-11.62	4.79	13	10.30	-14.52	46.10
				B. OUTLIERS REMOVED						
0286	1	0.85	15	0.86	1.18	8.14	12	0.88	3.53	12.50
	2	1.93	15	1.91	-1.04	5.76	11	1.92	-0.52	4.71
	3	5.35	16	5.32	-0.56	4.89	12	5.31	-0.75	3.58
	4	8.89	17	8.85	-0.45	5.88	13	8.98	1.01	6.46
	5	11.79	16	10.85	-7.97	4.33	13	10.94	-7.21	4.20
	6	11.96	16	11.91	-0.42	4.70	12	11.89	-0.59	3.78
0886	1	1.24	19	1.27	2.42	9.45	8	1.36	-9.68	16.18
	2	0.62	17	0.63	1.61	17.46	8	0.66	6.45	12.52
	3	4.74	19	4.75	0.21	4.84	10	4.78	0.84	5.85
	4	8.46	20	8.27	-2.24	5.97	10	8.36	-1.18	4.56
	5	13.29	19	12.97	-2.41	3.93	9	13.32	0.23	6.01
	6	12.05	20	10.68	-11.37	4.78	9	11.05	-8.30	5.43

TABLE 11. PERCENT OF NITRATE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
		A. ALL DATA				
0286	1	0.85	68.4	71.7	76.3	84.2
	2	1.93	71.9	78.9	86.8	89.5
	3	5.35	84.6	92.3	94.8	94.8
	4	8.89	74.4	92.3	94.8	94.8
	5	11.17	71.8	89.7	92.3	92.3
	6	11.96	76.9	92.3	92.3	94.8
0886	1	1.24	48.8	76.7	86.0	88.4
	2	0.62	44.2	65.1	72.1	76.7
	3	4.74	73.3	86.7	95.6	95.6
	4	8.46	80.0	86.7	93.3	95.6
	5	13.29	73.3	84.4	88.9	93.3
	6	12.05	36.3	88.6	88.6	90.9
		B. OUTLIERS REMOVED				
0286	1	0.85	72.2	75.0	80.6	88.9
	2	1.93	75.0	83.3	91.7	94.4
	3	5.35	89.2	97.3	100.0	100.0
	4	8.89	78.4	97.3	100.0	100.0
	5	11.17	75.7	94.6	97.3	97.3
	6	11.96	81.1	97.3	97.3	100.0
0886	1	1.24	53.8	82.1	89.7	92.3
	2	0.62	48.7	69.2	76.9	82.1
	3	4.74	80.5	92.7	100.0	100.0
	4	8.46	87.8	95.1	97.6	100.0
	5	13.29	80.5	90.2	95.1	97.6
	6	12.05	40.0	95.0	95.0	95.0

TABLE 12. AUDIT RESULTS FOR LEAD ON FILTER STRIPS

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0186	1	80	0.72	0.69	-4.17	10.14
	2	80	1.44	1.38	-4.17	8.69
	3	80	2.52	2.43	-3.57	7.00
	4	80	3.78	3.62	-4.23	8.01
	5	80	7.10	6.93	-2.39	11.98
	6	80	7.50	7.20	-4.00	11.25
0786	1	93	0.39	0.38	-2.58	13.16
	2	92	1.80	1.73	-3.89	6.94
	3	92	2.36	2.32	-1.69	9.91
	4	93	4.24	4.03	-4.95	9.43
	5	93	5.25	4.95	-5.71	9.49
	6	93	8.36	8.09	-3.23	10.63
			B. OUTLIERS REMOVED			
0186	1	72	0.72	0.70	-2.78	5.71
	2	72	1.44	1.39	-3.41	5.71
	3	73	2.52	2.46	-2.38	4.04
	4	75	3.78	3.69	-2.38	4.61
	5	73	7.10	7.12	0.42	3.51
	6	74	7.50	7.37	-1.73	3.12
0786	1	91	0.39	0.39	0.00	7.69
	2	90	1.80	1.75	-2.78	5.14
	3	90	2.36	2.33	-1.27	5.15
	4	89	4.24	4.10	-3.30	5.37
	5	88	5.25	4.99	-4.95	4.81
	6	90	8.36	8.22	-1.67	5.84

TABLE 13. PERCENT OF LEAD MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
		A. ALL DATA				
0186	1	0.72	81.3	93.8	98.7	100.0
	2	1.44	84.6	93.6	98.7	100.0
	3	2.52	88.5	97.4	98.7	100.0
	4	3.78	85.9	95.0	97.4	100.0
	5	7.10	89.7	94.9	96.2	98.7
	6	7.50	92.3	95.0	97.4	98.7
0786	1	0.39	68.8	94.6	97.8	98.9
	2	1.80	85.9	94.7	94.7	100.0
	3	2.36	90.2	94.7	94.7	98.9
	4	4.24	86.0	94.6	96.8	100.0
	5	5.25	84.9	93.5	94.6	100.0
	6	8.36	90.3	93.5	96.8	98.9
		B. OUTLIERS REMOVED				
0186	1	0.72	86.7	95.9	100.0	100.0
	2	1.44	90.4	98.6	100.0	100.0
	3	2.52	94.5	100.0	100.0	100.0
	4	3.78	91.7	98.6	98.6	100.0
	5	7.10	95.9	97.3	97.3	98.6
	6	7.50	98.6	98.6	98.6	98.6
0786	1	0.39	69.7	95.7	98.9	98.9
	2	1.80	86.8	98.9	98.9	100.0
	3	2.36	91.2	98.9	98.9	100.0
	4	4.24	87.0	95.7	97.8	100.0
	5	5.25	85.9	94.6	95.7	100.0
	6	8.36	91.3	94.6	97.8	98.9

TABLE 14. AUDIT RESULTS FOR SULFUR DIOXIDE CONTINUOUS MONITORS (ALL DATA)

Flow setting	Number of reported values*	Range of values (ppm)	Average of bias	Standard deviation (ppm)
1	35	0.468 to 0.842	0.3	0.062
2	237	0.210 to 0.561	1.9	0.027
3	246	0.112 to 0.303	2.4	0.016
4	246	0.077 to 0.230	2.6	0.012
5	244	0.024 to 0.082	2.6	0.004
6	208	-0.006 to 0.007	---	0.002

*In the 1986 audit data were returned for 246 monitors

TABLE 15. AUDIT RESULTS FOR SULFUR DIOXIDE CONTINUOUS MONITORS BY VARIOUS INSTRUMENTAL METHODS

Flow setting	Flame photometric			Fluorescence			Coulometric		
	average difference			average difference			average difference		
	n	ppm	%	n	ppm	%	n	ppm	%
1	0	---	---	33	-0.010	1.4	0	---	---
2	6	0.012	2.6	223	0.008	2.0	2	-0.010	-2.2
3	6	0.013	5.3	236	0.006	2.4	2	-0.004	-1.8
4	6	0.010	5.6	232	0.005	2.7	2	0.003	1.7
5	6	0.002	3.2	231	0.001	2.6	2	0.0	0.7
6	5	0.000	---	195	0.000	---	2	0.000	---

TABLE 16. PERCENT OF HIGH VOLUME FLOW MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE (ALL DATA)

Plate number	Number of measurements	Approximate flow (m^3/min)	10%	20%	30%	50%
5	608	0.7	80.9	90.3	95.4	97.5
7	748	0.9	78.9	94.4	97.6	98.0
10	917	1.1	87.4	96.7	98.0	98.4
13	933	1.2	91.0	97.6	98.3	98.7
18	927	1.3	91.0	97.6	98.2	98.3

TABLE 17. ACID RAIN RESULTS FOR pH, CONDUCTIVITY AND ACIDITY (ALL DATA)

Audit		Level	n	Assigned value	Mean	% Acc.	% CV
0486	pH	1	43	4.53	4.40	-2.86	6.51
		2	44	3.43	3.45	0.47	6.04
		3	44	3.93	3.90	-0.76	7.54
	Conductivity (µS/cm)	1	39	15.90	17.26	8.85	29.98
		2	40	265.80	247.53	-6.87	28.77
		3	40	65.27	66.24	1.49	57.82
	Acidity (µequiv/L)	1	23	35.90	63.15	75.91	95.07
		2	23	398.80	415.02	4.07	41.95
		3	23	128.30	150.44	17.25	64.64
1086	pH	1	36	4.31	4.29	-0.44	4.52
		2	36	3.80	3.81	0.13	2.84
		3	36	3.47	3.47	0.00	1.84
	Conductivity (µS/cm)	1	34	24.10	29.74	23.38	124.27
		2	34	77.10	75.34	-2.28	20.66
		3	34	162.40	157.53	-3.00	19.94
	Acidity (µequiv/L)	1	18	54.40	71.69	31.78	50.15
		2	18	161.20	184.44	14.42	35.89
		3	19	363.90	365.10	0.33	43.28

TABLE 18. ACID RAIN RESULTS FOR pH, CONDUCTIVITY AND ACIDITY (OUTLIERS REMOVED)

Audit		Level	n	Assigned value	Mean	% Acc.	% CV
0486	pH	1	41	4.53	4.43	-2.28	4.99
		2	43	3.43	3.42	-0.26	3.68
		3	42	3.93	3.89	-1.01	4.81
	Conductivity (μS/cm)	1	38	15.90	15.89	-0.61	56.30
		2	37	265.80	250.51	-5.75	11.12
		3	39	65.27	61.07	-6.43	4.81
	Acidity (μequiv/L)	1	22	35.90	52.59	45.92	59.86
		2	23	398.80	415.02	4.07	41.95
		3	22	128.30	134.55	4.87	45.95
1086	pH	1	35	4.31	4.31	0.00	3.34
		2	35	3.80	3.82	0.50	1.89
		3	35	3.47	3.48	0.23	1.55
	Conductivity (μS/cm)	1	33	24.10	23.45	-2.69	20.70
		2	33	77.10	73.08	-5.22	11.48
		3	33	162.40	152.74	-5.95	9.62
	Acidity (μequiv/L)	1	17	54.40	67.06	23.27	46.28
		2	17	161.20	194.35	20.57	27.12
		3	17	363.90	406.81	11.79	25.20

TABLE 19. ACID RAIN AUDIT RESULTS FOR ANIONS (ALL DATA)

Audit		Level	n	Assigned value (mg/L)	Mean (mg/L)	% Acc.	% CV
0486	SO_4 (reported as S)	1	33	0.53	0.89	69.70	121.81
		2	36	7.16	7.47	4.30	48.51
		3	36	2.08	2.28	9.62	50.22
	NO_3 (reported as N)	1	33	0.15	0.21	40.00	120.00
		2	34	2.75	2.51	-8.76	24.55
		3	33	0.85	0.79	-7.08	28.41
	Cl	1	31	0.40	0.90	125.00	168.33
		2	34	20.53	24.09	17.34	90.28
		3	33	1.10	1.55	40.62	115.34
	F	1	17	0.05	0.13	160.00	190.30
		2	22	0.26	0.34	30.77	130.67
		3	22	0.19	0.34	78.95	143.11
1086	SO_4 (reported as S)	1	28	0.83	1.08	30.96	51.89
		2	28	3.23	3.55	9.91	40.07
		3	39	4.62	4.49	-2.84	33.98
	NO_3 (reported as N)	1	27	0.14	0.15	7.14	58.28
		2	27	0.15	0.23	54.11	163.11
		3	28	1.78	1.88	5.69	68.10
	Cl	1	27	0.37	0.37	0.00	31.35
		2	27	0.78	0.81	3.20	17.47
		3	27	1.20	1.15	-4.69	13.38
	F	1	17	0.06	0.10	66.67	125.74
		2	17	0.11	0.14	29.09	84.51
		3	17	0.31	0.35	12.90	26.51

TABLE 20. ACID RAIN AUDIT RESULTS FOR ANIONS (OUTLIERS REMOVED)

Audit		Level	n	Assigned value (mg/L)	Mean (mg/L)	% Acc.	% CV
0486	SO_4 (reported as S)	1	32	0.53	0.73	37.73	81.09
		2	34	7.16	6.68	-6.71	22.70
		3	34	2.08	2.04	-1.88	28.76
	NO_3 (reported as N)	1	31	0.15	0.14	-6.67	32.89
		2	31	2.75	2.69	-2.22	7.14
		3	30	0.85	0.84	-1.15	13.37
	Cl	1	29	0.40	0.53	32.00	84.28
		2	33	20.52	20.46	-0.30	25.33
		3	31	1.10	1.12	1.80	31.66
	F	1	16	0.05	0.07	40.00	79.73
		2	21	0.26	0.25	-3.85	26.28
		3	20	0.19	0.19	0.00	42.71
1086	SO_4 (reported as S)	1	26	0.83	0.98	18.02	42.73
		2	27	3.23	3.33	3.13	24.35
		3	26	4.62	4.62	0.00	11.15
	NO_3 (reported as N)	1	26	0.14	0.14	0.00	35.77
		2	26	0.15	0.16	7.53	71.33
		3	27	1.78	1.64	-7.38	21.09
	Cl	1	25	0.37	0.36	-2.70	15.47
		2	25	0.78	0.77	-1.28	7.78
		3	26	1.20	1.13	-5.89	11.37
	F	1	16	0.06	0.07	16.67	20.00
		2	16	0.11	0.11	0.00	25.44
		3	16	0.31	0.33	6.45	11.93

TABLE 21. ACID RAIN RESULTS FOR CATIONS (ALL DATA)

Audit		Level	n	Assigned value (mg/L)	Mean (mg/L)	% Acc.	% CV
0486	NH_3 (reported as N)	1	27	0.10	0.13	30.10	46.97
		2	28	3.61	3.51	-2.71	12.44
		3	28	0.34	0.39	15.00	35.81
	Ca	1	23	0.06	0.07	18.03	77.78
		2	28	6.25	6.37	1.97	9.56
		3	28	0.15	0.15	0.00	51.30
	K	1	25	0.08	0.14	74.39	117.48
		2	29	2.97	2.96	-0.40	8.53
		3	29	0.53	0.55	3.55	24.91
	Mg	1	22	0.01	0.02	100.00	165.00
		2	28	0.52	0.51	-2.29	20.39
		3	27	0.05	0.07	40.05	134.72
	Na	1	27	0.24	0.32	33.35	78.80
		2	29	2.92	2.89	-0.89	15.73
		3	29	1.34	1.24	-7.45	24.40
1086	NH_3 (reported as N)	1	22	0.10	0.10	0.00	22.22
		2	21	0.79	0.78	-0.88	8.71
		3	21	1.00	1.02	2.02	9.98
	Ca	1	23	0.07	0.07	0.00	40.28
		2	23	0.17	0.17	0.00	21.71
		3	21	0.01	0.04	300.11	191.89
	K	1	24	0.11	0.13	27.36	92.59
		2	21	0.11	0.11	0.00	25.23
		3	22	0.12	0.13	8.33	19.69
	Mg	1	23	0.04	0.04	0.00	41.03
		2	22	0.02	0.02	0.00	72.00
		3	23	0.08	0.08	0.00	32.89
	Na	1	22	0.24	0.25	4.94	9.41
		2	23	0.31	0.31	0.00	9.32
		3	23	0.62	0.62	0.00	6.49

TABLE 22. ACID RAIN AUDIT RESULTS FOR CATIONS (OUTLIERS REMOVED)

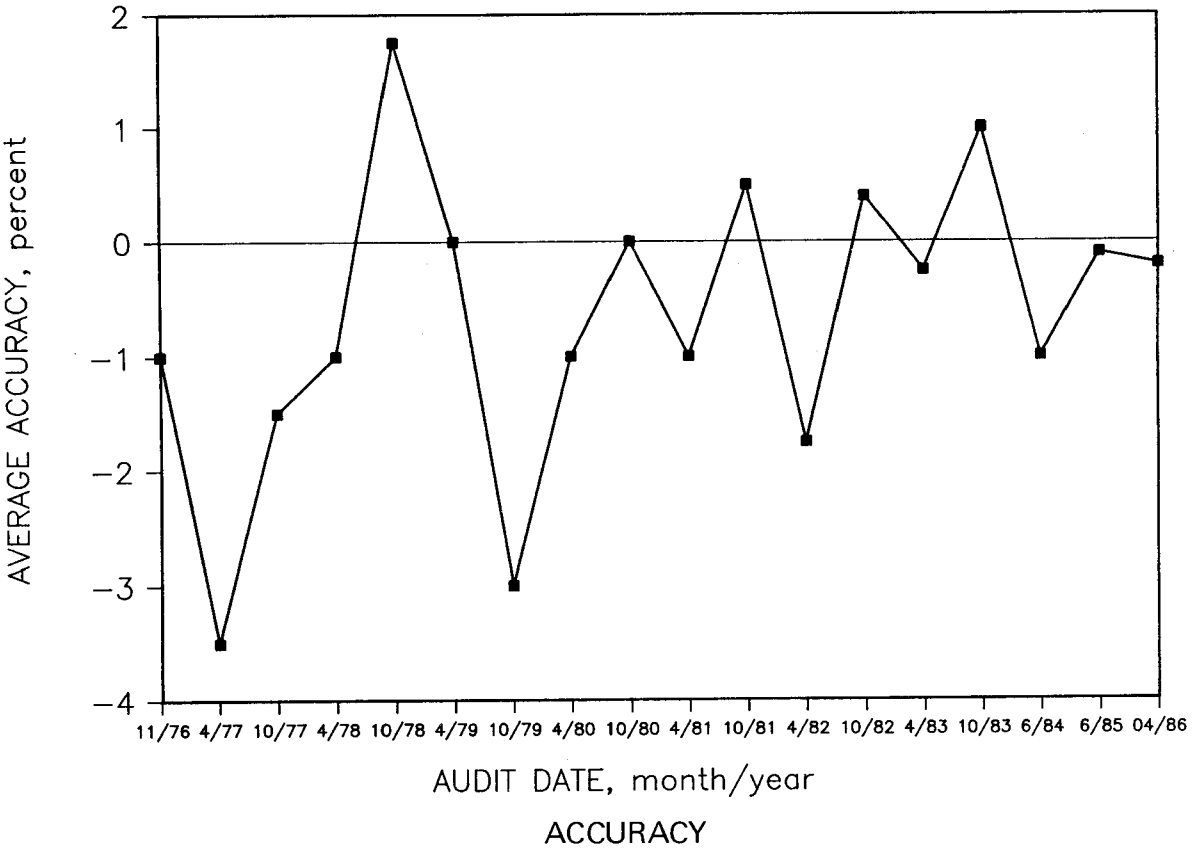
Audit		Level	n	Assigned value (mg/L)	Mean (mg/L)	% Acc.	% CV
0486	NH_3 (reported as N)	1	25	0.10	0.12	20.00	22.41
		2	27	3.61	3.56	-1.38	10.08
		3	26	0.34	0.36	5.88	18.49
	Ca	1	22	0.06	0.06	0.00	53.23
		2	27	6.25	6.30	0.08	7.95
		3	27	0.15	0.14	-7.10	43.06
	K	1	23	0.08	0.10	25.00	56.57
		2	29	2.97	2.96	-0.40	8.53
		3	27	0.54	0.55	3.36	8.14
	Mg	1	21	0.01	0.01	0.00	78.57
		2	27	0.52	0.53	1.92	10.65
		3	26	0.05	0.05	0.00	35.19
	Na	1	25	0.24	0.25	4.12	33.99
		2	28	2.92	2.96	1.47	9.01
		3	27	1.34	1.31	2.01	10.27
1086	NH_3 (reported as N)	1	20	0.10	0.10	0.00	15.15
		2	20	0.79	0.79	0.00	7.61
		3	20	1.00	1.01	1.00	8.62
	Ca	1	21	0.07	0.07	0.00	22.54
		2	23	0.17	0.17	0.00	21.71
		3	20	0.01	0.02	100.00	145.83
	K	1	23	0.11	0.11	0.00	18.18
		2	20	0.11	0.12	8.41	16.38
		3	22	0.12	0.13	8.33	15.38
	Mg	1	23	0.04	0.04	0.00	41.03
		2	21	0.02	0.02	0.00	56.52
		3	21	0.08	0.08	0.00	15.79
	Na	1	21	0.24	0.25	3.70	7.54
		2	22	0.31	0.31	0.00	6.84
		3	22	0.62	0.61	-1.30	3.94

TABLE 23. ACID RAIN AUDIT RESULTS FOR TRACE METALS (ALL DATA)

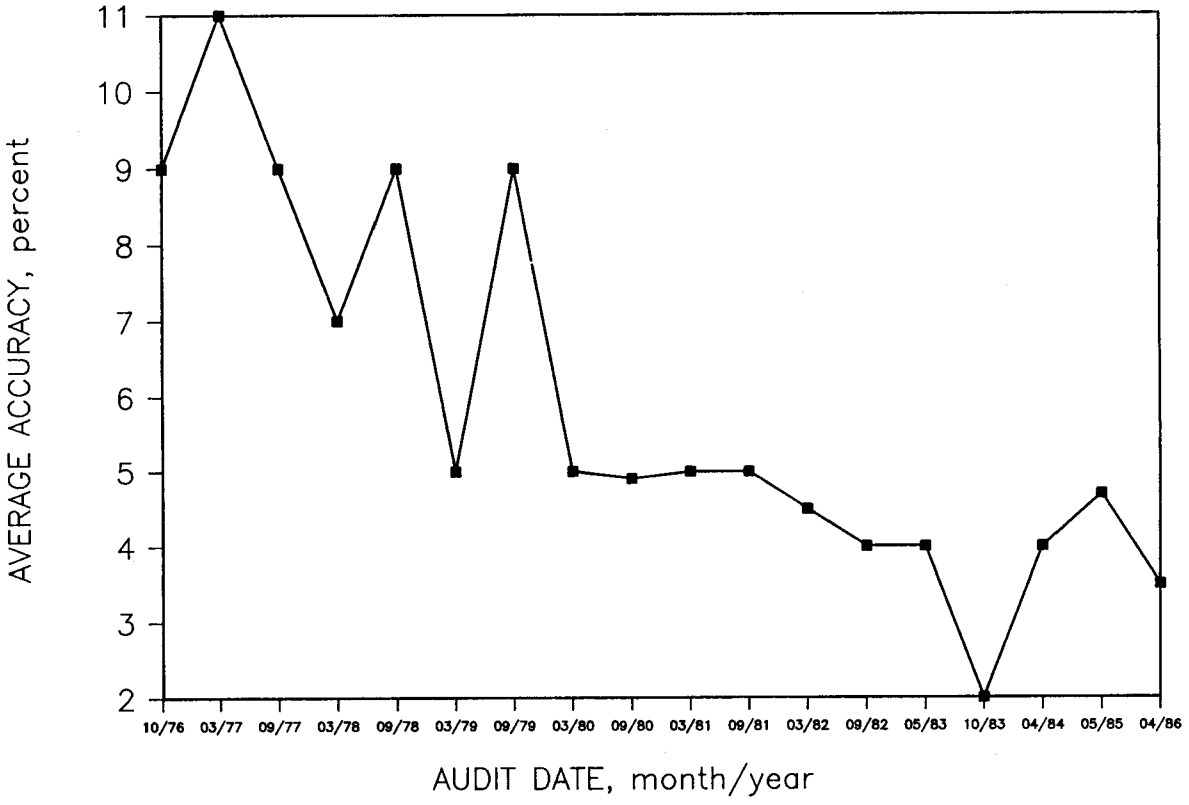
Audit		Level	n	Assigned value (mg/L)	Mean (mg/L)	% Acc.	% CV
0486	Mn	4	19	0.04	0.04	0.00	11.90
		5	19	0.10	0.09	-10.00	8.42
	Fe	4	17	0.04	0.05	25.00	41.30
		5	18	0.14	0.14	0.00	15.33
	Cd	4	19	0.03	0.03	0.00	17.24
		5	19	0.14	0.15	7.14	8.90
	Cu	4	18	0.03	0.03	0.00	12.90
		5	19	0.29	0.28	-3.40	22.18
	Ni	4	19	0.49	0.44	-10.00	32.21
		5	19	0.06	0.06	0.00	39.29
	Pb	4	20	1.36	1.34	-1.39	10.80
		5	20	0.26	0.25	-3.85	15.69
	Zn	4	18	0.10	0.11	10.00	16.22
		5	18	0.83	0.82	-1.21	7.20
1086	Mn	4	15	0.05	0.05	0.00	29.17
		5	14	0.03	0.03	0.00	34.29
	Fe	4	14	0.07	0.07	0.00	30.56
		5	12	0.02	0.03	50.00	30.77
	Cd	4	14	0.06	0.06	0.00	11.29
		5	13	0.02	0.03	12.50	22.22
	Cu	4	15	0.44	0.42	-4.55	25.00
		5	14	0.05	0.05	0.00	4.00
	Ni	4	12	0.02	0.03	50.00	45.16
		5	12	0.05	0.05	0.00	31.91
	Pb	4	15	0.43	0.42	-2.34	26.32
		5	18	0.13	0.13	0.00	27.78
	Zn	4	15	0.47	0.46	-2.95	25.44
		5	14	0.16	0.15	-6.17	26.97

TABLE 24. ACID RAIN AUDIT RESULTS FOR TRACE METALS (OUTLIERS REMOVED)

Audit		Level	n	Assigned value (mg/L)	Mean (mg/L)	% Acc.	% CV
0486	Mn	4	18	0.04	0.04	0.00	11.90
		5	19	0.10	0.09	-10.00	8.42
	Fe	4	16	0.04	0.04	0.00	41.30
		5	17	0.14	0.13	-7.14	12.78
	Cd	4	18	0.03	0.03	0.00	14.29
		5	18	0.14	0.15	7.14	6.80
	Cu	4	16	0.03	0.03	0.00	6.45
		5	18	0.29	0.30	3.44	5.03
	Ni	4	17	0.49	0.49	0.00	7.33
		5	17	0.06	0.06	0.00	20.97
	Pb	4	19	1.36	1.32	-2.94	7.35
		5	19	0.26	0.25	-3.85	13.20
	Zn	4	17	0.10	0.11	10.00	13.89
		5	17	0.83	0.83	0.00	5.68
1086	Mn	4	14	0.05	0.05	0.00	15.69
		5	13	0.03	0.04	33.33	24.32
	Fe	4	13	0.07	0.08	14.80	14.10
		5	11	0.02	0.02	0.00	24.00
	Cd	4	13	0.06	0.06	0.00	8.20
		5	13	0.02	0.03	50.00	22.22
	Cu	4	14	0.44	0.45	2.21	5.61
		5	13	0.05	0.06	20.00	28.81
	Ni	4	11	0.02	0.03	50.00	22.22
		5	11	0.05	0.05	0.00	13.73
	Pb	4	14	0.43	0.45	4.21	7.62
		5	13	0.13	0.13	0.00	10.37
	Zn	4	14	0.47	0.49	3.16	4.91
		5	13	0.16	0.16	0.00	7.41

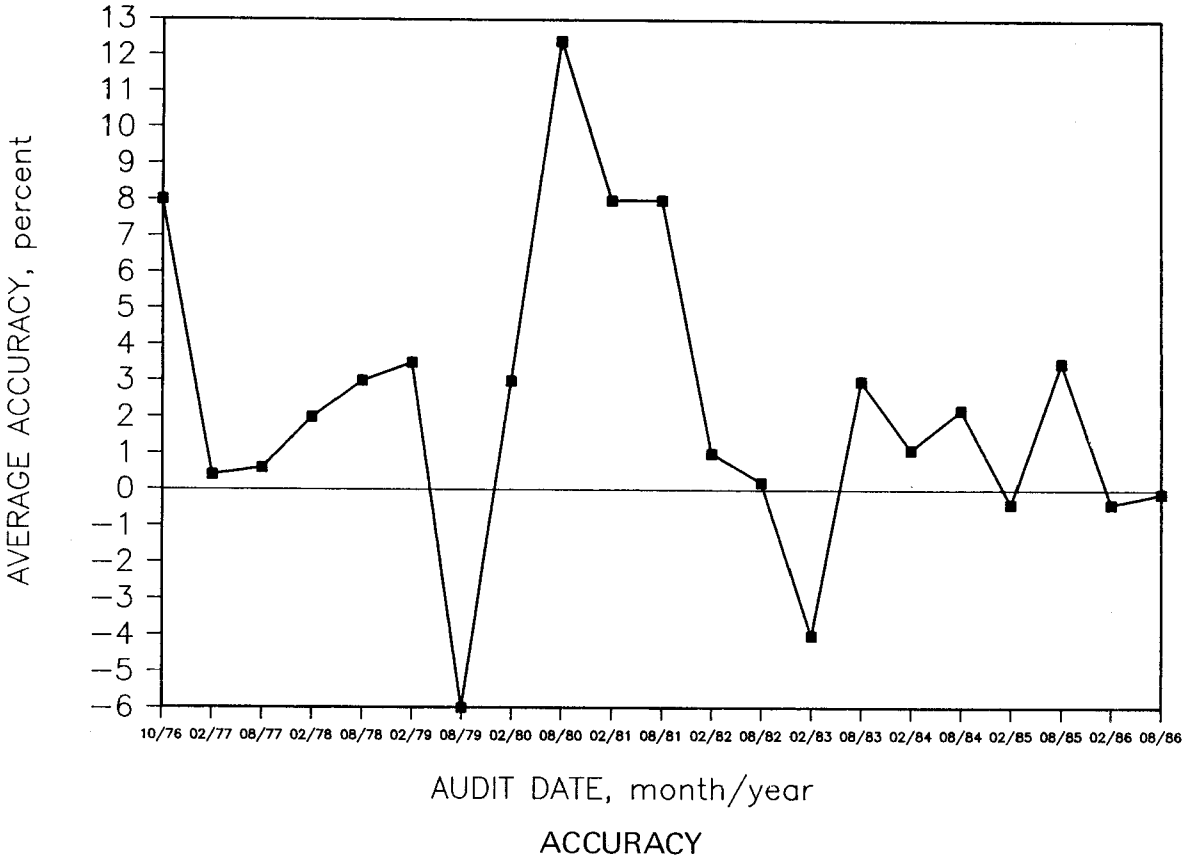


ACCURACY

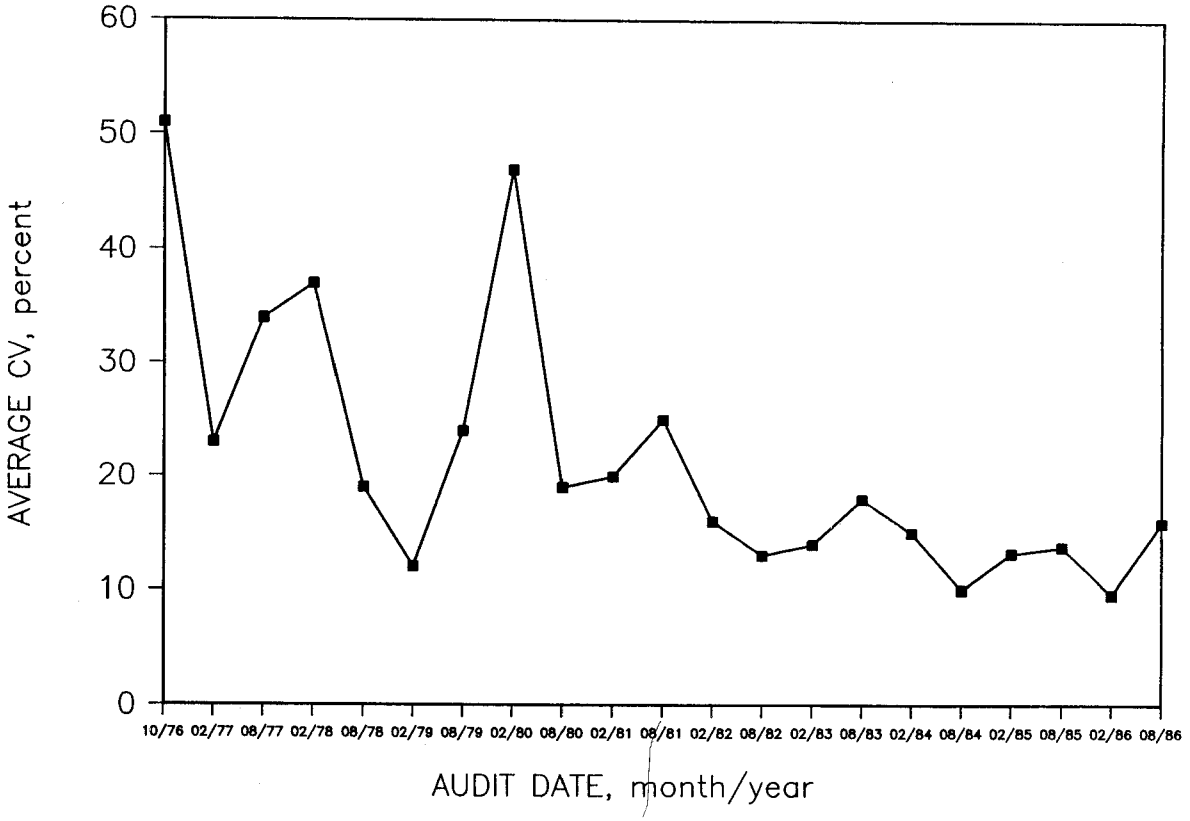


PRECISION

Figure 1. Carbon Monoxide Audits.

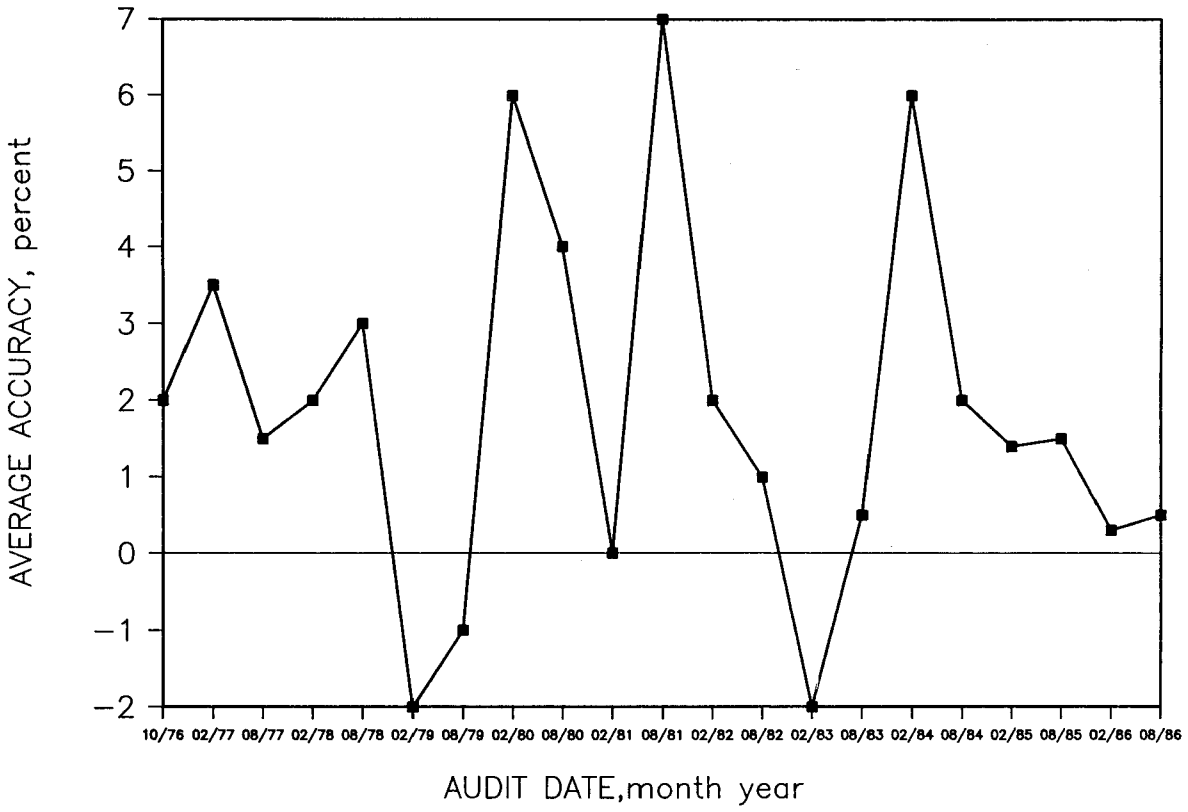


ACCURACY

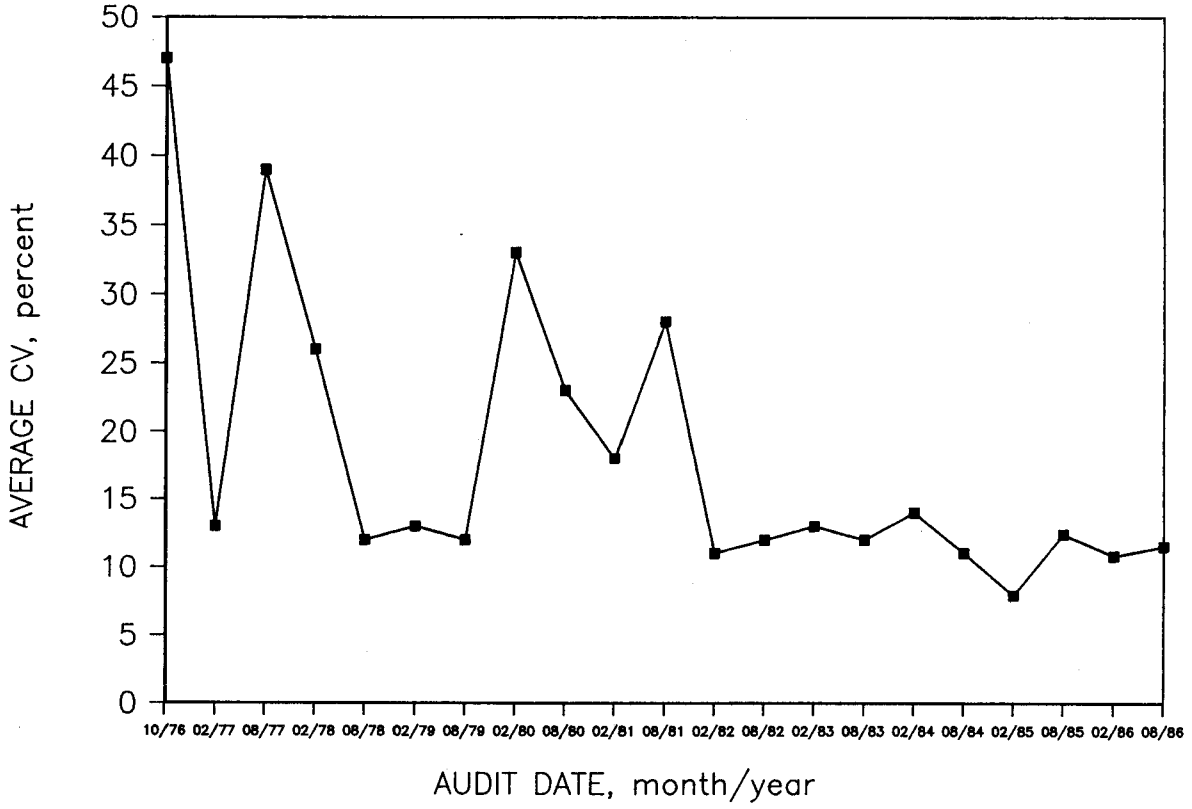


PRECISION

Figure 2. Sulfate Audits.

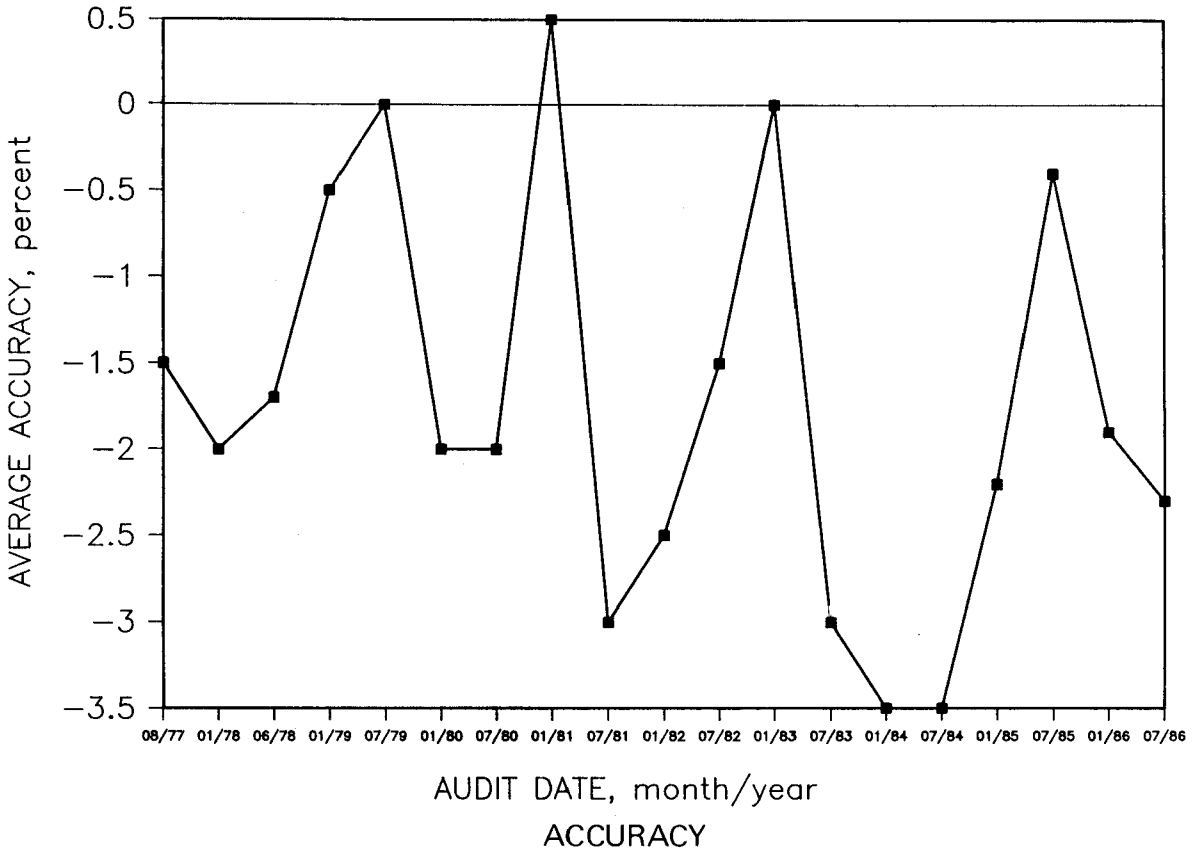


ACCURACY



PRECISION

Figure 3. Nitrate Audits.



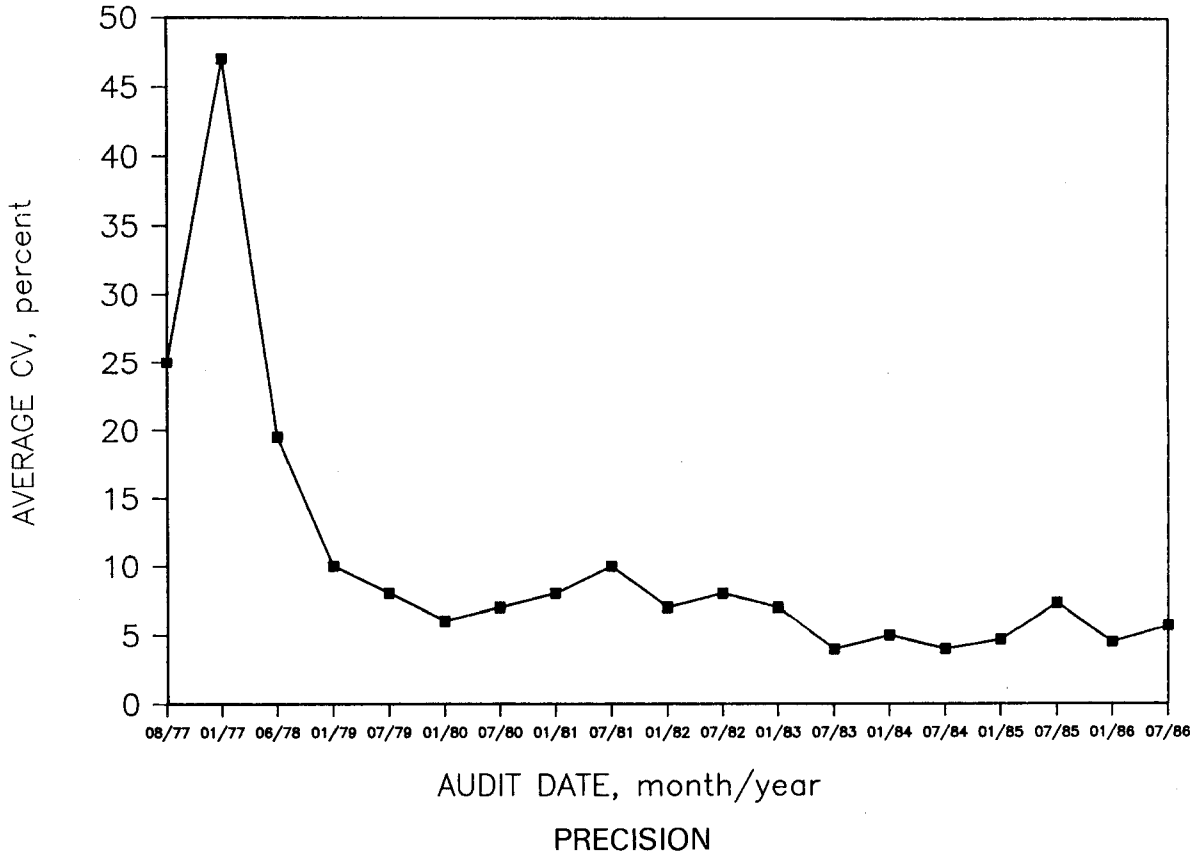


Figure 4. Lead Audits.

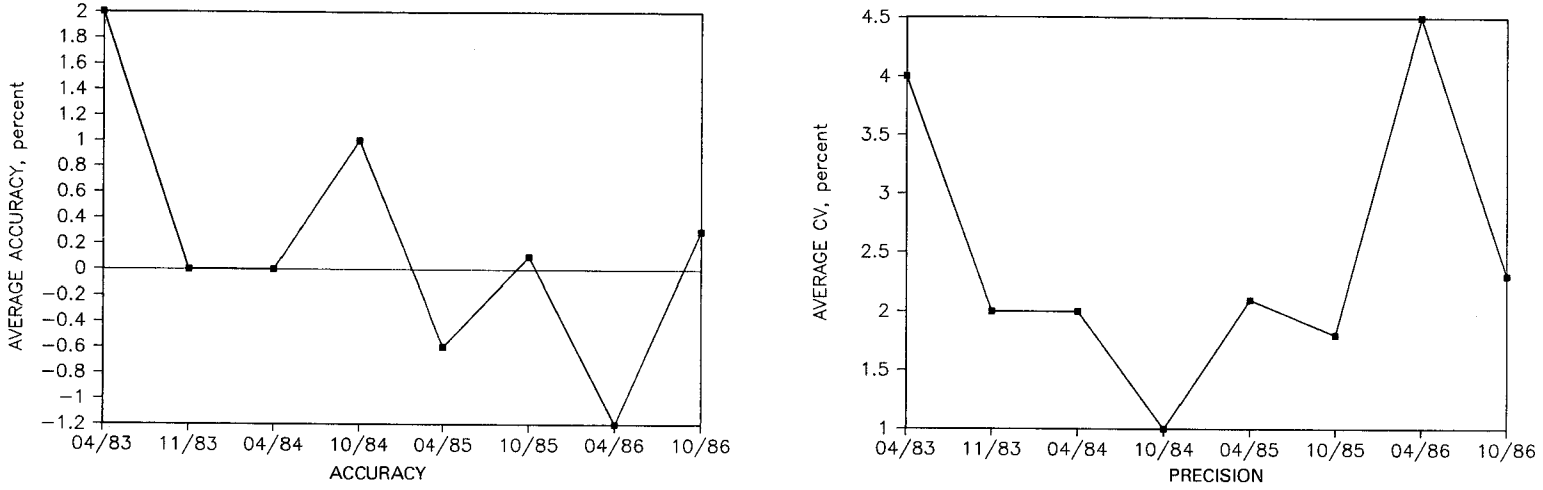


Figure 5. Acid Rain Audit Results for pH.

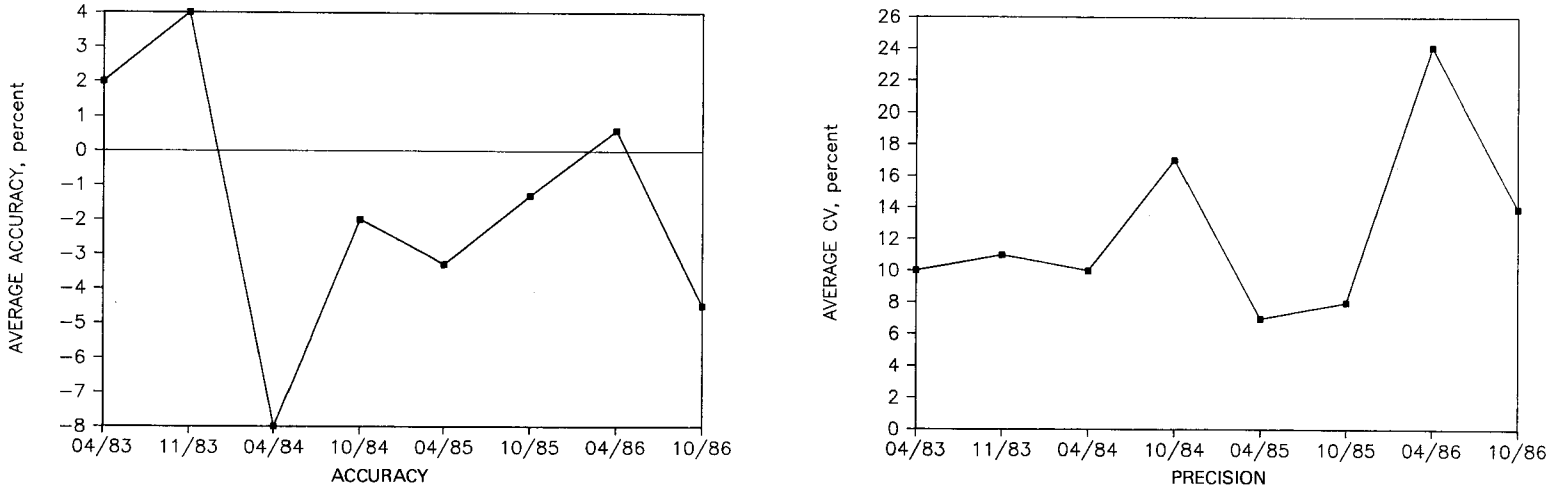


Figure 6. Acid Rain Audit Results for Conductivity.

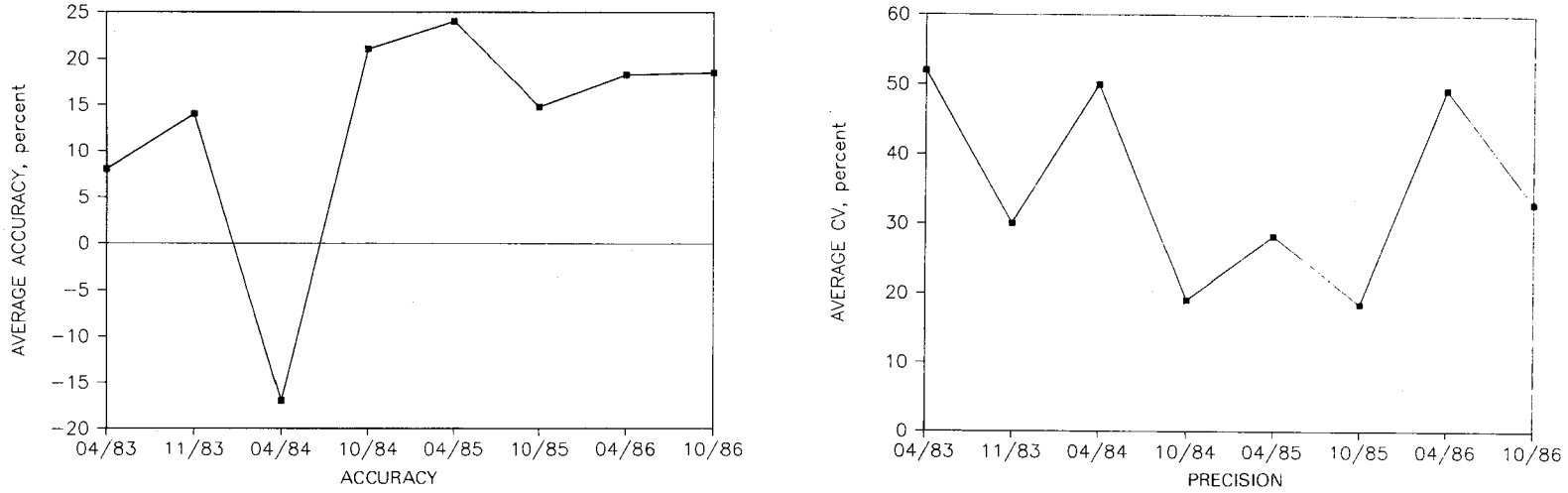


Figure 7. Acid Rain Audit Results for Acidity

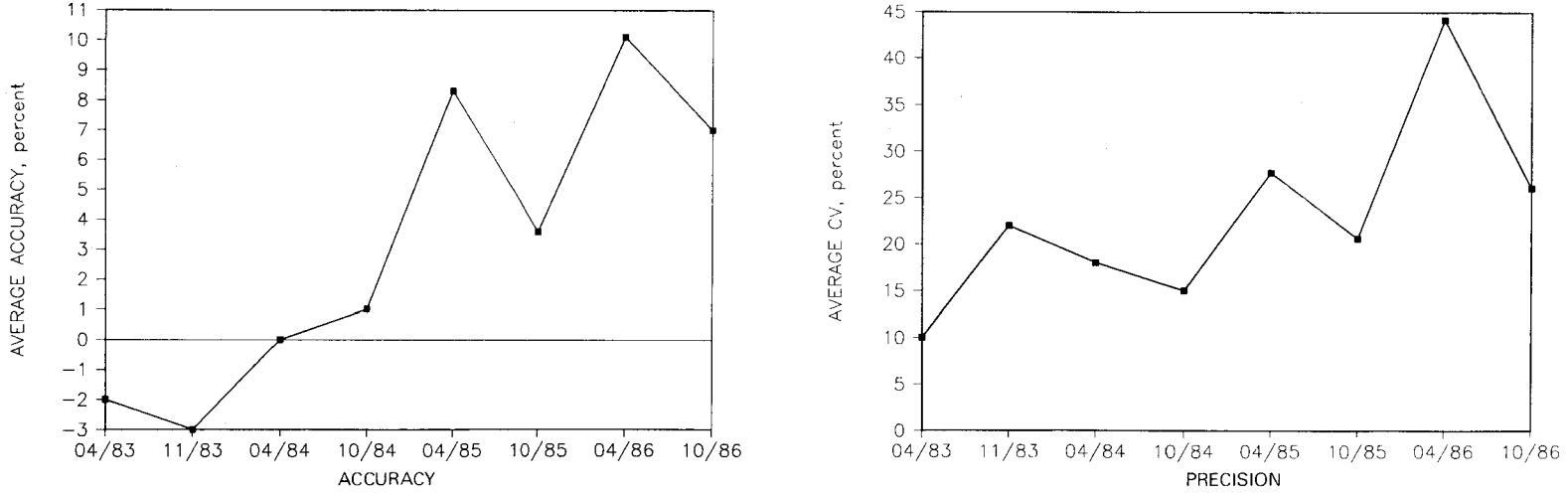


Figure 8. Acid Rain Audit Results for SO_4 (Reported as S).

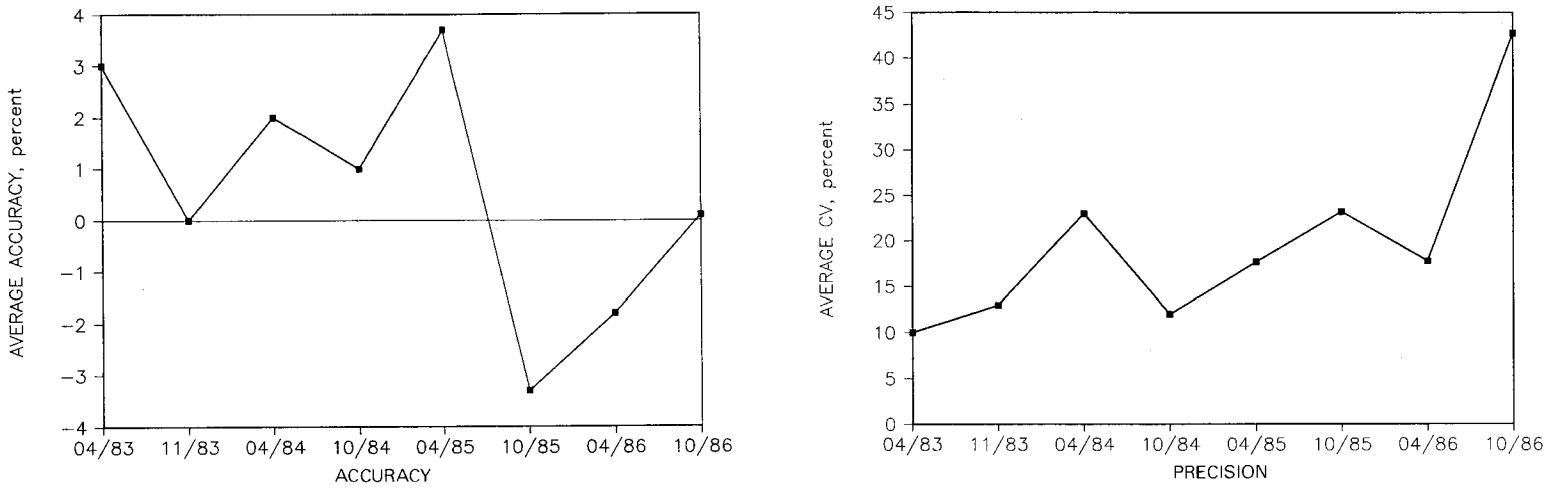


Figure 9. Acid Rain Audit Results for NO_3 (Reported as N).

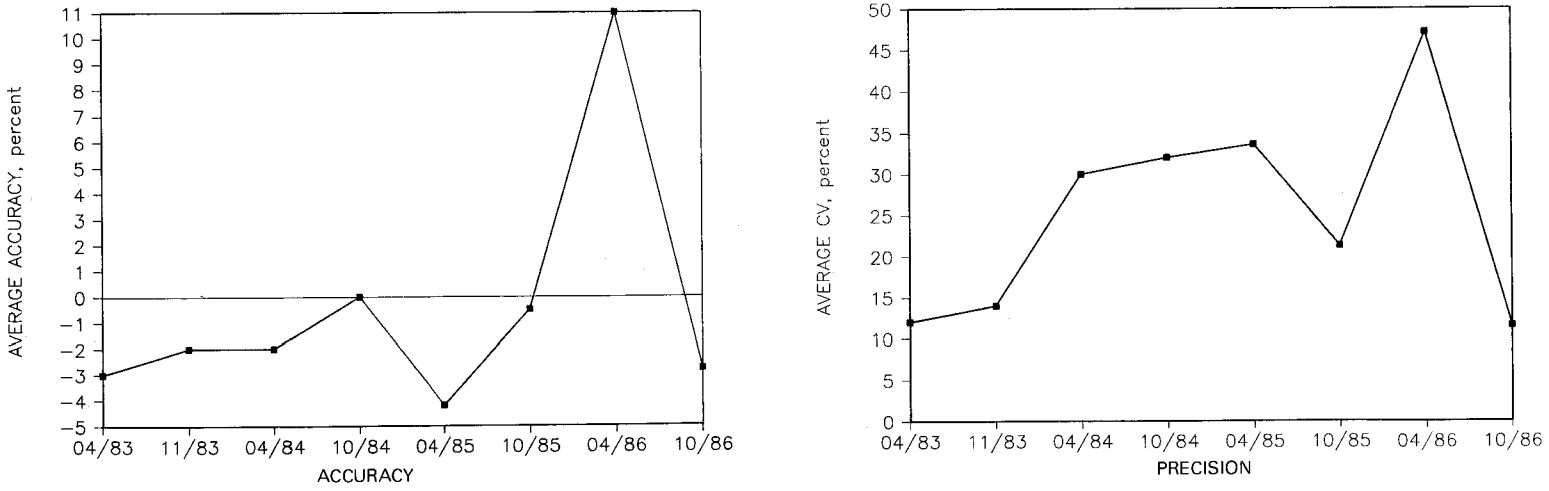


Figure 10. Acid Rain Audit Results for Cl.

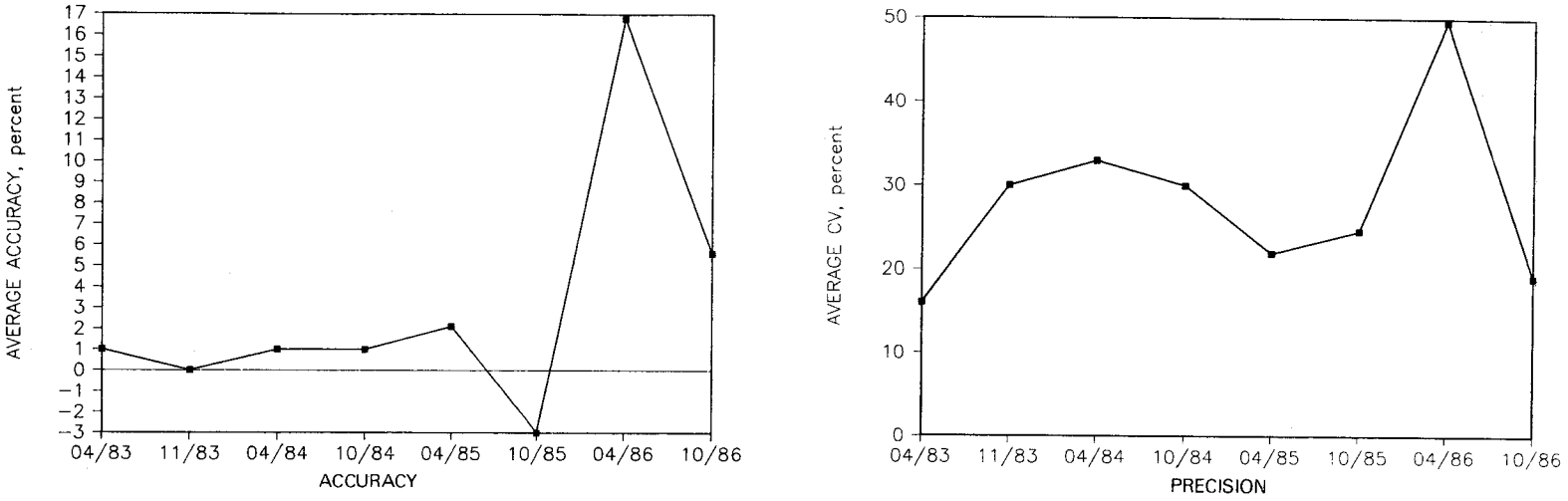


Figure 11. Acid Rain Audit Results for F

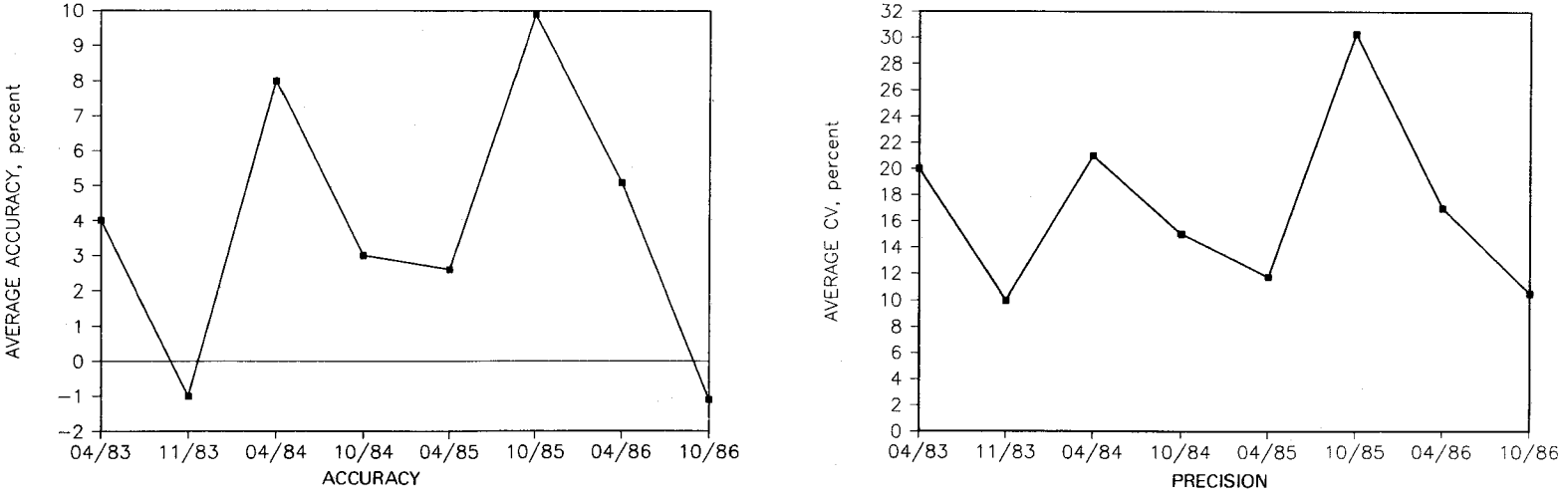


Figure 12. Acid Rain Audit Results for NH_4 (Reported as N).

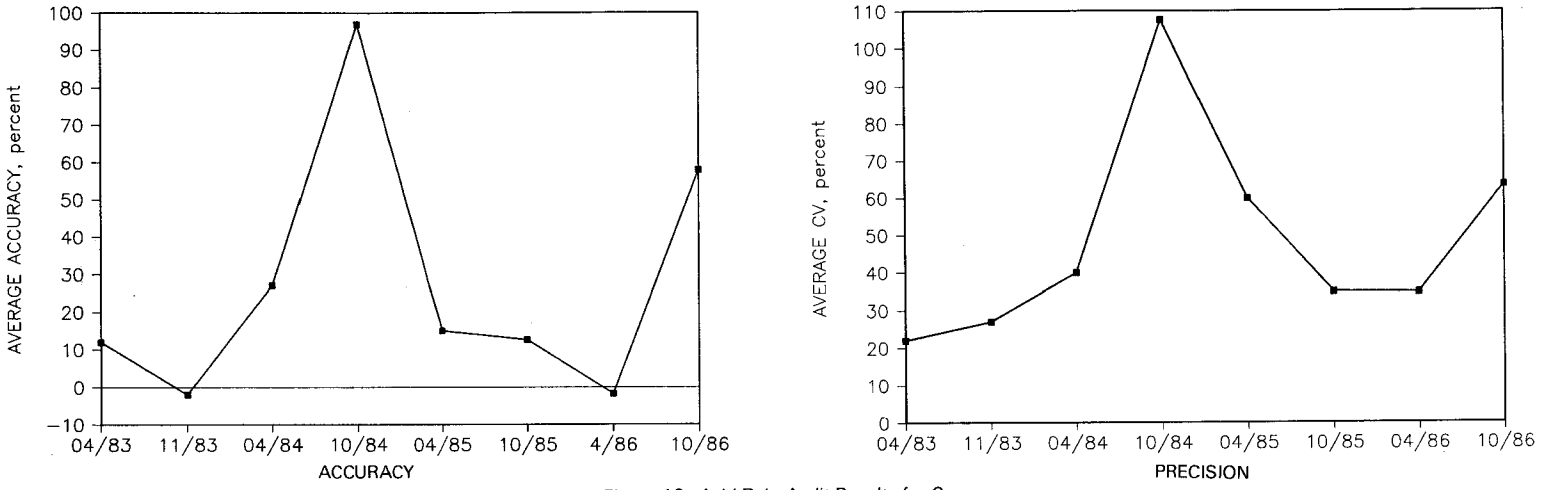


Figure 13. Acid Rain Audit Results for Ca.

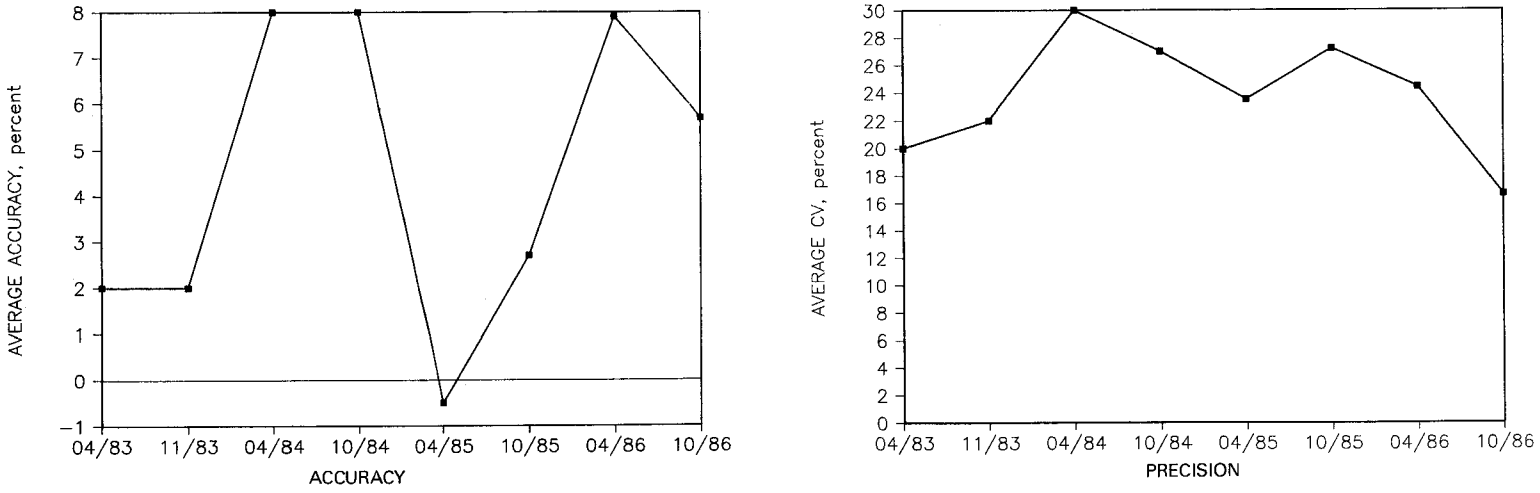


Figure 14. Acid Rain Audit Results for K.

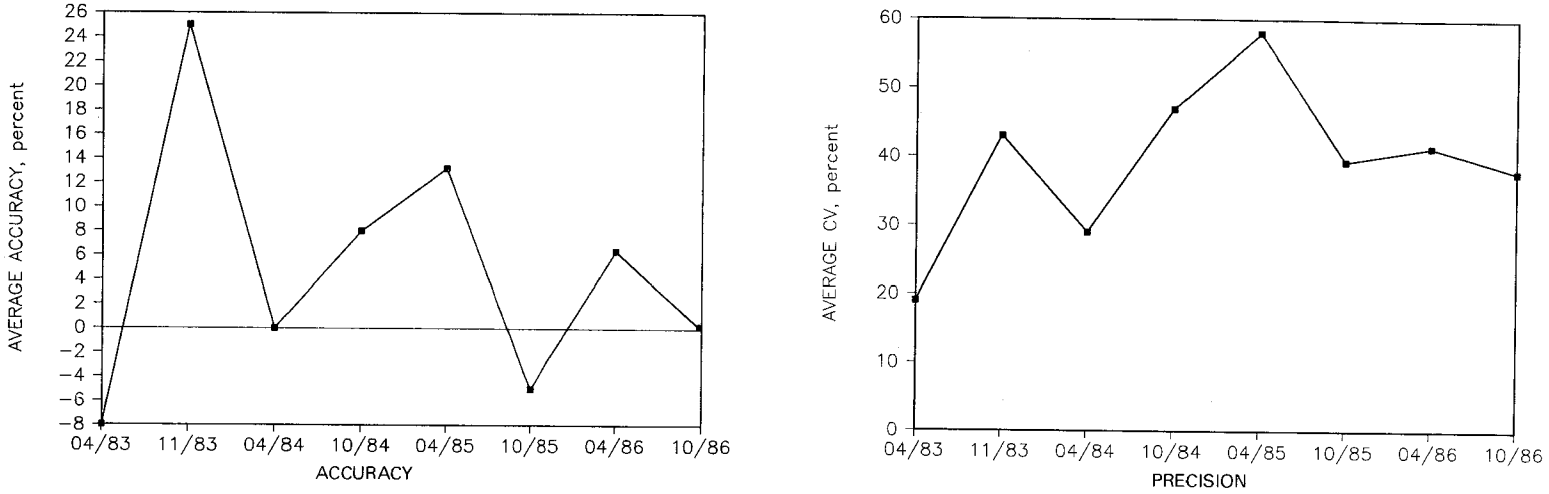


Figure 15. Acid Rain Audit Results for Mg.

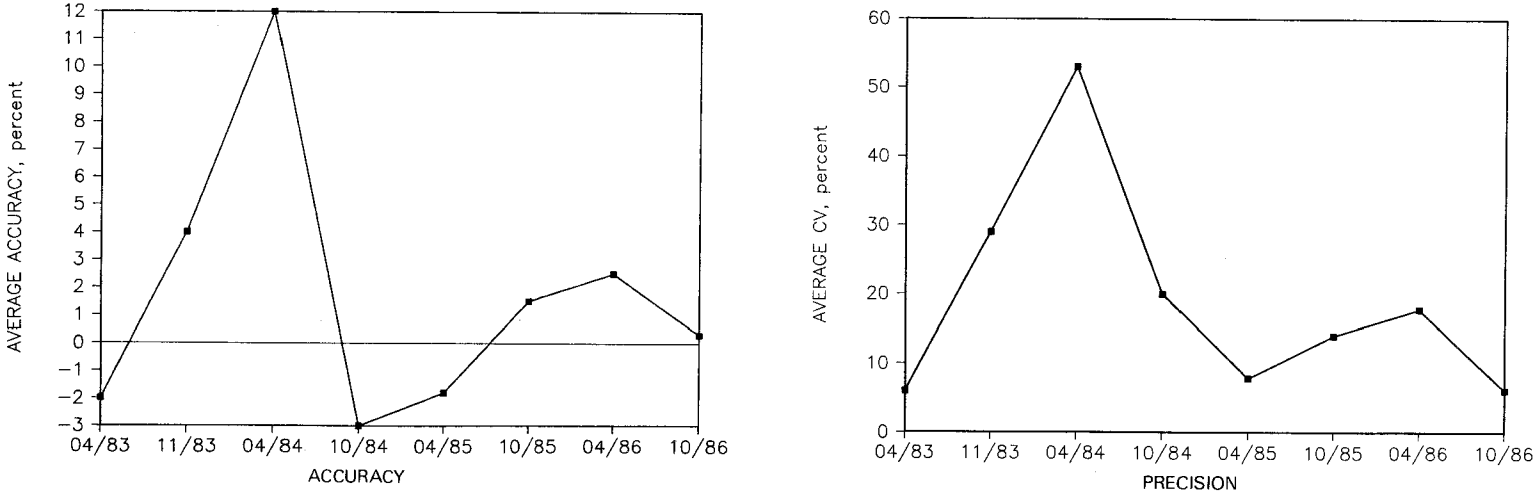


Figure 16. Acid Rain Audit Results for Na.

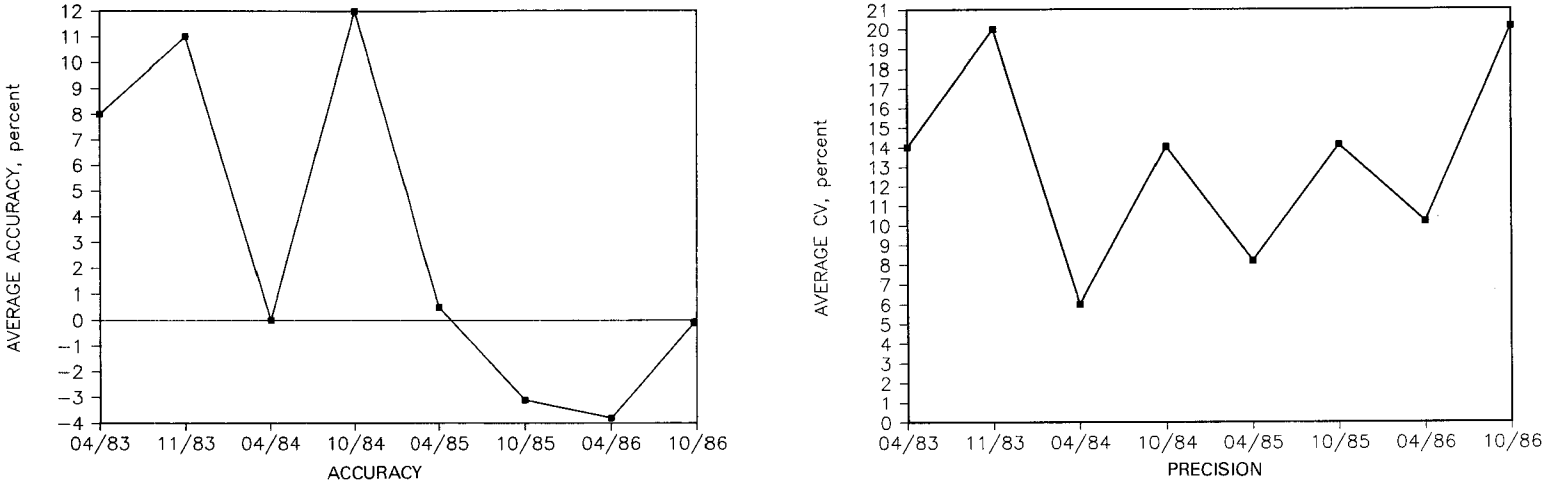


Figure 17. Acid Rain Audit Results for Mn.

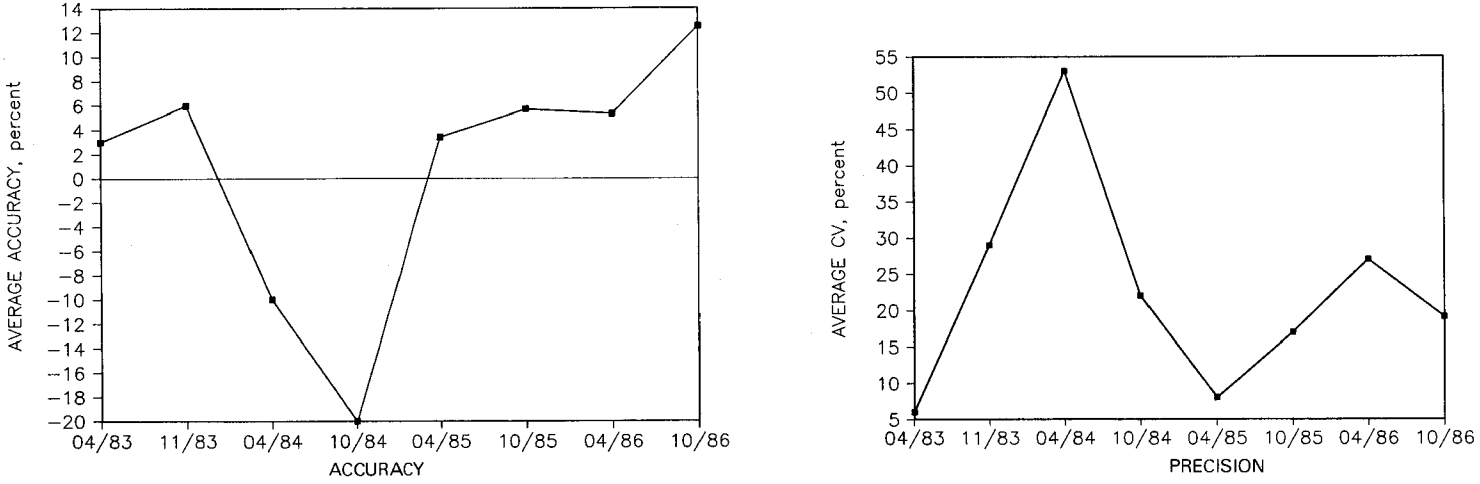


Figure 18. Acid Rain Audit Results for Fe.

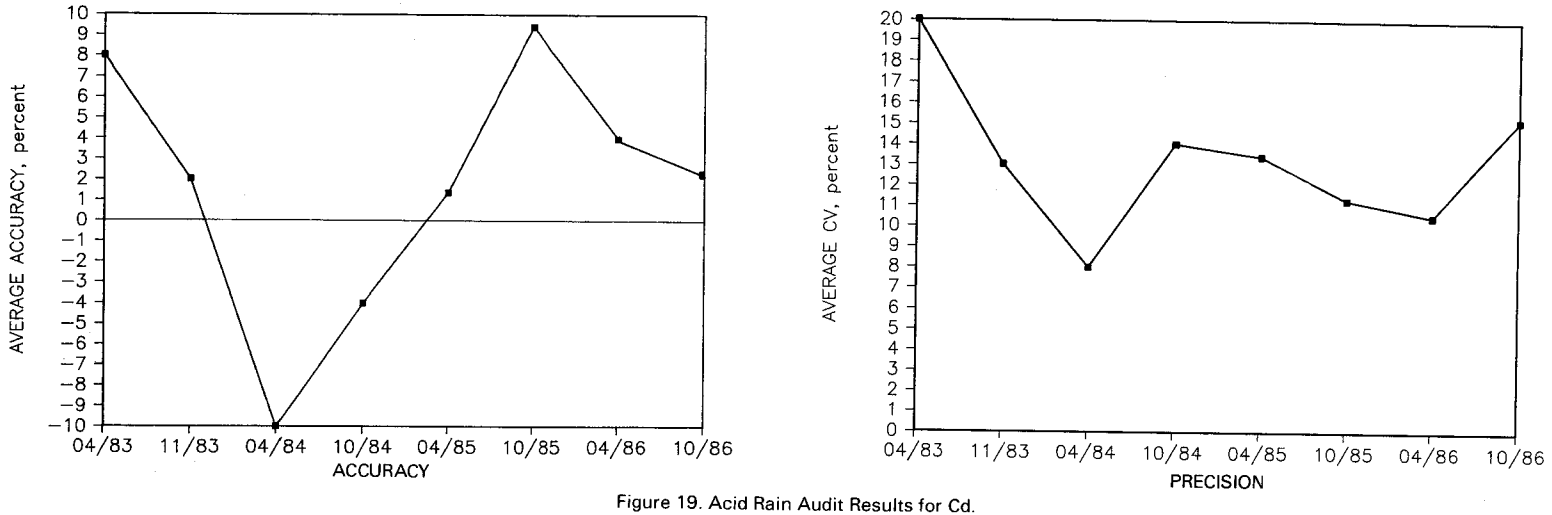


Figure 19. Acid Rain Audit Results for Cd.

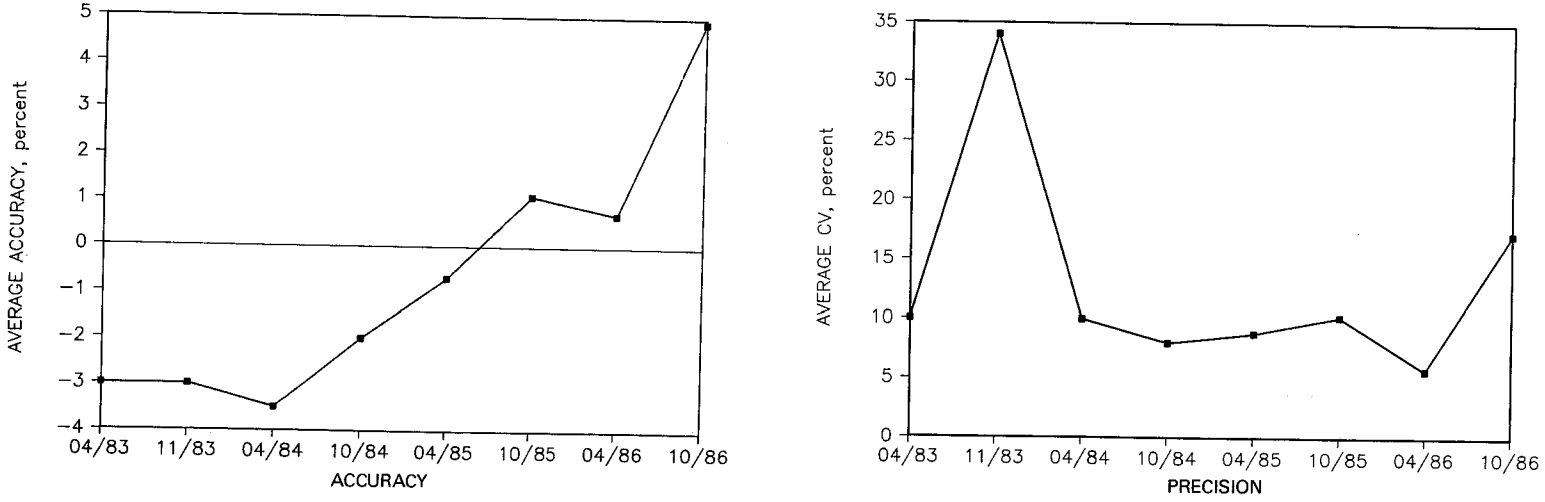
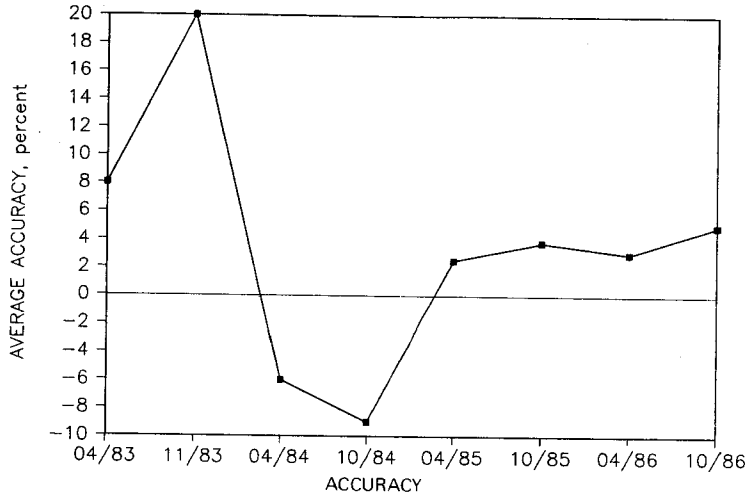


Figure 20. Acid Rain Audit Results for Cu.



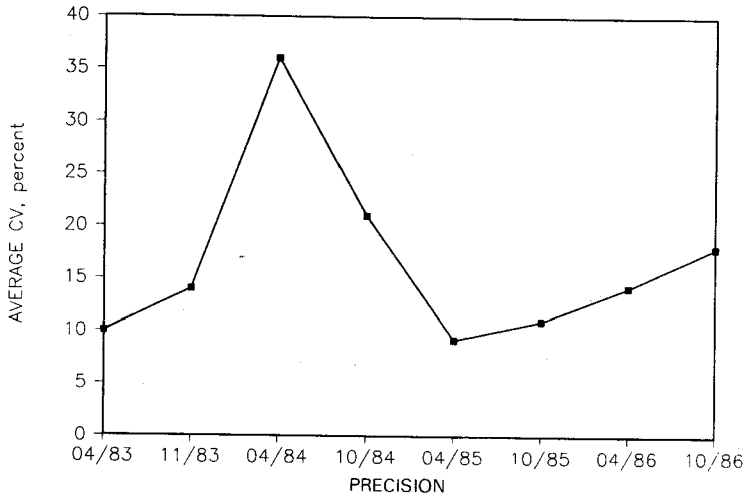
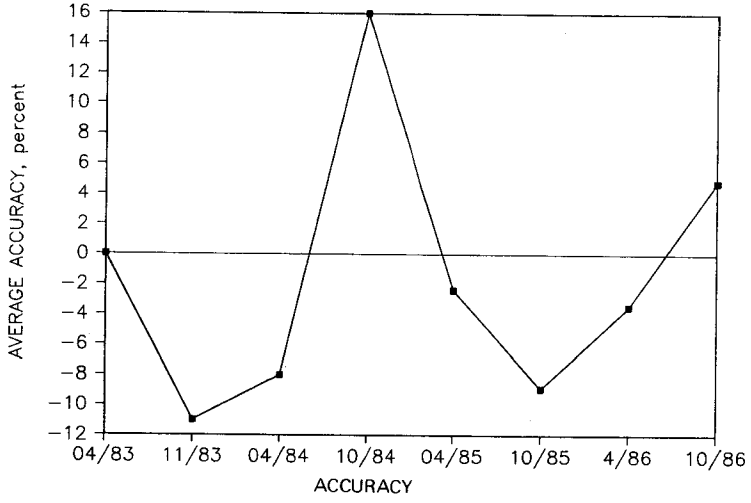


Figure 21. Acid Rain Audit Results for Ni.



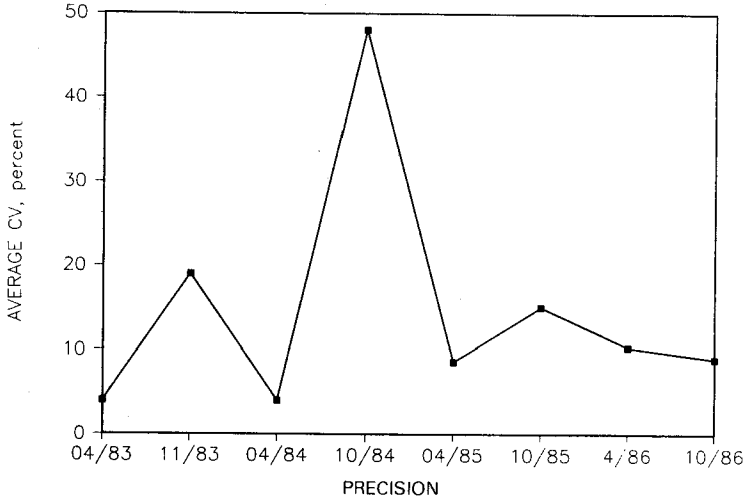
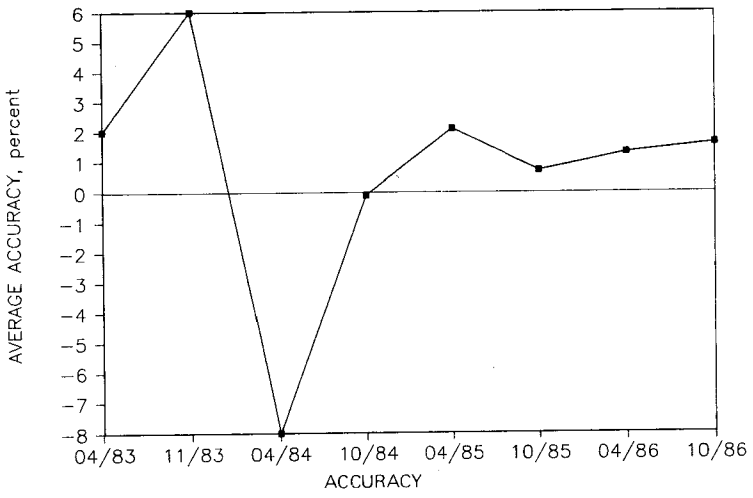


Figure 22. Acid Rain Audit Results for Pb.



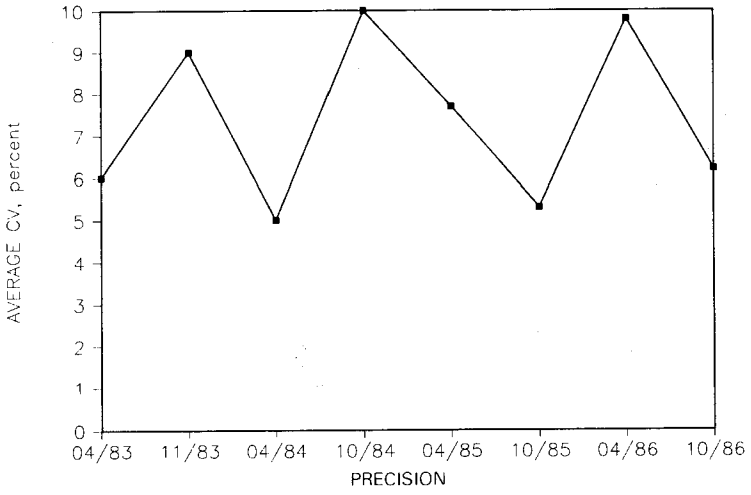


Figure 23. Acid Rain Audit Results for Zn

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