United States
Environmental Protection
Agency

Office of Acid Deposition, Environmental
Monitoring and Quality Assurance
Washington DC 20460

EPA/600/4-89/029
July 1989

Research and Development

EPA

Eastern Lake Survey - Phase II Quality Assurance Report

EPA/600/4-89/029
July 1989

Eastern Lake Survey - Phase II Quality Assurance Report

by

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A Contribution to the
National Acid Precipitation Assessment Program

U.S. Environmental Protection Agency
Office of Modeling, Monitoring Systems, and Quality Assurance
Office of Ecological Processes and Effects Research
Office of Research and Development
Washington, D.C. 20460

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Notice

The information in this document has been funded wholly or in part by the United States Environmental Protection Agency under Contract Number 68-03-3249 to Lockheed Engineering & Sciences Company (formerly Lockheed Engineering and Management Services Company) and Cooperative Agreement Number 812189-03 to the Environmental Research Center of the University of Nevada at Las Vegas. This document has been subject to the Agency's peer and administrative review, and it has been approved for publication as an EPA report.

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This document is one volume of a set which fully describes the Eastern Lake Survey - Phase II. The complete document set includes the major data report[1], quality assurance plan, analytical methods manual, field operations report, processing laboratory operations report, and quality assurance report. Similar sets are being produced for each Aquatic Effects Research Program component project. Colored covers, artwork, and the use of the project name in the document title serve to identify each companion document set.

The correct citation of this document is:

Mitchell-Hall, T. E.[2], A. C. Neale[2], S. G. Paulsen[3], and J. E. Pollard[2]. 1989. Eastern Lake Survey - Phase II: Quality Assurance Report. EPA/600/4-89/029. U. S. Environmental Protection Agency, Las Vegas, Nevada.

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Abstract

The Eastern Lake Survey - Phase II was designed primarily to assess seasonal variability in regional surface water chemistry. This report describes and evaluates the quality assurance program employed during the survey. The operations component included quality assurance and quality control procedures to ensure that all samples were collected and analyzed consistently and to estimate the accuracy and precision of the reported values with a known degree of confidence. The data management component established a means to store and track data; to identify and correct entry, reporting, and analytical errors; and to keep a record of such changes. The survey design identified 24 physical and chemical characteristics of lake water for measurement. Data quality objectives for detectability, accuracy, precision, representativeness, completeness, and comparability for ELS-II were based on previous related surveys. During data verification and validation activities, several issues (concentrated primarily on the data from the chloride, nitrate, sulfate, and alkalinity analyses) prompted a Special Data Assessment. This process produced a list of recommendations and justifications for changes to be made to the official verified data base.

Overall, the quality assurance program was successful in identifying and resolving a number of data quality issues and assuring that the data were of known and documented quality. For ELS-II as a whole, the data are of acceptable quality and every effort was made to correct any deficiencies. The accuracy and precision of data for four analytes of primary interest in acidic deposition research (acid neutralizing capacity, pH, nitrate, and sulfate) were close to or better than the goals set for intralaboratory performance. The representativeness, completeness, and comparability of the data meet the project objectives. Special attention should be given to the data quality objectives for surveys with multiple components, including consideration of specific objectives for each component.

This report is submitted in partial fulfillment of contract number 68-03-3249 by Lockheed Engineering and Sciences Company under the sponsorship of the U.S. Environmental Protection Agency. This report covers a field work period from March 25 to May 3, 1986, for the Spring Seasonal subsurvey; from July 23 to August 11, 1986, for the Summer Seasonal subsurvey; and from October 8 to November 14, 1986, for the Fall Seasonal subsurvey. Data verification was completed in September 1987. The Special Data Assessment began in February 1988 and ended in March 1989.

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Abbreviations and Acronyms

Acronyms

AAS	atomic absorption spectroscopy
AERP	Aquatic Effects Research Program
APHA	American Public Health Association
AQUARIUS	Aquatics Quality Assurance Review, Interactive Users' System
ASTM	American Society for Testing and Materials
B	field blank sample
CADAVERS	Computer Aided Data Verification System
CRDL	contract required detection limit
D	duplicate lake sample
DQO	data quality objective
ELS-I	Eastern Lake Survey, Phase I
ELS-II	Eastern Lake Survey, Phase II
EMSL-LV	U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada
EPA	U.S. Environmental Protection Agency
ERL-C	U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon
FIA	flow injection analyzer
FL	field low synthetic audit type
FN	field natural audit type
IC	ion chromatograph
ICPES	inductively coupled emission spectroscopy
IDL	instrument detection limit
LDR	linear dynamic range
LESC	Lockheed Engineering & Sciences Company
LL	laboratory low synthetic audit type
LN	laboratory natural audit type
LS	laboratory synthetic
MDL	method detection limit
MIBK	methyl isobutyl ketone
NAPAP	National Acid Precipitation Assessment Program
NLS	National Lake Survey
NSS	National Stream Survey
NSS-I	National Stream Survey, Phase I
NSWS	National Surface Water Survey
OMMSQA	Office of Modelling, Monitoring Systems, and Quality Assurance
PCV	pyrocatechol violet
QA	quality assurance
QAMS	U.S. Environmental Protection Agency, Quality Assurance Management Staff
QC	quality control
QCCS	quality control check sample
R	routine lake sample
RO	reverse osmosis
RSD (%)	percent relative standard deviation
RWH	rainwater high synthetic audit type
RWL	rainwater low synthetic audit type
S	split sample

Abbreviations and Acronyms (continued)

Acronyms

SAI	Systems Applications, Inc.
SAS	Statistical Analysis System
SOP	standard operating procedures
WLS	Western Lake Survey

Variables and Units

Al-ext	aluminum, total extractable
Al-dis	aluminum, dissolved monomeric
Al-org	aluminum, nonexchangeable monomeric
Al-total	aluminum, total
ANC	acid neutralizing capacity
BNC	base neutralizing capacity
Ca	calcium
Cl^-	chloride
CO_3^{2-}	carbonate
cond	specific conductance
cond-in situ	specific conductance, measured in the lake at 1.5 meters
DIC	dissolved inorganic carbon
DIC-closed	DIC, closed system
DIC-eq	DIC, equilibrated
DIC-open	DIC, open system
DO	dissolved oxygen
DOC	dissolved organic carbon
eq/L	equilvalents per liter
Fe	iron
F^-	fluoride, total dissolved
H^+	hydrogen ion
HCO_3^-	bicarbonate
K	potassium
m	meter
mg/L	milligrams per liter
Mg	magnesium
Mn	manganese
moles/L	moles per liter
Na	sodium
NH_4^+	ammonium
NO_3^-	nitrate
NTU	nephelometric turbidity unit
OH^-	hydroxyl ion
P_{10}	tenth percentile
P_{50}	fiftieth percentile
P_{90}	ninetieth percentile
P_{95}	ninety-fifth percentile
P_{99}	ninety-ninth percentile
PCU	platinum cobalt unit
pH	negative logrithm of the hydrogen ion activity
pH-ANC	pH, measured before acid titration for ANC
pH-BNC	pH, measured before base titration for BNC
pH-closed	pH, closed system
pH-eq	pH, equilibrated
pH-in situ	pH, measured in the lake at 1.5 meters

Abbreviations and Acronyms (continued)

Variables and Units

ppm	parts per million
P-total	phosphorus, total
SiO_2	silica
SO_4^{2-}	sulfate
$\bar{X}$	mean
µeq/L	microequivalents per liter
µS/cm	microSiemens per centimeter
σ	standard deviation

Acknowledgements

The completion of this report would not have been possible without the efforts of many individuals. In particular, the authors wish to acknowledge the technical assistance, contributions, and editorial comments that were provided by the following people: R. A. Linthurst, R. D. Schonbrod, and D. T. Heggem (U.S. Environmental Protection Agency); E. P. Brantly (Research Triangle Institute); D. Coffey and T. Whittier (NSI Technology Services Corporation); L. W. Creelman (Radian Corporation); S. C. Hern (U. S. Environmental Protection Agency); D. J. Chaloud, B. N. Cordova, M. E. Silverstein, D. V. Peck, D. W. Sutton, J. E. Teberg, K. M. Peres, M. L. Faber, C. M. Monaco, D. C. Hillman, F. X. Suarez, L. A. Stanley, B. C. Hess, S. K. Drousé, J. K. Bartz, G. Satterwhite, T. Hody, and G. E. Byers (Lockheed Engineering and Sciences Company).

Section 1

Introduction

In 1980 Congress passed the Acid Precipitation Act, thus establishing the Interagency Task Force on Acid Precipitation. Given a 10-year mandate, the Task Force implemented the National Acid Precipitation Assessment Program (NAPAP) to investigate the causes and effects of acidic deposition.

The U.S. Environmental Protection Agency (EPA), as a participant in NAPAP, designed and implemented the Aquatic Effects Research Program (AERP). The responsibility of AERP is to assess the effects of acid deposition on aquatic ecosystems. A major component of AERP is the National Surface Water Survey (NSWS). The primary objectives of the NSWS were to (1) document chemical and biological changes in lakes and streams that are potentially susceptible to acid deposition and (2) select representative regions to quantify future effects of acid deposition on surface waters. The NSWS is divided into two components: the National Lake Survey (NLS) and the National Stream Survey (NSS). The NLS consists of the Eastern Lake Survey (ELS), Phases I and II, and the Western Lake Survey (WLS). Figure 1 shows the relationships and time frames of these various projects.

This report presents the results of the quality assurance program for the Eastern Lake Survey - Phase II (ELS-II). The ELS-II was designed primarily to assess seasonal variability in regional surface water chemistry. A quality assurance (QA) program was designed for the ELS-II to ensure consistency in the collection and analysis of samples, to verify the reported results, and to inform data users of the quality and potential limitations of the data base. In addition to summarizing the results of the QA program for ELS-II, this report includes an assessment of analytical data quality.

The major components of ELS-II that will be discussed in this report are the Spring Seasonal, Summer Seasonal, and Fall Seasonal subsurveys. However, the assessment of analytical data quality discussed in this report also applies to the data generated by the Fall Variability study. The Fall Variability study, conducted during the Fall Seasonal subsurvey, was designed to estimate the sampling variability associated with the Eastern Lake Survey - Phase I (ELS-I) Fall Index Site. Other components of ELS-II which are not evaluated in this report include: special studies for trace metals, zooplankton, chlorophyll, anoxic iron and anoxic manganese, total nitrogen and total phosphorous, and the Spring Variability Pilot Study. The Spring Variability Pilot Study was designed to obtain data describing the spatial and temporal variability of lake chemistry and to provide experience in winter sampling techniques during snowmelt.

Overview of the Eastern Lake Survey - Phases I and II

The Eastern Lake Survey consists of two phases: Phase I took place in the Fall of 1984 and Phase II was conducted in the spring, summer, and fall of 1986.

Eastern Lake Survey - Phase I

The ELS-I, a synoptic survey of the chemistry of 1,798 lakes in the eastern United States, was designed to obtain a regional data base of water quality parameters that are pertinent to evaluating the effects of acidic deposition. Lakes that were representative of the southeastern, northeastern, and upper midwestern regions of the United States were sampled to provide characteristic information. The survey was designed to yield information that was complete and consistent in terms of the parameters measured and the sampling

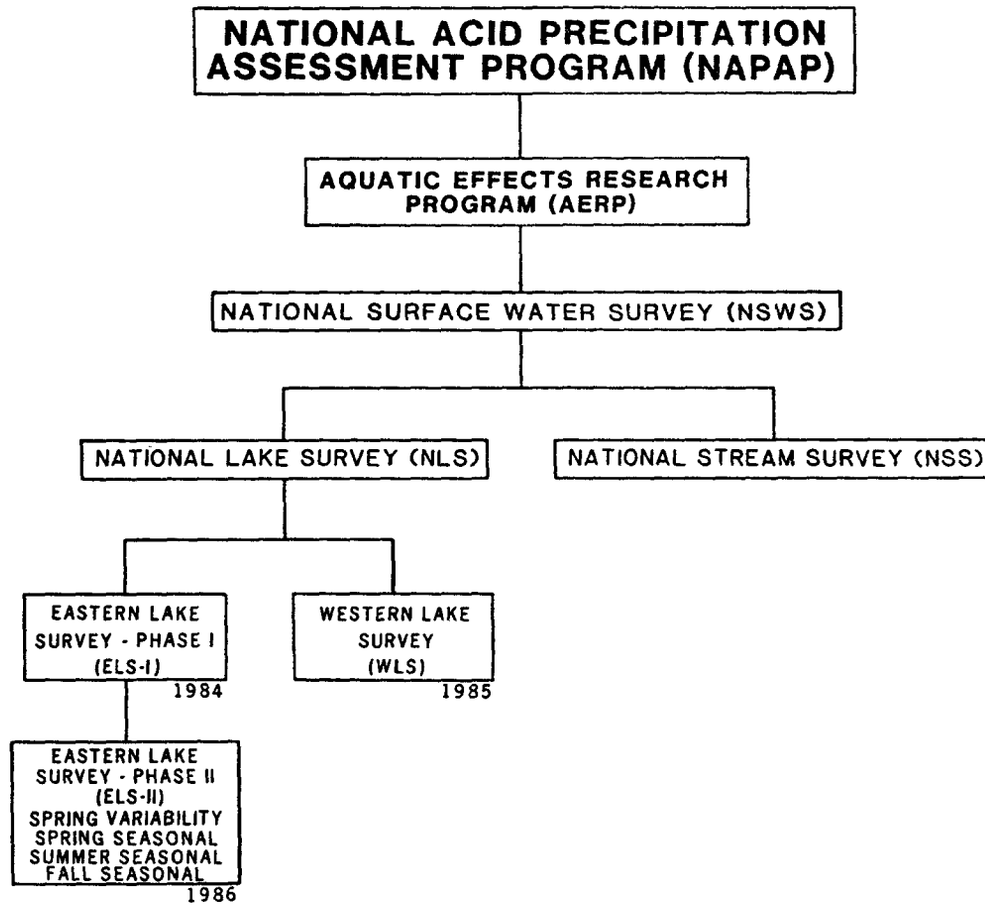

Figure 1. Component studies of the National Surface Water Survey.

and analytical procedures used. Detailed sampling procedures (Morris et al., 1986) and a rigorous QA program (Drousé et al., 1986) were implemented. The QA program and quality of the analytical data were evaluated in Best et al. (1986). The ELS-I program design and data interpretations are documented in Linthurst et al. (1986).

Eastern Lake Survey - Phase II

In the ELS-II, a subset of the lakes sampled in the ELS-I was resampled to assess chemical variability and biological status. Lakes chosen to be included in the ELS-II were restricted to those lakes considered susceptible to acidification.

To assess this chemical variability, a subset of 150 lakes that had been sampled in the northeast region during ELS-I was sampled during each of the ELS-II seasonal subsurveys. Figure 2 shows the major geographical subregions of interest for the ELS-II. To produce comparable data, procedures for sample collection, sample analysis, and data reporting were based on the protocols established during ELS-I. Details of the ELS-II survey design are discussed in an internal document (Kent Thornton, Joan P. Baker, Kenneth H. Reckhow, Dixon H. Landers, Parker J. Wigington, Jr.; February 1986; National Surface Water Survey: Eastern Lake Survey - Phase II, Research Plan; U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Office of Research and Development).

The ELS-II was designed to provide statistically comparable data that could be extrapolated, with a known degree of confidence, to a regional scale. The ELS-II also provides information that can be used to develop correlative, rather than cause-and-effect, relationships. The specific objectives of the ELS-II seasonal subsurveys were as follows:

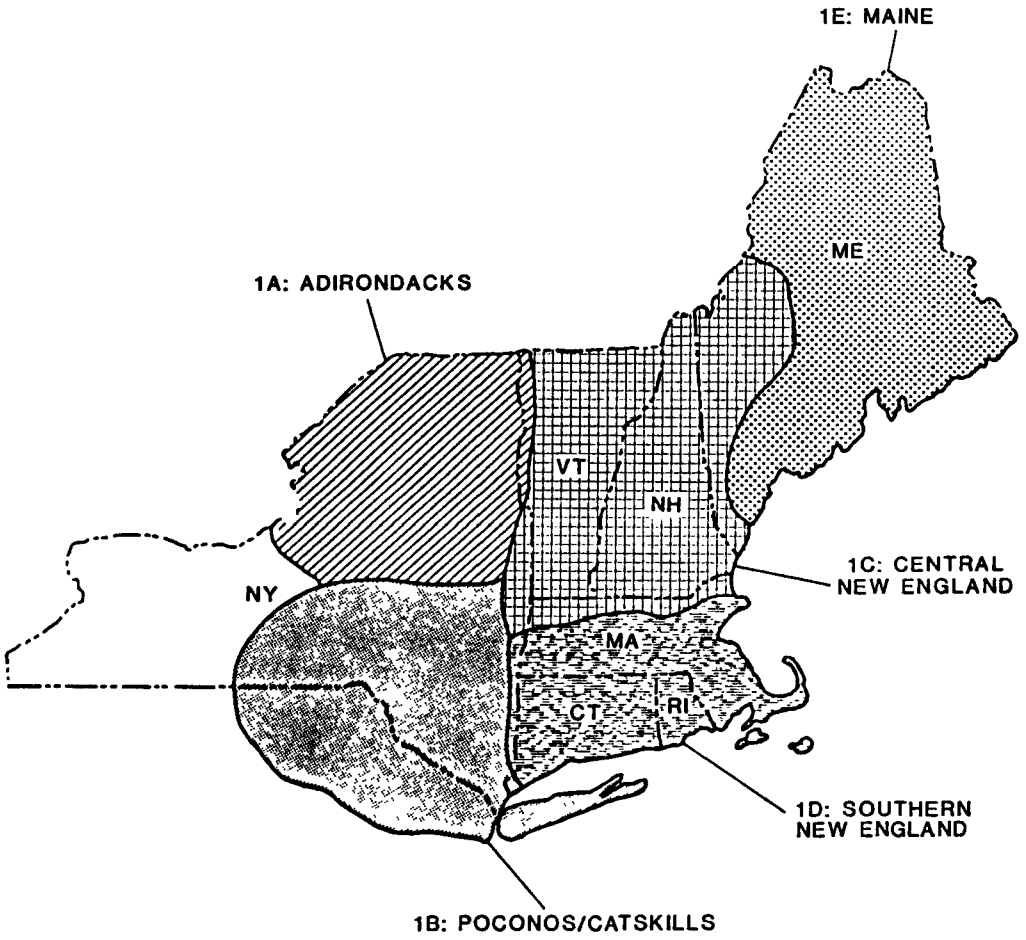

Figure 2. Major geographical subregions of interest for the Eastern Lake Survey-Phase II.

- Provide temporal data from a subset of lakes that were sampled in ELS-I and that are characteristic of the overall population of lakes within a region.
- Use standardized methods of sample and data collection.
- Measure a complete set of variables thought to influence or known to be influenced by surface-water acidification.
- Provide data that can be used to quantify relationships among chemical variables on a regional basis.
- Provide reliable estimates of the chemical status of lakes within a specific subregion.

Survey Participants

Various organizations were involved in the design and implementation of ELS-II. The EPA Office of Modeling, Monitoring Systems, and Quality Assurance (OMMSQA) in Washington, D.C., funded and administered the ELS-II. The EPA Environmental Research Laboratory in Corvallis, Oregon (ERL-C), was responsible for coordinating the survey activities and for project design, site selection, data validation, and lake data interpretation. Northrop Services, Inc., provided technical services to ERL-C. The EPA Environmental Monitoring Systems Laboratory in Las Vegas, Nevada (EMSL-LV), was responsible for QA and quality control (QC) activities, sampling and logistical operations, communications coordination, analytical support, and QA data interpretation. Lockheed Engineering & Sciences Company (LESC) provided support to EMSL-LV in these areas and also provided experimental performance audit samples. The U.S. Soil Conservation Service and other federal and state agencies assisted in determining land ownership and in obtaining access to lake sites. Analytical services for this survey were provided by two contractor laboratories that are identified in

this report as Laboratory 1 and Laboratory 2. Performance audit samples were provided by Radian Corporation (Austin, Texas). Systems Applications, Inc. (SAI), in San Rafael, California, was responsible for the development and the management of the ELS-II data bases and also assisted ERL-C in data interpretation, statistical programming, and mapping and other geographical analyses. The EPA Sample Management Office in Alexandria, Virginia, was responsible for sample tracking and assessment of analytical laboratory performance to determine financial compensation.

Eastern Lake Survey - Phase II Documents

This QA report is one of a number of publications that describe the ELS-II. The QA program for the ELS-II is documented in the QA Plan (Engels et al., 1988). Field operations are described in Merritt et al. (1988). The processing laboratory activities are discussed by Arent et al. (1988). Kerfoot et al. (1988) documents the analytical methods used during the ELS-II at the standard operating procedure (SOP) level of detail. At the time of this publication, the plans for an ELS-II final report containing the details of the survey design and results have not been completed.

Section 2

Conclusions and Recommendations

This section provides a summary of conclusions and recommendations based on descriptions and evaluations of the ELS-II quality assurance (QA) program discussed in Sections 3 through 6. For an explanation or additional details of the premises on which the following statements are made, the reader should refer to the appropriate section.

Conclusions

Overall, the QA program was successful in identifying and resolving a number of data quality issues. The program also was effective in assuring that the data were of known and documented quality. The majority of the data are of acceptable quality and every effort was made to correct any deficiencies. The following subsections list conclusions about data quality.

Detectability

- Laboratory 1 had consistently higher system decision limits than Laboratory 2 for 8 of 21 analytes (nonexchangeable monomeric aluminum, chloride, conductivity, equilibrated dissolved inorganic carbon (DIC-eq), initial dissolved inorganic carbon (DIC-initial), potassium, magnesium, and sulfate).

- The issue of detectability should be viewed in the context of the routine sample values. For example, when a substantial portion of the routine values are well above the decision limit, then seasonal differences between laboratories in their decision limits become less important.

Interlaboratory Bias

- Nineteen of the thirty analytes in the Summer Seasonal subsurvey exhibited no interlaboratory bias. Only the values for conductivity, DIC-eq, DIC-initial, and iron showed consistent interlaboratory bias. Additionally, values for acid neutralizing capacity (ANC), calcium, chloride, total dissolved fluoride, potassium, equilibrated pH, and turbidity showed weak evidence for slight interlaboratory bias.

Accuracy and Precision

- Data quality objectives for accuracy and precision were defined in percent difference and percent variability for all concentration ranges of a given analyte (with the exception of pH). This procedure was not effective for low ranges of analyte (within 10 times the detection goals). The quality of analyte values in low concentration ranges cannot be evaluated using the preestablished data quality objectives.

- The accuracy and precision of data for four analytes of primary interest in acidic deposition research (ANC, pH, nitrate, and sulfate) were close to or better than the goals for intralaboratory performance during the National Surface Water Survey (NSWS).

- Extractable aluminum data from natural audits were highly variable. The accuracy and precision data quality objectives set for this analyte appear to be too stringent for current methodological capabilities.

Other Conclusions

- No amount of quality assurance, quality control, or software will replace a meticulous laboratory.

- At the time of this publication, the only data qualifiers that remain appropriate in the modified verified data base are the X flags (indicating invalid data) which were the only flags evaluated during the Special Data Assessment (Section 5). Plans to update these qualifiers have not been finalized.

- The representativeness, completeness, and comparability of the data are adequate for the project objectives.

- The ELS-II QA program was successful in identifying and resolving several significant data quality issues (e.g., acid neutralizing capacity (ANC) in the Spring Seasonal subsurvey, sodium data in the Fall Seasonal subsurvey, dissolved organic carbon in the Spring Seasonal subsurvey) and in documenting data quality.

- In a few cases, data interpretation may be limited by considerations of data quality in terms of precision, accuracy, and detectability. This may be especially true for Laboratory 1 analyses of chloride.

- Internal consistency checks of the analytical results for each sample provided support to the conclusions based on the other procedures used to assess the data quality.

- Both the plots of the sum of anions versus the sum of cations and of the measured versus calculated conductivities illustrate that when Laboratory 1 chloride values of greater than 7.0 mg/L are eliminated in the plots, almost all data points fall in close proximity to the 1-to-1 line, for all seasonal subsurveys.

- When both the plots of the sum of anions versus the sum of cations and of the measured versus calculated conductivities are plotted by subregions for the Spring Seasonal subsurvey, it is evident that all data points for subregions 1A (Adirondacks) and 1E (Maine) fall in close proximity to the 1-to-1 line.

- The results from the Phase I of the Eastern Lake Survey (ELS-I) and the ELS-II Fall Seasonal subsurvey appear to be comparable based on internal consistency checks. ELS-I and the Fall Seasonal subsurvey plots for measured ANC versus calculated carbonate alkalinity, sum of anions versus sum of cations, and measured versus calculated conductivity display similar patterns.

- The plots of measured ANC versus carbonate alkalinity calculated by using the processing laboratory closed-system pH and DIC measurements show that Laboratory 1 (Spring Seasonal subsurvey) measured ANC results may be slightly lower than Laboratory 2 (Fall Seasonal subsurvey) measured ANC results.

- Analyses of interlaboratory bias and comparison of the measured ANC versus the calculated alkalinity indicate a problem with the analytical laboratory DIC measurements. This problem is not evident in alkalinity balance checks when the processing laboratory DIC and pH are used. Closed-system pH and DIC measurements should be used in data interpretation. These measurements are less subject to changes in the dissolved carbon dioxide concentration between the time of collection and analysis. Therefore, the closed-system measurements provide the best estimates of the in-situ conditions at the time of sampling.

Recommendations

The experience gained and conclusions drawn from the ELS-II provided insight for the following recommendations.

Field and Processing Laboratory Activities

- The FIA-aluminum method provides more specific information concerning particular aluminum species. Because a reliable FIA-aluminum method has been developed, eliminating the extractable aluminum method (MIBK) should be considered. Sole use of the FIA methods provides specific aluminum species data, reduces laboratory cost, and substantially reduces the volume, handling, and disposal of hazardous waste in the laboratory.

- Designate an assistant to the field base coordinator for the purpose of reviewing and correcting all field data forms before shipment to the QA staff.

- The simultaneous use of two pH meters for batches with more than 20 samples was successful in ELS-II and should be continued for future surveys. This method helps ensure that the maximum allowable holding times are achieved.

Analytical Laboratory Activities

- Analytical laboratories should be required not only to perform the charge balance

and the conductivity balance checks, but also to report these results.

- At least two on-site evaluations should be conducted at the analytical laboratories during early sample analyses. Follow-up evaluations may then be performed, when necessary.

- Dilutions should either be limited to a certain dilution factor (e.g., 1 to 5) or dilutions should be required to be performed in a stepwise manner (e.g., 2X, 5X, 10X) with a step after each dilution to determine if the result is within the range of the instrument calibration.

- The laboratories should be required to titrate a QCCS for ANC measurement to assess the titration capabilities of the laboratories as well as the ability to measure pH.

Data Evaluation

- Closed-system pH and DIC measurements should be used in data interpretation. These measurements are less subject to changes in the dissolved carbon dioxide concentration between the time of collection and analysis. Therefore, the closed-system measurements provide the best estimates of the in-situ conditions at the time of sampling.

- Perform as much data verification as possible while the survey is in progress so that any analytical problems can be identified early in the process and so that any necessary reanalysis can be performed within sample holding times. Early verification should include statistical analysis of the QA data to assess overall data quality and detect any problems not identified through sample-by-sample verification. Early verification should also include internal consistency data. For example, plotting measured ANC versus calculated carbonate alkalinity, the sum of anions versus the sum of cations, and measured versus calculated conductivities early in the survey would also help identify problems.

- Use the system detection limits to determine the lowest concentrations desirable for both natural and synthetic audit materials.

- Name sample types to reflect accurately the purpose and use of the samples for future surveys. The use of the term "field natural audit" is misleading as these audit samples were not taken into the field. Field natural audit samples were introduced into the system at the processing laboratory and can therefore only be used to assess the components of processing and analytical laboratory variability. The term "field natural" was introduced in previous NSWS surveys when sample processing was conducted in mobile processing laboratories (trailers) stationed at the field base sites. The use of the term "field natural" is used in this report to keep terminology consistent with previous NSWS reports and with the ELS-II QA Plan.

- View interlaboratory bias in the context of the magnitude of the seasonal differences which are of interest.

- Use Laboratory 1 chloride data with caution, especially at concentrations greater than 7.0 mg/L.

Design of the Quality Assurance Program

- If the goal of the QA program is quality management rather than quality documentation, design the QA program for this goal.

- Develop data quality objectives (DQOs) for both the total and analytical systems. Also, define DQOs at low analyte concentrations by absolute difference rather than percent relative standard deviation or percent difference (Hunt and Wilson).

- Establish data quality objectives for interlaboratory bias whenever more than one laboratory is involved in sample analyses. Establish within-laboratory control limits in order to achieve the desired among-laboratory goal. Consider the use of analyses of audit samples or collocated samples (replicate splits of routine samples) representing a wide range of concentrations in order to monitor, assess, and possibly correct for any biases that occur.

- Design future surveys that have multiple components (e.g., the spring, summer, and fall seasonal subsurveys of ELS-II) to be as consistent as possible across

components. Analytical laboratories across components should be consistent or the differences between the laboratories must be quantifiable.

- Evaluate methods designed to improve the precision and accuracy of the aluminum speciation and recommend improved methods for future research.

- Include only double-blind audit samples in the first two batches in future surveys to ensure the analytical capabilities of the laboratory. (The laboratory should have some type of electronic data transfer to make rapid data evaluations possible.) When it is determined that the laboratory is performing acceptably, the number of double-blind audit samples should be optimized during the course of the study.

- Include the laboratory managers in relevant aspects of the planning process in order to ensure their full understanding of the scope and needs of the project.

- Design contingency plans (including a back-up laboratory designation) to accommodate possible emergencies in cases of an analytical laboratory shutdown or if laboratory performance is unresolvably inadequate to complete the sample analyses.

- Provide the analytical laboratories with, or require them to obtain, known performance standards from a single source so that all laboratories can calibrate their measurement systems to a given target value to reduce interlaboratory bias.

- Provide well-characterized natural audit samples for use in a QA program. This characterization is best accomplished by large-scale round-robin analyses. From a QA program design perspective, each laboratory should receive the same number and type of audit samples.

- Consider any programmatic need to identify error components within the system when designing the QA sample distribution. Well-characterized natural audit samples can be used to identify sources of error by inserting them into various steps of collection, processing, and analysis.

- Specify clearly in the contract the number of points to be used in the calibration curve.

- Specify clearly in the contract the required number of decimal places or significant figures to which the analytical results must be reported.

- Use identical software at each laboratory to calculate the ANC and BNC.

- Include all titration data used to calculate ANC and BNC part of the raw data base or require that it at least be available electronically. If an electronic form of the titration data is available, then electronic QC checks of the titration data points can be performed. These checks are especially important if the titration was not performed on an automatic titrator or whenever the titration data are entered manually. If a problem is found with the ANC determinations, the data would be recoverable if these titration files are readily available.

- Design verification software to be completely automated and include in this software all the data verification checks so a rapid verification process can be implemented. This recommendation could significantly decrease transcription errors and increase efficiency for both the QA staff and the analytical laboratory.

Section 3

Design and Operations of the Quality Assurance Program

Overview

The quality assurance (QA) and quality control (QC) program is a multifaceted program designed to reduce uncertainty in the data quality. Numerous approaches were implemented to perform this task. Monitoring techniques were incorporated at each stage of collecting, processing, and analyzing the lake sample. For the purpose of this report, these stages are referred to collectively as the system.

One method of monitoring the system was to introduce QA and QC samples at each stage. On-site evaluations also were performed to monitor the system. As a reference, data quality objectives (DQOs) were established to determine the relative (compared to the DQOs) quality of the data. Involvement in the data base management system was also part of the QA program.

Other ELS-II companion documents provide more details for specific subjects. The QA plan (Engels et al., 1988) describes the design of the QA program for ELS-II. Kerfoot et al. (1988) documents the analytical methods used during the survey at the standard operating procedure level of detail. The major aspects of the operational QA program are summarized in the following subsections; the results of the QA program operations are presented in Section 4.

Field Operations

Field operations, under the supervision of base coordinators, were conducted from field base sites. Both helicopter and ground crews (direct access by boat) performed the sampling activities. A helicopter crew consisted of a pilot, an observer, and a sampler; a ground crew consisted of a crew leader and a sampler.

Lake samples were collected for each seasonal subsurvey from each lake at approximately the same location and depth (1.5 meters below the water surface), and by the same sampling protocols as used during ELS-I. Lake site measurements are summarized in Table 1. All measurements were recorded on the lake field data form. The QC protocols for the field measurements are documented in Engels et al. (1988). The timeframe of the sampling activities is given in Table 2.

Processing Laboratory Activities

During earlier NSWS surveys, sample processing was conducted in mobile processing laboratories (trailers) stationed at field base sites near the sampling areas. For ELS-II and NSS-I, the processing facilities were centrally located in Las Vegas. The Spring Seasonal subsurvey samples were processed during the same period of time as the NSS-I samples. The processing laboratory consisted of four stations for filtration and aliquot preparation; two stations for pH, dissolved inorganic carbon (DIC), true color, and specific conductivity determinations; one station for flow-injection analysis (FIA); and one station for methyl isobutyl-ketone (MIBK) extraction. Additional stations were also available for filtration and aliquot preparation. Analytical measurements that were performed in the processing laboratory are summarized in Table 1.

The main function of the processing laboratory was to process (preserve and organize into batches) water samples received from the field and, on the same day, ship the prepared aliquots to analytical laboratories for subsequent analyses. Each ELS-II batch

Table 1. Chemical and Physical Variables Measured during the Eastern Lake Survey-Phase II

Variable (units)	Abbreviation[a]	Instrument or analytical method[b]
	Field Site	
Conductivity (μS/cm)	cond-in situ	Hydrolab Surveyor II
Depth (m)	—	Weighted Secchi disk Hydrolab Surveyor II calibrated cable; Digital Sonar
Dissolved oxygen (mg/L)	DO	Hydrolab Surveyor II
pH, field (pH units)	pH-field	Hydrolab Surveyor II
Temperature (°C)	—	Hydrolab Surveyor II
	Processing Laboratory	
Aluminum (mg/L)		
Total monomeric	Al-dis	Colorimetry (complexation with pyrocatechol violet, automated flow injection analyzer); La Chat Quick Chem System IV Colorimeter
Nonexchangeable monomeric	Al-org	Same as total monomeric
pH, closed system (pH units)	pH-closed	pH/millivolt meter (Ross Model 611), and glass combination electrode (Orion-Ross Model 8104)
Dissolved inorganic carbon, closed system (mg/L)	DIC-closed	Infrared spectrophotometry (carbon analyzer) (Dohrmann Model DC-80)
True color (PCU)	—	Comparator (Hach Model CO-1)
Turbidity (NTU)	—	Nephelometer (Monitek Model 21)
	Analytical Laboratory	
Acid-neutralizing capacity (μeq/L)	ANC	Acidimetric titration, modified Gran analysis
Aluminum, (mg/L)		
Total extractable	Al-ext	Atomic absorption spectroscopy (furnace) on methylisobutyl ketone extract
Total	Al-total	Atomic absorption spectroscopy (furnace)
Ammonium (mg/L)	NH_4^+	Colorimetry (phenate, automated)
Base-neutralizing capacity (μeq/L)	BNC	Alkalimetric titration, modified Gran analysis
Calcium (mg/L)	Ca	Atomic absorption spectroscopy (flame) or inductive coupled plasma emission spectroscopy (ICPES)
Chloride	Cl^-	Ion chromatography
Conductivity (μS/cm)	Cond	Conductivity cell and meter
Dissolved inorganic carbon (mg/L)		
Initial	DIC-initial	Infrared spectrophotometry
Equilibrated	DIC-eq	Infrared spectrophotometry
Dissolved organic carbon (mg/L)	DOC	Infrared spectrophotometry
Fluoride, total dissolved (mg/L)	F^--total	Ion-specific electrode
Iron (mg/L)	Fe	Atomic absorption spectroscopy (flame) or inductively coupled plasma emission spectroscopy (ICPES)

(Continued)

Table 1. Continued.

Variable (units)	Abbreviation[a]	Instrument or analytical method[b]
	Analytical laboratory (continued)	
Magnesium (mg/L)	Mg	Atomic absorption spectroscopy (flame) or inductively coupled plasma emission spectroscopy (ICPES)
Manganese (mg/L)	Mn	Atomic absorption spectroscopy (flame) or inductively coupled plasma emission spectroscopy (ICPES)
Nitrate (mg/L)	NO_3^-	Ion chromatography
pH (pH units) Equilibrated	pH-eq	pH electrode and meter; sample equilibrated with 300 ppm CO_2 in air
Initial (acid titration for ANC)	pH-ANC	pH electrode and meter
Initial (base titration for BNC)	pH-BNC	pH electrode and meter
Phosphorus, total dissolved (mg/L)	P-total	Automated colorimetry (phosphomolybdate or modification)
Potassium (mg/L)	K	Atomic absorption spectroscopy (flame)
Silica (mg/L)	SiO_2	Automated colorimetry (molybdate blue)
Sodium (mg/L)	Na	Atomic absorption spectroscopy (flame)
Sulfate (mg/L)	SO_4^{2-}	Ion chromatography

[a] These abbreviations for variables are used throughout this report.
[b] Methods and instruments are described in Merritt and Sheppe (1988) for field activities and in Kerfoot et al. (1988) for processing and analytical laboratory analyses. Use of these analytical methods and instruments was a prerequisite of ELS-II sample analysis.

Table 2. Sample Collection Time Frames for the Eastern Lake Survey - Phase II.

Seasonal Subsurvey	Sample collection time frame	
	start	completion
Spring	March 25, 1986	May 3, 1986
Summer	July 23, 1986	August 11, 1986
Fall	October 8, 1986	November 14, 1986

contained as many as 30 samples and included both routine and QA samples. The samples in a batch were processed together. Each batch was assigned a unique batch ID number, which was recorded on the labels of all samples. Each sample in a batch was randomly assigned a sample ID number from a series of numbers which ran consecutively from 1 to the total number of samples in a batch. Batch ID numbers were assigned as follows: 3500 - 3528 were assigned for the Spring Seasonal subsurvey, 3600 - 3616 and 3650 - 3666 for the Summer Seasonal subsurvey, and 3700 - 3725 for the Fall Seasonal subsurvey. Batches 3650 - 3666 in the Summer Seasonal subsurvey contained only samples for the interlaboratory bias study (i.e., these batches contained 1 or 2 split samples and 1 or 2 natural audit samples only).

Sample codes that were assigned at the processing laboratory are defined in Table 3. The term "field" as it is used to describe audit samples is misleading because these audit samples were not taken into the field. Field natural audit samples were introduced into the system at the processing laboratory. Processing laboratory operations are discussed in detail in Arent et al. (1988).

Analytical Laboratory Activities

The two analytical laboratories that participated in ELS-II were provided with explicit instructions on sample analysis protocol in a Statement of Work (contract). Each laboratory was to use the same protocols to measure the 24 analytes of interest. Table 1 lists the chemical and physical variables measured during ELS-II. The methods the

Table 3. Sample Codes Used for the Eastern Lake Survey - Phase II

Sample type	Code	Description
Routine lake sample	R	
Duplicate lake sample	D	
Field blank sample	B	
Processing laboratory blank	TB	
Processing laboratory duplicate	TD	
Triplicate lake sample	S	
Audit	F L 1	
		1 — Concentrate lot[a] number
		L — Concentration level/audit type: L = low; N = natural; S = synthetic
		F — Type of audit sample: F = field audit sample; L = laboratory audit sample; RW = simulated rainwater audit sample

[a] A lot is a quantity of bulk material of similar composition whose properties are under study (Taylor, 1987).

analytical laboratories used to measure each analyte also are listed in Table 1. A detailed description of these procedures is given in the methods manual (Kerfoot et al., 1988). The ELS-II QA plan and the contract provide a detailed discussion of laboratory requirements such as holding times and internal QC procedures. Table 4 includes the description, function, and frequency of use of the various QC samples.

Types of Quality Assurance and Quality Control Samples

The QA program used a variety of QA and QC samples, the characteristics of which are summarized in Table 4. QA samples were double-blind to the analyst (i.e., the analyst did not know the sample type or the chemical composition). QC samples were control samples for which the theoretical or true analyte concentrations were known by the analyst. The uses and limitations of the various QA and QC sample types are discussed in detail in Section 6 of this report. QA and QC samples were used by the EMSL-LV QA staff to monitor activities during the survey, to assist in verification, and finally to assess data quality.

Data Quality Objectives

Data quality objectives (DQOs) for ELS-II were based on previous NSWS DQOs. DQOs were established for completeness, comparability,representativeness,detectability, accuracy, and precision. These terms are defined and discussed in Section 6, Assessment of Data Quality. Table 20 in Section 6 provides the specific goals for detectability, accuracy, and precision.

Quality Assurance System Audits (On-Site Evaluations)

A system audit is a qualitative evaluation of the field, processing laboratory, and analytical laboratory facilities, equipment, and operations such as record keeping, data reporting, sample analysis, and QC procedures. The results of the system audits were documented and submitted to the EPA technical monitor at EMSL-LV. The questionnaires that were used by evaluators during system audits can be found in the ELS-II QA plan (Engels et al., 1988). The results of the on-site evaluations are summarized in Section 4.

Data Base Management

The data management system was designed to assemble, modify, and store data collected during the NSWS surveys. An independent data management company, Systems Applications, Inc. (SAI), was contracted to manage the data base generated during ELS-II. As was the case in each of the previous NSWS surveys, SAS (Statistical Analysis System) software was used to manipulate the data. The ELS-II data bases are SAS data set libraries or groups of SAS data set libraries. Each SAS data set library is composed of files (members) which contain specific types of survey data (Table 5).

The ELS-II data bases are: the raw data base (DS1), the official verified data base (DS2), the validated data base (DS3A), the reduced validated data base (DS3B), the final data base (DS4A), and the personal computer (PC) final data base (DS4B). An additional data base, the modified verified data base, was created as a result of the Special Data Assessment (Section 5).

Table 4. Quality Assurance and Quality Control Samples Used in the Eastern Lake Survey-Phase II

Sample type	Description	Function	Frequency of use[a]
		Quality Assurance	
Field blank	Type I reagent-grade deionized water[b] subjected to sample collection, processing, and analysis	To assess system detectability and identify possible sample contamination resulting from collection, processing and analysis	One per batch
Processing laboratory blank	Type I Reagent-grade deionized water[b] subjected to sample processing and analysis	To verify the quality of the reverse osmosis (RO) water purification system; to identify possible processing and analytical laboratory contamination	As scheduled
Field duplicate	Duplicate sample collected immediately after the routine lake sample	To estimate overall within-batch system precision at various concentrations ranges; estimate processing precision.	One per batch[c]
Field performance audit[d]	Synthetic or natural lake sample; prepared at support laboratory and processed at processing laboratory	To estimate analytical precision of processing and analytical laboratory measurements; to estimate relative accuracy	As scheduled[e]
Laboratory performance audit[d]	Synthetic or natural lake sample; prepared and processed at support laboratory	To estimate analytical precision of analytical laboratory measurements; to estimate relative accuracy	As scheduled[e]
Field triplicate[f]	Triplicate routine sample	To estimate relative interlaboratory bias	1 or 2 per batch
		Quality Control	
Calibration blank	Type I reagent-grade deionized water[b]	To identify signal drift	One per batch for applicable variables
Reagent blank	Reagent-grade deionized water[b] plus reagents for total aluminum and silica analyses	To identify contamination due to reagents	One per batch for total aluminum and silica
Quality control check sample (QCCS)	Standard solution from source other than instrument calibration standard	To determine accuracy and consistency of instrument calibration; to check statistical control of measurement process; to evaluate batch-to-batch precision and within-batch precision.	Before the first measurement, after the last, and at specified intervals in between for each batch
Detection limit QCCS	Standard solution at 2 to 3 times the required detection limit	To determine precision and accuracy at lower end of linear dynamic range of measurement method; to verify instrument detection limits	One per batch for applicable variables
Processing laboratory duplicate	Split of lake sample	To monitor analytical precision of processing laboratory measurements	One per batch
Analytical laboratory duplicate	Split of sample aliquot	To monitor analytical precision of analytical laboratory measurements	One per batch

[a] Planned frequency for use of QA samples was not always possible due to logistical constraints.
[b] As specified in ASTM (1984).
[c] The Summer Seasonal subsurvey included a duplicate sample from both the epilimnetic and hypolimmetic layers of the lake.
[d] Performance audit samples were provided by a support laboratory.
[e] The schedule is documented in the ELS-II QA Plan (Engels et al., 1988).
[f] Summer Seasonal only.

Table 5. Data Base Members for the Eastern Lake Survey - Phase II

Member name	Form number within member	Description
M01	1D	Lake data
	02	Batch/QC processing laboratory data
	11	Summary of sample results
F18	18	Required and reported instrument detection limits
F19	19	Sample date of analysis and holding time Summary
F20	20	Calibration/reagent blanks and QCCS results
F22	22	Internal duplicate results

Raw Data Base

The EMSL-LV QA staff sent copies of the field forms, the processing laboratory form, and the analytical laboratory data package to SAI for entry of the data into the raw data base. Analytical data packages consisted of either hard copy or electronic copy of forms 11, 18, 19, 20, and 22. These forms are described in Table 5. In some cases, corrections were made to the forms after they were received by SAI but before the data were entered into the raw data base. Such corrections were made at the direction of the EMSL-LV QA staff. For the Spring Seasonal subsurvey, data packages were submitted on hard copy. During the Summer Seasonal and Fall Seasonal subsurveys, the analytical laboratories used the Aquatics Data Entry System, which was developed at EMSL-LV. The analytical laboratory data packages for the Summer and Fall Seasonal subsurveys were submitted on floppy diskette. The analytical laboratories sent a copy of each diskette directly to SAI.

SAI used a PC-based, double-entry system to ensure correct transcription of data submitted on paper. Two data entry operators independently entered data into separate dBASE III data base files. The two text files were then compared using software written by SAI specifically for that purpose. The program generated a report identifying the inconsistencies between the two data bases. Any inconsistencies between the two data bases were corrected.

SAI used the dBASE III data base files to write ASCII text files containing the data. Two different procedures were used to produce SAS data sets from those text files. PC SAS was used to create SAS data bases for the Spring Seasonal subsurvey. That data base was later uploaded to the SAI mainframe computer. The text files for the Summer Seasonal subsurvey and the Fall Seasonal subsurvey were uploaded to the mainframe. Mainframe SAS was used to create the Summer and Fall Seasonal subsurvey SAS data bases.

Official Verified Data Base

Although SAI was responsible for producing the official verified data base, the EMSL-LV QA staff had primary responsibility for verifying the data. The Computer-Aided Data Verification System (CADAVERS) was developed by the EMSL-LV QA staff to facilitate data analysis and data modification. CADAVERS is a driver system which provides an environment for data processing and analysis. CADAVERS was referred to as AQUARIUS III in the ELS-II QA Plan.

SAI sent the raw data base for the Spring Seasonal subsurvey on floppy diskettes to Las Vegas where the EMSL-LV QA staff uploaded the data to the IBM 3090 computer at the National Computer Center (NCC). SAI sent the raw data bases for the Summer Seasonal subsurvey and the Fall Seasonal subsurvey to NCC on magnetic tape. The EMSL-LV QA staff then copied them. CADAVERS created an initial working data base for each subsurvey by copying the raw data base.

All changes to the working data base were made via transactions. A transaction is a record which reflects changes made to a data base. An auditor would generate the transaction and check it before the working data base was updated with it. Only the CADAVERS data base administrator (DBA) updated the working data base with the transaction. Updating the working data base did two things; it modified the working data base by incorporating the changes contained in the transaction and it recorded the transaction in the history files. The CADAVERS data bases were protected from unauthorized modification by internal as well as external security systems. CADAVERS allowed only the DBA to modify the working data base and history data base. Only the auditor or the DBA could modify the auditor's transaction data base. CADAVERS provided no facility whatsoever for any modification of the raw data base. RACF (Resource Access Control Facility) protected

the data bases from modification by someone outside the CADAVERS system.

When data verification had been completed, the EMSL-LV QA staff sent both the final working data base and the history data base to SAI via magnetic tape prepared at NCC. SAI read the tape and produced the official verified data base by updating a copy of the raw data base with the history data base. The official verified data base was then compared with the working data base sent by the EMSL-LV QA staff to ensure the integrity of the data.

Other Data Bases (Data Bases 3 and 4)

Other data bases, i.e., the validated data base, the reduced validated data base, the final data base, and the PC final data base, were produced by SAI under the direction of ERL-C. The ERL-C staff had primary responsibility for validating the data and directed all value changes made by SAI during the validation process. These other data bases do not reflect the changes made as a result of the Special Data Assessment (Section 5). At the time of this publication, plans have not been finalized to create updated versions of these data bases.

Modified Verified Data Base

The modified verified data base is the product of the Special Data Assessment (Section 5) which occurred after verification and validation were completed. This data base was created by much the same process as discussed in the previous subsection titled Official Verified Data Base. Through CADAVERS, a working data base was created for each seasonal subsurvey by copying the verified data base. All changes were made via transactions, which were updated at the working data base by the DBA. All changes were recorded in the history files. At the time of this printing, the modified verified data base exists as a working data base at EMSL-LV. All changes made between the official verified and the modified verified data bases are contained in Appendix A.

Data Evaluation and Verification

The objectives of data evaluation and verification were to identify and then correct or qualify suspect data and to maintain continuous control over the data acquisition process. These objectives were accomplished following an organized process that included: (1) communicating with the field base coordinators and the laboratories, (2) reviewing field and processing laboratory data forms, (3) evaluating preliminary QA data from each analytical laboratory, (4) checking on the completeness of each data package and on the consistency of sample data, (5) confirming or correcting suspect data, (6) requesting reanalysis of samples for which data remained suspect after confirmation or correction, (7) assigning of data qualifier tags and flags to data when necessary, and (8) entering the corrected values and data qualifiers into a copy of the raw data base for the creation of the verified data set. Figure 3 shows the processes used during data evaluation and verification.

Communications

Telephone calls were made to the field base coordinators as needed to discuss field sampling QC. Daily telephone calls were made to the processing laboratory and to each analytical laboratory to check that QA/QC guidelines were being followed and that samples were being handled and analyzed properly, to obtain preliminary sample data, and to discuss problems that may have occurred during analyses. The intent of frequent calls was to identify and resolve issues before they affected data quality or interfered with the completion of the sample analyses.

During data review and verification, communication with the analytical laboratories continued to obtain documentation such as copies of data forms that were incomplete when originally submitted, corrections of previously reported data, confirmation of previously reported results, and results of reanalysis for samples that previously did not meet QA and QC criteria. The QA staff often requested that raw data be submitted to support the confirmation of data for a particular sample or batch. Each analytical laboratory was required to submit confirmation and reanalysis data on a standard form, and the QA staff tracked requests for these data.

Field and Processing Laboratory Data Review

All forms received from the field crews and processing laboratory were reviewed by the QA staff. This review included the following: (1) lake IDs, (2) Hydrolab calibration and

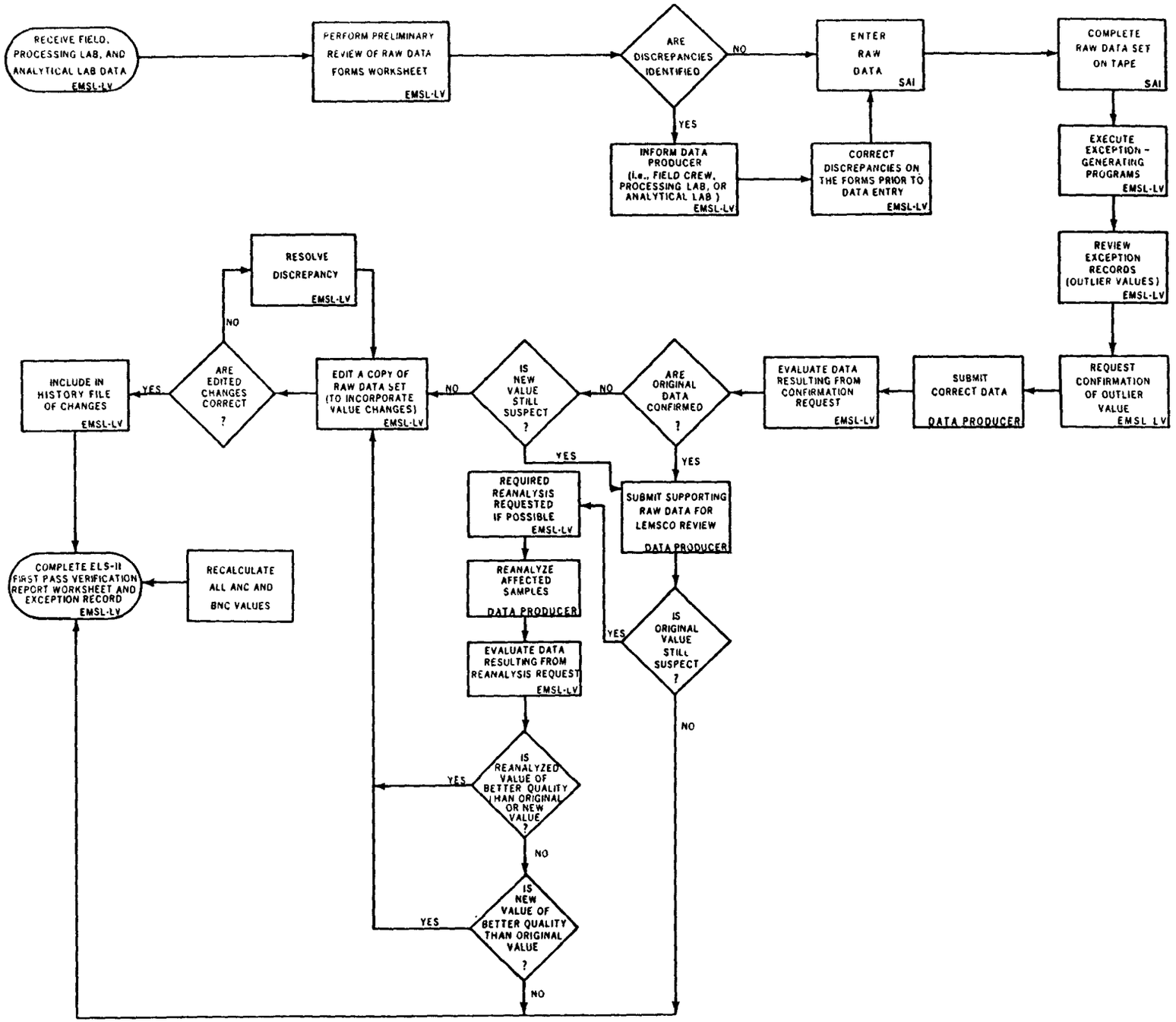

Figure 3. Procedures used for data verification, Eastern Lake Survey - Phase II.

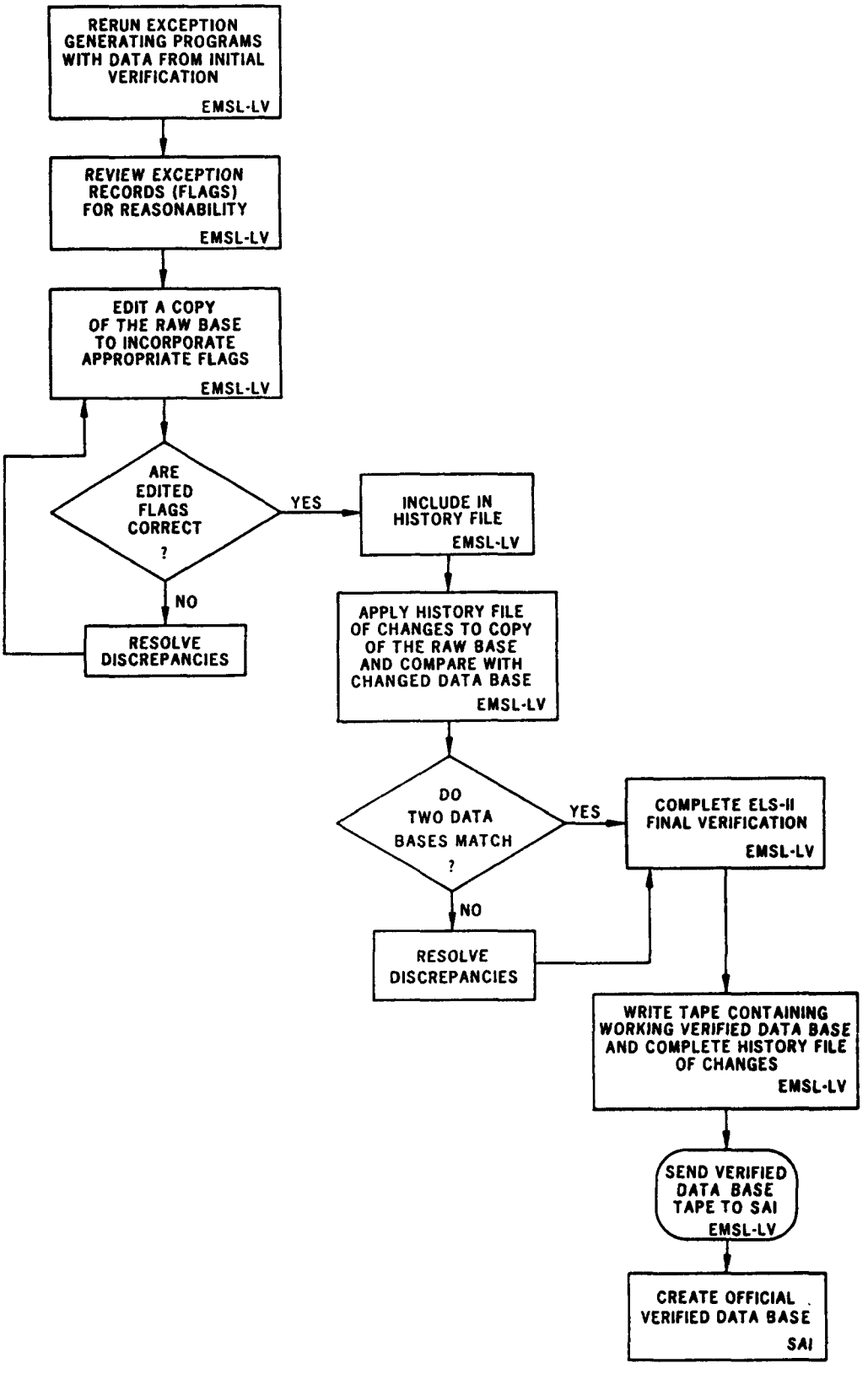

Figure 3. Continued.

QCCS data, (3) comparison of pH values from the Hydrolab and processing laboratory, (4) processing laboratory QC data, (5) data qualifiers, and (6) comments made by the sampling crew and processing laboratory staff. Data anomalies were reported to the field base coordinator or the processing laboratory coordinator for review, and data reporting errors were corrected before entry into the raw data base.

Preliminary Quality Assurance Data Review

Preliminary QA data were obtained from each analytical laboratory via telephone or computer modem. These data were examined by QA staff so that analytical problems might be identified immediately after the samples had been analyzed and before the data packages were submitted. Each data package contained the sample results for one batch of routine, QA, and QC samples and was due 35 days after the batch had been received by the laboratory.

Data Verification

After each data package was received, the ELS-II verification report (Engels et al., 1988) systematically guided the QA staff through the verification process. The report is a worksheet that tracks data resubmissions, tracks confirmation and reanalysis requests, lists the steps to explain exceptions, explains how to flag data, and summarizes modifications to the raw data base. The report ensures consistent review of all data packages.

Each data package was reviewed for completeness, internal QC compliance, and appropriate use of data qualifiers. Any discrepancies related to analytical data were reported to the appropriate analytical laboratory manager for corrective action. Comments provided in the cover letter also were reviewed to determine their impact on data quality and the need for any follow-up action by the QA staff or the laboratory. The remainder of the verification report was completed with the use of data packages, field forms, and printed output from the exceptions programs. These computer programs identified samples that did not meet QA or QC criteria and generated the appropriate data qualifier flags. A listing and description of these programs is documented in Engels et al. (1988).

The verification process was completed in three steps which were termed first pass, second pass, and final pass. The exceptions programs were used in each pass. The first pass was performed to detect data that did not meet QA and QC criteria and then to confirm or correct suspect data or to request reanalysis of the affected samples. The second pass was primarily to flag data. During the final pass, flag changes as a result of the recalculation of all ANC and BNC data and reanalysis results not previously available were incorporated in the data base. For ELS-II, CADAVERS automated much of the verification process and provided a mechanism for editing the data set and applying data qualifiers. CADAVERS included the exceptions programs and also provided for updating the data base and for creating the history file, which contained all changes made to the data set.

Exceptions programs were used to verify all analytical data by individual sample and by batch. Each sample was checked for both the anion-cation percent ion balance difference and the percent conductance difference criteria. The synthetic audits used for the Fall Seasonal subsurvey were not designed to meet these criteria. The percent ion balance difference was calculated by converting measured values in milligrams per liter to microequivalents per liter (see Table 6 for conversion factors) and then comparing the sum of the measured anions to the sum of the measured cations. A calculated conductance value was determined by multiplying the concentration of each ion in milligrams per liter by the corresponding conversion factor (Table 7) and then summing the individual calculated conductance values. This total in microSiemens per centimeter then was compared to the conductivity measurement. If any sample data fell outside the criteria, the reason for the imbalance was investigated. Imbalances could indicate analytical errors, data reporting errors, or the presence of unmeasured organic species or of ions measured but not in the algorithm (e.g., iron, total aluminum). Any samples for which the data remained outside the criteria after confirmation, correction, or reanalysis were flagged appropriately.

Values for a given analyte were flagged on a batch basis when the field blanks, field duplicates, or audits did not meet the QA criteria. Data also were flagged if internal duplicate precision, instrumental detection limits, QCCS results, calibration blanks,

Table 6. Factors[a] Used to Convert mg/L to μeq/L

Ion	Factor	Ion	Factor
Ca^{+2}	49.9	NH_4^+	55.4
Cl^-	28.2	K^+	25.6
Mg^{+2}	82.3	Na^+	43.5
NO_3^-	16.1	SO_4^{-2}	20.8
F^--total	52.6		

[a] Engels et al. (1988).

Table 7. Factors to Determine the Conductivity of Ions[a,b]

Ion	Factor per mg/L	Ion	Factor per mg/L
Ca^{+2}	2.60	Na^+	2.13
Cl^-	2.14	NH_4^+	4.13
CO_3^{-2}	2.82	SO_4^{-2}	1.54
H^+	3.5×10^5[c]	NO_3^-	1.15
HCO_3^-	0.715	K^+	1.84
Mg^{+2}	3.82	OH^-	1.92×10^3[c]

[a] Specific conductance is expressed in μS/cm at 25 °C.
[b] Modified from American Public Health Association et al. (1985) and Weast (1972).
[c] H^+ and OH^- are converted by factors in moles/L.

reagent blanks, or required holding times did not meet specifications. An auditor evaluated all flags generated by the exceptions programs and decided whether or not each flag was appropriate. Subsequently, these flags were reevaluated by a second auditor before they were entered into the verified data base. In addition, flags were generated by the protolyte analysis program. This program performed a rigorous evaluation of all pH, DIC, DOC, ANC, and BNC data (Engels et al., 1988). Based on this rigorous evaluation, the program generated flags for any suspect results. The list of all flags that were applied to the data are given in the ELS-II QA Plan (Engels et al., 1988). Data users should be aware that although many of the flags would remain the same, the flags apply to the official verified data base and not to the modified verified data base.

Reanalysis data and corrections submitted by each laboratory, as well as flags, were entered into the working data base by QA staff. All entries were reviewed manually to check for entry errors. Entry was accomplished by using CADAVERS to generate transaction files that were updated to the working data base. This system also generated a history file which was sent to the data base manager. The official verified data base (DS2) was created by applying the history file to the raw data set.

Differences Between the Eastern Lake Survey - Phases I and II

Many concepts developed during ELS-I were implemented in ELS-II. In addition, further modifications based on the experience gained from previous NSWS surveys were made to improve the ELS-II program. Table 8 summarizes the changes that were implemented in ELS-II.

Table 8. Differences Between the Eastern Lake Survey Phases I and II

ELS-I	ELS-II
QA program	**QA program**
• The matrix spike analysis was required. These results were used to determine possible matrix interference in lake chemistry data.	• The matrix spike analysis requirement was eliminated from the contract because no matrix interference was apparent in the ELS-I (Best et al., 1987) or WLS (Silverstein et al., 1987) routine lake samples. Eliminating the spike also resulted in the reduction of sample analysis costs.
• During the preliminary data review, the majority of data were retreived from the analytical laboratory over the telephone.	• Daily direct data transfers via electronic media were implemented (at the point of the sample analysis) between the analytical laboratories and the QA staff.
• Synthetic audit samples were available at or two concentration levels.	• An improved synthetic audit sample system was designed that enables precision and accuracy to be estimated at five concentration levels.
• The Gran analysis program used a manual system of outlier elimination.	• The Gran analysis program was modified to eliminate outliers electronically.
• The protolyte program considered all possible ANC, BNC pH, and DIC measurements in determining the calculated ANC.	• In the Phase II, the protolye program was modified to run faster and to calculate ANC taking into consideration the partial pressure of carbon dioxide.
• An Interlaboratory Bias Study was not conducted during ELS-I.	• An Interlaboratory Bias Study was conducted in the Summer Seasonal subsurvey of ELS-II.
• The "tuple" system of data management was used. This system was limited in producing the documentation of all changes that were made to a data set.	• A transaction editing system was developed for the mainframe computer. This system allowed the QA staff to edit (change) data more efficiently. The system also included a history file that contains the historical record of all value and flag changes.
Field site	**Field site**
• Helicopters were used to access lakes for sample collection.	• Helicopters and boats were used for lake access. A comparability study conducted during WLS-I (Landers et al., 1986) demonstrated there was no significant difference between the two sampling methods that would affect data interpretation.
• DO was not measured as an in-situ measurement.	• DO was measured as an in-situ measurement.
Processing laboratory	**Processing laboratory**
• The ELS-I samples were processed in the field laboratories located near or at the field base site.	• The ELS-II samples were processed in one centralized processing laboratory.
• Dissolved and nonexchangeable monomeric aluminums were not measured in the processing laboratory.	• The processing laboratory performed dissolved and nonexchangeable monomeric aluminum measurements.
• Only one pH meter was used per batch of samples.	• Two pH meters were used for one batch when the batch size was >20 samples. Field routine-duplicate pairs were always analyzed on the same meter.
Analytical laboratory	**Analytical laboratory**
• All final data packages were submitted to the QA staff in the form of a hard copy.	• Final data packages from the analytical laboratories were submitted electronically (on computer disks).
• The precision (% RSD) requirement for conductivity was 1%.	• The precision (% RSD) requirement for conductivity was 2%.

Section 4

Results of the Quality Assurance Operations

This section describes field, processing laboratory, and analytical laboratory operations including the results of on-site evaluations. Data review and verification activities will also be discussed in this section.

Field Operations

Field operations for ELS-II successfully completed collection and shipping of samples according to protocol. Details of the field operations are documented in Merritt and Sheppe (1988).

On-site evaluations were used to monitor all field operations. The EMSL-LV QA staff conducted on-site evaluations of the field sampling operations during both Summer and Fall Seasonal subsurveys. The Summer Seasonal subsurvey on-site evaluation was conducted July 27-28, 1986, at two base sites. The Fall Seasonal subsurvey on-site evaluation was conducted November 4-5, 1986, at one base site.

On-site evaluations included inspections of Hydrolab calibrations, QC procedures, sample collection activities, in-situ measurement techniques, and sample shipping procedures. Both evaluations concluded that a checklist for field equipment should be used by field crews prior to departure from the base site. During the Fall Seasonal subsurvey the evaluators observed a problem related to completing the forms and stressed the necessity of correct and concise completion in discussion with the base coordinator. The results of both of the on-site evaluations concluded that the field sampling personnel, most of whom had previous experience in other NSWS projects, were adhering to QA/QC protocols. None of the findings of the field on-site evaluations had an adverse effect on data quality.

Processing Laboratory Operations

The processing laboratory successfully processed and analyzed the ELS-II samples. Samples were prepared for shipment to the analytical laboratories within the specified holding times in all cases. The processing laboratory operations are documented in Arent et al. (1988).

Two processing laboratory on-site evaluations were performed by the EMSL-LV QA staff to assure that laboratory procedures and QA and QC protocols were being performed properly and to identify and resolve any existing problems. One evaluation during the Spring Seasonal subsurvey was conducted on April 3, 1986; a follow-up evaluation prior to the Summer Seasonal subsurvey (during the sample processing of NSS-I samples) was conducted on May 13, 1986. The significant results of the on-site evaluations are as follows.

At the sample filtration station, the non-acid-washed filtration apparatus was placed in the middle of a series of acid-washed filtration apparatus in order to expedite sample processing and to allow two technicians to filter samples simultaneously. The QA auditors were concerned that there was a potential nitrate contamination in aliquot 3 when the squeeze bottle filled with dilute nitric acid solution was used to rinse the surrounding apparatus.

During the follow-up on-site evaluation, the two acid-washed filtration apparatus were now separated by a larger space from the non-acid-washed apparatus. However, the non-acid-washed filtration apparatus was still placed between the two acid-washed apparatus. Plexiglas shields were installed between the filtration apparatus to reduce the

possibility of contamination before the Summer Seasonal subsurvey began.

Although the measurement error introduced by Laboratory 1 at low concentrations (Section 5, Chloride, Sulfate, and Nitrate Assessments, and Section 6, Detectability) makes it difficult to evaluate whether any nitrate contamination occurred, the results of the on-site evaluations indicated that processing laboratory operations were satisfactory and that laboratory personnel performed their duties well.

Analytical Laboratory Operations

Standard EPA contract laboratory procurement procedures were used to secure the services of two analytical laboratories to perform sample analyses for the ELS-II. Laboratory 1 performed the sample analyses for the Spring Seasonal subsurvey. Laboratory 2 performed the sample analyses for the Fall Seasonal subsurvey. Both Laboratory 1 and Laboratory 2 analyzed samples for the Summer Seasonal subsurvey. During the Summer Seasonal subsurvey, samples designed to evaluate interlaboratory bias were analyzed by both laboratories (Section 6, Interlaboratory Bias).

Laboratory 1 reported analyses results to the number of decimal places recommended under the original ELS-II contract (Table 9) for the Spring Seasonal subsurvey. However, early in the subsurvey the laboratory was asked to comply with the reporting recommendations of a new contract which had not yet gone into effect. The new contract recommended that the values be reported to the instrument detection limit (IDL), plus one decimal place, or to a maximum of four significant figures (Table 9).

The decimal places reported by the laboratory for the Spring Seasonal subsurvey were as follows:

- Batches 3500 through 3503: Al-ext, Al-total, Ca, DIC-eq, DIC-initial, DOC, Fe, F^--total, K, Mg, Mn, Na, NH_4^+, P-total, and SiO_2 were reported in accordance with the original contract for these batches.

- Batches 3504 through 3508: F^--total, P-total, and SiO_2 were reported in accordance with the original contract for these batches.

Table 9. Recommended Number of Decimal Places for Reporting Data, Eastern Lake Survey-Phase II

Analyte	Units	Original contract[a]	New contract[b]
Al-ext	mg/L	3	4
Al-total	mg/L	3	4
ANC	μeq/L	1	1
BNC	μeq/L	1	1
Ca	mg/L	2	3
Cl^-	mg/L	2	3
Cond	μS/cm	1	1
DIC-eq	mg/L	2	3
DIC-initial	mg/L	2	3
DOC	mg/L	1	2
F^--total	mg/L	3	4
Fe	mg/L	2	3
K	mg/L	2	3
Mg	mg/L	2	3
Mn	mg/L	2	3
Na	mg/L	2	3
NH_4^+	mg/L	2	3
NO_3^-	mg/L	3	4
P-total	mg/L	3	4
pH-ANC	pH units	2	2
pH-BNC	pH units	2	2
pH-eq	pH units	2	2
SiO_2	mg/L	2	3
SO_4^{2-}	mg/L	2	3

[a] Laboratory 1 was operating under the original contract during the Spring Seasonal subsurvey and the new contract during the Summer Seasonal subsurvey. However, a request was made for Laboratory 1 to report data for the Spring Seasonal subsurvey in accordance with the new contract which would be in place for the Summer Seasonal subsurvey.

[b] Laboratory 2 was operating under the new contract during the Summer and Fall Seasonal subsurveys.

- Batches 3509 through 3528: P-total and SiO_2 were reported in accordance with the original contract for these batches.

All other analytes not listed above were reported in accordance with the new contract. For the Summer and Fall Seasonal subsurveys, both laboratories reported to the numbers of decimal places recommended under the new contract.

An on-site evaluation of Laboratory 1 was conducted on April 7, 1986, by the EMSL-LV QA staff. At this time, Laboratory 1 was completing analyses of samples collected during the Spring Variability Pilot Study and had begun to analyze Spring Seasonal samples for some analytes. The laboratory evaluation resulted in several findings:

- Sample receipt, storage, and labelling procedures were adequate.

- Ion chromatograph (IC): Laboratory 1 had purchased a Dionex 2000i IC complete with autosampler and integrator/recorder. However, the system was not fully automated with respect to controlling the pump and detector. The primary disadvantage was that it was necessary to conduct two analyses per sample, i.e., one for NO_3^- and one for Cl^- and SO_4^{2-}, because the detector range could not be adjusted during the analysis. A second problem was that the integrator was not fully utilized. The detector was being used to drive the strip-chart recorder instead of the integrator. Peak height measurements and data reduction were performed manually. Using the integrator as a data system to perform all measurements and data reduction would have hastened analyses and would have reduced the chance of human error.

- The instrument detection limit for Cl^- (0.02 mg/L) exceeded the contract-required detection limit of 0.01 mg/L. This problem was discussed with laboratory personnel during the audit. The laboratory was advised to increase the loop size on the instrument (i.e., the amount of sample injected into the IC column). This recommendation was implemented and did resolve this particular problem.

- Laboratory 1 was well equipped to analyze metals. However, the laboratory had experienced problems with aluminum contamination in the total aluminum digestion. The laboratory was advised of various techniques used by other laboratories to resolve the problem. These techniques include the isolation of the digestion from the atmosphere by constructing a Plexiglas cover to minimize dust contaminants or cleaning the hood where the digestion was being performed.

- Laboratory 1 personnel had not been preparing QCCS control charts, but instead had been preparing percent relative standard deviation (%RSD) control charts using the internal duplicate data. QCCS control charts monitor both accuracy and precision, whereas %RSD control charts only monitor precision. The laboratory personnel were advised that QCCS control charts were contractually required. At this point in the survey, the laboratory was brought into compliance with the contract by initiating the use of QCCS control charts.

In summary, Laboratory 1 had some deficiencies at the time of the on-site evaluation but was performing adequately. However, the purchase of a system controller for the pump and detector and full utilization of the integrator for the ion chromatograph would have improved laboratory efficiency for determining Cl^-, SO_4^{2-}, and NO_3^-.

The EMSL-LV QA staff conducted an on-site evaluation of Laboratory 2 on August 8, 1986. During this evaluation, analyses of the samples from the Summer Seasonal subsurvey were being performed. The evaluation of Laboratory 2 resulted in several findings:

- Sample receipt, storage, and labelling procedures were adequate.

- Data for pH-ANC and pH-BNC were reported incorrectly on Form 11 (Sample Results). Laboratory 2 had been reporting a calculated pH value instead of the measured pH value. The evaluation team requested that the laboratory report the measured pH value. All instances prior to the on-site evaluation, for which the pH values were reported incorrectly, were corrected during data verification.

- Laboratory 2 was not warming samples in a temperature-controlled water bath to 25 °C before performing specific conductance measurements as contractually required. Laboratory 2 did purchase a water bath, but, for samples analyzed before this purchase, a temperature-compensated result was reported. There should be no significant impact on the data quality as the result of this deviation in protocol.

Other minor problems detected during the on-site evaluation were discussed with the laboratory personnel. The evaluation team concluded that the overall performance of Laboratory 2 was acceptable and that the laboratory was operating within the contractual framework.

Data Review and Verification

The data review and verification process implemented by the EMSL-LV QA staff for the ELS-II is described in Section 3. The following

discussions address the reanalysis request process, specific anomolies found during data verification, and the resolution of problems. In addition to this process, the ELS-II data were also subjected to an intensive investigation which is discussed in detail in Section 5.

Sample reanalysis was only requested as a final corrective action when there was no other alternative for correcting data problems identified by the data review and verification process. Reanalyses were requested at two different times. A nominal number of reanalyses were requested in 1986 as a result of analytical problems detected during actual sample analyses. Some of these reanalyses were performed at the laboratory's own volition and some were requested by the EMSL-LV QA staff as a result of analytical problems identified using the QA data. These reanalyses were performed either within or just outside the maximum required holding time.

The majority of the reanalyses were requested by the EMSL-LV QA staff during data verification in April and May of 1987. Because of contractual complications, the verification process for ELS-II differed from previous NSWS surveys in that a longer time period elapsed between the end of the analytical activities and the verification of the data. The number of these reanalyses was kept to a minimum because the delayed verification process caused the sample holding time to be exceeded and because it was necessary to finalize the data bases.

Dissolved Organic Carbon

During the Spring Seasonal subsurvey data verification process, four batches were identified with problems in the dissolved organic carbon (DOC) results. Reanalyses were requested for all samples in batches 3517 (10 samples), 3519 (10 samples), 3525 (9 samples), and 3526 (10 samples). Reanalyses were perfomed on all samples requested except for one sample (sample ID # 26) in batch 3526 for which there was an insufficient volume of sample to perform the reanalysis. The contract-required holding time for DOC was 14 days; sample reanalyses were performed one year after the holding time had expired. Although carbonaceous leachate was a holding time concern, the data for the field blanks associated with these four batches (Table 10) did not exhibit any evidence of leaching of organic material from the polyethylene containers in which the samples were stored.

Table 10 presents the QA sample data originally reported and reanalyses results for the above batches. All four batches show an improvement in accuracy based on the field natural audit data. In three of the four batches, precision improved based on the routine/duplicate paired data. The fourth batch (3526), showed a slight decrease in precision. Because the reanalysis results improved the quality of the DOC data in these four batches, all reanalysis results were incorporated in the official verified data base.

Total Aluminum

Reanalyses of samples for total aluminum were requested for all samples in batch 3508 (8 samples) for the Spring Seasonal subsurvey and also for batch 3714 (9 of the 13 samples) for the Fall Seasonal subsurvey. Table 11 presents the QA sample data for batches 3508 and 3714 for the originally reported results and the reanalysis results. The QA data in the table show a substantial improvement in both accuracy and precision. For this reason, the reanalysis data were included in the official verified data base.

Chloride, Sulfate, and Nitrate Issues

During the actual sample analyses (1986), preliminary QA and QC data were obtained for review of the Spring Seasonal data. This review by the EMSL-LV QA staff identified problems with the chloride, sulfate, and nitrate results. Laboratory 1 personnel determined that calibration standards were diluted incorrectly. To correct for this error, the laboratory submitted new values for batches 3500 through 3522 (201 of 247 samples). Laboratory 1 reported that these new values were the results of recalculations. Further investigation by EMSL-LV during the Special Data Assessment (Section 5, Chloride, Sulfate, and Nitrate Assessments) determined that these data resulted from reanalyses rather than recalculations.

During data verification (1987), the QA data indicated that there were still problems with chloride, sulfate, and nitrate analyses performed by Laboratory 1. The EMSL-LV QA staff requested reanalysis of several samples for these anions. As a result of reanalysis, 48 chloride, 26 nitrate, and 28 sulfate reanalysis

Table 10. Quality Assurance Samples for the Originally Reported and Reanalyses Dissolved Organic Carbon Data Results for Batches 3517, 3519, 3525, and 3526; Spring Seasonal Subsurvey, Eastern Lake Survey - Phase II

Batch ID	QA sample type[a]	Reference value[b] (mg/L)	Originally reported result (mg/L)	% RSD[c] of routine-duplicate pair	Reanalysis result (mg/L)	% RSD[c] of routine-duplicate pair
3517	FN7	3.56	4.15	NA	3.77	NA
	B	NA	0.73	NA	0.161	NA
	R, D[d]	NA	3.37, 2.68	16.13	3.09, 3.00	2.09
3519	FN8	3.55	3.45	NA	3.64	NA
	B	NA	0.55	NA	0.34	NA
	R, D[d]	NA	3.16, 3.99	16.42	3.25, 3.07	4.03
3525	FN7	3.56	6.17	NA	3.53	NA
	B	NA	1.54	NA	1.57	NA
	R, D[d]	NA	1.58, 2.29	25.95	1.55, 1.46	4.23
3526	LN7	3.56	7.18	NA	[e]	NA
	FN7	3.56	10.77	NA	3.65	NA
	B	NA	2.03	NA	0.22	NA
	R, D[d]	NA	16.83, 18.03	4.87	11.40, 10.44	6.21

[a] Only QA samples are shown to indicate the improvement in accuracy, precision, and detectability.
[b] The reference values were generated from all the ELS-II data (including Spring Variability Pilot study) for the Seventh Lake natural audit data reference value. Big Moose Lake audit data were determined from ELS-II and NSS-I data. NA = not applicable to this sample type.
[c] The percent relative standard deviation (%RSD) is calculated by dividing the standard deviation of the routine-duplicate pair by the mean of that same pair. NA = not applicable to this sample type.
[d] The concentrations of the samples in the routine-duplicate pair are indicated by: R for the routine and D for the duplicate sample.
[e] Insufficient sample value to perform reanalysis.

Table 11. Quality Assurance Samples for the Originally Reported and Reanalyses Total Aluminum Results for Batches 3508 and 3714; Spring and Fall Seasonal Subsurveys, Eastern Lake Survey - Phase II

Batch ID	QA sample type[a]	Reference value[b] (mg/L)	Originally reported result (mg/L)	% RSD[c] of routine-duplicate pair	Reanalysis result (mg/L)	% RSD[c] of routine-duplicate pair
3508[d]	FN8	0.265	0.1615	NA	0.3010	NA
	B	NA	0.0094	NA	0.0100	NA
	R, D[e]	NA	0.0770, 0.0370	49.62	0.2871, 0.3328	10.43
3714[f]	LS1	0.020	0.2358	NA	0.0220	NA
	B	NA	0.0829	NA	[g]	NA
	R, D[e]	NA	0.0124, 0.0791	103.12	0.0290, 0.0270	5.05

[a] Only QA samples are shown to indicate the improvement in accuracy, precision, and detectability.
[b] The reference values were generated from all the ELS-II data (including Spring Variability Pilot study) for the Seventh Lake natural audit data reference value. Big Moose Lake audit data were determined from ELS-II and NSS-I data. NA = not applicable to this sample type.
[c] The percent relative standard deviation (%RSD) is calculated by dividing the standard deviation of the routine-duplicate pair divided by the mean of that same pair. NA = not applicable to this sample type.
[d] The samples in this batch were analyzed by Laboratory 1 during the Spring Seasonal subsurvey.
[e] The concentrations of the samples in the routine-duplicate pair are indicated by: R for the routine and D for the duplicate sample.
[f] The samples in this batch were analyzed by Laboratory 2 during the Fall Seasonal subsurvey.
[g] This sample was not reanalyzed.

results were incorporated into the official verified data base. These reanalyses represent 19.4 percent of all the chloride values, 10.5 percent of the nitrate values, and 11.3 percent of the sulfate values in the Spring Seasonal subsurvey official verified data base. However, further modifications to chloride, sulfate, and nitrate data were made in 1988 as the result of the Special Data Assessment (Section 5, Chloride, Nitrate, and Sulfate Assessments).

During analyses of samples from the Summer Seasonal subsurvey, Laboratory 1 was not always able to meet the contract-required instrument detection limit (IDL) for chloride. This limit is defined as three times the standard deviation of ten nonconsecutive measurements of calibration blanks (Engels et al., 1988) or 0.01 mg/L. For batches 3603, 3605, 3663, and 3665, the laboratory reported and confirmed an IDL of 0.1176 mg/L for chloride, which is much higher than the 0.01 mg/L required by the contract. When the detection limit criteria was not met, the exception generating program flagged values of less than ten times the reported IDL. Twenty-six values from these four batches are less than ten times the reported IDL and therefore should be used with caution.

Ammonium Reporting

During the verification of the Summer Seasonal subsurvey data, the exception generating programs detected problems with the Laboratory 1 reported ammonium (NH_4^+) data. The suspect NH_4^+ data were consistently confirmed by Laboratory 1 at 1.28 times the originally reported results. All Laboratory 1 Summer Seasonal NH_4^+ data then became suspect. The laboratory confirmed that all NH_4^+ data had been reported incorrectly as nitrogen. After all the analytical laboratory raw data for NH_4^+ were obtained and reviewed, the results were corrected by the EMSL-LV QA staff. The corrected data were incorporated into the official verified data base.

Anion/Cation and Conductivity Balances

Once all the analyte values were determined for each sample, the laboratories were contractually required to check the anion/cation balance and the conductivity balance. If there were imbalances outside specified criteria and if there was no obvious reason for these imbalances, such as unmeasured organic protolytes, then the laboratories were supposed to reanalyze the samples for the analytes suspected of causing the imbalance or contact the QA manager for consultation. The QA plan (Engels et al., 1988) documents the criteria to be used by the laboratories in regard to sample reanalysis.

Laboratory 2 calculated these balances for every sample and performed the necessary reanalyses. During data verification Laboratory 1 stated that the anion/cation and conductivity balances were only spot checked. Unfortunately, the laboratory could not quantify the frequency of the spot checks.

Although the laboratories were required to perform anion/cation and conductivity balances, they were not required to submit the results with the rest of the data. The submission of balance results should be a recommendation for future surveys.

Recalculation of the ANC and BNC

ANC and BNC were originally calculated by the analytical laboratories using software provided by EMSL-LV. During data verification all the titration data were obtained by EMSL-LV. Based on the submitted data, the ANC and BNC were recalculated using an improved calculation procedure. To ensure consistency among surveys, recalculation was performed for all NSWS surveys. The values originally submitted were replaced with the recalculated values in the official verified data base for ELS-II.

Batch-Specific Problems

Due to an error in preparing standard solutions, Laboratory 1 had incorrectly reported all sulfate and nitrate values for batches 3602 (29 samples) and 3603 (24 samples). To correct the data, the analytical laboratory manager confirmed that all the sulfate and nitrate values for these batches must be multiplied by a factor of 2. This correction was implemented by the EMSL-LV QA staff during the data verification. The problems with these batches were identified by the anion/cation balances and the conductivity balances. It is probable that these errors would have been detected by Laboratory 1 at the time of the sample analysis if the contractually required anion/cation and conductivity balances had been calculated more frequently.

In addition to the sulfate and nitrate errors, batch 3602 data contained gross recording errors. During the sample log-in procedure at Laboratory 1, sample 19 was overlooked and was added to the end of the work order. A data entry clerk failed to notice that the sample numbers were out of sequence. Consequently, the results for total fluoride, equilibrated pH, equilibrated dissolved inorganic carbon, initial dissolved inorganic carbon, and total aluminum for samples 19 through 29 were entered incorrectly. The majority of the errors associated with these

batches were corrected during data verification. The remainder of the errors were corrected during the Special Data Assessment (see the next section) after all the analytical raw data were received.

Section 5

Special Data Assessment

During the ELS-II data verification and validation activities, several issues regarding data quality were of concern. This concern, which concentrated primarily on the data from the chloride, nitrate, sulfate, and alkalinity analyses, prompted a Special Data Assessment. This Special Data Assessment took place after the completion of the official verified data base and during the final phases of data validation. This assessment included an extensive examination of the raw data from both analytical laboratories for many parameters. The analytical raw data include the sample login sheets, recorded results from the analytical instruments, and data entry forms.

The procedures used in the Special Data Assessment are described in detail in the flowchart shown in Figure 4. The following discussion summarizes the procedures shown in the figure. All modifications were applied to the official verified data base. Changes that were initially agreed to by EMSL-LV and ERL-C were made to the official verified data base to create a working data base. Various computer programs were developed and run using data from QA and QC samples (e.g., method and system blanks, routine-duplicate pairs, internal duplicates, splits, and audits). Each sample that was identified as an outlier was placed in a separate file based on the respective program algorithm. The exception generating programs for anion-cation and conductivity balances were also run and the sample values targeted as outliers were also placed in the outlier data base. In addition, samples that were flagged by the ERL-C validation process were included in the outlier data base. The collective set of files of sample values targeted as outliers was referred to as the outlier data base. In summary, the outlier data base consisted of outliers targeted from three primary sources: the QA and QC sample programs, the verification programs, and the validation outliers. This method of identifying problem samples provided a mechanism for the QA auditor to determine if an analyte had multiple problems. Historical data were also used as a separate indication of outliers. These results, however, were not placed in the outlier data base, but were provided to each QA auditor to aid in detecting trends in the data.

All outliers in the outlier data base were prioritized by analyte. Chloride, sulfate, nitrate, and alkalinity were of the highest priority. If a sample was considered an outlier, then the entire batch was reviewed using the analytical raw data. A list was generated of recommendations and justifications for changes.

As a result of the Special Data Assessment, changes were made to a copy of the official verified data base. The resulting data base is referred to as the modified verified data base. The list of changes made is given in Appendix A. Changes were made only to the M01 member due to time and cost constraints. Therefore, data in other members do not reflect results of the Special Data Assessment. The only flags or tags that remain appropriate in the modified verified data base are the X flags which were the only flags evaluated during the Special Data Assessment. The samples and analytes for which X flags changed as a result of the Special Data Assessment are presented in Appendix A, Table A-3. The following discussion, organized by the type of modification made to the data base, describes the findings and corrective actions taken as a result of the Special Data Assessment.

Chloride, Sulfate, and Nitrate Assessments

At the onset of the Special Data Assessment, EMSL-LV and ERL-C personnel agreed that all samples analyzed by Laboratory 1 should be reanalyzed for chloride, sulfate, and

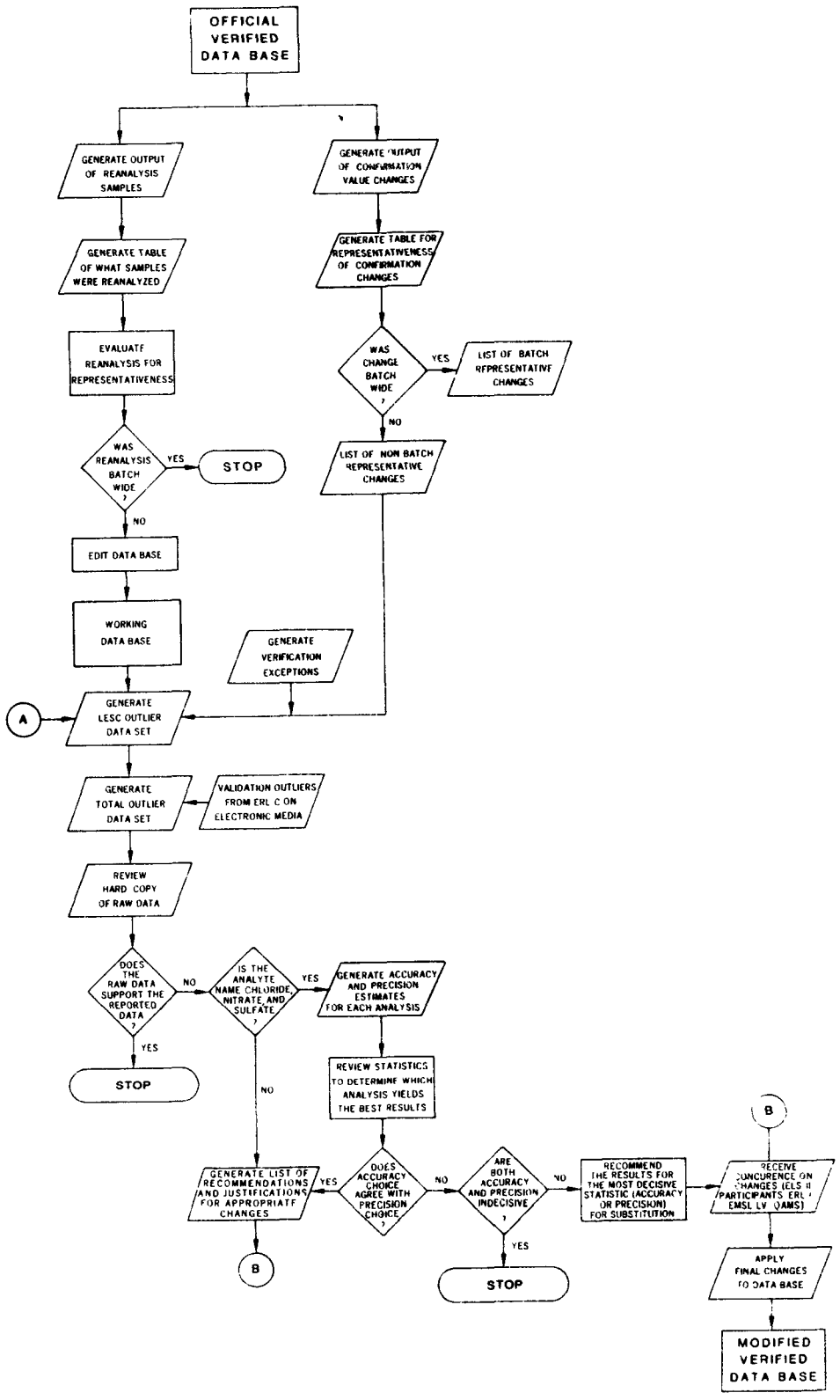

Figure 4. Procedures used during the Special Data Assessment to create the modified verified data base, ELS-II.

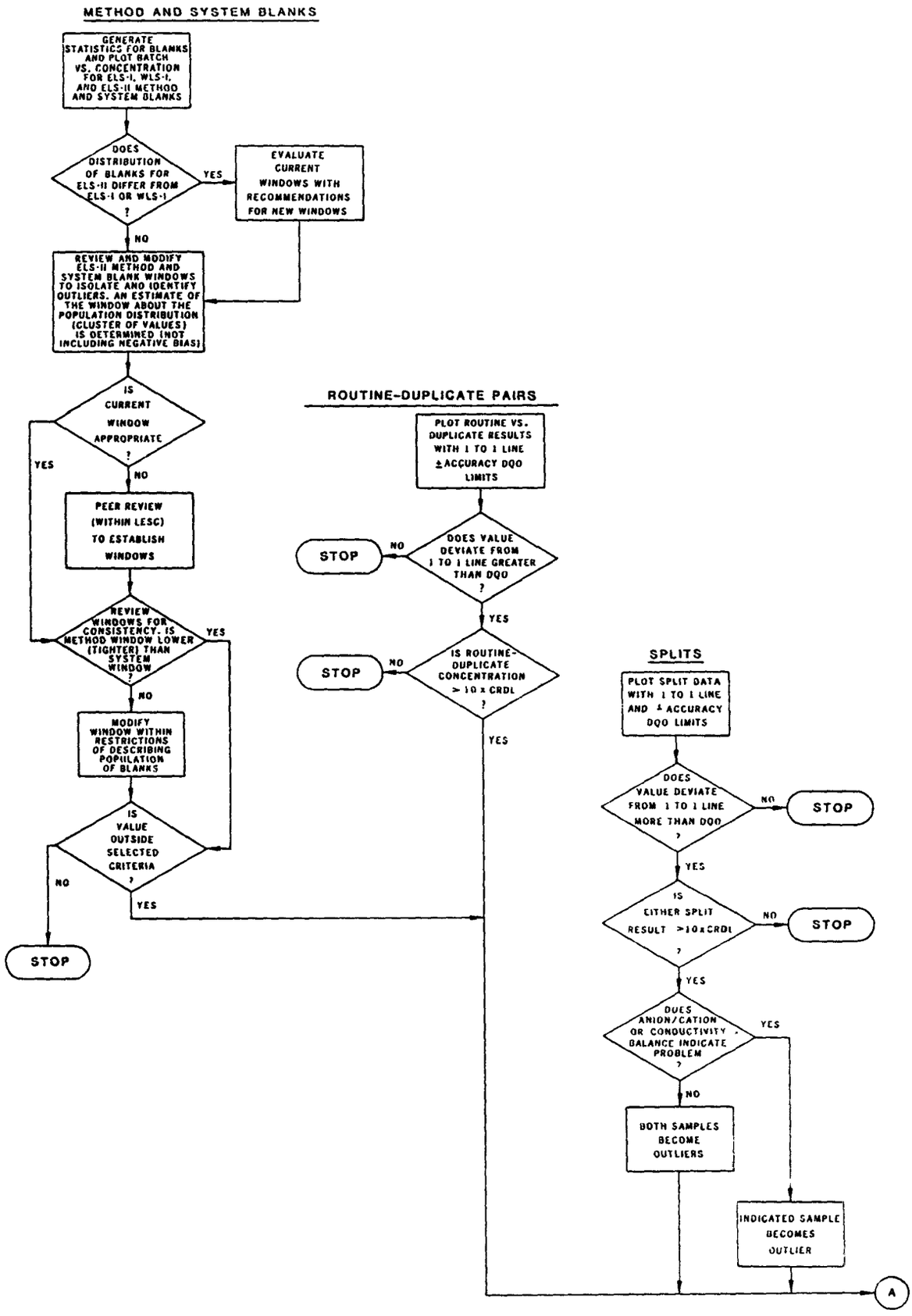

Figure 4. (Continued).

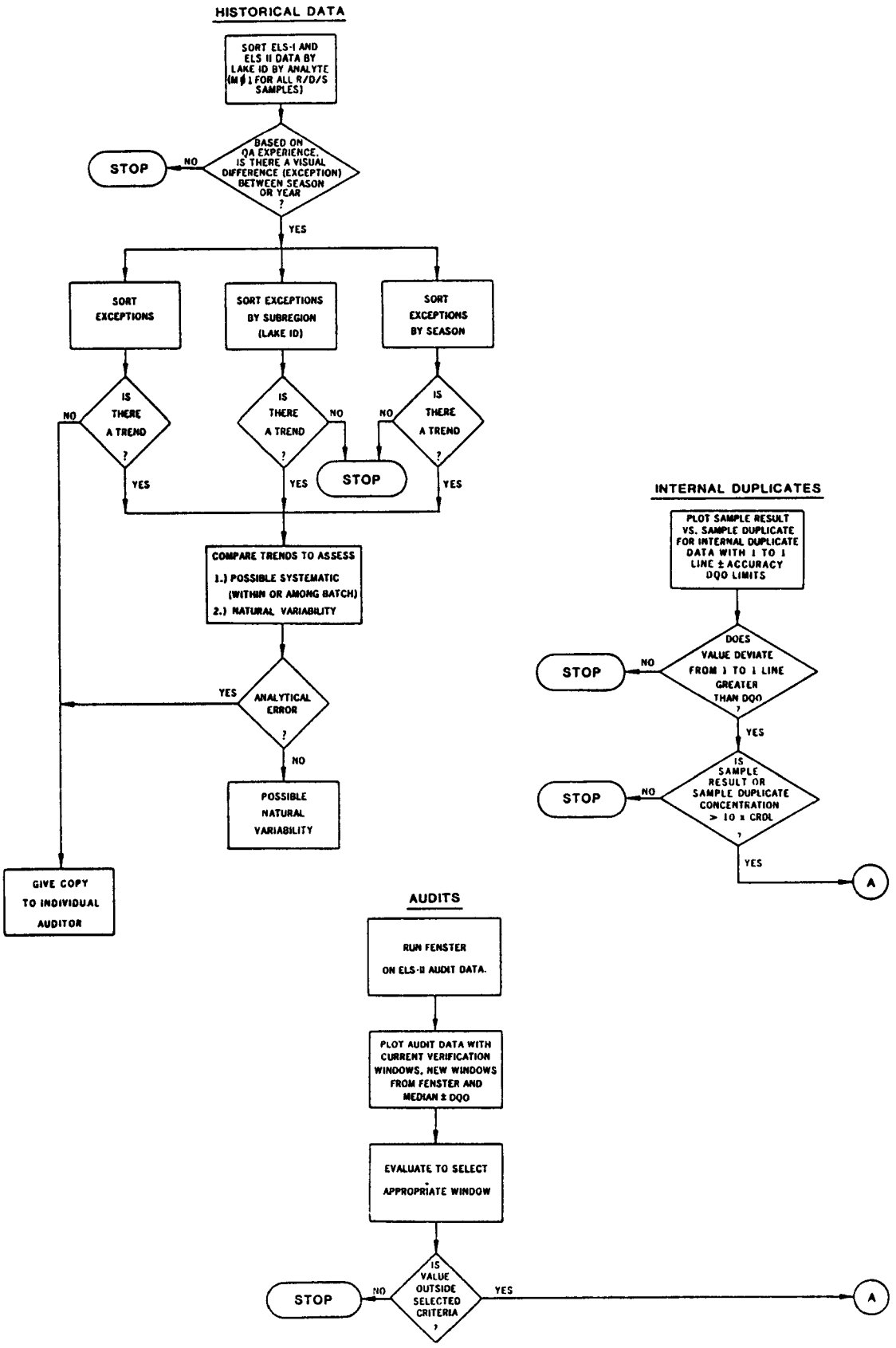

Figure 4. (Continued).

nitrate. However, the laboratory had inadvertently disposed of the samples, thereby eliminating any possibility of further analyses. An alternative data restoration plan was implemented.

All the raw data documentation generated by the analytical laboratory was obtained and examined by EMSL-LV QA staff. It was during this raw data examination that it became apparent that Laboratory 1 had not recalculated the first set of results as reported to EMSL-LV during data verification, but had actually reanalyzed the samples (Section 4, Chloride, Sulfate, and Nitrate Issues).

The first analysis, which took place in March and April of 1986, consisted of chemical analyses of all Spring Seasonal subsurvey samples. This analysis is referred to in this discussion as "Analysis 1." The second analysis (or reanalysis), which took place in May and June of 1986 and also consisted of analyses for chloride, nitrate, and sulfate of all Spring Seasonal subsurvey samples, is referred to as "Analysis 2." A third set of analyses also exists and is referred to as "Analysis 3"; it consists of reanalyses requested by EMSL-LV QA staff during data verification. These reanalyses, which occurred in May of 1987, were only performed on selected samples (Section 4, Chloride, Sulfate, and Nitrate Issues). The objectives of the chloride, sulfate, and nitrate Special Data Assessment were not only to investigate and correct, where possible, the problems related to Laboratory 1 analyses, but also to make a choice, on a batch-by-batch basis, of which analytical result to include in the modified verified data base. To make a reasonable choice between analysis 1, 2, or 3 data, a thorough examination of the result of each analysis was necessary.

The following discussion begins with the evaluation of the Analysis 2 data because the Analysis 2 data, included in the official verified data base, prompted the Special Data Assessment.

Evaluation of Analysis 2 Data

Several different types of problems contributed to the poor quality of chloride, nitrate, and sulfate data. These problems include, but were not limited to, dilution errors, QCCS values exceeding the contract-required limits, and reporting errors.

Dilution--

The linear dynamic range (LDR) for the chloride analysis was 0.02 to 2.0 mg/L. Approximately 47 percent of the routine samples contained concentrations outside this range and therefore required dilution. Dilution, which is a normal laboratory practice, may have been a major source of variability in Laboratory 1 chloride analyses. In contrast, approximately 97 percent of the sulfate samples were within the LDR of 0.1 to 10 mg/L and a similar percentage of the nitrate samples were also within the LDR of 0.01 to 2.0 mg/L. Thus, dilution was not a major factor in the variability of sulfate and nitrate.

Table 12 presents the dilutions used for chloride analysis. Unfortunately, there were not any systematic procedures for determining the dilution factor to be used; thus samples with concentrations just above the LDR may have been diluted by a factor of 5, 10, or even higher. Dilution alone does not necessarily lead to increased variability; however, the apparently random approach of selecting the dilution factor and the large percentage of samples diluted by a factor of 10 or more (17 percent) increases the probability that dilution may have introduced a high degree of variability into chloride data.

QCCS Data--

The contract specified that quality control check samples (QCCS) must be analyzed at the beginning and at the end of each batch, as well as after every ten samples within a batch, and that these concentrations must be reported. The contract also required that the difference between the target value and the measured value must be within a specified percentage (±5 percent for chloride and sulfate; ±10 percent for nitrate). If an unacceptable value for the QCCS was obtained, then the instrument must be recalibrated and all samples that were analyzed after the last acceptable QCCS must be reanalyzed.

On examination of the raw data, it became apparent that many samples were associated with analyses for which the QCCS values were outside the contractual limits. The contractually required QCCS values that were reported indicated general laboratory control. However, the analytical laboratory raw data contained many QCCS results that were outside the contractual limits; however, the

Table 12. Summary of Samples Diluted for Chloride Analysis; Spring Seasonal Subsurvey, Eastern Lake Survey-Phase II

Sample type	Dilution ratio	Number of samples diluted	Total number of samples	Percentage of samples diluted[a]
Routine	1:2	5	146	3.42
	1:5	14	146	9.59
	1:10	6	146	4.11
	1:20	20	146	13.70
	Total diluted	45	146	30.82
Duplicate	1:10	2	29	6.90
	1:20	6	29	20.69
	1:40	1	29	3.45
	Total diluted	9	29	31.03
Seventh Lake field natural audit (FN7)[b]	1:2	1	11	9.09
	1:5	4	11	36.36
	1:10	1	11	9.09
	Total diluted	6	11	54.55
Seventh Lake laboratory natural audit (LN7)[b]	1:5	2	5	40.00
	Total diluted	2	5	40.00

[a] Number of samples diluted divided by total number of samples x 100.
[b] These were the only audit samples with concentrations outside of linear dynamic range.

laboratory did not follow the correct procedure as explained in the preceding paragraph in response to these results. These poor QCCS results were not originally reported with the rest of the data. Such an unreported QCCS measurement that was outside contractual limits does not necessarily indicate poor quality analyses. There were many instances in which the QCCS in the raw data were poor but in which the QA data for double-blind samples indicated adequate data quality. Therefore, although QCCS measurements that were out of specified control limits showed that a problem did exist, these measurements alone do not provide adequate information to evaluate the laboratory performance.

Calibration Standards Used to Define the Calibration Curve--

In most cases, seven instrument calibration standards were prepared and analyzed for use in defining the calibration curve for each of the three analytes. For all three analytes, some standards were eliminated by the laboratory when calculating the calibration regression. Although this is not considered unusual laboratory practice, in some instances as few as three points were used to calculate the calibration regression. Problems with the calibration curves and linear dynamic ranges were most prevalent for the nitrate analyses. The CRDL for nitrate was 0.005 mg/L. All the Analysis 2 calibration blank results were below -0.005 mg/L. Calibration standards below 0.1 mg/L were eliminated for five of the twelve calibration curves. Therefore, the low-level concentrations were calculated on an extrapolated curve. Twenty-six percent of the routine samples were below the lower limit of the actual LDR. Twenty of the twenty-nine field blanks analyzed had the same value as the calibration blanks. For seven of the ten curves where low-level standards were eliminated, the instrument readings for calibration blanks were zero. Consequently, any routine sample with a value less than the lowest standard used in the calibration curve would be reported at the value of the calibration blank.

Reporting Errors--

There were various other errors made during the sample analysis of chloride, nitrate, and sulfate in Analysis 2. These included transcription errors, values reported that were outside the LDR when a value that was within the LDR was available, and reporting of average values of laboratory duplicate

analyses rather than the original sample result. All reporting errors were corrected.

Evaluation of Analysis 1 Data

Although a thorough evaluation of the Analysis 1 data was performed, the review of the dilutions, QCCSs, and standards used to define the calibration curve could not be assessed as extensively as was done for the Analysis 2 data evaluation. The strip charts, which are direct printouts from the ion chromatograph, were the only form of raw data provided (by Laboratory 1) for the Analysis 1 data evaluation and did not provide the same degree of detail as the Analysis 2 analytical laboratory raw data.

Based on information provided by Laboratory 1 and based on double-blind audit data, it was evident that, for certain dates of analyses, the instrument was incorrectly calibrated to read the concentration of a 2 mg/L calibration standard as 1 mg/L. After the evaluation of the audit sample data and comparison of ELS-I and ELS-II routine lake data, the appropriate ELS-II routine and QA sample results were multiplied by 2. This adjustment was made based on the date of analysis (i.e., either all values or no values were multiplied by 2 for any given date). However, there was one date of analysis (April 21, 1986) for which the sulfate data were multiplied by a factor of 20 based on the QA and historical data patterns. In addition, analytical laboratory field blank results recalculated by the EMSL-LV QA staff were not the same as the Laboratory 1 results; therefore, all field blank values were set to zero for Analysis 1.

After all of the modifications were completed, comparisons were made to determine how consistent and reasonable the data were. The sample concentrations that were modified by multiplication were statistically compared to the samples that were not modified. The mean, median, and standard deviation of each audit type for the modified data and the unmodified data were compared to a reference value for that audit type (see Appendix C for reference values). As a secondary comparison, the routine data (for a given lake) were reviewed for the ELS-I and the Summer and Fall Seasonal data. These routine data were compared to both the modified Analysis 1 data and the unmodified Analysis 1 data for consistency. The results of the comparisons indicated that the modifications made to the data were consistent and reasonable.

Evaluation of Analysis 3 Data

For Analysis 3, all of the QCCSs were within the contractual limits, all of the calibration standards were used in the calibration regression, and sample dilution was performed effectively. Based on this information, the laboratory was operating in control.

Selection Process for Analysis 1, 2, or 3

At this point of the Special Data Assessment, three distinct data sets, each containing one of the three analyses, had been created (i.e., one data set contained Analysis 1 data, one data set contained Analysis 2 data, and one contained Analysis 3 data). A stepwise approach was developed to make the appropriate selection between analyses 1, 2, or 3. For each analysis, the percent difference relative to the reference value was calculated for each natural audit sample and percent difference of the routine sample relative to its duplicate sample for the routine-duplicate data. The audit percent differences (accuracy estimates) were calculated using the following equation:

$$\text{\% Relative Difference} = \left| \frac{(\text{reference} - \text{measured})}{\text{reference}} \right| \times 100$$

The reference concentration for a given audit sample is the median value of all the Laboratory 2 data and, where possible, the National Stream Survey (NSS-I) data. The measured value refers to the measured concentration of a given audit sample.

The percent differences for the routine-duplicate pairs (precision estimates) were calculated using the following equation:

$$\text{\% Relative Difference} = \left| \frac{(\text{routine} - \text{duplicate})}{\text{routine}} \right| \times 100$$

Thus, accuracy and precision estimates were used to select the data from analyses 1, 2, or 3. Chloride, nitrate, and sulfate selections were made independently of each other (e.g., for a given batch chloride could be selected from Analysis 1, nitrate could be selected from Analysis 2, and sulfate could be selected from Analysis 3). There were cases where the choice was clear. However, there were also cases where the decision was not straightforward. Appendix B illustrates the

precision and accuracy estimates (for each analysis) used in the selection process.

The following is a description of the process used to select the chloride, nitrate, and sulfate data for inclusion in the modified verified data base:

1. Accuracy estimates based on audit sample results and precision estimates based on pairs of routine and duplicate samples were compared for analyses 1, 2, and 3 for a given batch. If the accuracy and precision estimates indicated the selection of the same analysis (e.g., for chloride, both the accuracy and precision estimates selected Analysis 1 as the best data), then that analysis was selected for that given batch.

2. For the accuracy estimates, a number of batches had multiple audits for a batch. In a few cases (e.g., chloride data for batch 3507, Appendix B, Table B-1), the two audit sample results were contradictory. In these cases, accuracy for that batch was considered indecisive.

3. If the choice for precision was not in agreement with the choice for accuracy, then the accuracy estimate determined the selection. For most cases this selection was justifiable because the precision estimate may be misleading. Low concentrations in the routine-duplicate pair samples resulted in very small absolute differences between routine and duplicate values, even though the percent relative difference may have been large.

4. If the choice for either accuracy or precision was not clear (e.g., Analysis 1 precision estimate is not significantly different from the Analysis 2 precision estimate), then the results based on the decisive statistic (whether accuracy or precision) were used to select the analysis.

5. If both accuracy and precision were indecisive, and there was no other evidence that any selection would improve the data quality, then the default value (Analysis 2) remained in the data base.

Table 13 summarizes the results of the decision process based on accuracy and precision as presented in Appendix B. Summary statistics for analyses 1, 2, 3, and the selected chloride, sulfate, and nitrate field natural audit data are provided in Table 14. This table demonstrates that the selected combination of the three analyses yielded results that were generally of better quality than any one analysis. The changes made as the result of the analyses 1, 2, and 3 selection process reflect the best possible data that are documentable and defensible. All changes made in the modified verified data base as a result of these chloride, sulfate, and nitrate assessments are contained in Appendix A (Table A-1, footnote a).

Acid Neutralizing Capacity

There were two batches in the Spring Seasonal subsurvey (batches 3515 and 3517) that contained acid neutralizing capacity (ANC) values that were much too high. The average calculated alkalinity is derived from the alkalinity values calculated from the processing and analytical laboratory pH and DIC results. This value, calculated by the protolyte analysis program, indicated that the reported ANC results were two to three times what they should have been. Results for audit samples were also two to three times too high (see Table 15 for reported and expected results). The titrations for these two batches, along with batches 3514 and 3516, were performed by a different analyst than for the rest of the Spring Seasonal subsurvey batches. Communications with Laboratory 1 indicated that the alternate analyst was less familiar with the instrument than the regular analyst.

A detailed investigation suggested that the concentration of the acid titrant reported by the laboratory and used in calculating ANC values for batches 3515 and 3517 was less than one-half the value that Laboratory 1 had reported (Table 15). To support this theory, the Gran-analysis program (used to calculate ANC and BNC from the titration data) was modified to calculate the actual concentration of the acid titrant used in the titration. The program then calculated an ANC value using the calculated concentration of acid titrant instead of that reported by Laboratory 1. The results of this investigation are presented in Table 15. Batch 3516 is included in the table to demonstrate how this approach would affect a batch with correctly reported acid titrant concentrations. The newly calculated ANC values are much closer to the expected result for QA samples and much closer to the average calculated alkalinity. It should be noted that the measured pH values were used

Table 13. Summarized Results of the Decision Process for Chloride, Sulfate, and Nitrate Using the Decisions Based on Accuracy and Precision; Spring Seasonal Subsurvey, Eastern Lake Survey - Phase II

	Chloride			Sulfate			Nitrate		
Batch ID	Decision based on accuracy	Decision based on precision	Final decision[a]	Decision based on accuracy	Decision based on precision	Final decision[a]	Decision based on accuracy	Decision based on precision	Final decision[a]
3500	Indecisive	Analysis 1	Analysis 1	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Indecisive	Analysis 2
3501	Indecisive	Analysis 1	Analysis 1	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2
3502	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2
3503	Indecisive	Analysis 3	Analysis 3	Analysis 1	Analysis 1	Analysis 1	Analysis 1	Analysis 1	Analysis 1
3504	Indecisive	Analysis 1	Analysis 1	Analysis 1	Analysis 1	Analysis 1	Analysis 1	Indecisive	Analysis 1
3505	Analysis 3	Analysis 3	Analysis 3	Analysis 1	Analysis 1	Analysis 1	Indecisive	Indecisive	Analysis 2
3506	Analysis 3	Analysis 3	Analysis 3	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Indecisive	Analysis 2
3507	Indecisive	Analysis 1	Analysis 1	Indecisive	Analysis 1	Analysis 1	Indecisive	Analysis 1	Analysis 1
3508	Indecisive	Analysis 2	Analysis 2	Indecisive	Analysis 1	Analysis 1	Indecisive	Analysis 1	Analysis 1
3509	Indecisive	Analysis 2	Analysis 2	Analysis 1	Indecisive	Analysis 1	Analysis 1	Analysis 2	Analysis 1
3510	Analysis 2	Analysis 2	Analysis 2	Analysis 3	Analysis 3	Analysis 3	Analysis 1	Analysis 2	Analysis 1
3511	Analysis 2	Indecisive	Analysis 2	Indecisive	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2
3512	Analysis 2	Analysis 1	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2
3513	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2
3514	Analysis 2	Analysis 1	Analysis 2	Indecisive	Indecisive	Analysis 2	Indecisive	Analysis 2	Analysis 2
3515	Analysis 2	Indecisive	Analysis 2	Analysis 2	Indecisive	Analysis 2	Analysis 1	Analysis 2	Analysis 1
3516	Indecisive	Indecisive	Analysis 2	Indecisive	Analysis 1	Analysis 1	Indecisive	Analysis 2	Analysis 2
3517	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Indecisive	Analysis 2	Analysis 1	Indecisive	Analysis 1
3518	Analysis 1	Analysis 1	Analysis 1	Analysis 1	Analysis 1	Analysis 1	Analysis 1	Analysis 1	Analysis 1
3519	Analysis 1	Indecisive	Analysis 1	Analysis 1	Indecisive	Analysis 1	Analysis 1	Indecisive	Analysis 1
3520	Analysis 1	Analysis 1	Analysis 1	Analysis 2	Indecisive	Analysis 2	Analysis 1	Indecisive	Analysis 1
3521	Analysis 1	Analysis 1	Analysis 1	Analysis 1	Analysis 3	Analysis 1	Analysis 1	Indecisive	Analysis 1
3522	Indecisive	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Indecisive	Indecisive	Analysis 2
3523	Indecisive	Indecisive	Analysis 2	Analysis 1	Analysis 1	Analysis 1	Analysis 2	Indecisive	Analysis 2
3524	Indecisive	Indecisive	Analysis 2	Analysis 2	Analysis 1	Analysis 2	Indecisive	Indecisive	Analysis 2
3525	Indecisive	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Analysis 2	Indecisive	Analysis 2
3526	Analysis 2	Analysis 1	Analysis 2	Analysis 2	Indecisive	Analysis 2	Analysis 2	Analysis 1	Analysis 2
3527	Analysis 2	Analysis 1	Analysis 2	Analysis 2	Indecisive	Analysis 2	Analysis 2	Analysis 1	Analysis 2
3528	Analysis 2	Indecisive	Analysis 2	Analysis 2	Indecisive	Analysis 2	Analysis 2	Indecisive	Analysis 2

[a] Data from this analyses were included in the modified verified data base.

Table 14. Summary Statistics[a] for Chloride, Sulfate, and Nitrate Data Based on Natural Audit Samples; Spring Seasonal Subsurvey, Eastern Lake Survey Phase -II

Audit type[b]	Analysis 1				Analysis 2				Analysis 3				Selected data[c]			
	Number	Mean	Median	Standard deviation	Number	Mean	Median	Standard deviation	Number	Mean	Median	Standard deviation	Number	Mean	Median	Standard deviation
Chloride																
FN7 (2.950)	11	2.897	2.916	0.936	11	3.961	3.020	1.823	1	4.251	4.251	—	11	3.175	2.940	1.103
LN7 (2.950)	5	2.421	2.464	1.210	5	3.935	3.101	1.391	0	—	—	—	5	2.196	2.464	0.938
FN8 (0.412)	10	0.352	0.341	0.156	10	0.355	0.369	0.160	3	0.463	0.431	0.069	10	0.408	0.434	0.077
LN8 (0.412)	6	0.284	0.241	0.114	6	0.378	0.348	0.191	2	0.423	0.423	0.011	5[d]	0.390	0.395	0.047
Sulfate																
FN7 (6.850)	11	6.258	6.269	0.710	11	7.051	7.169	0.676	0	—	—	—	11	6.798	6.849	0.321
LN7 (6.850)	5	5.893	6.602	2.125	5	7.709	7.450	1.243	0	—	—	—	5	6.777	6.602	0.527
FN8 (6.335)	10	5.666	5.878	0.761	10	6.176	6.269	0.810	2	6.828	6.828	0.037	10	6.082	6.097	0.570
LN8 (6.335)	6	5.207	5.646	1.341	6	5.645	5.692	1.388	2	6.774	6.774	0.113	6	6.115	6.227	0.649
Nitrate																
FN7 (1.264)	11	1.241	1.159	0.199	11	1.558	1.373	0.627	1	1.125	1.125	—	11	1.256	1.272	0.108
LN7 (1.264)	5	1.252	1.238	0.151	5	1.458	1.370	0.204	1	1.008	1.008	—	5	1.224	1.238	0.119
FN8 (1.200)	10	1.029	1.071	0.134	10	1.181	1.228	0.190	1	1.381	1.381	—	10	1.083	1.066	0.139
LN8 (1.200)	6	0.933	1.041	0.285	6	1.305	1.268	0.399	1	1.305	1.305	—	6	1.097	1.056	0.144

[a] All mean and median concentrations are in mg/L.
[b] Reference values for each sample type are given in parentheses and are in mg/L. Reference value is the median concentration of all the Laboratory 2 data and, where possible, the NSS-I data. Medians were derived from pooled FN7 and LN7 audit data and pooled FN8 and LN8 data.
[c] These are the data that were selected for inclusion in the modified verified data base.
[d] One LN8 chloride value was flagged with an X0 flag in the modified verified data base and is therefore not included in these statistics.

Table 15. Acid Neutralizing Capacity Recalculations as a Result of the Special Data Assessment; Spring Seasonal Subsurvey, Eastern Lake Survey-Phase II

Batch ID	Sample ID	Sample type	Mean[a] (μeq/L)	Reported ANC[b] (μeq/L)	Average calculated alkalinity[c] (μeq/L)	Recalculated ANC[d] (μeq/L)	Difference[e] (μeq/L)	Reported acid titrant conc.[f] (eq/L)	Calculated acid titrant conc.[g] (eq/L)
3515	1	R	NA	82.0	33	28.7	53.3	0.0096	0.0038
3515	2	R[h]	NA	-15.1	-4	-3.1	-12.0	0.0096	0.0038
3515	3	D[h]	NA	3.3	-5	1.9	1.4	0.0096	0.0038
3515	4[i]	B	NA	7.6	-1	10.1	-2.5	0.0096	0.0089
3515	5	FL15	113	265.5	97	100.2	165.3	0.0096	0.0038
3515	6	R	NA	-12.4	-5	-10.3	-2.1	0.0096	0.0038
3515	7	R	NA	136.4	48	50.6	85.8	0.0096	0.0038
3515	8	R	NA	268.9	98	99.2	169.7	0.0096	0.0038
3516[j]	1	R[h]	NA	15.9	16	16.1	-0.2	0.0096	0.0088
3516[j]	2	FL15	113	130.6	87	127.6	3.0	0.0096	0.0092
3516[j]	3	D[h]	NA	17.5	11	12.6	4.9	0.0096	0.0088
3516[j]	4	LL15	113	120.9	108	112.9	8.0	0.0096	0.0089
3516[j]	5	R	NA	47.0	45	42.9	4.1	0.0096	0.0088
3516[j]	6	R	NA	318.1	351	306.2	11.9	0.0096	0.0092
3516[j]	7	R	NA	371.8	405	339.3	32.5	0.0096	0.0087
3516[j]	8	B	NA	15.3	2	17.0	-1.7	0.0096	0.0089
3517	1	R	NA	157.7	52	59.3	98.4	0.0096	0.0039
3517	2	R	NA	182.8	89	70.2	112.6	0.0096	0.0039
3517	3	FN7	154	392.0	169	153.2	238.8	0.0096	0.0039
3517	4	D[h]	NA	96.9	46	38.2	58.7	0.0096	0.0040
3517	5	R[h]	NA	107.4	43	41.6	65.8	0.0096	0.0039
3517	6	R	NA	213.1	82	84.8	128.3	0.0096	0.0040
3517	7	R	NA	422.6	178	166.9	255.7	0.0096	0.0039
3517	8	R	NA	80.2	23	29.3	50.9	0.0096	0.0039
3517	9	R	NA	215.6	72	82.8	132.8	0.0096	0.0039
3517	10	B	NA	28.3	9	10.4	17.9	0.0096	0.0039

[a] Reference value for the respective audit type. Mean calculated using all ELS-II ANC data for the specific audit type. Grubbs list was used to eliminate outliers. NA means not applicable for these sample types.
[b] ANC value in the official verified data base.
[c] Average alkalinity value calculated by the protolyte analysis program.
[d] ANC value calculated by Gran analysis using calculated acid titrant concentration instead of reported acid titrant concentration.
[e] Difference between reported and recalculated ANC.
[f] Concentration of acid titrant standardized and reported by Laboratory 1 and used to calculate ANC values in the official verified data base.
[g] Acid titrant concentration calculated from the titration data.
[h] Indicates field duplicate pair contained within each batch.
[i] This sample from batch 3515 was analyzed with samples from batch 3516.
[j] Batch 3516 is included to demonstrate how this approach would affect a batch with correctly reported acid titrant concentrations.

in the recalculations to obtain both the acid titrant concentration and the ANC values. In contrast, the ELS-II ANC values in the official verified data base were derived from the calculated pH values.

To perform the above calculations of ANC, it was assumed that the measured pH values and the volume of titrant added, both recorded by a Fischer computer-aided titrator, were accurate. There was no evidence to suggest a problem with the pH values recorded by the titrator. There did not appear to be any problems with the pH QCCSs for these two batches. There is also no evidence to suggest that the volume of titrant added was incorrect. It is unlikely that the Laboratory 1 Fischer titrator would add one volume but record another, especially without the laboratory being aware of such an occurrence. As a result of this investigation, the appropriate changes were made in the modified verified data base (Appendix A, Table A-1, footnote e). These changes substantially improved the quality of the ANC data for batches 3515 (7 samples) and 3517 (10 samples).

Sodium

The analytical laboratory contract specifies that sodium must be measured by either atomic absorption spectroscopy (AAS) or inductively coupled plasma emission spectroscopy (ICPES). Both methods should yield the same results. Laboratory 2 used the Perkin Elmer 703 AAS to measure sodium in the Fall Seasonal subsurvey samples. Laboratory 2 also used the Gerald Ash 1150 ICPES for a sodium measurement. Although the ICPES was not calibrated for the measurement of sodium, the double-blind quality assurance samples indicated that the ICPES results had less variability than the AAS results (Table 16). However, the ICPES results for one day of analyses exhibited more variability and higher bias than the AAS results. For this one day during which batches 3720, 3721, and 3723 were analyzed, the sodium data using the AAS method remain in the modified verified data base. For the other Fall Seasonal batches, the sodium ICPES results were substituted for the AAS results in the modified verified data base.

The result of the comparison between the methods indicates that the precision improved when using the ICPES data for each of the specified audit types with the exception of the laboratory synthetic lots 2 and 3. Although there is a slight increase in the variation from AAS to ICPES for these two lots, there is no statistical difference between the AAS and ICPES sodium results for the LS2 or the LS3. Also, the number of samples in the range of the Lot 2 and Lot 3 synthetics is relatively small. The reference concentration of an LS2 is 10 mg/L. Seven percent (17 samples) of the total 239 routine samples are at a concentration of 9.582 or above. The LS3 reference concentration is 0.03 mg/L. Less than 1 percent (2 samples) of the routine samples are in the range of 0.058 mg/L or less. In summary, substituting the ICPES sodium results for the AAS results improved the quality of the sodium data substantially as evidenced in Table 16. As a result of this investigation, the appropriate changes were made in the modified verified data base (Appendix A, Table A-1, footnote m).

Table 16. Summary Statistics for the Flame Atomic Absorption Spectroscopy and Inductively Coupled Plasma Emission Spectroscopy Methods of Sodium Analysis; Fall Seasonal subsurvey, Eastern Lake Survey-Phase II

Audit type	Reference value[a] (mg/L)	Support lab measured value[b] (mg/L)	Support lab standard deviation[b]	Flame Atomic Absorption			Inductively Coupled Plasma		
				Number	Mean (mg/L)	Standard deviation	Number	Mean (mg/L)	Standard deviation
FN7	2.176	NA	NA	11	2.197	0.229	11	2.203	0.066
FN8	0.606	NA	NA	11	0.612	0.158	11	0.616	0.042
LS1	0.800	0.826	0.019	8	0.799	0.144	8	0.837	0.053
LS2	10.000	10.295	0.055	7	10.596	0.352	6[c]	10.701	0.510
LS3	0.030	0.043	0.002	6	0.032	0.008	5[c]	0.052	0.052
LS4	3.500	3.665	0.021	6	3.765	0.379	5[c]	3.717	0.063
LS5	1.500	1.622	0.030	7	1.665	0.136	7	1.633	0.130

[a] Reference value for FN7 and FN8 is a median of all the available Seventh Lake and Big Moose Lake field natural audit sample data, respectively. Reference values for LS audit types are the theoretical concentrations.
[b] The mean and standard deviation of five experimental laboratory synthetic audit sample values measured by the support laboratory that prepared them. NA means not applicable for these audit types.
[c] One day of analyses (batches 3520, 3521, and 3523) was not included because of analytical error.

Other Modifications

There were other modifications that were made during the Special Data Assessment. These changes included sample switches, missing values reported as zero, and nonrepresentative reanalysis removal. These are all discussed below.

Sample Switches

Sample switches are defined as samples that were inadvertantly switched when the analyst was performing the sample analysis. These can be analyte specific or aliquot specific, or can involve the entire sample. These anomalies were discovered by using the

double-blind QA samples to monitor each batch. When the QA sample concentration was substantially different from the expected value, investigative procedures were initiated. One of the first steps was to check the samples in the batch that are directly before and after the QA sample to determine if that concentration is in the expected range of the QA sample. If so, further investigation was warranted to determine if the concentrations of the samples in the batch were shifted by one or more samples. To assist in identifying sample switches, the other historical lake data were used as a comparison to estimate the approximate concentration of the routine samples.

Analyte-specific sample switches were identified in both the Spring Seasonal and Summer Seasonal subsurvey data. In the Fall Seasonal subsurvey, a lake sample switch was identified by comparing the data for the lakes to historical data. This lake sample switch was also detected during data validation. The data for batch 3713, sample 3 (Lake ID 1C1-068) were switched with batch 3713, sample 14 (Lake ID 1C1-066). The sample container was mislabeled in the field. All appropriate corrections were applied in the modified verified data base and are illustrated in Appendix A (Table A-1).

Missing Values Reported as Zero

The Aquatics Data Entry System recorded missing values as zeros. Most of these zeros were replaced with a character denoting missing values during the data verification. The few remaining zeros were replaced during the Special Data Assessment (Appendix A, Table A-1, footnotes j and n).

Nonrepresentative Reanalysis Removal

Results of reanalysis, for a given analyte, that were not representative of the analysis of at least 50% of the samples in a given batch were removed. The majority of reanalysis values that were removed were for QA samples that had not been reanalyzed with the routine samples in the batch. The rationale for removal of these data was that QA samples did not represent the analysis of the routine samples. In addition, the reanalysis value was removed for several routine samples which were reanalyzed without the reanalysis of associated QA samples. The originally reported result or, if possible, a corrected value obtained from scrutiny of the analytical laboratory raw data was included in the modified verified data base (Appendix A, Table A-1, footnote b).

Miscellaneous Changes

There are several other types of modifications included in Appendix A (Table A-1). Most of these modifications are self-explanatory. The category "transcription error" includes such errors as misplaced decimal points or misrecorded values introduced at any of various stages of sample analysis.

Section 6

Assessment of Data Quality

The quality of the ELS-II data base is described in terms of six characteristics: completeness, comparability, representativeness, detectability, precision, and accuracy. Completeness, representativeness, and comparability apply to the sampling design and its implementation. Detectability, accuracy, and precision quantify the performance of one or several components of the collection and measurement system. Interlaboratory bias is also discussed as an estimate of the systematic and random differences in performance between Laboratory 1 and Laboratory 2. The following subsections also discuss other methods used to assess the quality of the ELS-II data; these methods include measured ANC to calculated carbonate alkalinity comparisons, ion charge balances, and conductivity balances.

All tables and plots presented in the following discussions and in the appendices relative to these discussions were derived from the modified verified data base. Values that were assigned an X flag (invalid data) are not included in the plots or tables.

Completeness

Completeness refers to the amount of data that was successfully collected with respect to the amount intended in the survey design. A certain percentage of the intended amount of data must be successfully collected in order for conclusions based on these data to be valid. For example, missing data may reduce the precision estimates, introduce bias, and thus reduce the level of confidence in the conclusions. In this regard, the goal of the ELS-II was to obtain data bases that were at least 90 percent complete. Completeness of the data base met program goals, based on the ratio of lake samples collected to the lake samples targeted for collection and on the percentage of acceptable data generated from those samples.

Sample Collection

All sampling periods yielded results that were between 99 and 100 percent complete even though there were some unsampled lakes. In the original ELS-II lake selection design, 150 lakes were selected to be sampled during each season (i.e., spring, summer, and fall). There were two lakes, however, that were removed from the list of lakes to be sampled either because of pollution or because of other lake treatment that could interfere with the natural lake chemistry. During the Spring Seasonal subsurvey, 146 of the 148 targeted lakes were sampled. One lake (1B3-025) was not sampled because it was a bog. A second lake (1E2-069) was not sampled because permission for access was not granted.

The number of lakes targeted for sampling during the Summer Seasonal subsurvey was reduced to 146 to match the number of lakes sampled in the Spring Seasonal subsurvey. All 146 of the Summer Seasonal lakes were sampled. In addition to the targeted lakes, the lake (1B3-025) identified as a bog during the Spring Seasonal subsurvey was accidentally sampled.

The total number of lakes selected for sampling in the Fall Seasonal subsurvey was 146. One of the lakes (1A1-059) sampled during the Fall Seasonal subsurvey was not sampled during the Spring or Summer Seasonal subsurveys. Lake 1A2-058, which was sampled during the Spring Seasonal and Summer Seasonal subsurveys, was not sampled during the Fall Seasonal subsurvey due to inclement weather. Details of the ELS-II lake sampling design are discussed in Merritt and Sheppe (1988).

Analytical Measurements

Completeness with respect to ELS-II analytical measurements was evaluated for each parameter for both the processing and analytical laboratories. The percent completion for analyses for each parameter ranged from 98 to 100 percent. Data that were missing or qualified with an X flag (invalid data) in the data base were considered incomplete. The X qualifier recommends to the data user that these data should not be used in any statistical analyses. For further definition of the different types of X flags, refer to the ELS-II QA plan (Engels et al., 1988). The percent completion for any given parameter was calculated by subtracting the total number of incomplete data points from the total number of data points, and then dividing the result by the total number of data points. This value was multiplied by 100 to yield units of percent.

Comparability

The ability to compare the ELS-II data base with the other data bases generated from the AERP projects was a critical objective of the ELS-II. Although several differences exist between the ELS-II and its precursor, ELS-I (Table 8), the use and documentation of standardized sampling and analytical procedures allow for a quantitative evaluation of the data between the ELS-I and the ELS-II as well as allowing ELS-II data to be compared to data from other past and future studies. Some of the primary comparability issues are discussed below.

Comparability of Aluminum Methodology

The ELS-I, and the ELS-II both used the 8-hydroxyquinoline method was used for the determination of monomeric aluminum. This method assumes that only monomeric aluminum is complexed with 8-hydroxyquinoline at a pH level of 8.3 and extracted into methyl isobutyl ketone (MIBK). The ELS-II also incorporated an additional method for monomeric aluminum determination. This method is based on a colorimetric reaction of monomeric aluminum with pyrocatechol violet (PCV) at a pH of 6.1. This method was adapted to be performed using flow injection analysis (FIA). Although the 8-hydroxyquinoline method performed satisfactorily, a more efficient and less hazardous method (MIBK is a hazardous material) of monomeric aluminum measurement was desirable. The PCV-FIA method fulfilled these specifications. The results of the comparability study indicated that the results from the PCV-FIA and the 8-hydroxyquinoline methods correlate well, despite the apparent differences in affinity for monomeric aluminum compounds (Henshaw et al., 1988).

Comparability of Lake Access Procedures

In the ELS-I, all samples were collected by helicopter crews. In the ELS-II, lakes were sampled by both helicopter and ground crews. Although there were two methods of lake access in the ELS-II, a comparability study conducted during the Western Lake Survey indicated that there were no significant differences between the samples collected by helicopter crews and samples collected by ground crews that would affect data quality or interpretation (Landers et al., 1987; Silverstein et al., 1987). The ELS-II was designed on the premise that there would be no significant difference between the ELS-I and the ELS-II samples because of differences in lake access procedures.

Nitrate Data Comparability

For both the ELS-I and the ELS-II, nitrate was analyzed using Aliquot 3, a filtered, unpreserved 250-mL sample. During the ELS-I, nitrate contamination was evident in the field blanks. Because the contamination was apparent in Aliquot 3 for all samples processed on or before November 1, 1984, reanalysis was performed using Aliquot 5, an unfiltered, unpreserved 500-mL sample. Thus, in the ELS-I, all nitrate data processed on or before November 1, 1984, were replaced with the Aliquot 5 nitrate reanalysis results. Details of the ELS-I nitrate contamination are discussed in Best et al. (1986). For the ELS-II, there was no evidence of any significant nitrate contamination. The final nitrate data used in the ELS-I should be comparable to the ELS-II nitrate data.

Representativeness

Representativeness refers to the degree to which the data collected accurately reflect the population, group, or medium being sampled. Standardized protocols defined the appropriate weather conditions for sampling activities and the criteria for selecting the appropriate sampling sites. These protocols

helped to ensure that each of the samples collected was representative of the chemical condition of the lake at the time of sampling.

From the QA perspective, representativeness can be defined by how well the audit samples reflected the matrices and the concentration ranges of the routine samples. Field natural audit samples were used during the ELS-II. These audit samples were composed of characterized, stabilized lake water. Two lakes, Seventh and Big Moose, were chosen as the lakes from which the reference materials would be collected. Seventh Lake was representative of a dilute lake that has moderate ANC, and Big Moose Lake was representative of an acidic system.

Experimental laboratory synthetic audit samples used during the Fall Seasonal subsurvey were designed to represent the expected concentration ranges of the ELS-II routine samples. These laboratory audit samples were prepared at five concentrations. As a product of a continually evolving QA program, this approach was developed in time for implementation into the Fall Seasonal subsurvey on an experimental basis.

Detectability

Detectability can be addressed at two levels. The first level concerns the detectability associated with a particular instrument or analytical method (i.e., instrument detection limits [IDLs] and method detection limits [MDLs]). These limits represent the lowest value of an analyte that can be detected under ideal laboratory conditions and are generally determined by using calibration blanks or reagent blanks. Method-level limits represent the optimum detectability that can be expected for a given methodology and that can be used by program and laboratory managers to establish and implement QC measures. These limits can be compared with DQOs to determine if the analytical laboratories are meeting contract specifications. It is important to note that the samples used to determine method level limits are not blind to the analyst.

The second level evaluates the system detectability. System-level limits represent the lowest value of an analyte that can be detected when the entire process, from sample collection through laboratory analysis, is taken into consideration. Field blank samples (reagent grade distilled water poured through the sampling device and sent through the entire processing and analytical procedure) were used to determine the system-level limits. These limits differ from the method-level limits in that they consider the background contamination that occurs from the time the sample is taken until it is analyzed in the analytical laboratory. System-level limits give the data user a more realistic value for the lowest level of analyte detectable.

Within each level (method and system) two specific limits can be distinguished: the decision limit and the detection limit. It is extremely important to understand clearly the definition of each of these limits and their application in data interpretation. The use of these limits has historically caused some misunderstanding among user groups, and the problem is largely due to semantics. As used in this report the terms are defined as follows:

> Decision limit: The decision limit represents the lowest measured sample value that can be distinguished from a blank sample or from background noise.
>
> Detection limit: The detection limit represents the lowest true or theoretical concentration, above the decision limit, that can be measured with a specified level of reliability.

Two types of statistical errors are important in evaluating the question of detectability: Type I and Type II errors. A Type I error is the error of concluding that an analyte is present when, in fact, it is not. The second error, Type II, is the error of concluding that an analyte is not present when, in fact, it is.

The decision limit and detection limit differ in two important respects. The first is the specification of Type II error allowable, and the second is the actual function of each limit.

The decision limit is selected as a point along the distribution of blank samples, whether it is the distribution of field blanks or calibration blanks, such that a specified portion of the blank measurements fall below that point. This decision limit which specifically addresses the Type I error, has in past NSWS QA reports been set at the 95th percentile (P_{95}) of the blank measurements. There is a 0.05 probability of making a Type I error, i.e., concluding that an analyte is present when in fact it is not. The specification of allowable Type II errors is not of concern when calculating the

decision limit. The decision limit is the point to which routine measurements are compared when trying to determine if they are different from blank measurements or from background noise. If the measurements are above the decision limit, they can be considered to contain analyte above the background concentrations. If the measurements are below the decision limit, they fall within the range of blank measurements and cannot be reliably distinguished from the blanks.

The detection limit answers a very different question. In calculating this limit, one wants to avoid concluding that an analyte is absent when in fact it is present (Type II error). A value is selected such that a small portion of the distribution about that true concentration is below the decision limit. Past NSWS QA reports (Best et al., 1986, Cougan et al., 1988, Silverstein et al., 1987) set this true concentration such that only 5 percent of the distribution fell below the decision limit (Type II error of 0.05 probability). Thus, in repeatedly analyzing a sample with a concentration at the detection limit, at least 95 percent of the measurements on that sample should yield values that are above the decision limit, i.e., distinguishable from blank samples or background noise. In preparing a synthetic audit sample or selecting a natural audit material with low analyte concentration, the detection limit represents the lowest true concentration that can be measured reliably and thus is the lowest concentration that should be used for the audit material.

Note that once measurements on routine samples are obtained, measurement values that fall between the decision limit and detection limit should not be considered less reliable than values above the detection limit. Both measurements fall above the range of 95 percent of the blank measurements and thus are reliably (0.05) different from blanks. However, if a measurement has not yet been taken, and the purpose is to measure a sample that has a concentration between the decision limit and detection limit, the probability, and therefore confidence, of detecting the concentration (Type II error) would be between 50 percent and 95 percent.

For most data users, the system decision limit will be of primary interest. Only this limit provides the data user with a number that can be compared to the values for the routine samples, in order to determine if the samples are distinguishable from blanks or background. This may appear confusing, because many chemists and biologists call this limit the detection limit or limit of detection. Because much of the chemical and biological literature refers to this limit as the "limit of detection," it is important for the data user to be aware of the semantic difference and to understand that, conceptually, the "decision limit" cited in NSWS literature is often the same as the "limit of detection" cited in the general chemical and biological literature.

Calculation of Limits

The limits of detectability for ELS-II are based on the mean and standard deviation of the blank measurements. These limits differ from the calculations of detectability for the ELS-I and WLS which were based on nonparametric statistics (Permutt and Pollack 1985; Best et al., 1986). Unfortunately, the number of blank samples in any one subsurvey of ELS-II is too small to permit the use of the same nonparametric calculations. The traditional calculation for detection limit has been:

$$\bar{X} + 3\sigma$$

The conceptual limit to which this actually refers is the same conceptual limit referred to in NSWS as the decision limit. The $\bar{X} + 3\sigma$ is comparable to a decision limit at P_{99}, although P_{95} was used as the decision limit in the ELS-I and WLS reports. A comparable measurement for P_{95} would be $\bar{X} + 1.65\sigma$. Based on the logic used in the ELS-I QA report (Best et al., 1986), the detection limit should be twice the distance from the mean of the blanks, as is the decision limit. This would make the detection limit $\bar{X} + 3.3\sigma$. For the purposes of this report, the following computations were used for the indicated limits:

System
decision limit $= \bar{X} + 1.65\sigma$ (field blanks)

System
detection limit $= \bar{X} + 3.3\sigma$ (field blanks)

System-Level Detectability

For the purposes of routine data interpretation, system-level detectability is of most interest. This assessment of detectability will therefore deal exclusively with system-level detectability.

System-level detectability was calculated by using field blank samples. These samples

consisted of reagent-grade deionized water which was taken into the field, poured through the sampling device, and processed as a routine sample. These samples were designed to evaluate the amount of analyte introduced into samples during collection, processing, and analysis. Additionally, they can be used to evaluate relative precision of the measurement process at low or zero analyte levels. One field blank was placed in each field batch analyzed by the analytical laboratories.

Table 17 presents the calculated system decision and detection limits for samples collected each of the seasons studied for ELS-II. Of interest is the comparability between the data for the different seasons in the level of detectability. If significant differences exist between seasons, the ability to interpret the seasonal data will vary and thus interpretation of the overall program will be more difficult. The primary concern, because of ELS-II objectives, is a comparison of spring and fall detectability. Given the method of calculating decision and detection limits, it is only necessary to examine the results of the decision limit calculations, because the detection limit is a straightforward multiple. Differences in the decision limits may result from differences in the mean values for the blank measurements, variability of the measurements, or both. Table 18 provides summary statistics for the field blank data for ELS-II. A difference in mean values would most likely be an indication of potential contamination, and a difference in standard deviations would likely result from greater variability in the measurement process, indicating poorer laboratory performance.

The decision limits for 13 of the analytes in Table 17 are greater in the spring than in the fall. For nine of these (Al-org, Ca, Cl^-, DIC-eq, DIC-initial, K, Mg, P-total, and SiO_2) the greater decision limit resulted from both a higher mean value and a larger standard deviation (Table 18). Two of these thirteen analytes (DOC, and SO_4^{2-}) had larger decision limits as a result of poor precision for the blank measurements. The larger decision limits for Cond and Na resulted primarily from larger mean values. For three analytes (Al-ext, Al-total, NH_4^+) there were larger decision limits in fall than in spring.

The summer sampling period presents an interesting analysis because overall detectability during that season results from work performed by two different laboratories. There are 11 analytes for which the decision limits resulting from Laboratory 1's performance exceed those of Laboratory 2 (Al-total, Al-org, Cl^-, Cond, DIC-eq, DIC-initial, Fe, K, Mg, NO_3^-, SO_4^{2-}). For four analytes, the decision limit for Laboratory 2 exceeded Laboratory 1 (Al-ext, DOC, NH_4^+, and SiO_2).

The system decision limits calculated from the field blanks should be used to identify measurements on routine field samples that cannot be distinguished from background. Routine sample measurements with values below the system decision limits cannot confidently be said to contain analyte or to contain analyte above the background contamination levels. The data should be interpreted with extreme caution because, although analyte may be present, it is uncertain whether the analyte was contained in the lake sample or was introduced in the handling and processing procedure. Routine sample measurements that have values above the system decision limits can reliably be said to contain analyte above background contamination.

The system decision limits also provide a means of evaluating the routine data. If the routine data are consistently greater than the system decision limits, detectability is not a critical issue. If the routine data are consistently at or below the system decision limit, then the data must be evaluated cautiously. It is not a matter of poor quality or high quality data, but rather a matter of how the routine values compare with expected background values. Table 19 presents the percentage of routine samples with values below the system decision limit for each analyte in each seasonal sampling. This table can be used to evaluate the degree of caution needed when interpreting the values obtained for each analyte.

The routine samples contain very low concentrations of ammonium; 70 to 80 percent of the routine ammonium values are below the system decision limits, and 64 percent of summer nitrate values are below the decision limit. All species of aluminum are found in relatively low concentrations in the routine samples: anywhere from 2 percent to 94 percent of the routine values are below the system decision limit. Routine values for DIC-eq are also quite low: 37 percent to 50 percent of the values are below the system decision limit. Eighteen to ninety-three percent of the total phosphorus values measured for routine samples are less than the system decision limit.

Table 17. Contract-Required Detection Limits (CRDL), System Decision, and System Detection Limits Calculated From Field Blanks for the Three Seasonal Surveys From ELS-II

			System decision limit[a]					System detection limit[a]				
			Spring	Summer			Fall	Spring	Summer			Fall
Analyte	(units)	CRDL	Lab 1 (29)	Lab 1 (6)	Lab 2 (11)	Pooled (17)	Lab 2 (26)	Lab 1 (29)	Lab 1 (6)	Lab 2 (11)	Pooled (17)	Lab 2 (26)
Al-ext	(mg/L)	0.005	0.001	-0.001	0.005	0.012	0.008	0.011	0.016	0.009	0.029	0.012
Al-total	(mg/L)	0.005	0.013	0.056	0.011	0.034	0.054	0.020	0.094	0.016	0.058	0.094
Al-dis[b]	(mg/L)	NA	0.016	NA	NA	0.016	0.017	0.022	0.020	0.023	0.022	0.025
Al-org[b]	(mg/L)	NA	0.029	NA	NA	0.019	0.007	0.042	0.044	0.021	0.031	0.011
Ca	(mg/L)	0.01	0.033	0.025	0.029	0.029	0.014	0.058	0.037	0.051	0.048	0.027
Cl^-	(mg/L)	0.01	0.284	0.138	0.018	0.079	0.028	0.531	0.242	0.028	0.142	0.045
Cond	(µS/cm)	<0.9	2.403	2.475	1.570	2.114	2.071	2.929	3.086	1.866	2.741	2.867
DIC-eq	(mg/L)	0.05	0.730	0.940	0.153	0.659	0.194	1.085	1.368	0.204	1.071	0.270
DIC-initial	(mg/L)	0.05	0.544	0.670	0.328	0.546	0.268	0.793	0.881	0.430	0.783	0.372
DOC	(mg/L)	0.10	0.610	0.218	0.505	0.444	0.347	1.087	0.322	0.747	0.678	0.495
F^--total	(mg/L)	0.005	0.011	0.007	c	0.007	c	0.014	0.008	c	0.013	c
Fe	(mg/L)	0.01	0.005	0.015	0.003	0.012	0.004	0.009	0.021	0.008	0.022	0.010
K	(mg/L)	0.01	0.020	0.011	0.005	0.007	0.008	0.035	0.019	0.008	0.013	0.018
Mg	(mg/L)	0.01	0.007	0.021	0.003	0.013	0.002	0.011	0.033	0.005	0.023	0.004
Mn	(mg/L)	0.01	0.001	c	-0.003	0.001	0.001	0.001	c	-0.001	0.004	0.003
Na	(mg/L)	0.01	0.071	0.009	0.010	0.009	0.064	0.135	0.015	0.017	0.016	0.132
NH_4^+	(mg/L)	0.01	0.024	0.018	0.026	0.024	0.033	0.048	0.030	0.054	0.048	0.061
NO_3^-	(mg/L)	0.005	0.030	0.086	0.015	0.057	0.033	0.070	0.129	0.022	0.094	0.054
P-total	(mg/L)	0.002	0.023	0.005	0.004	0.005	0.004	0.042	0.007	0.007	0.008	0.006
SiO_2	(mg/L)	0.05	0.046	0.016	0.053	0.045	0.020	0.090	0.025	0.104	0.086	0.052
SO_4^{-2}	(mg/L)	0.05	0.067	0.059	0.031	0.046	0.039	0.135	0.083	0.040	0.064	0.056

[a] Numbers in parentheses represent the number of samples.
[b] This analyte was measured only in the processing laboratory. The decision limit for this analyte is for the processing laboratory for the indicated season.
[c] Standard deviation not calculated; only a single value was reported by the laboratory.
NA - Not applicable.

Table 18. Summary Statistics for Field Blank Data, Eastern Lake Survey - Phase II[a]

Analytes (units)	Spring-1			Summer-1			Summer-2			Summer-1+2			Fall-2		
	N	Mean	STD	N	Mean	STD	N	Mean	STD	N	Mean	STD	N	Mean	STD
Al-ext (mg/L)	29	-0.0085	0.0060	6	-0.0169	0.0100	11	0.0005	0.0025	17	-0.0056	0.0104	26	0.0036	0.0025
Al-total (mg/L)	29	0.0064	0.0042	6	0.0182	0.0230	11	0.0061	0.0031	17	0.0104	0.0144	26	0.0132	0.0245
Al-dis[b] (mg/L)	29	0.0109	0.0034	6	0.0108	0.0027	11	0.0106	0.0039	17	0.0107	0.0034	26	0.0103	0.0043
Al-org[b] (mg/L)	29	0.0151	0.0083	6	0.0112	0.0099	11	0.0052	0.0047	17	0.0073	0.0073	26	0.0018	0.0029
ANC (ueq/L)	29	2.9207	5.7421	6	3.6500	4.3693	11	2.1273	6.1693	17	2.6647	5.5060	26	1.6000	2.7527
BNC (ueq/L)	29	32.0379	12.6142	6	27.9500	11.7740	11	21.0727	6.3032	17	23.5000	8.9235	26	19.8538	4.5423
Ca (mg/L)	29	0.0090	0.0147	6	0.0133	0.0072	11	0.0077	0.0132	17	0.0097	0.0116	26	0.0018	0.0075
Cl^- (mg/L)	29	0.0369	0.1497	6	0.0339	0.0631	11	0.0076	0.0062	17	0.0169	0.0379	26	0.0110	0.0102
Cond (uS/cm)	29	1.8759	0.3192	6	1.8633	0.3706	11	1.2810	0.1754	17	1.4865	0.3800	26	1.2749	0.4824
DIC-eq (mg/L)	29	0.3762	0.2147	6	0.5115	0.2595	11	0.1016	0.0310	17	0.2463	0.2498	26	0.1186	0.0460
DIC-initial (mg/L)	29	0.2947	0.1509	6	0.4592	0.1278	11	0.2265	0.0617	17	0.3086	0.1436	26	0.1646	0.0629
DOC (mg/L)	29	0.1336	0.2888	6	0.1148	0.0627	11	0.2636	0.1464	17	0.2111	0.1414	26	0.1981	0.0900
F^--total (mg/L)	29	0.0077	0.0019	6	0.0063	0.0004	11	0.0000	0.0000	17	0.0022	0.0031	26	0.0000	0.0000
Fe (mg/L)	29	0.0005	0.0026	6	0.0095	0.0034	11	-0.0006	0.0025	17	0.0030	0.0057	26	-0.0023	0.0036
K (mg/L)	29	0.0048	0.0091	6	0.0032	0.0048	11	0.0010	0.0021	17	0.0018	0.0033	26	-0.0022	0.0062
Mg (mg/L)	29	0.0026	0.0026	6	0.0088	0.0074	11	0.0008	0.0014	17	0.0036	0.0058	26	-0.0001	0.0013
Mn (mg/L)	29	-0.0002	0.0004	6	0.0000	0.0000	11	-0.0039	0.0008	17	-0.0026	0.0020	26	0.0000	0.0008
Na (mg/L)	29	0.0069	0.0389	6	0.0030	0.0036	11	0.0018	0.0047	17	0.0022	0.0043	26	-0.0035	0.0412
NH_4^+ (mg/L)	29	-0.0002	0.0147	6	0.0051	0.0075	11	-0.0019	0.0169	17	0.0006	0.0144	26	0.0053	0.0170
NO_3^- (mg/L)	29	-0.0103	0.0244	6	0.0421	0.0263	11	0.0082	0.0041	17	0.0201	0.0225	26	0.0113	0.0129
P-total (mg/L)	29	0.0042	0.0115	6	0.0030	0.0011	11	0.0008	0.0017	17	0.0016	0.0018	26	0.0015	0.0013
pH-BNC (pH units)	29	5.7331	0.1542	6	5.4953	0.1930	11	5.6636	0.1826	17	5.6042	0.1984	26	5.8835	0.1929
pH-ANC (pH units)	29	5.7169	0.1501	6	5.4993	0.1902	11	5.6364	0.2203	17	5.5880	0.2150	26	5.7231	0.0678
pH-eq (pH units)	29	5.6924	0.3211	6	5.5902	0.1557	11	6.1082	0.5118	17	5.9254	0.4862	26	5.6281	0.1416
SiO_3 (mg/L)	29	0.0010	0.0270	6	0.0072	0.0055	11	0.0014	0.0312	17	0.0035	0.0250	26	-0.0115	0.0192
SO_4^{2-} (mg/L)	29	-0.0018	0.0416	6	0.0361	0.0141	11	0.0218	0.0054	17	0.0269	0.0114	26	0.0233	0.0098

[a] This analyte was measured only in the processing laboratory. The decision limit for this analyte is for the processing laboratory for the indicated season.
[b] The number following the season indicated the laboratory; where the 1 represents Laboratory 1, the 2 represents Laboratory 2, and the 1+2 represent the combined laboratory 1 and 2 data.

Table 19. Percentage of Routine Samples Having Values Less Than or Equal to the System Decision Limit[a]

Analyte	Spring	Summer	Fall
Al-ext	23	58	36
Al-total	2	43	52
Al-dis	17	32	16
Al-org	52	94	20
Ca	0	0	0
Cl^-	7	2	0
Cond	0	0	0
DIC-eq	50	46	37
DIC-initial	11	17	2
DOC	2	2	1
F^--total	2	0	1
Fe	5	18	8
K	0	3	0
Mg	0	0	0
Mn	3	26	3
Na	0	0	1
NH_4^+	75	81	71
NO_3^-	22	64	34
P-total	93	23	18
SiO_2	3	2	2
SO_4^{2-}	0	0	0
True Color	25	11	8
Turbidity	10	*b*	1

[a] Routine values for each season are compared to the system decision limit for that season.
[b] There was no system decision limit for summer because all the values were reported as the same number.

Summary of Detectability

The greatest concern in the field blank data is the apparent difference in the results of Laboratory 1 and Laboratory 2. For 8 of 23 analytes measured, Laboratory 1 consistently had a larger system decision limit as a result of either larger values, poorer precision, or both. This was especially consistent for Al-org, Cl^-, Cond, DIC-eq, DIC-initial, K, Mg, and SO_4^{-2}. The importance of this apparent problem depends entirely on the relative levels of these analytes in the routine samples. As indicated in Table 19, this presents a potential problem for Al, DIC, NH_4^+, NO_3^-, and P-total which are present in relatively low concentration in the lakes surveyed. This is not surprising for ammonium, nitrate, and phosphorus because the lakes under consideration are, in general, dilute, oligotrophic systems. These systems are often nutrient-limited with respect to phytoplankton primary productivity and, although phytoplankton biomass is low, dissolved nutrients will be assimilated quickly. The systems usually have low buffering capacity, which corresponds to low DIC values. With this background in mind, it is not unexpected to find a high percentage of samples below the decision limit. It does not necessarily indicate poor data quality but rather reflects the systems being studied. It does, however, mean that analysis and interpretation of trends in these data will require more attention to the issue of detectability, and differing levels of performance from participating laboratories can become a problem.

The analysis of concentrations found in audit samples with respect to system detection limits indicates that greater care must be taken in creating or selecting audit samples. The quantity of DIC, Cl^-, NH_4^+, and P-total present in the natural audit samples was low relative to the system detection limits. The NSWS has provided a great deal of background information on expected system detection limits; this information should be applied in creating or selecting future audit samples. The lowest concentrations in these audits should not be less than the expected system detection limits.

Accuracy and Precision

Accuracy or bias can be defined as the closeness of a measurement to a true or known value, and precision is the dispersion of repeated measurements about a central tendency. The EPA has evaluated accuracy by calculating a percent difference from a known value, and has evaluated precision by calculating the percent variability of repeated measurements (coefficient of variation or percent relative standard deviation). Although this approach to documentation of data quality has proven effective for studies of a single analyte over a limited range of concentrations, it is not as effective when evaluating multianalyte, wide concentration range, survey data. This report presents a different approach for assessing precision and accuracy than was used in previous QA reports for the NSWS. Summary statistics from QA data for each analyte are presented by season in appendices C and E. The procedures and calculations that can be used to interpret these statistics are presented within the text. The data user is then provided with the tools for evaluation of the level of error associated with survey data without any reference to preset DQOs.

Precision and accuracy measurements of ELS-II data indicate good quality data when compared with the DQOs for a majority of analytes. There were a few exceptions, which are discussed in detail in the following

subsections. Predetermined DQOs for the ELS-II were based upon previous NSWS DQOs for intralaboratory performance. These DQOs can be used as a relative standard to assess the quality of ELS-II data. Accuracy and precision DQOs (Table 20) were expressed in percent difference and percent relative standard deviation (variability), respectively, for all analytes except pH, which was expressed in pH units. Calculation of percent difference is based upon comparison of median target values to median measured values for a given audit/laboratory combination. Medians are considered the best statistic for this purpose because they are not influenced by outlier data points, whereas a mean value would be. The performance ranges (DQOs) in Table 20 only apply to data values that were at least 10 times greater than the detection limit for a given analyte, because percent difference and percent variability can be highly inflated at very low concentrations due to use of a percent scale. For example, a percent relative standard deviation of 100 at the extreme limits of measurement capability for an analyte represents a very small absolute error in the measurement.

The DQOs for ELS-II were established to provide a minimum acceptable performance range for each laboratory. The laboratories used numerous QC samples to monitor their own performance. These samples included laboratory blanks, QC check samples, and laboratory duplicates. Assessment of these data would provide a biased estimate of measurement error, because the laboratories knew the content of the samples and were required by contract to achieve prescribed quality standards for measurement of these samples. Therefore, the internal QC sample data are not used to describe measurement error in this report; they were used by the EMSL-LV QA staff to identify and correct, if possible, laboratory errors. Assessment of double-blind QA sample data (audits and field duplicates) does provide an unbiased estimate of laboratory performance, because the laboratories could not distinguish these performance samples from routine samples. A summary of the results of assessment of audit and duplicate data is presented below.

Natural Audit Samples

Natural audit samples from Seventh Lake and Big Moose Lake were the only double-blind QA performance audit samples that were used by both laboratories throughout all seasonal subsurveys. Field natural (FN) audit data provide the most conservative estimate of measurement precision and bias, because these samples were subject to all processing and analytical procedures except the field collection step. Laboratory natural (LN) audits were subject to analytical laboratory sources of error but were not exposed to shipping and handling procedures before the samples were preserved and divided into aliquots. Therefore, they may underestimate the magnitude of measurement error. Target values for analyte concentrations in natural audit samples were generated by taking the median of all available data for that sample generated during the NSWS by analytical laboratories. These values included data from four laboratories, two of which were operating during the NSS-I and two of which were operating during the ELS-II surveys. All four laboratories received natural audit samples from the same source and used the same protocols for preparation and analysis. Statistical characterization of both FN and LN audit material are presented in Appendix C along with estimates of the target values for each audit type. Descriptive statistics presented in Appendix C include sample size, median, mean, standard deviation, and percentile data for 10, 25, 75, and 90 percent of the data. In addition, the scatter and confidence interval plots given in Appendix D for the field natural audits can be used in conjunction with the summary statistics.

Several approaches can be used to define and assess the measurement error of survey data. The approach presented in this report is based upon the design of the QA program. This approach probably provides a conservative (worst case) estimate of measurement error, because the sample size for any given audit type is generally small (Appendix C).

The statistics and plots presented in appendices C and D can be used to estimate measurement error in the following manner:

- Confidence intervals can be calculated about the mean values using standard techniques (Sokal and Rohlf, 1969). Sample sizes and standard deviations are provided for this purpose in the tables.

- Percent relative standard deviation ([standard deviation/mean] × 100) can be calculated to determine the percent variability of audit sample data, or of grouped duplicate pair data. Standard deviations and means

Table 20. Analytical Data Quality Objectives for Detectability, Precision, and Accuracy for the Eastern Lake Survey-Phase II[a]

Analyte (Units)	Detection limit objective (units)	Within-laboratory precision (%RSD)[b]	Within-laboratory accuracy (%)
Field Site			
pH, field (pH units)	—	—	±0.20[c]
Conductivity (µS/cm)	—	—	±20[c]
Dissolved oxygen (mg/L)	—	—	—
Depth (m)	—	—	—
Processing Laboratory			
Aluminum (mg/L)			
Total monomeric	0.01	10 (>0.01 mg/L) 20 (≤0.01 mg/L)	10 (>0.01 mg/L) 20 (≤0.01 mg/L)
Nonexchangeable monomeric	0.01	10 (>0.01 mg/L) 20 (≤0.01 mg/L)	10 (>0.01 mg/L) 20 (≤0.01 mg/L)
pH, closed system (pH units)	—	0.1[c]	±0.1[c]
Dissolved inorganic carbon closed system (mg/L)	0.05	10	10
True color (PCU)	0	5[c]	—
Turbidity (NTU)	2	10	10
Analytical Laboratory			
Acid-neutralizing capacity (µeq/L)	*d*	10	10
Aluminum (mg/L)			
Total	0.005	10 (>0.01 mg/L) 20 (≤0.01 mg/L)	10 (>0.01 mg/L) 20 (≤0.01 mg/L)
Extractable	0.005	10 (>0.01 mg/L) 20 (≤0.01 mg/L)	10 (>0.01 mg/L) 20 (≤0.01 mg/L)
Ammonium (mg/L)	0.01	5	10
Base-neutralizing capacity (µeq/L)	*d*	10	10
Calcium (mg/L)	0.01	5	10
Chloride (mg/L)	0.01	5	10
Conductivity (µS/cm)	*e*	2	5
Dissolved inorganic carbon (mg/L)			
Initial	0.05	10	10
Equilibrated	0.05	10	10
Dissolved organic carbon (mg/L)	0.1	5 (>5.0 mg/L) 10 (≤5.0 mg/L)	10
Fluoride, Total dissolved (mg/L)	0.005	5	10
Iron (mg/L)	0.01	10	10
Magnesium (mg/L)	0.01	5	10

(Continued)

Table 20. Continued.

Analyte (Units)	Detection limit objective (units)	Within-laboratory precision (%RSD)[b]	Within-laboratory accuracy (%)
	Analytical Laboratory (continued)		
Manganese (mg/L)	0.01	10	10
Nitrate (mg/L)	0.005	10	10
pH (pH units)			
Initial ANC	—	0.05[c]	±0.1[c]
Initial BNC	—	0.05[c]	±0.1[c]
Equilibrated	—	0.05[c]	±0.1[c]
Phosphorus, total dissolved (mg/L)	0.002	10(>0.010 mg/L) 20(≤0.010 mg/L)	10(>0.010mg/L) 20(≤0.010mg/L)
Potassium (mg/L)	0.01	5	10
Silica (mg/L)	0.05	5	10
Sodium (mg/L)	0.01	5	10
Sulfate (mg/L)	0.05	5	10

[a] These data quality objective are applicable for all of the Eastern Lake Survey-Phase II subsurveys.
[b] %RSD = percent relative standard deviation. Unless otherwise noted, this is the precision goal at concentrations greater than or equal to 10 times the required detection limit.
[c] Precision or accuracy goal in terms of applicable units.
[d] The absolute value of each laboratory calibration blank measurement was required to be less than or equal to 10 μeq/L.
[e] The mean of six nonconsecutive blank measurements must not exceed 0.9 μS/cm.

calculated for duplicate pair data are pooled estimates of these statistics.

- The plots include both scatter diagrams by survey and means and confidence intervals for each survey. The plots can be used to screen analytes to determine if the error is acceptable for the intended use of the data. These plots provide a visual summary of the data that were designed to estimate measurement precision and accuracy.

- Interquartile ranges can be used as a nonconservative estimate of the expected spread of data about a central tendency (the median for nonparametric statistics).

- The range between the 10th and 90th percentiles can be used as a conservative estimate of the expected spread about a central tendency.

- Medians or means can be compared to target values to determine the accuracy of the data.

- Audit data represent the low and high range of data to be expected within the population of ELS-II lakes for most analytes measured. Midrange data should have error bounds somewhere between the high value and the low value data. Ideally, a midrange audit would provide this information. However, for ELS-II only two natural audit sources were available for use.

Comparison of natural audit data to the precision DQOs can be accomplished by comparing the mean and standard deviation columns in the tables in Appendix C. Because most of the precision DQOs were 5 percent or 10 percent, it is a simple matter to determine if the standard deviation was less than 5 percent or 10 percent of the mean. (The %RSD is the standard deviation divided by the mean). For example, if the mean value for an analyte

was 0.100, then the standard deviation should be 0.01 or less. Conductivity and pH are exceptions to the 5 percent and 10 percent DQOs and need to be compared somewhat differently. The DQO for pH is an absolute value and can be compared directly to the standard deviation column in Appendix C tables. Conductivity has a 2 percent precision DQO and needs to be calculated accordingly.

Comparison of natural audit data to the accuracy DQOs is complex, but because almost all the accuracy DQOs were 10 percent (pH and conductivity are again exceptions), the calculation is not unmanageable. In Appendix C tables, the Field Target and Lab Target columns should be compared to the Median column. These values should be within 10 percent of each other to meet the DQOs. For example, if a target value is 0.100, the median value should fall between 0.09 and 0.11. Conductivity values should be within 5 percent, and pH values should be within 0.1 pH units. It will be difficult to interpret this type of comparison in some cases because there are substantial differences between the field and laboratory target values. Extractable aluminum, ammonium, phosphorus, and laboratory DIC fall within this category for at least one of the natural audits. In addition, fluoride, iron, manganese, ammonium, and phosphorus are in very low concentration ranges in the natural audits, thus limiting comparability of these data to the DQOs.

Data quality for a majority of analytes was within or very close to the quality goals set prior to the survey (DQOs). Exceptions to this pattern were extractable aluminum in all seasons at low analyte concentrations and in fall at high concentrations, chloride in spring and summer for Laboratory 1, laboratory DIC-eq measurements, and summer sodium measurements for Laboratory 2. Extractable aluminum and DIC-eq appeared to be inaccurate and relatively imprecise. This pattern was confounded, however, by the discrepancies between the LN and FN target values, which may have been a function of method capability, laboratory capability, or a characteristic of the audit sample. Chloride for Laboratory 1 was imprecise in the spring (12.1 to 42.7 percent) and in the summer (3.4 to 88.5 percent). Summer sodium values appeared to be highly imprecise for Laboratory 2; however, the plots of these data presented in Appendix D indicate this imprecision was due to a single outlying value; the central tendency of the data appears comparable to other seasons and laboratories. Plots of Cl^- data indicate general imprecision rather than imprecision generated by a single outlier as shown for Na.

A series of analytes (ANC for Big Moose Lake, F^-- total for spring, Fe, Mn, NH_4^+, and P-total) had higher %RSD values than the DQOs, thus giving the appearance of poor quality data. Concentrations of analytes in the audits for these chemical species were less than 10 times the detection limit goals (Table 20). Therefore, comparison of the precision of these analytes in not relevant as explained above. The accuracy of these data appears very good, even at low analyte concentrations, with the exception of ammonium which did appear to exceed the accuracy DQOs. The quality of nitrate values for the Spring Seasonal subsurvey is very close to the DQOs, but is much more variable than the summer or fall nitrate values and shows no consistent trend for high or low bias.

Field Routine-Duplicate Pairs

Previous NSWS survey data emphasized field routine-duplicate pair data for documentation of overall within-batch precision. This was reasonably effective because large numbers of duplicate pairs were collected in these surveys. The sample size for duplicate pairs for each seasonal subsurvey in ELS-II ranged from 17 to 29. The number of duplicate pairs within any concentration range was variable, both between analytes and between surveys (Appendix E). In addition, analysis of these data would provide estimates of precision which only include the error associated with samples from one batch. Although duplicate-pair data theoretically include the field component of error, audit samples include among-batch error. This error is generally much larger than the within-batch error (see Cougan et al., 1988) because it includes batch to batch analytical sources of error (e.g., calibration error, dilution of standards). For example, the standard deviation of ANC values in the range of 100 to 150 μeq/L ranged from 2.2 to 5.5 for duplicate pairs and 6.2 to 27.2 for natural audits. The audits provide a much higher estimate of sample variance than do the duplicate pair data for a given concentration range. Therefore, it is not recommended that duplicate-pair data be used to assess precision. Statistical summaries for duplicate pairs are presented in Appendix E, which includes the sample size, grand mean, pooled standard deviation, and %RSD for data grouped into analyte ranges of interest. Appendix E also

contains plots of the mean concentration of the field routine-duplicate pair versus the %RSD. The ranges of interest for analytes follow those defined in Cougan et al. (1988) by data users interested in acidic deposition effects in streams and the range of concentration of ELS-II data. These data can be used as estimates of precision outside the range of audit sample concentrations. The data user needs to be aware that these values will underestimate the variance of samples because the among-batch error is not accounted for.

Duplicate pair data (Appendix E, %RSD column) can be compared to the predetermined DQOs for within-laboratory precision by comparing the precision column in Table 20 with the %RSD column in Appendix E. Additionally, the grand mean column in Appendix E tables can be compared to the detection limit column in Table 20 to evaluate the relevancy of the precision estimate for a given concentration range. Comparison of duplicate pair data to the DQOs is not relevant for aluminum, fluoride, manganese, ammonium, nitrate, phosphorus, and silica because of the low concentration of a majority of the samples collected. In addition, ANC data presented in Appendix E indicate high variation in the low concentration range. This does not indicate poor quality data, however, because high variability in this concentration range reflects a small (<10 μeq/L) absolute error in the data. With the exception of the Spring Seasonal and Summer Seasonal subsurvey chloride data from Laboratory 1, data for analytical laboratory DIC, and iron measurements, all analytes compared favorably with the preset DQOs.

Summary of Accuracy and Precision

Based upon the data from both audit and duplicate pair double-blind QA samples, the ELS-II data base reflects high quality data for most analytes of interest. For example, ANC, pH, NO_3^-, and SO_4^{2-} had accuracy and precision well below or near to the DQOs. Nitrate values were very close to the upper bounds of the DQOs for Spring Seasonal subsurvey data and need to be evaluated carefully by the data user to determine if the quality is adequate to answer the questions being asked. Analytes that did not meet preestablished DQOs included Laboratory 1 chloride data, and all analytical laboratory measurements of extractable Al, DIC, and DOC data. Processing laboratory measurements for DIC should be used rather than the DIC-eq values because the processing laboratory data met the DQOs. Extractable aluminum data are comparable in quality to those produced in other NSWS surveys (Best, et al., 1986, Silverstein et al., 1987, Cougan et al., 1988). High levels of total aluminum imprecision are a function of one or two outlying data points for all seasonal subsurveys (Appendix D). The data in this report should be closely examined to determine the impact of variability and bias on specific uses of the data. Ultimately, the data user must decide if the quality of the data described in this report is sufficient to satisfy the goals of a particular study.

Interlaboratory Bias

The issue of interlaboratory bias is an especially critical one in ELS-II. The survey design used two laboratories over the course of the three seasonal samplings. Both laboratories performed analyses for the Summer Seasonal subsurvey; Laboratory 1 was used exclusively during the Spring Seasonal subsurvey and Laboratory 2 was used exclusively during the Fall Seasonal subsurvey. If significant analytical bias exists between the laboratories, then apparent seasonal differences between routine samples could simply be the result of interlaboratory bias rather than actual differences. In analyzing the QA and QC data for interlaboratory bias, three sets of samples can be used. The first set is referred to as the summer split samples. During the summer a triplicate routine sample was taken. Then, equal portions of the split were sent to each laboratory for analysis. The second and third sets are the Seventh Lake and Big Moose Lake natural audit samples (Lots FN7 and FN8, respectively.)

Interlaboratory bias can only be directly assessed for the Summer Seasonal subsurvey, when both laboratories operated simultaneously. In order to apply the information to spring and fall data, it is necessary to assume that the interlaboratory bias that exists for the summer analyses is the same as the bias for spring and fall. Such bias should be apparent in data for audit material distributed during each season. Unstable audit material or variable seasonal performance for either of the laboratories invalidates this assumption. Additionally, the split data indicate only relative bias because they are based on samples for which a true or expected value is unknown. On the other hand, well-characterized natural

audit material (i.e., an established expected value) provides some basis for estimating absolute bias. However, the natural audit samples provide an indication of interlaboratory bias at only one specific concentration. In order to evaluate the impact of the interlaboratory bias on routine data, it is necessary to establish the interlaboratory bias over the range of concentrations seen in the routine data. In the following analysis, the split samples and the two natural audit materials are used to examine the issue of interlaboratory bias.

Analyses of the summer split samples of routine lake triplicates can be used to examine interlaboratory bias over the range of concentrations found in the routine samples. The expectation for the analyses of splits is that the data for the laboratories will fall on a line with a slope of one and an intercept of zero, the identity line. If a regression line is fit to the data, a 95 percent confidence interval can be generated for the estimate of the slope of the predicted regression line. If the slope of the identity line (i.e., slope=1) falls within the 95 percent confidence interval, then the best fit line for the data cannot be said to differ significantly from the identity line. The predicted line can have a slope of one and still indicate bias if the Y-intercept is significantly different from zero. This would result in a line parallel to the identity line with a non-zero intercept.

Results of split sample data analyses are presented in plots in Appendix F. The figures show the data for each analyte with the identity line plotted. In only two instances is there a visually apparent bias, DIC-initial and DIC-eq. In each of these instances, the bias appears to be a linear function of concentration with a slope of 1.5 for DIC-eq and 1.3 for DIC-initial, both of which are significantly different from a slope of one. Chloride exhibits a slight constant bias (slope 0.836) in which Laboratory 1 measures low relative to Laboratory 2. Conductivity shows a small (4.5 μS/cm) but constant bias, with Laboratory 1 measuring high relative to Laboratory 2. The bias shown for iron is created primarily by two samples at high concentrations with high measurements for Laboratory 1 relative to Laboratory 2. Given the lack of intermediate points, it would be difficult to consider this as strong evidence of overall bias in the iron measurements. For three analytes, Al-total, NO_3^-, and NH_4^+, the split plots show extremely poor relationships between measurements from Laboratory 1 and Laboratory 2. In all three instances, greater than 50 percent of the samples are below the system decision limit and fit the situation where Laboratory 1 exhibited poorer precision for field blank measurements than did Laboratory 2.

Analysis of the FN7 and FN8 audit samples for spring and fall provides information about interlaboratory bias at two specific concentrations, one for each audit type. Additionally, these data can be used to develop some idea of absolute bias because prior information is available on the expected values for these materials (see target values in Appendix C) and an assessment about which measurements are closer to the expected values can be made. Statistical summaries for FN7 and FN8 in each of the three seasons are presented in Appendix C. The figures in Appendix D present the same information in graphical form. Each figure consists of an upper and lower component. The upper component on each figure presents the mean and 95 percent confidence interval for each of the three seasons, and the lower component shows the individual sample points. There are two figures for each analyte, one representing the results for FN7 and a second the results for FN8. Analyses of the FN7 and FN8 data for interlaboratoy bias represent several interesting cases. For those analytes (Al-dis, Al-org, DIC-closed, pH-closed, True color, Turbidity) measured at the processing laboratory, which was located in Las Vegas during both the spring and fall subsurveys, the interlaborary bias analysis actually represents bias in the processing laboratory over time. For the remainder of the analytes that were measured by the analytical laboratories, the interlaboratory bias analysis represents bias between two different laboratories that made measurements during two different time periods. Because a primary interest of the survey is to evaluate spring and fall differences, both of the cases of interlaboratory bias are of interest and will be addressed.

In examining the data from FN7 and FN8, 14 of 60 (30 analytes for each audit type) analyses show statistically significant differences between spring and fall mean values. This represents 9 of 30 possible analytes. These analytes are: Al-ext, Al-org, Ca, Cond, DIC-eq, DIC-initial, F^--total, Fe, and pH-eq. Of these, only Cond, DIC-eq, F^--total, Fe, and pH-eq showed consistent results for both FN7 and FN8. The information obtained for conductivity, DIC-eq, and Fe appears to be

consistent with the results of the split plot analysis. For DIC-eq, FN7 and FN8 behave similarly, with Laboratory 1 producing results greater than Laboratory 2. The results of this analysis are consistent with the slope of 1.5 derived from the split analysis. Laboratory 1 also produces greater values for Fe than does Laboratory 2, again consistent with the split analysis. The results from the conductivity analysis also agree with the split plot analysis, with Laboratory 1 producing values greater than Laboratory 2 when the concentration is above 20 to 30 µS/cm.

In evaluating the results of all of these analyses, it is helpful to consider the relative magnitude of the apparent bias and the magnitude of seasonal differences. For example, if a bias of 4 µS/cm for conductivity is within the range of seasonal differences expected, then this statistically significant bias may also be important to data interpretation. However, if this bias is much smaller than the seasonal difference that is of interest, then statistically significant bias may be insignificant in a practical sense relative to the data interpretation.

The results of the split samples, FN7 audit, and FN8 audit analyses for interlaboratory bias are summarized in Table 21. The table is intended to serve as a tool to alert the data user to potential interlaboratory bias that may affect the interpretation of routine data. For the split samples, interlaboratory bias is indicated when the predicted line is significantly different from the identity line. For the FN7 and FN8 audit materials, interlaboratory bias is indicated if the means from spring and fall were statistically different for the analyte and audit material of concern. Additionally, analytes were targeted for potential interlaboratory bias if, upon visual examination of the data tables and scatter plots (appendices C and D, respectively), there appeared to be interlaboratory bias, which was masked by poor precision for either laboratory. An analyte was flagged for interlaboratory bias in the summary column when at least two of the analyses indicated potential problems with the data.

The results of these analyses support the conclusion that the clearest instances of interlaboratory bias are for measurements of Cond, DIC-eq, DIC-initial, and Fe. Additionally, there is somewhat weaker evidence to indicate potential problems with interlaboratory bias for ANC, Ca, Cl^-, F^--total, K, pH-eq, and Turbidity. As discussed above, there are other instances of interlaboratory bias which appear to be supported by either the split analyses or the natural audit analyses, but not both. The scientific implications of these biases depend almost entirely on the magnitude of differences that the data user is trying to detect between the data for different seasons.

Other Methods for Assessing Data Quality

In addition to the analyte-by-analyte evaluations, three checks of overall sample data quality are provided in the following discussions: comparison of measured ANC values and calculated carbonate alkalinity; comparison of the total ionic charge of anions and cations; and comparison of measured and calculated specific conductance values. These three checks, which were also used by the analytical laboratories during actual sample analysis and by the EMSL-LV QA staff during data verification, are useful because each sample can be evaluated on an individual basis.

Comparison of Measured ANC and Calculated Alkalinity Values

Comparison of measured ANC values and calculated carbonate alkalinity values provides (1) an indication of the reliability of pH, DIC, and ANC measurements, and (2) an indication of the presence of unmeasured noncarbonate protolytes.

The calculated carbonate alkalinity ($ALKA_c$) represents the contribution of bicarbonate, carbonate, hydroxide, and hydrogen ions to the ANC. The measured ANC represents the total acid-combining capacity of a water sample determined by titration with a strong acid. The ANC includes alkalinity (carbonate species) as well as other basic species (e.g., borates, dissociated organic acids, and aluminohydroxy complexes). Carbonate alkalinity values were calculated by using the following equation (Hillman et al., 1986):

$$ALKA_c = \left[\frac{[DIC]}{12{,}011} \left(\frac{[H^+]K_1 + 2K_1K_2}{[H^+]^2 + [H^+]K_1 + K_1K_2} \right) + \frac{K_w}{[H^+]} - [H^+] \right] \times 10^6$$

Table 21. Summary of the Analyses of the Split Data and the FN7 and FN8 Audit Samples for Interlaboratory Bias.

Analyte	Splits	FN7	FN8	Potential interlaboratory bias
Al-ext	*a*	Y	N	No
Al-total	N	N	Y	No
Al-dis	*b*	N	N	No
Al-org	*b*	Y	N	No
ANC	Y	Y(slight)	Y(slight)	Yes
BNC	N	N	N	No
Ca	Y(slight)	Y(slight)	N	Yes
Cl^-	Y	N	Y(slight)	Yes
Cond	Y(slight)	Y(slight)	Y(slight)	Yes
DIC-closed	*b*	N	N	No
DIC-eq	Y	Y	Y	Yes
DIC-initial	Y	Y	N	Yes
DOC	N	N	N	No
F^--total	N	Y	Y(slight)	Yes
Fe	Y(slight)	Y(slight)	Y	Yes
K	Y(slight)	Y(slight)	N	Yes
Mg	Y(slight)	N	N	No
Mn	Y(slight)	N	N	No
Na	N	N	N	No
NH_4^+	N(poor correlation)	N	Y(slight)	No
NO_3^-	N(poor correlation)	N	Y(slight)	No
P-total	N	N	N	No
pH-closed	*b*	N	N	No
pH-ANC	N	N	N	No
pH-BNC	N	N	N	No
pH-eq	N	Y(slight)	Y(slight)	Yes
SiO_3	N	N	N	No
SO_4^{3-}	Y(slight)	N	N	No
Color	*b*	N	Y(slight)	No
Turbidity	*b*	Y(slight)	Y(slight)	Yes

[a] Al-ext was not a required measurement for the interlaboratory bias split sample.
[b] These analytes were measured by the processing laboratory and were not part of the interlaboratory bias study.

where:

$ALKA_c$ = calculated carbonate alkalinity
DIC = DIC-initial value or the closed system DIC measurement in units of mg/L (12,011 converts mg/L to moles/L).
$[H^+]$ = $10^{-(pH)}$
pH = value from the mean of the analytical laboratory initial pH measurements or the closed-system pH measurement, which-ever is applicable.
K_1 = 4.4463×10^{-7} at 25 degrees C
K_2 = 4.6881×10^{-11} at 25 degrees C
K_w = 1.0023×10^{-14} at 25 degrees C

Calculated carbonate alkalinity values were obtained by using both the processing laboratory closed system pH and DIC measurements (Calculated Alkalinity 1) and by using the analytical laboratory pH (mean of pH-ANC and pH-BNC) and DIC-initial measurements (Calculated Alkalinity 2).

Figures 5, 7, and 9 show the relationships between the measured ANC and Calculated Alkalinity 1 for each season of the ELS-II. Figures 6, 8, and 10 show the relationship between the measured ANC and Calculated Alkalinity 2 for each season. The diagonal line drawn on the plots represents the 1:1 correspondence line, where measured ANC equals calculated carbonate alkalinity. The measured ANC should be greater than or equal to the carbonate alkalinity because the carbonate alkalinity is a portion of the titrated ANC. If calculated carbonate alkalinity is greater than measured ANC, then pH, DIC, or ANC analytical errors are indicated. Observed differences between the measured ANC and the calculated carbonated alkalinity that are above the 1:1 line can be explained by the presence of noncarbonate protolytes such as DOC, aluminum, dissolved metal complexes, or particulate metal oxides or inorganic acid species such as silicic acid.

For the Spring Seasonal subsurvey, Figure 5 demonstrates that for all routine samples,

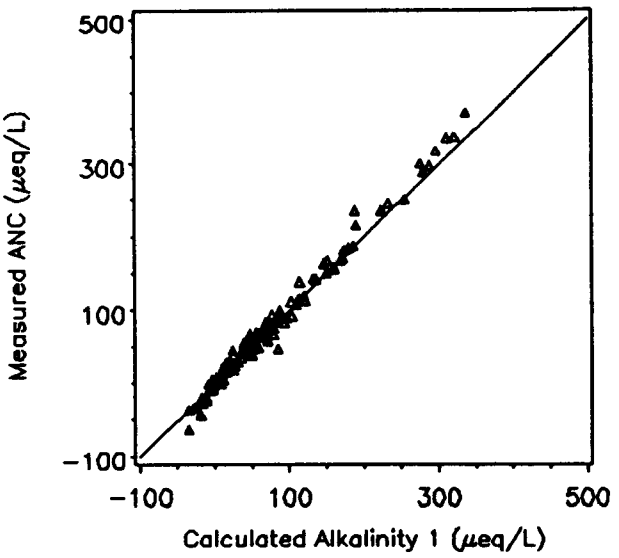

Figure 5. Measured ANC versus carbonate alkalinity calculated from closed system pH and DIC values for routine samples, Spring Seasonal subsurvey, ELS-II. n = 145.

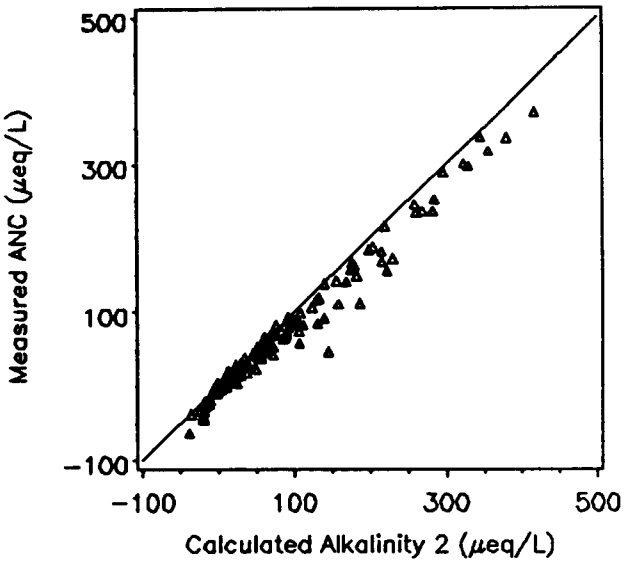

Figure 6. Measured ANC versus carbonate alkalinity calculated from analytical laboratory initial pH and DIC values for routine samples, Spring Seasonal subsurvey, ELS-II. n = 145.

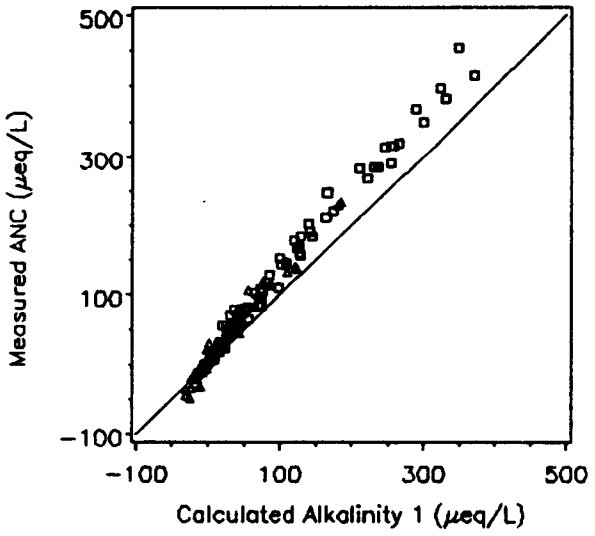

Figure 7. Measured ANC versus carbonate alkalinity calculated from closed system pH and DIC values for epilemnetic routine samples, Summer Seasonal subsurvey, ELS-II. Δ = Laboratory 1. □ = Laboratory 2. n = 147.

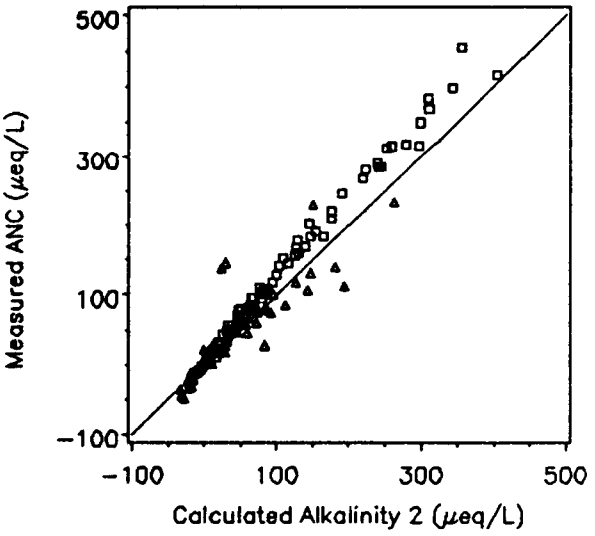

Figure 8. Measured ANC versus carbonate alkalinity calculated from analytical laboratory initial pH and DIC values for epilemnetic routine samples, Summer Seasonal subsurvey, ELS-II. Δ = Laboratory 1. □ = Laboratory 2. n = 147.

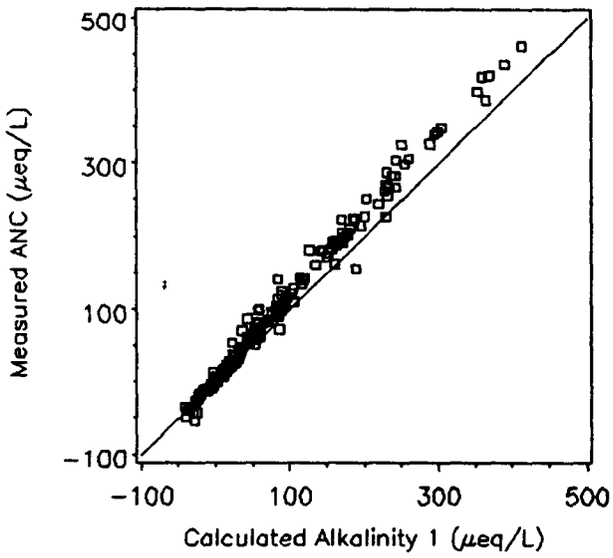

Figure 9. Measured ANC versus carbonate alkalinity calculated from closed system pH and DIC values for routine samples, Fall Seasonal subsurvey, ELS-II. n = 238

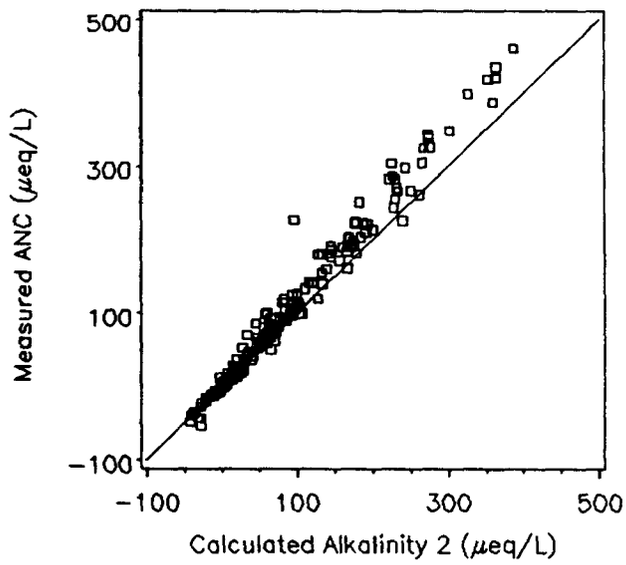

Figure 10. Measured ANC versus carbonate alkalinity calculated from analytical laboratory initial pH and DIC values for routine samples, Fall Seasonal subsurvey, ELS-II. n = 238

data points fall just below, on, or above the line when measured ANC was plotted against Calculated Alkalinity 1. In contrast, Figure 6 (measured ANC versus calculated alkalinity 2) shows the majority of the points falling below the 1:1 line. An analytical problem not with ANC but with either pH-initial or DIC initial is indicated by Figure 6 because a problem with measured ANC was not indicated when measured ANC was plotted against alkalinity calculated from processing laboratory pH and DIC values. The interlaboratory bias discussion notes that analytical Laboratory 1 DIC-initial results were high relative to Laboratory 2. Summary statistics for estimates of accuracy (Appendix C) also indicate that Laboratory 1 DIC measurements were high relative to the target values. The relationship shown in Figure 6 is probably due to an overestimation of the DIC content of the samples.

The majority of the points fell above the 1:1 line for the Fall Seasonal subsurvey as shown in Figures 9 and 10, and for the Summer Seasonal as shown in Figure 7. Figure 8, a plot of measured ANC versus Calculated Alkalinity 2 for the Summer Seasonal subsurvey, also shows several data points falling below the 1:1 line. As was the case for the Spring Seasonal subsurvey samples analyzed by Laboratory 1, the Figure 8 results are probably due to an overestimation of the DIC-initial content of the samples by Laboratory 1.

A comparison of Figures 5 and 9 shows that when measured ANC values are compared to calculated alkalinities (processing lab pH and DIC values) the Spring Seasonal subsurvey measured ANC values may be slightly lower than the Fall Seasonal subsurvey ANC values, assuming that the processing laboratory pH and DIC were measured consistently. Table 21 indicates that there was no interseasonal bias between the Spring Seasonal and Fall Seasonal subsurvey measurements of closed system pH and DIC.

Figures 11 and 12 show ELS-I relationships between measured ANC and calculated alkalinities. These plots show data points from the ELS-I verified data base and only include the lakes that were sampled in ELS-II. From a visual inspection of the plots, there does not appear to be a significant difference between the measured ANC and calculated alkalinity relationships between the Fall Seasonal subsurvey and ELS-I.

Charge Balances

The anion and cation balance, another method of assessing data quality, provides an estimate of the internal consistency of the samples. An ion balance was calculated for all the routine lake samples in the ELS-II. The sum value for anions was the total of chloride, sulfate, nitrate, fluoride, bicarbonate,

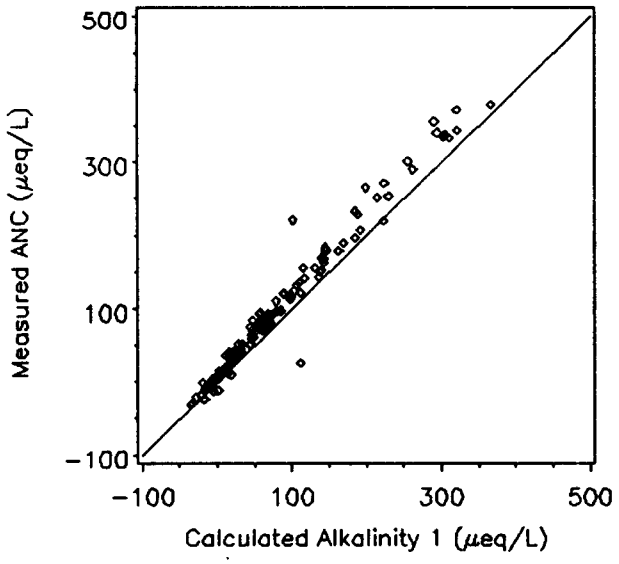

Figure 11. Measured ANC versus carbonate alkalinity calculated from closed system pH and DIC values for routine samples, ELS-I (ELS-II lakes only). n = 149

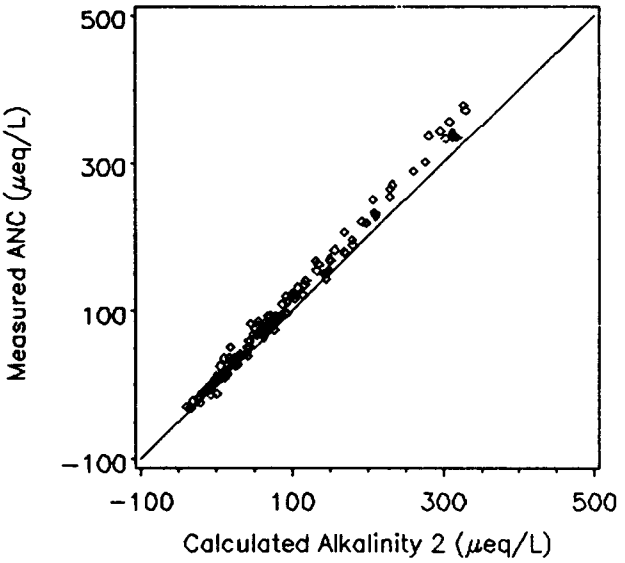

Figure 12. Measured ANC versus carbonate alkalinity calculated from analytical initial pH and DIC values for routine samples, ELS-I (ELS-II lakes only). n = 149.

carbonate, and hydroxide ion equivalents. The sum value for cations was the total of calcium, magnesium, potassium, sodium, ammonium, and hydronium ion equivalents. Table 6 gives the conversion factors for mg/L to μeq/L for anions and cations. Theoretically, the sum of the anion equivalents is expected to equal the sum of the cation concentrations. In the practical application, however, this is rarely the case. There can be deviations from the ideal because of analytical errors, significant concentrations of unmeasured ions, the method used to determine the anion and the cation equivalents, or any combination of these three.

Analytical laboratory pH-initial and DIC-initial values were used to calculate the carbonate, bicarbonate, hydroxide, and hydronium ions. If the apparent high DIC-initial bias is real, as previously discussed, then the estimation of the anion concentration may also be inflated.

The relationship between anions and cations for all routine samples in the Spring Seasonal subsurvey is shown in Figure 13 (the number of observations equals 143). The diagonal line represents the 1:1 correspondence, where the sum of the anions equals the sum of the cations. Obviously, a number of the data points do not illustrate the ideal of a 1:1 relationship. Figure 14 shows the relationship between anions and cations for the Spring Seasonal subsurvey but only for routine samples with chloride concentrations of less than 7.0 mg/L (the number of observations equals 111). This figure shows that after high chloride values are excluded, all remaining points are much closer to the 1:1 line. Figure 15 is included to illustrate the variability of the samples containing chloride concentrations greater than or equal to 7.0 mg/L.

When the relationship between anions and cations is illustrated by subregion (Figures 16 through 20), it is evident that all data points for subregion 1A (Adirondacks) and for subregion 1E (Maine) fall in close proximity to the 1:1 line. Samples from these two subregions contained chloride concentrations of less than 7 mg/L. Data points from subregion 1B (Poconos/Catskills) also fall close to the 1:1 line with the exception of three data points. Data points from subregion 1C (Central New England) and 1D (Southern New England) show more variability than the other subregions. Twenty-eight percent (9 out of 32 samples) from subregion 1C and eighty-three percent (20 out of 24 samples) from subregion 1D have chloride values greater than 7.0 mg/L.

For the Summer Seasonal subsurvey, Figures 21, 22, and 23 demonstrate the same type of relationships as discussed for the Spring Seasonal subsurvey. Although the

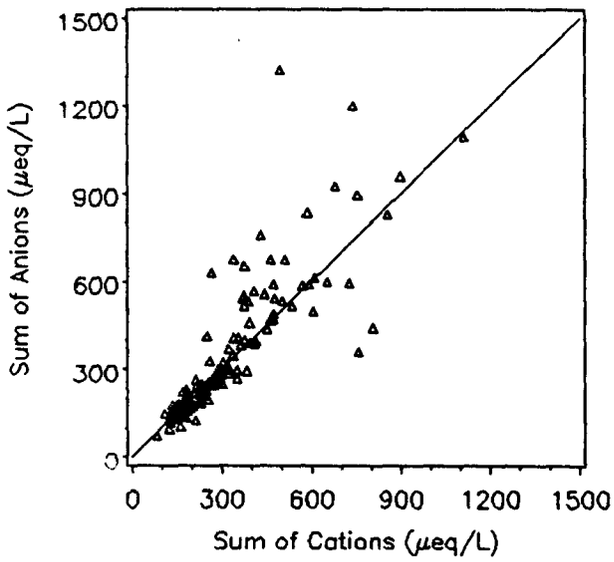

Figure 13. Sum of anions versus sum of cations for all routine samples, Spring Seasonal subsurvey, ELS-II. n = 143.

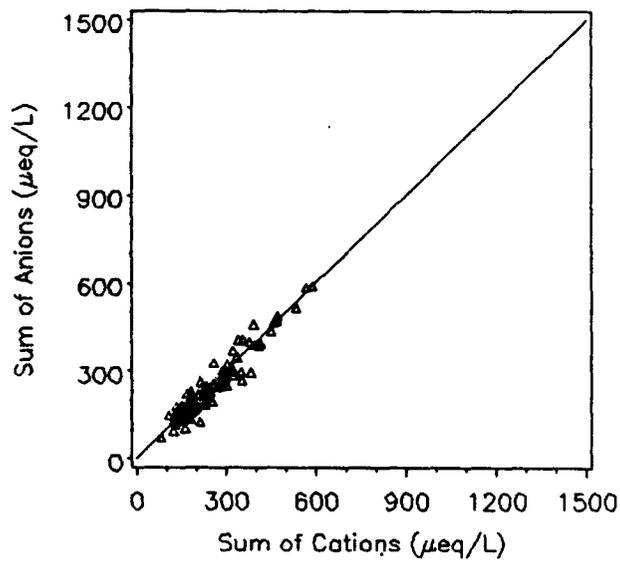

Figure 14. Sum of anions versus sum of cations for routine samples with chloride concentrations of less than 7.0 mg/L, Spring Seasonal subsurvey, ELS-II. n = 111.

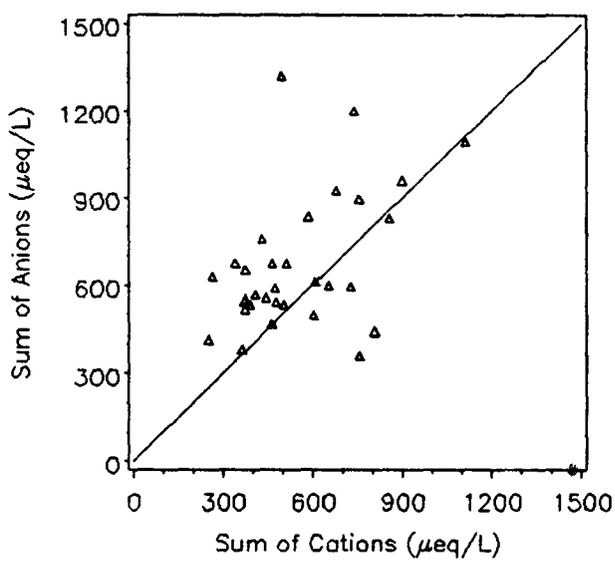

Figure 15. Sum of anions versus sum of cations for routine samples with chloride concentrations of greater than or equal to 7.0 mg/L, Spring Seasonal subsurvey, ELS-II. n = 32.

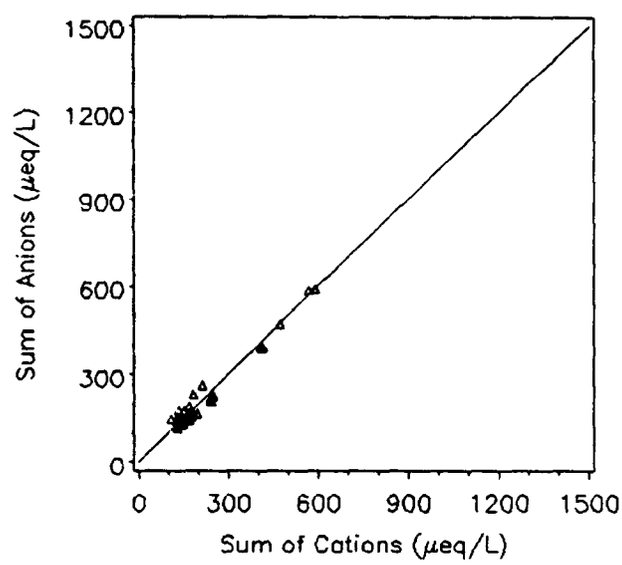

Figure 16. Sum of anions versus sum of cations for subregion 1A, Spring Seasonal subsurvey, ELS-II. n = 36.

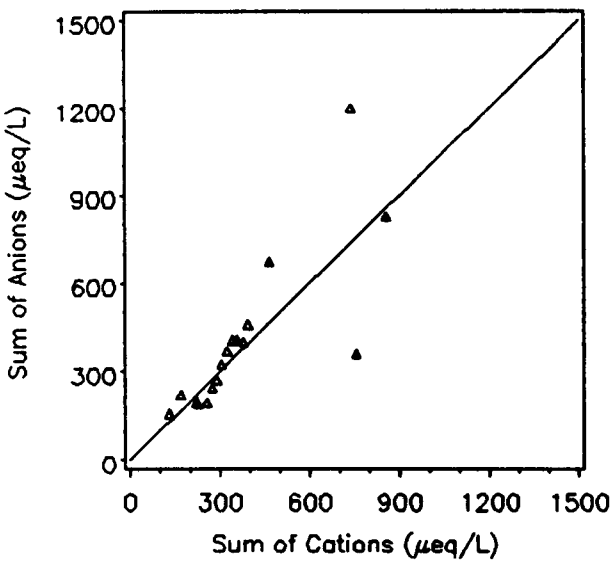

Figure 17. Sum of anions versus sum of cations for subregion 1B, Spring Seasonal subsurvey, ELS-II. n = 17.

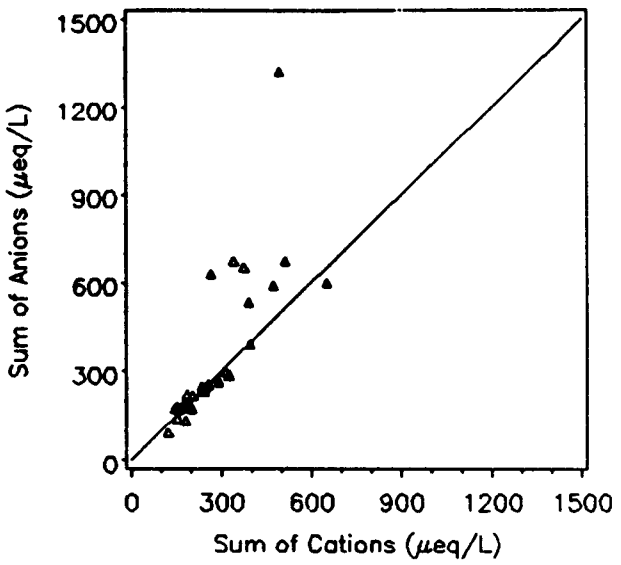

Figure 18. Sum of anions versus sum of cations for subregion 1C, Spring Seasonal subsurvey, ELS-II. n = 32.

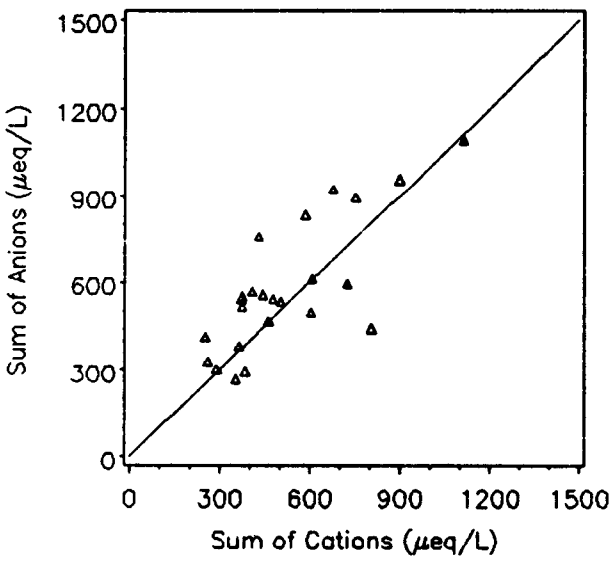

Figure 19. Sum of anions versus sum of cations for subregion 1D, Spring Seasonal subsurvey, ELS-II. n = 24.

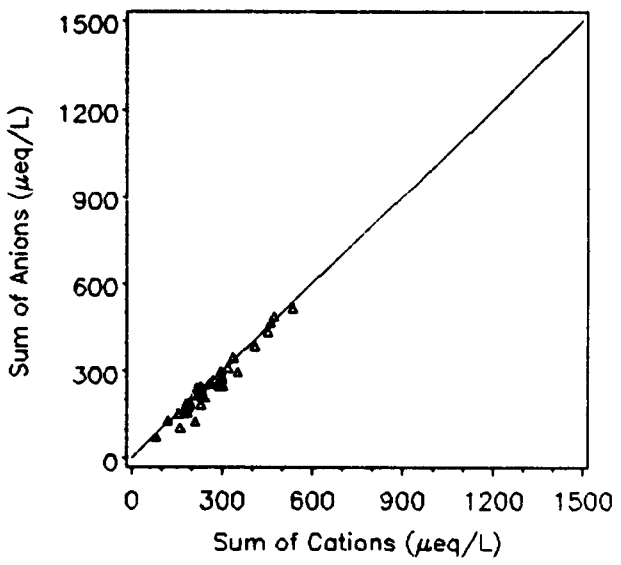

Figure 20. Sum of anions versus sum of cations for subregion 1E, Spring Seasonal subsurvey, ELS-II. n = 34.

variability associated with samples containing greater than 7.0 mg/L is greater than for those containing less than 7.0 mg/L, it is not as extreme as for the Spring Seasonal subsurvey. Most of the variability in the Summer Seasonal subsurvey plot can probably be attributed to the Laboratory 1 analysis for chloride. Figures 21, 22, and 23 also show that, with the exception of Laboratory 1 results containing high (>7.0 mg/L) chloride values, the majority of the data points fall below the 1:1 line for the Summer Seasonal subsurvey. For the Fall Seasonal subsurvey, Figure 24 shows the majority of the data falling below the line. This relationship could be due to slight overestimation of cations, slight underestimation of anions, the presence of unmeasured anions, or a combination of all three.

Figure 25 is a plot of the sum of anions versus the sum of cations of the ELS-I results for the lakes sampled in ELS-II. This plot was generated by using values in the ELS-I verified data base. The relationship between the anions and cations based on a visual inspection of the plots does not appear to be significantly different from the Fall Seasonal subsurvey (Figure 24).

Conductivity Balances

Comparison of the measured and the calculated values for specific conductivity provides an additional check on analytical errors in the measurements or on the presence of unmeasured ionic species. The calculated conductivity was estimated by summing the equivalent conductivity of ions for calcium, magnesium, potassium, sodium, ammonium, chloride, sulfate, nitrate, carbonate, bicarbonate, hydronium, and hydoxide. The conversion factors used to derive conductivities of ions are given in Table 7.

Plots illustrating the relationships between measured and calculated conductivity for routine samples are provided in Figures 26 through 38. The diagonal line on the plot represents the 1:1 correspondence, where the measured conductivity equals the calculated conductivity. The same relationships are illustrated for the Spring Seasonal subsurvey measured versus calculated conductivity (Figures 26 through 28) as are illustrated for the sum of anions versus the sum of cations for the Spring Seasonal subsurvey (Figures 13 through 15). When chloride values of greater

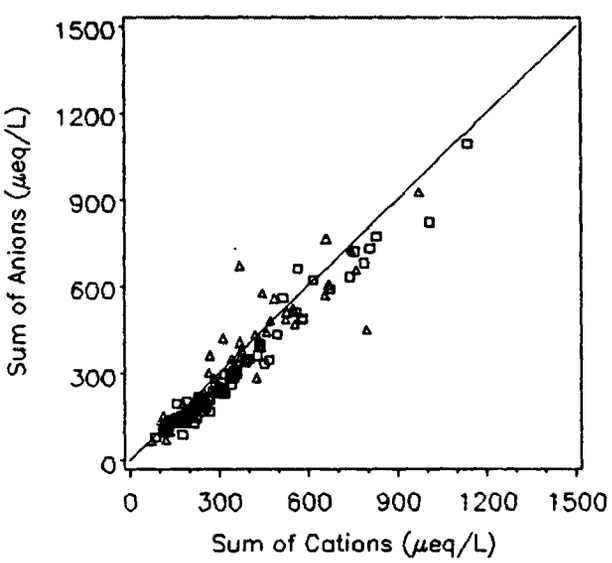

Figure 21. Sum of anions versus sum of cations for all epilemnetic routine samples, Summer Seasonal subsurvey, ELS-II. Δ = Laboratory 1. □ = Laboratory 2. n = 146.

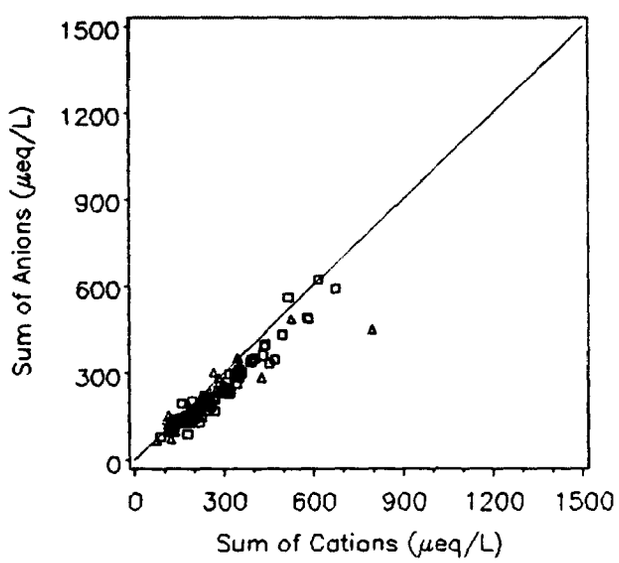

Figure 22. Sum of anions versus sum of cations for epilemnetic routine samples with chloride concentrations of less than 7.0 mg/L, Summer Seasonal subsurvey, ELS-II. Δ = Laboratory 1. □ = Laboratory 2. n = 113.

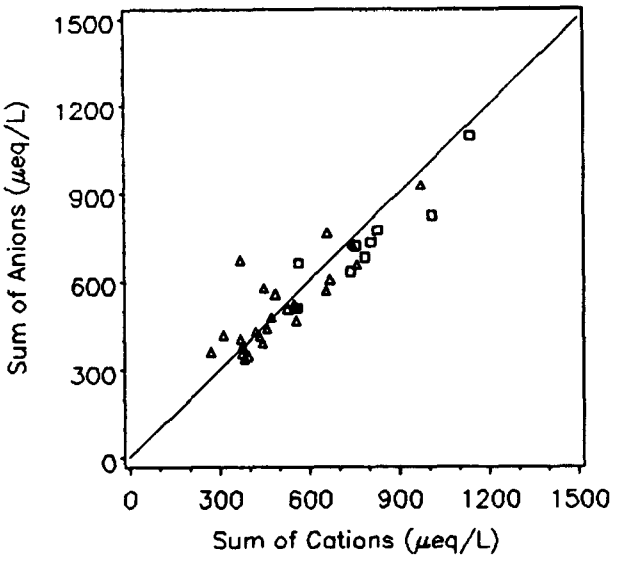

Figure 23. Sum of anions versus sum of cations for epilemnetic routine samples with chloride concentrations of greater than or equal to 7.0 mg/L, Summer Seasonal subsurvey, ELS-II. Δ = Laboratory 1. □ = Laboratory 2. n = 33.

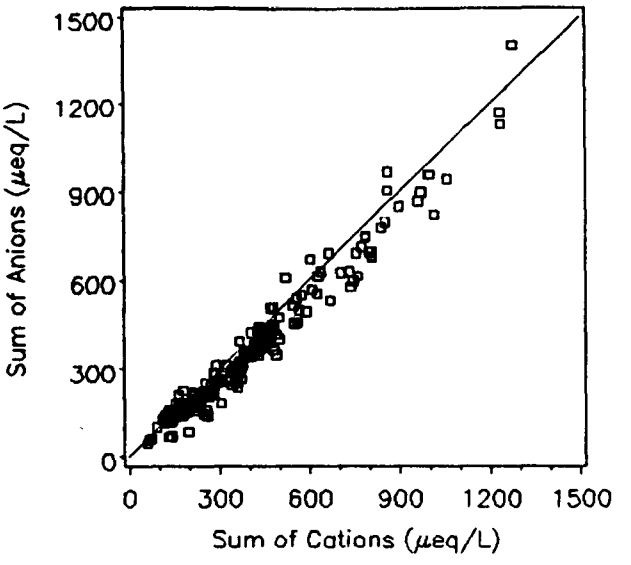

Figure 24. Sum of anions versus sum of cations for routine samples Fall Seasonal subsurvey, ELS-II. n = 239.

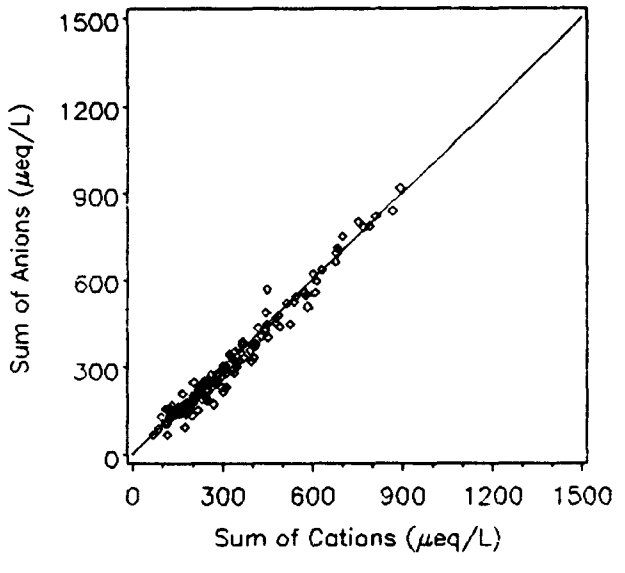

Figure 25. Sum of anions versus sum of cations for routine samples, ELS-I (ELS-II lakes only). n = 149.

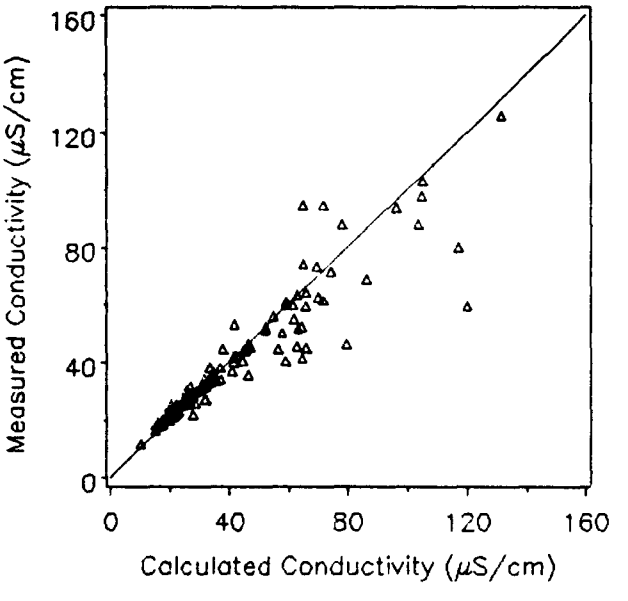

Figure 26. Measured versus calculated conductivity for all routine samples, Spring Seasonal subsurvey, ELS-II. n = 143.

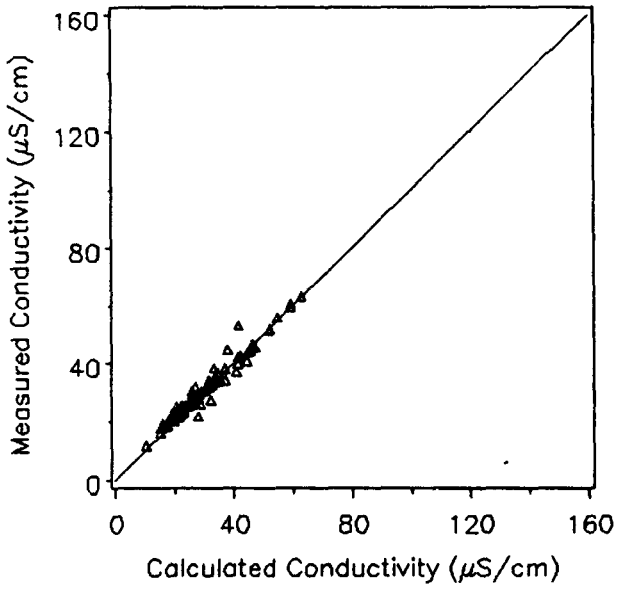

Figure 27. Measured versus calculated conductivity for routine samples with chloride concentrations of less than 7.0 mg/L, Spring Seasonal subsurvey, ELS-II. n = 111.

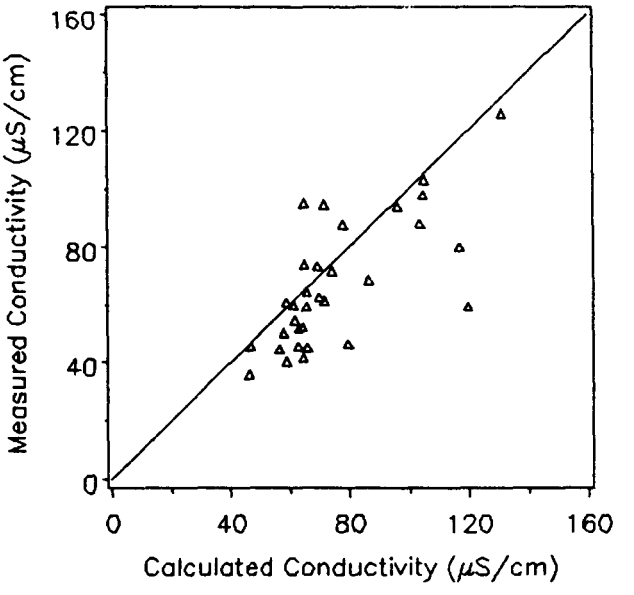

Figure 28. Measured versus calculated conductivity for routine samples with chloride concentrations of greater than or equal to 7.0 mg/L, Spring Seasonal subsurvey, ELS-II. n = 32.

than 7.0 mg/L are excluded, the data points fall close to the 1:1 line (Figures 27). When measured versus calculated conductivities are plotted by subregion (Figures 29-33), plots for subregions 1A (Adirondacks) and 1E (Maine) demonstrate that most data points fall in close proximity to the 1:1 line. For subregion 1B (Poconos/Catskills), all data points fall close to the 1:1 line with two exceptions. Data points from subregions 1C (Central New England) and 1D (Southern New England) show more variability than the other subregions due to high chloride content of samples from those two subregions.

The plots of the Summer Seasonal subsurvey measured versus calculated conductivities (Figures 34 through 36) once again show less variability when chloride values of less than 7.0 mg/L are excluded (Figure 35). Two outliers also appear on the plot (Figures 34 and 35) but are probably due to analytical error other than for chloride.

The plot of the Fall Seasonal subsurvey measured versus calculated conductivity (Figure 37) shows most data points falling in close proximity to the 1:1 line. One data point from the Fall Seasonal subsurveys was not plotted because it fell outside the axis range.

Figure 38 is a plot of the measured versus calculated conductivity for ELS-I results for those lakes sampled in ELS-II. This plot was constructed by using values from the ELS-I verified data base. The relationship between measured versus calculated conductivity does not appear to be different between the Fall Seasonal subsurvey (Figure 37) and ELS-I.

Summary of Other Methods of Assessing Data Quality

The plots of measured ANC versus Calculated Alkalinity 1 (Figures 5 and 9) show that Laboratory 1 (Spring Seasonal subsurvey) measured ANC results may be slightly lower than Laboratory 2 (Fall Seasonal subsurvey) measured ANC results. The plots also show that the DIC-initial measurements performed by Laboratory 1 have a high bias. As a recommendation to the data user, the DIC data from the processing laboratory would provide a better estimate of the DIC content of the sample.

The plots of the sum of anions versus cations (Figures 13 through 23) and of the measured versus calculated conductivities (Figures 26 through 36) both illustrate the problems at Laboratory 1 related to chloride analysis. When only those chloride values of less than 7.0 mg/L are included in the plots, almost all data points fall in close proximity to the 1:1 line.

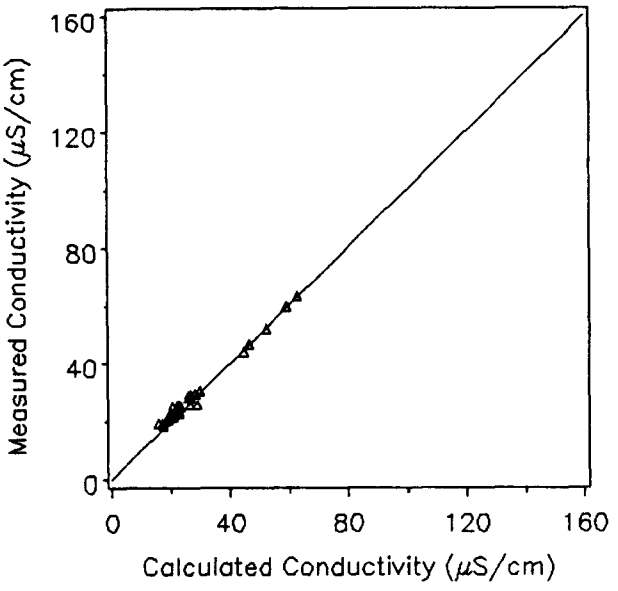

Figure 29. Measured versus calculated conductivity for subregion 1A, Spring Seasonal subsurvey, ELS-II. n = 36.

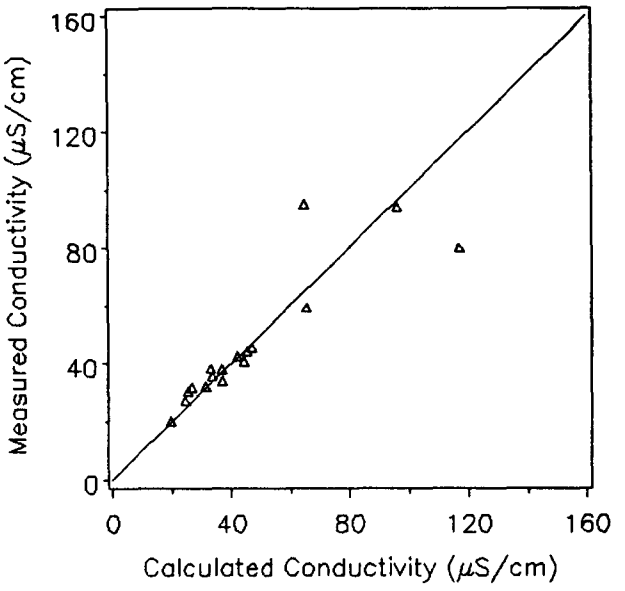

Figure 30. Measured versus calculated conductivity for subregion 1B, Spring Seasonal subsurvey, ELS-II. n = 17

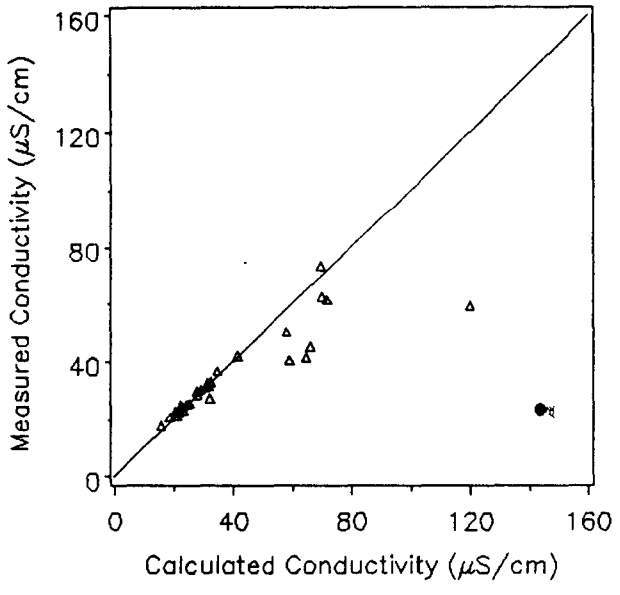

Figure 31. Measured versus calculated conductivity for subregion 1C, Spring Seasonal subsurvey, ELS-II. n = 32

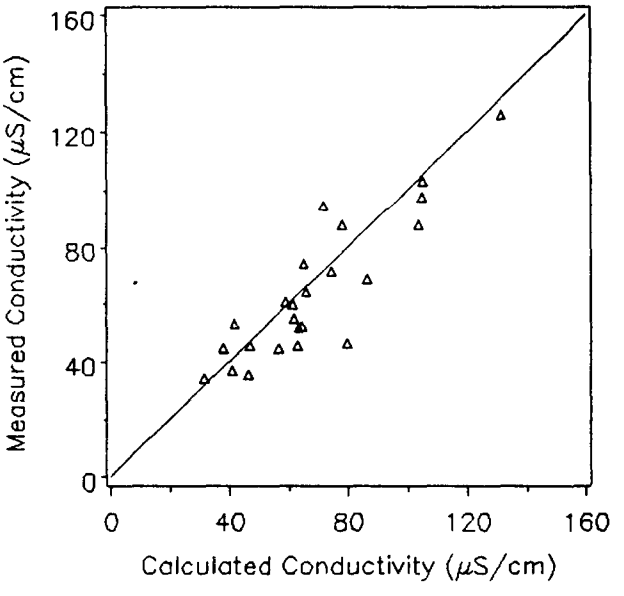

Figure 32. Measured versus calculated conductivity for subregion 1D, Spring Seasonal subsurvey, ELS-II. n = 24.

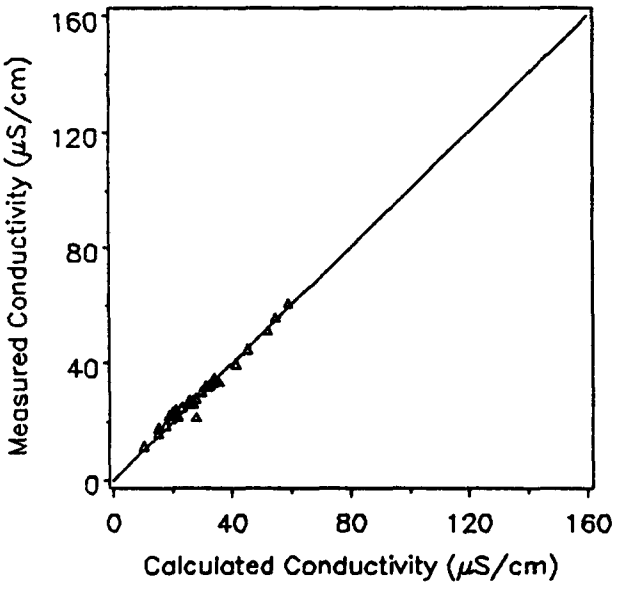

Figure 33. Measured versus calculated conductivity for subregion 1E, Spring Seasonal subsurvey, ELS-II. n = 34.

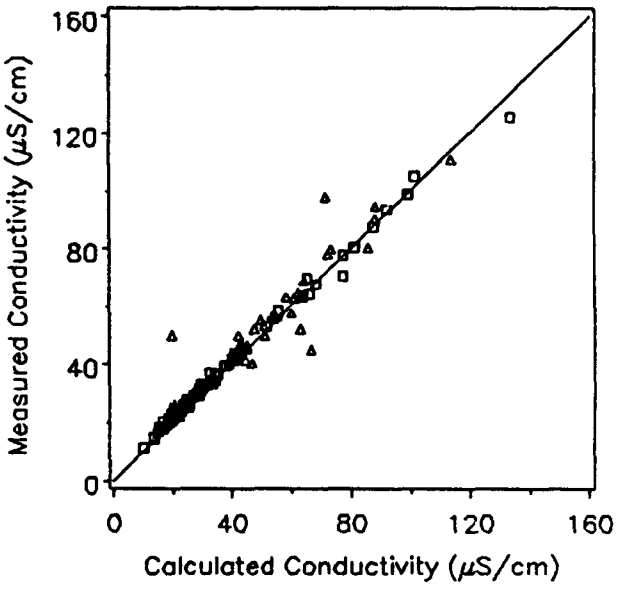

Figure 34. Measured versus calculated conductivity for all epilemnetic routine samples, Summer Seasonal subsurvey, ELS-II. Δ = Laboratory 1. □ = Laboratory 2. n = 145.

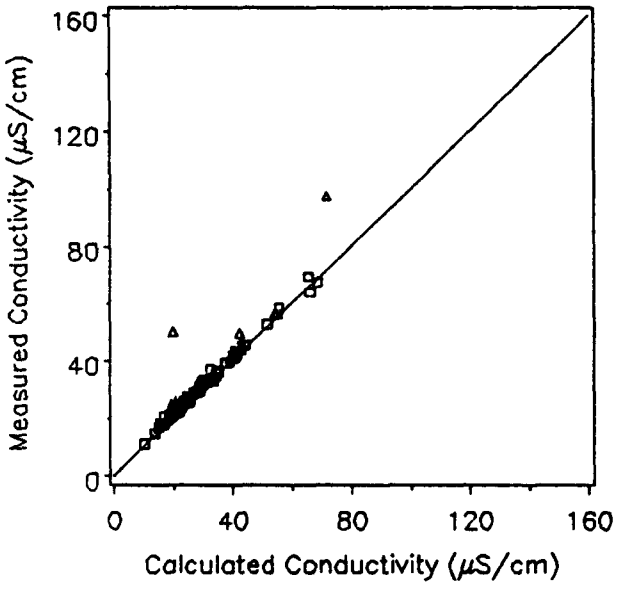

Figure 35. Measured versus calculated conductivity for epilemnetic routine samples with chloride concentrations of less than 7.0 mg/L, Summer Seasonal subsurvey, ELS-II. Δ = Laboratory 1. □ = Laboratory. n = 112

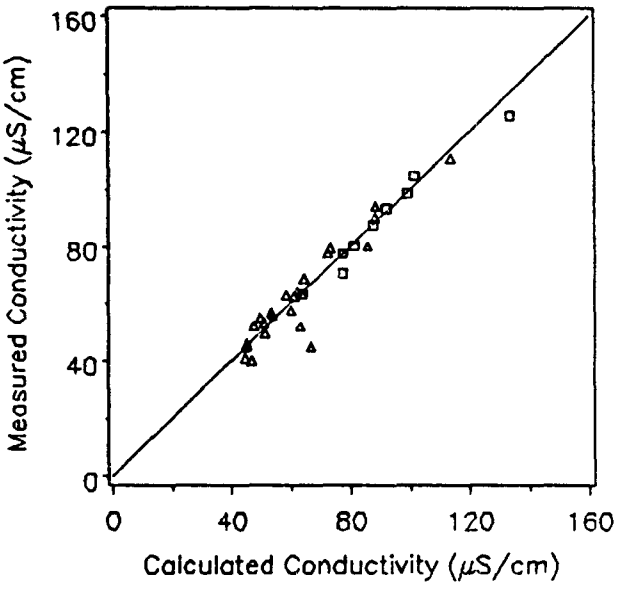

Figure 36. Measured versus calculated conductivity for epilemnetic routine samples with chloride concentrations of greater than or equal to 7.0 mg/L, Summer Seasonal subsurvey, ELS-II. Δ = Laboratory 1. □ = Laboratory 2. n = 33.

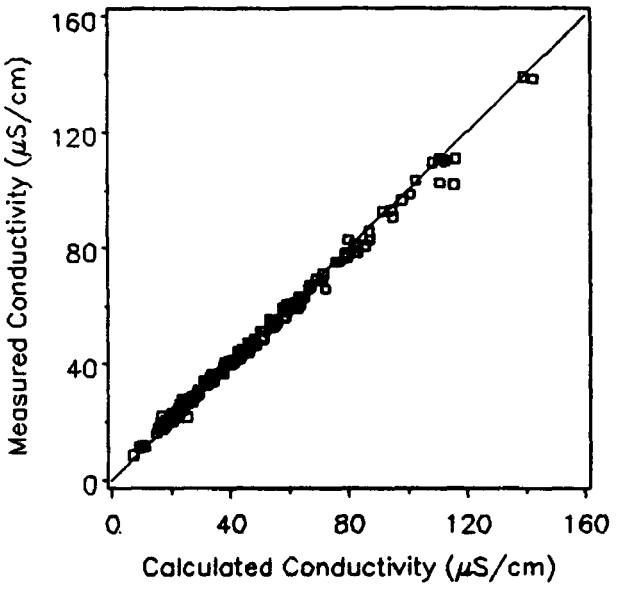

Figure 37. Measured versus calculated conductivity for all routine samples, Fall Seasonal subsurvey, ELS-II. n = 239

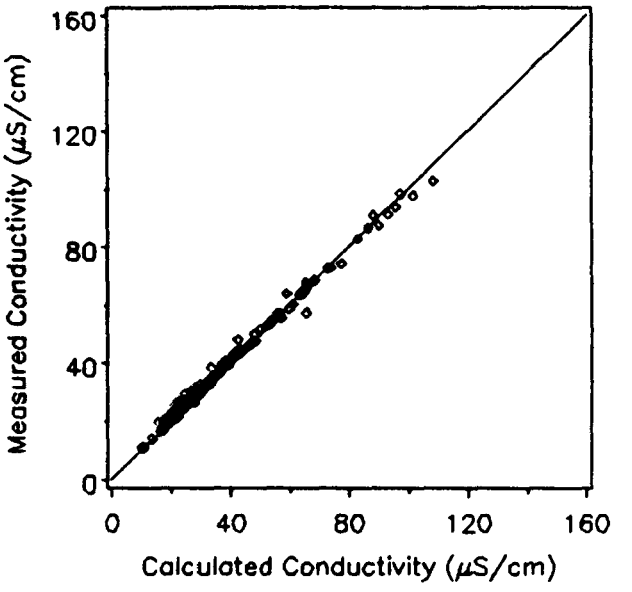

Figure 38. Measured versus calculated conductivity for routine samples, ELS-I (ELS-II lakes only). n = 149

The results of ELS-I and the Fall Seasonal subsurvey appear to be comparable based on internal consistency checks. ELS-I and the Fall Seasonal subsurvey plots for measured ANC versus calculated carbonate alkalinity, sum of anions versus sum of cations, and measured versus calculated conductivity display similar patterns.

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Appendix A

Summary of Changes Made During the Special Data Assessment

Changes applied to the official verified data base to create the modified verified data base as a result of the ELS-II Special Data Assessment are presented in Tables A-1 through A-3. Table A-1 contains all numeric data changes and Table A-2 contains predominately character data changes. Table A-3 consists of X flag changes. An X flag is applied when a value is deemed invalid. It is recommended that this value should not be used in statistical analyses.

All changes apply to member M01 only. The member M01 consists of data from Form 1D (Lake Data), Form 02 (Processing Laboratory Data), and Form 11 (Analytical Laboratory Summary of Sample Results). Identifications in the three tables are provided by batch ID, sample ID, and data base variable name. Variable (data base variable name) refers to the analytical laboratory derived concentration for the particular analyte. The units for the official verified value and the modified verified value are the same.

Sample codes used in these tables are:

R = routine lake sample
D = field duplicate lake sample
B = field blank sample
FN,FL,LN,LL = audit types; numeric notation is the audit lot (e.g., FN7 = field natural audit, lot 7)

The official verified value refers to the reported concentration in the verified data base before the Special Data Assessment. The modified verified value refers to the best concentration for that sample as determined by the Special Data Assessment.

Table A-1. Numeric Changes Applied to the Official Verified Data Base to Create the Modified Verified Data Base (for Member M01 Only), Eastern Lake Survey - Phase II

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3500	1	CL11	R	38.218	11.439	a
3500	2	CL11	FN7	4.120	2.050	a
3500	3	CL11	D	16.604	12.637	a
3500	4	CL11	R	24.244	12.748	a
3500	5	CL11	B	-0.044	0.000	a
3501	1	CL11	R	8.122	13.368	a
3501	1	NO311	R	0.8223	0.9745	a
3501	1	SO411	R	6.521	7.129	a
3501	2	CL11	R	12.604	10.184	a
3501	2	NO311	R	-0.0432	0.0005	a
3501	2	SO411	R	7.129	6.393	a
3501	3	CL11	LN7	5.469	0.951	a
3501	3	NO311	LN7	1.0080	1.3700	a
3501	3	SO411	LN7	6.393	7.450	a
3501	4	CL11	D	8.658	8.868	a
3501	4	NO311	D	0.8223	0.9509	a
3501	4	SO411	D	6.383	7.048	a
3501	5	CL11	R	7.816	12.702	a
3501	5	NO311	R	-0.0432	0.0309	a
3501	5	SO411	R	7.048	8.140	a
3501	6	CL11	B	0.017	0.000	a
3501	6	NO311	B	-0.0432	-0.0413	a
3501	6	SO411	B	-0.014	0.001	a
3501	7	CL11	FN7	3.004	4.363	a
3501	7	NO311	FN7	1.1251	1.3456	a
3502	5	CL11	R	13.810	21.352	a
3503	1	NO311	R	-0.0419	0.4040	a
3503	1	SO411	R	-0.057	7.046	a
3503	2	NO311	R	-0.0011	0.0056	a
3503	2	SO411	R	11.948	11.774	a
3503	3	NO311	FN7	1.3659	1.2720	a
3503	3	SO411	FN7	7.216	6.912	a
3503	4	NO311	B	0.0086	0.0000	a
3503	4	SO411	B	-0.014	0.000	a
3503	5	NO311	D	-0.0419	0.0056	a
3503	5	SO411	D	13.442	12.730	a
3503	6	NO311	R	0.7293	0.4040	a
3503	6	SO411	R	8.842	9.156	a
3504	1	CL11	R	10.657	5.778	a
3504	1	NO311	R	-0.0208	0.0000	a
3504	1	SO411	R	2.773	5.898	a
3504	2	CL11	D	15.295	5.662	a
3504	2	NO311	D	-0.0208	0.0000	a
3504	2	SO411	D	2.535	5.968	a
3504	3	CL11	R	19.786	7.406	a
3504	3	NO311	R	-0.0208	0.0000	a
3504	3	SO411	R	3.589	8.278	a
3504	4	CL11	FN7	3.815	1.451	a
3504	4	NO311	FN7	1.4076	1.2170	a
3504	4	SO411	FN7	7.617	6.932	a
3504	5	CL11	R	23.966	7.392	a
3504	5	NO311	R	-0.0208	0.0100	a
3504	5	SO411	R	6.912	6.708	a
3504	6	CL11	R	4.163	1.632	a
3504	6	NO311	R	0.0862	0.3990	a
3504	6	SO411	R	6.157	5.578	a
3504	7	CL11	LN7	5.437	1.530	a
3504	7	NO311	LN7	1.7013	1.2380	a
3504	7	SO411	LN7	7.895	7.144	a
3504	8	CL11	R	11.204	3.942	a
3504	8	NO311	R	0.2098	0.1850	a

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3504	8	SO411	R	7.549	6.966	*a*
3504	9	CL11	B	0.026	0.000	*a*
3504	9	NO311	B	-0.0320	0.0000	*a*
3504	9	SO411	B	0.025	0.000	*a*
3504	10	CL11	R	1.751	0.998	*a*
3504	10	NO311	R	-0.0208	0.0000	*a*
3504	10	SO411	R	11.272	13.602	*a*
3505	1	SO411	R	5.682	6.221	*a*
3505	2	NO311	FN8	1.1923	0.8808	*a*
3505	2	SO411	FN8	6.534	5.578	*a*
3505	3	SO411	R	5.774	6.272	*a*
3505	4	SO411	R	6.270	6.890	*a*
3505	5	NO311	B	0.0362	-0.0524	*a*
3505	5	SO411	B	-0.026	0.000	*a*
3505	6	SO411	R	4.795	5.866	*a*
3505	7	SO411	D	4.868	6.406	*a*
3505	8	SO411	R	2.672	3.912	*a*
3505	9	SO411	R	3.972	5.268	*a*
3506	1	PTL11	B	0.0017	0.0600	*b*
3506	1	SO411	B	-0.013	-0.129	*a*
3506	3	PTL11	LN8	0.0006	0.0290	*b*
3506	5	PTL11	FN8	0.0012	0.0270	*b*
3507	1	CL11	B	-0.013	0.000	*a*
3507	1	NO311	B	-0.0267	0.0000	*a*
3507	1	SO411	B	-0.026	0.000	*a*
3507	2	CL11	D	24.774	18.742	*a*
3507	2	NO311	D	1.2255	1.3904	*a*
3507	2	SO411	D	10.299	12.803	*a*
3507	3	CL11	R	1.386	1.354	*a*
3507	3	NO311	R	0.4764	0.5162	*a*
3507	3	SO411	R	5.542	6.290	*a*
3507	4	CL11	R	19.900	13.796	*a*
3507	4	NO311	R	0.6597	0.9836	*a*
3507	4	SO411	R	6.822	7.943	*a*
3507	5	CL11	FN7	2.454	2.582	*a*
3507	5	NO311	FN7	0.9994	1.1036	*a*
3507	5	SO411	FN7	5.444	6.269	*a*
3507	6	CL11	R	1.694	1.314	*a*
3507	6	NO311	R	-0.0267	0.0000	*a*
3507	6	SO411	R	5.576	4.589	*a*
3507	7	CL11	R	31.376	21.024	*a*
3507	7	NO311	R	1.5288	1.3634	*a*
3507	7	SO411	R	12.266	12.495	*a*
3507	8	CL11	LN7	6.114	2.464	*a*
3507	8	NO311	LN7	1.2660	1.0772	*a*
3507	8	SO411	LN7	6.876	6.103	*a*
3507	9	ALKA11	R	146.3	155.1	*c*
3507	9	CL11	R	0.598	0.126	*a*
3507	9	NO311	R	0.6661	0.5444	*a*
3507	9	SO411	R	7.005	6.060	*a*
3508	1	NO311	R	0.2485	0.1954	*a*
3508	1	SO411	R	8.795	8.446	*a*
3508	2	NO311	R	0.0187	0.0432	*a*
3508	2	SO411	R	6.768	6.017	*a*
3508	3	NO311	FN8	1.1069	1.0134	*a*
3508	3	SO411	FN8	5.753	5.624	*a*
3508	4	NO311	R	0.4626	0.3930	*a*
3508	4	SO411	R	8.039	8.014	*a*
3508	5	NO311	R	0.9845	0.9060	*a*
3508	5	SO411	R	9.297	9.743	*a*
3508	6	NO311	D	0.0134	0.0399	*a*
3508	6	SO411	D	5.486	6.074	*a*

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3508	7	NO311	B	-0.0267	0.0000	a
3508	7	SO411	B	-0.022	0.000	a
3508	8	NO311	LN8	0.9325	1.0316	a
3508	8	SO411	LN8	4.843	5.823	a
3509	1	NO311	D	0.8814	0.6014	a
3509	1	SO411	D	11.811	10.071	a
3509	2	NO311	R	0.8692	0.6692	a
3509	2	SO411	R	11.838	10.140	a
3509	3	NO311	FN7	1.4376	1.1586	a
3509	3	SO411	FN7	7.463	6.441	a
3509	4	ALKA11	B	-15.8	2.5	d
3509	4	NO311	B	-0.0267	0.0000	a
3509	4	SO411	B	-0.023	0.000	a
3510	1	NO311	R	0.3480	0.1774	a
3510	2	NO311	LN8	1.4503	1.0208	a
3510	3	NO311	R	0.0692	0.0614	a
3510	4	NO311	R	0.3555	0.1954	a
3510	5	NO311	FN8	1.4822	1.0050	a
3510	6	NO311	D	0.2800	0.1082	a
3510	7	CL11	B	-0.049	-0.036	a
3510	7	NO311	B	-0.0267	0.0000	a
3511	4	SO411	R	3.956	3.959	a
3511	8	CL11	R	14.584	17.370	a
3512	2	CL11	R	4.829	12.336	a
3512	3	CL11	R	4.874	37.324	a
3512	4	CL11	R	4.833	25.728	a
3512	4	NA11	R	10.656	10.769	b
3512	4	NO311	R	0.7376	0.7169	a
3512	8	CL11	D	4.889	14.534	a
3513	3	CL11	D	4.775	10.698	a
3513	4	CL11	R	4.767	15.694	a
3513	9	CL11	R	4.810	15.910	a
3514	1	CL11	R	4.786	14.566	a
3514	5	CL11	R	4.745	16.256	a
3515	1	ALKA11	R	82.0	28.7	e
3515	1	NO311	R	1.2497	1.1022	a
3515	2	ALKA11	R	-15.1	-3.1	e
3515	2	NO311	R	0.1802	0.1062	a
3515	3	ALKA11	D	3.3	1.9	e
3515	3	NO311	D	0.1895	0.1540	a
3515	4	NO311	B	-0.0211	0.0000	a
3515	5	ALKA11	FL15	265.5	100.2	e
3515	5	NO311	FL15	0.2371	0.3680	a
3515	6	ALKA11	R	-12.4	-10.3	e
3515	6	NO311	R	0.4371	0.3320	a
3515	7	ALKA11	R	136.4	50.6	e
3515	7	NO311	R	0.2383	0.1890	a
3515	8	ALKA11	R	268.9	99.2	e
3515	8	NO311	R	0.1079	0.0902	a
3516	1	SO411	R	3.152	2.674	a
3516	2	SO411	FL15	2.071	1.924	a
3516	3	SO411	D	2.910	2.738	a
3516	4	CL11	LL15	0.288	0.188	a
3516	4	SO411	LL15	2.020	2.120	a
3516	5	CL11	R	4.925	6.652	a
3516	5	SO411	R	2.741	2.636	a
3516	6	SO411	R	6.186	6.086	a
3516	7	SO411	R	6.477	6.564	a

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3516	8	CL11	B	-0.001	-0.004	*a*
3516	8	NA11	B	-0.004	0.188	*b*
3516	8	SO411	B	-0.003	0.000	*a*
3517	1	ALKA11	R	157.7	59.3	*e*
3517	1	NO311	R	0.0453	0.1226	*a*
3517	2	ALKA11	R	182.8	70.2	*e*
3517	2	NO311	R	0.2391	0.1866	*a*
3517	3	ALKA11	FN7	392.0	153.2	*e*
3517	3	NO311	FN7	3.3706	1.1308	*a*
3517	4	ALKA11	D	96.9	38.2	*e*
3517	4	NO311	D	1.2084	0.8626	*a*
3517	5	ALKA11	R	107.4	41.6	*e*
3517	5	NO311	R	1.2003	0.8612	*a*
3517	6	ALKA11	R	213.1	84.8	*e*
3517	6	NO311	R	0.4500	0.3368	*a*
3517	7	ALKA11	R	422.6	166.9	*e*
3517	7	NO311	R	0.3332	0.2796	*a*
3517	8	ALKA11	R	80.2	29.3	*e*
3517	8	NO311	R	0.0122	0.0000	*a*
3517	9	ALKA11	R	215.6	82.8	*e*
3517	9	NO311	R	-0.0046	0.0000	*a*
3517	10	ALKA11	B	28.3	10.4	*e*
3517	10	NO311	B	0.0080	0.0000	*a*
3518	1	CL11	R	0.335	0.452	*a*
3518	1	NO311	R	0.5761	0.4320	*a*
3518	1	SO411	R	5.422	5.144	*a*
3518	2	CL11	FN7	4.475	3.310	*a*
3518	2	NO311	FN7	1.7795	1.1490	*a*
3518	2	SO411	FN7	8.087	6.494	*a*
3518	3	CL11	D	0.469	0.442	*a*
3518	3	NO311	D	0.8662	0.4202	*a*
3518	3	SO411	D	6.837	5.122	*a*
3518	4	CL11	B	0.011	0.000	*a*
3518	4	NO311	B	-0.0237	0.0000	*a*
3518	4	SO411	B	-0.037	0.000	*a*
3518	5	CL11	R	4.751	3.372	*a*
3518	5	NO311	R	0.0211	0.1626	*a*
3518	5	SO411	R	5.135	3.526	*a*
3518	6	CL11	R	2.874	2.614	*a*
3518	6	NO311	R	-0.0237	0.0000	*a*
3518	6	SO411	R	6.461	4.372	*a*
3518	7	CL11	LN7	6.986	3.252	*a*
3518	7	NO311	LN7	1.6528	1.1354	*a*
3518	7	SO411	LN7	9.740	6.602	*a*
3518	8	CL11	R	6.685	0.242	*a*
3518	8	NO311	R	1.5505	0.7510	*a*
3518	8	SO411	R	8.060	5.302	*a*
3518	9	CL11	R	9.632	5.840	*a*
3518	9	NH411	R	-0.013	-0.003	*f*
3518	9	NO311	R	0.1345	0.0766	*a*
3518	9	SO411	R	15.211	13.886	*a*
3518	10	CA11	R	6.350	6.191	*b*
3518	10	CL11	R	22.125	7.634	*a*
3518	10	NA11	R	5.717	5.541	*b*
3518	10	NO311	R	-0.0237	0.0000	*a*
3518	10	SO411	R	6.422	5.638	*a*
3518	11	CL11	R	3.403	3.328	*a*
3518	11	NO311	R	0.1234	0.1240	*a*
3518	11	SO411	R	6.308	5.882	*a*
3519	1	CL11	R	0.207	0.308	*a*
3519	1	NO311	R	0.5719	0.4912	*a*
3519	1	SO411	R	4.503	4.612	*a*
3519	2	CL11	R	0.214	0.280	*a*

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3519	2	NO311	R	2.9748	2.4074	a
3519	2	SO411	R	5.520	5.330	a
3519	3	CL11	R	0.965	1.136	a
3519	3	NO311	R	1.8948	1.7046	a
3519	3	SO411	R	6.099	5.752	a
3519	4	CL11	B	0.064	0.000	a
3519	4	NO311	B	0.0586	0.0000	a
3519	4	SO411	B	-0.038	0.000	a
3519	5	CL11	D	1.008	1.140	a
3519	5	NO311	D	1.8770	1.6926	a
3519	5	SO411	D	6.042	5.722	a
3519	6	CL11	R	3.503	3.540	a
3519	6	NO311	R	1.6638	1.4146	a
3519	6	SO411	R	6.969	6.448	a
3519	7	CL11	FN8	0.366	0.448	a
3519	7	NO311	FN8	1.3631	1.0936	a
3519	7	SO411	FN8	6.791	6.148	a
3519	8	CL11	R	4.211	3.326	a
3519	8	NO311	R	-0.0237	0.0000	a
3519	8	SO411	R	3.711	3.304	a
3519	9	CL11	R	2.859	3.346	a
3519	9	NO311	R	0.0731	0.1060	a
3519	9	SO411	R	3.435	3.018	a
3519	10	CL11	R	1.249	1.326	a
3519	10	NO311	R	0.0908	0.1044	a
3519	10	SO411	R	3.983	3.482	a
3520	1	CL11	R	0.478	0.336	a
3520	1	NO311	R	2.2823	1.9728	a
3520	2	CL11	R	0.289	0.336	a
3520	2	NO311	R	1.6427	1.4478	a
3520	3	CL11	FL15	0.674	0.386	a
3520	3	NO311	FL15	0.1924	0.4150	a
3520	4	CL11	R	0.338	0.440	a
3520	4	NO311	R	0.2301	0.2660	a
3520	5	CL11	B	-0.032	0.000	a
3520	5	NO311	B	-0.0237	0.0000	a
3520	6	CL11	R	0.264	0.370	a
3520	6	NO311	R	0.3601	0.2818	a
3520	7	CL11	R	0.386	0.308	a
3520	7	NO311	R	1.9059	1.6840	a
3520	8	CL11	R	0.332	0.438	a
3520	8	NO311	R	0.5633	0.4650	a
3520	9	CL11	D	0.214	0.320	a
3520	9	NO311	D	1.6009	1.4342	a
3520	10	CL11	R	4.277	4.384	a
3520	10	NO311	R	-0.0237	0.0448	a
3521	1	CL11	D	0.352	0.340	a
3521	1	NO311	D	0.9267	0.8722	a
3521	1	SO411	D	6.428	5.770	a
3521	2	CL11	B	-0.044	0.000	a
3521	2	NO311	B	-0.0116	0.0000	a
3521	2	SO411	B	-0.026	0.000	a
3521	3	CL11	R	0.241	0.288	a
3521	3	NO311	R	1.4565	1.2220	a
3521	3	SO411	R	5.254	4.700	a
3521	4	CL11	R	1.127	2.928	a
3521	4	NO311	R	0.9267	0.7912	a
3521	4	SO411	R	6.641	6.064	a
3521	5	CL11	R	0.257	0.360	a
3521	5	NO311	R	0.9267	0.8592	a
3521	5	SO411	R	6.321	5.584	a
3521	6	CL11	R	0.289	0.344	a
3521	6	NO311	R	0.3970	0.3712	a
3521	6	SO411	R	5.894	5.310	a

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3521	7	CL11	R	0.289	0.328	a
3521	7	NO311	R	1.2673	1.0250	a
3521	7	SO411	R	5.574	4.952	a
3521	8	CL11	R	0.289	0.332	a
3521	8	NO311	R	1.9862	1.7400	a
3521	8	SO411	R	5.574	4.942	a
3521	9	CL11	FN8	0.542	0.436	a
3521	9	NO311	FN8	1.3808	1.0868	a
3521	9	SO411	FN8	6.854	6.046	a
3521	10	CL11	R	0.273	0.286	a
3521	10	NO311	R	1.7970	1.4960	a
3521	10	SO411	R	6.108	5.452	a
3521	11	CL11	R	0.368	0.320	a
3521	11	NO311	R	3.0129	2.5572	a
3521	11	SO411	R	6.001	5.392	a
3521	12	CL11	R	0.431	0.434	a
3521	12	COND11	R	25.1	25.3	b
3521	12	NO311	R	1.6457	1.4216	a
3521	12	SO411	R	5.681	5.040	a
3521	13	CL11	LN8	0.415	0.428	a
3521	13	COND11	LN8	27.4	29.0	b
3521	13	NO311	LN8	1.3051	1.0814	a
3521	13	SO411	LN8	6.694	6.082	a
3521	14	CL11	R	5.953	4.542	a
3521	14	COND11	R	28.8	21.8	b
3521	14	NO311	R	0.1700	0.1356	a
3521	14	SO411	R	4.454	3.916	a
3521	15	CL11	R	2.642	2.516	a
3521	15	COND11	R	21.2	24.5	b
3521	15	NO311	R	0.0565	0.1256	a
3521	15	SO411	R	2.108	1.956	a
3521	16	CL11	R	5.888	4.664	a
3521	16	COND11	R	54.7	51.3	b
3521	16	NO311	R	-0.0570	0.4794	a
3521	16	SO411	R	6.428	5.688	a
3523	1	SO411	R	3.515	3.334	a
3523	2	SO411	B	0.056	0.000	a
3523	3	SO411	R	3.885	3.734	a
3523	4	SO411	LL15	2.074	2.126	a
3523	5	SO411	R	4.121	3.966	a
3523	6	SO411	FL15	1.996	2.108	a
3523	7	SO411	D	3.946	3.954	a
3523	8	SO411	R	3.132	3.182	a
3525	6	CL11	B	0.062	0.362	a
3526	2	CL11	R	0.214	0.950	a
3526	3	CL11	D	0.225	0.275	a
3600	1	DOC11	R	2.15	2.51	f
3600	3	DICI11	R	0.418	0.337	b
3600	5	NO311	R	0.5826	0.0352	g
3600	6	MN11	R	5.066	0.507	f
3600	7	DICE11	D	0.332	0.168	b
3600	7	DICI11	D	0.387	0.748	b
3600	8	DICE11	FN8	0.097	0.332	b
3600	8	DICI11	FN8	0.488	1.524	b
3600	12	DICI11	S	0.761	0.571	b
3600	12	NO311	S	0.5528	0.0553	f
3600	15	DICI11	R	1.899	1.945	b
3600	19	DICE11	R	0.382	0.255	b
3600	19	DICI11	R	0.101	0.390	b
3600	19	DOC11	R	1.18	1.81	f
3600	21	NH411	R	0.018	0.043	d
3600	22	CL11	D	12.465	14.695	f

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3600	22	NH411	D	0.044	0.005	*h*
3600	23	NH411	LN8	0.005	0.063	*h*
3600	24	NH411	R	0.063	0.033	*h*
3600	25	NH411	TB	0.033	0.012	*h*
3600	26	NH411	S	0.012	0.023	*h*
3601	1	NO311	R	0.0382	0.0361	*g*
3601	13	DICE11	R	0.108	4.108	*f*
3601	23	DOC11	R	6.33	8.10	*f*
3602	19	FTL11	LN8	0.5370	0.0714	*i*
3602	19	NO311	LN8	0.1446	1.2609	*i*
3602	19	PHEQ11	LN8	6.94	5.15	*i*
3602	19	SO411	LN8	6.744	6.654	*i*
3602	20	FTL11	R	0.4430	0.0537	*i*
3602	20	PHEQ11	R	4.56	6.94	*i*
3602	21	FTL11	R	0.0348	0.0443	*i*
3602	21	NO311	R	0.0411	0.0421	*i*
3602	21	PHEQ11	R	4.58	4.56	*i*
3602	22	FTL11	R	0.0702	0.0348	*i*
3602	22	PHEQ11	R	6.45	4.58	*i*
3602	23	FTL11	R	0.0212	0.0702	*i*
3602	23	NO311	R	0.0439	0.0301	*i*
3602	23	PHEQ11	R	5.84	6.45	*i*
3602	24	ALTL11	R	0.1928	0.0114	*i*
3602	24	FTL11	R	0.0419	0.0212	*i*
3602	24	PHEQ11	R	7.03	5.84	*i*
3602	25	FTL11	FL16	0.0816	0.0419	*i*
3602	25	PHEQ11	FL16	6.91	7.03	*i*
3602	26	FTL11	R	0.0859	0.0816	*i*
3602	26	PHEQ11	R	6.93	6.91	*i*
3602	27	ALEX11	S	0.0000	.	*j*
3602	27	FTL11	S	0.0711	0.0854	*i*
3602	27	PHEQ11	S	6.47	6.93	*i*
3602	28	FTL11	D	0.0777	0.0711	*i*
3602	28	PHEQ11	D	6.08	6.47	*i*
3602	29	SiO211	S	0.463	1.852	*f*
3602	29	ALEX11	S	0.0000	.	*j*
3602	29	FTL11	S	0.0714	0.0777	*i*
3602	29	PHEQ11	S	5.15	6.08	*i*
3603	3	CL11	R	2.830	0.279	*k*
3603	19	CL11	B	0.275	0.023	*f*
3603	21	DIC02	R	-1.090	1.090	*f*
3603	24	FE11	S	0.685	0.168	*f*
3604	3	CL11	LN8	0.399	0.790	*b*
3604	7	NO311	S	0.0516	0.0596	*f*
3604	10	CL11	B	0.020	0.104	*f*
3604	11	CL11	R	0.114	0.273	*f*
3604	12	CL11	TB	0.032	0.061	*f*
3604	12	SO411	TB	6.232	.	*l*
3604	13	SO411	R	6.511	6.232	*l*
3604	14	SO411	LN7	9.137	6.511	*l*
3604	15	SO411	R	5.081	9.137	*l*
3604	16	SO411	R	5.756	5.081	*l*
3604	17	SO411	R	4.473	5.756	*l*
3604	18	SO411	S	2.033	4.473	*l*
3604	19	SO411	LL16	2.631	2.033	*b,l*
3604	20	SO411	R	5.405	5.176	*l*
3604	21	SO411	R	5.549	5.405	*l*
3604	25	NO311	R	0.0636	0.0634	*f*
3605	10	CL11	LL16	0.338	0.554	*b*
3605	12	CL11	B	0.008	0.079	*f*
3605	19	NO311	R	0.4524	0.0452	*f*

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3610	23	NO311	D	4.1300	0.7031	*f*
3659	2	CL11	LN7	3.873	2.873	*f*
3661	3	NH411	S	0.006	0.001	*f*
3662	1	CL11	LN8	1.463	0.371	*l*
3662	1	NO311	LN8	0.0205	1.2586	*l*
3662	1	SO411	LN8	14.138	5.895	*l*
3662	2	CL11	S	0.371	0.345	*l*
3662	2	NO311	S	1.2586	0.0150	*l*
3662	2	SO411	S	5.895	4.328	*l*
3662	3	CL11	S	0.345	1.463	*l*
3662	3	NO311	S	0.0150	0.0205	*l*
3662	3	SO411	S	4.328	14.138	*l*
3664	2	DOC11	S	4.73	9.456	*k*
3665	3	CA11	S	1.780	5.820	*l*
3665	3	MG11	S	0.313	1.145	*l*
3666	1	FE11	S	0.080	0.585	*l*
3666	1	SO411	S	7.171	7.576	*f*
3666	2	CA11	LN8	5.820	1.780	*l*
3666	2	FE11	LN8	0.585	0.080	*l*
3666	2	MG11	LN8	1.145	0.313	*l*
3700	1	NA11	D	0.326	0.396	*m*
3700	2	ALTL11	LS4	0.1170	0.2183	*b*
3700	2	NA11	LS4	3.110	3.702	*m*
3700	3	NA11	R	0.529	0.718	*m*
3700	4	NA11	R	0.372	0.387	*m*
3700	5	NA11	LN8	0.589	0.569	*m*
3700	6	NA11	TB	0.003	-0.056	*m*
3700	7	NA11	R	0.663	3.828	*m*
3700	8	NA11	B	0.004	-0.047	*m*
3700	9	NA11	R	0.564	0.713	*m*
3700	10	NA11	R	0.494	0.694	*m*
3701	1	K11	FN10	0.329	0.250	*b*
3701	1	NA11	FN10	0.561	0.536	*m*
3701	2	NA11	R	0.400	0.359	*m*
3701	3	NA11	R	2.610	2.587	*m*
3701	4	NA11	FN7	2.220	2.172	*m*
3701	5	NA11	D	0.417	0.368	*m*
3701	6	NA11	B	0.002	-0.051	*m*
3701	7	NA11	LS2	10.000	10.028	*m*
3701	8	NA11	R	1.450	1.408	*m*
3701	9	NA11	R	3.780	3.789	*m*
3702	1	NA11	LS5	1.560	1.552	*m*
3702	2	NA11	FN8	0.589	0.554	*m*
3702	3	NA11	R	0.483	0.476	*m*
3702	4	NA11	R	0.256	0.219	*m*
3702	5	NA11	LS3	0.042	-0.023	*m*
3702	6	NA11	D	0.250	0.219	*m*
3702	7	NA11	RWHA	0.303	0.389	*m*
3702	8	NA11	B	-0.001	-0.070	*m*
3703	1	NA11	R	0.884	0.860	*m*
3703	2	K11	LS1	0.256	0.531	*b*
3703	2	NA11	LS1	0.884	0.773	*m*
3703	3	NA11	FN9	1.563	2.629	*m*
3703	4	NA11	D	1.450	1.477	*m*
3703	5	NA11	R	1.563	1.445	*m*
3703	6	K11	LS1	0.256	0.287	*b*

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3703	6	NA11	LS1	0.884	0.778	*m*
3703	7	NA11	R	0.356	0.526	*m*
3703	8	NA11	FN8	0.615	0.567	*m*
3703	9	NA11	LS5	1.790	1.541	*m*
3703	10	NA11	B	-0.002	-0.004	*m*
3703	11	NA11	R	0.771	0.700	*m*
3703	12	NA11	R	1.111	0.476	*m*
3703	13	NA11	R	1.111	0.970	*m*
3703	14	NA11	R	0.997	0.892	*m*
3704	1	NA11	R	0.884	0.871	*m*
3704	2	NA11	R	1.903	1.873	*m*
3704	3	NA11	R	0.884	0.790	*m*
3704	4	NA11	FN7	2.242	2.214	*m*
3704	5	NA11	R	0.347	0.554	*m*
3704	6	NA11	R	0.365	0.611	*m*
3704	7	NA11	R	0.884	0.872	*m*
3704	8	NA11	B	-0.000	-0.029	*m*
3704	9	NA11	D	0.365	0.612	*m*
3704	10	NA11	RWHB	0.260	0.424	*m*
3704	11	NA11	LS2	10.960	10.670	*m*
3704	12	NA11	R	0.884	0.872	*m*
3704	13	NA11	R	0.884	0.900	*m*
3704	14	NA11	TB	-0.000	-0.038	*m*
3704	15	NA11	R	0.884	0.842	*m*
3705	1	NA11	R	1.286	1.262	*m*
3705	2	NA11	FN7	2.386	2.277	*m*
3705	3	NA11	R	1.530	1.406	*m*
3705	4	NA11	R	1.530	1.402	*m*
3705	5	NA11	FN8	0.675	0.597	*m*
3705	6	NA11	R	1.286	1.165	*m*
3705	7	NA11	LS4	4.218	3.795	*m*
3705	8	NA11	R	1.652	1.541	*m*
3705	9	NA11	R	1.164	0.939	*m*
3705	10	NA11	B	-0.003	-0.048	*m*
3705	11	NA11	D	1.408	1.257	*m*
3705	12	NA11	R	1.041	0.939	*m*
3706	1	NA11	R	2.695	2.494	*m*
3706	2	NA11	R	0.048	0.058	*m*
3706	3	NA11	R	0.997	0.925	*m*
3706	4	NA11	B	-0.003	-0.019	*m*
3706	5	NA11	R	2.356	2.191	*m*
3706	6	NA11	FN7	2.242	2.176	*m*
3706	7	NA11	D	0.048	0.058	*m*
3706	8	NA11	FN10	0.374	0.544	*m*
3706	9	NA11	FN8	0.405	0.587	*m*
3706	10	NA11	R	1.450	1.377	*m*
3706	11	NA11	R	2.016	1.959	*m*
3706	12	NA11	R	2.695	2.576	*m*
3706	13	NA11	R	2.922	2.705	*m*
3706	14	NA11	R	1.676	1.647	*m*
3706	15	NA11	R	5.864	5.786	*m*
3706	16	NA11	R	1.676	1.598	*m*
3706	17	NA11	R	2.695	2.657	*m*
3706	18	NA11	R	3.148	3.028	*m*
3706	19	NA11	R	1.450	1.463	*m*
3707	1	NA11	R	5.196	5.246	*m*
3707	2	NA11	R	0.553	0.545	*m*
3707	3	NA11	R	0.798	0.942	*m*
3707	4	NA11	LN7	2.263	2.190	*m*
3707	5	NA11	R	0.453	0.455	*m*
3707	6	NA11	R	2.263	2.172	*m*
3707	7	NA11	R	2.630	2.672	*m*

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3707	8	NA11	D	2.019	2.095	*m*
3707	9	NA11	R	0.445	0.482	*m*
3707	10	NA11	R	0.438	1.532	*m*
3707	11	NA11	R	2.874	2.929	*m*
3707	12	NA11	LS1	1.041	0.906	*m*
3707	13	NA11	R	2.996	2.866	*m*
3707	14	NA11	FN7	2.386	2.285	*m*
3707	15	NA11	R	0.553	0.617	*m*
3707	16	NA11	R	3.119	2.740	*m*
3707	17	NA11	R	2.019	2.064	*m*
3707	18	NA11	R	2.263	2.226	*m*
3707	19	NA11	R	0.438	0.473	*m*
3707	20	CL11	RWLA	0.000	.	*n*
3707	20	NA11	RWLA	0.250	0.227	*m*
3707	20	NO311	RWLA	0.0000	.	*n*
3707	20	SO411	RWLA	0.000	.	*n*
3707	21	NA11	R	3.241	3.182	*m*
3707	22	NA11	R	0.508	2.564	*m*
3707	23	NA11	B	-0.002	0.058	*m*
3707	24	NA11	R	0.677	0.919	*m*
3707	25	NA11	R	3.730	3.821	*m*
3707	26	NA11	R	0.919	0.865	*m*
3708	1	NA11	FN9	2.514	2.842	*m*
3708	2	NA11	R	1.988	2.260	*m*
3708	3	NA11	R	0.058	0.157	*m*
3708	4	NA11	R	2.198	2.057	*m*
3708	5	NA11	LS2	10.393	10.792	*m*
3708	6	NA11	R	2.724	2.603	*m*
3708	7	NA11	R	3.565	3.770	*m*
3708	8	NA11	LS3	0.025	0.103	*m*
3708	9	NA11	LS4	3.985	3.762	*m*
3708	10	NA11	R	1.778	1.770	*m*
3708	11	NA11	R	1.673	1.996	*m*
3708	12	NA11	R	0.728	0.734	*m*
3708	13	NA11	R	1.253	1.347	*m*
3708	14	NA11	D	0.728	0.715	*m*
3708	15	NA11	R	3.667	3.789	*m*
3708	16	NA11	R	1.778	1.822	*m*
3708	17	NA11	R	0.728	0.764	*m*
3708	18	NA11	B	-0.001	0.058	*m*
3709	1	NA11	R	0.094	0.474	*m*
3709	2	NA11	FN10	0.728	0.609	*m*
3709	3	NA11	R	2.304	2.208	*m*
3709	4	NA11	R	1.043	0.932	*m*
3709	5	NA11	LS5	1.568	1.546	*m*
3709	6	NA11	D	0.048	0.387	*m*
3709	7	NA11	LS5	1.463	1.522	*m*
3709	8	NA11	R	3.565	3.666	*m*
3709	9	NA11	R	0.004	0.387	*m*
3709	10	NA11	LS2	11.024	10.333	*m*
3709	11	NA11	RWHD	0.728	0.454	*m*
3709	12	NA11	B	-0.004	0.024	*m*
3710	1	NA11	B	-0.004	0.044	*m*
3710	2	NA11	RWHC	0.056	0.464	*m*
3710	3	NA11	FN10	0.728	0.614	*m*
3710	4	NA11	R	5.666	6.900	*m*
3710	5	NA11	FN8	0.728	0.662	*m*
3710	6	NA11	LS4	3.774	3.696	*m*
3710	7	NA11	D	6.716	6.997	*m*
3710	8	NA11	LN8	0.079	0.633	*m*
3710	9	NA11	R	1.778	1.745	*m*
3710	10	NA11	TB	0.000	0.010	*m*

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3711	1	NA11	LS5	1.801	1.643	m
3711	2	NA11	R	0.864	0.503	m
3711	3	NA11	R	1.883	0.768	m
3711	4	NA11	FN7	2.197	2.208	m
3711	5	NA11	FN8	0.836	0.667	m
3711	6	NA11	D	1.437	0.507	m
3711	7	NA11	RWLC	0.049	0.237	m
3711	8	NA11	R	1.271	1.015	m
3711	9	NA11	R	1.780	0.903	m
3711	10	NA11	R	0.624	0.469	m
3711	11	NA11	R	1.179	0.609	m
3711	12	NA11	R	1.536	1.493	m
3711	13	NA11	R	0.991	0.686	m
3711	14	NA11	R	3.124	3.179	m
3711	15	NA11	B	-0.000	0.039	m
3711	16	NA11	R	2.991	2.864	m
3711	17	NA11	R	7.094	7.243	m
3711	18	NA11	R	1.801	1.662	m
3712	1	NA11	R	1.404	1.241	m
3712	2	NA11	R	3.918	3.931	m
3712	3	NA11	LS2	10.666	10.469	m
3712	4	NA11	FN8	0.466	0.652	m
3712	5	NA11	D	1.272	1.241	m
3712	6	NA11	R	6.962	7.106	m
3712	7	NA11	B	-0.010	0.034	m
3712	8	NA11	RWLB	0.364	0.256	m
3712	9	NA11	R	2.462	2.376	m
3712	10	NA11	R	5.242	5.293	m
3712	11	NA11	R	4.315	4.252	m
3712	12	NA11	LN8	0.719	0.647	m
3713	1	NA11	LS3	0.031	0.041	m
3713	2	NA11	FN7	2.330	2.140	m
3713	3	ACCO11	R	44.4	174.5	o
3713	3	ALD02	R	0.0360	0.0992	o
3713	3	ALEX11	R	0.0099	0.0390	o
3713	3	ALKA11	R	95.4	-54.3	o
3713	3	ALO_02	R	0.0302	0.0750	o
3713	3	ALTL11	R	0.1861	0.1250	o
3713	3	CA11	R	3.285	0.630	o
3713	3	CL11	R	8.020	0.842	o
3713	3	COLOR02	R	95	200	o
3713	3	COND11	R	52.9	23.1	o
3713	3	DIC02	R	1.535	0.658	o
3713	3	DICE11	R	0.796	0.058	o
3713	3	DICI11	R	1.405	0.539	o
3713	3	DOC11	R	7.48	15.30	o
3713	3	FE11	R	0.616	0.261	o
3713	3	FTL11	R	0.0634	0.0350	o
3713	3	K11	R	0.660	0.152	o
3713	3	MG11	R	0.739	0.189	o
3713	3	MN11	R	0.018	0.025	o
3713	3	NA11	R	5.638	1.195	m
3713	3	NH411	R	0.035	0.010	o
3713	3	NO311	R	0.3172	0.0090	o
3713	3	PH02	R	6.51	4.55	o
3713	3	PHAC11	R	6.66	4.57	o
3713	3	PHAL11	R	6.59	4.50	o
3713	3	PHEQ11	R	6.99	4.42	o
3713	3	PTL11	R	0.0125	0.0190	o
3713	3	SIO211	R	5.054	0.935	o
3713	3	SO411	R	4.970	1.970	o
3713	3	TUR02	R	1.40	1.80	o
3713	4	NA11	R	0.478	0.497	m
3713	5	NA11	R	4.050	3.855	m

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3713	6	NA11	R	3.388	3.231	m
3713	7	NA11	B	-0.009	-0.017	m
3713	8	NA11	LN7	2.198	2.118	m
3713	9	NA11	R	7.358	7.645	m
3713	10	NA11	R	0.633	0.739	m
3713	11	NA11	R	6.300	6.446	m
3713	12	NA11	R	1.404	1.154	m
3713	13	NA11	R	1.393	0.957	m
3713	14	ACCO11	R	174.5	44.4	o
3713	14	ALD02	R	0.0992	0.0360	o
3713	14	ALEX11	R	0.0390	0.0100	o
3713	14	ALKA11	R	-54.3	95.4	o
3713	14	ALO_02	R	0.0750	0.0302	o
3713	14	ALTL11	R	0.1249	0.1860	o
3713	14	CA11	R	0.630	3.285	o
3713	14	CL11	R	0.842	8.020	o
3713	14	COLOR02	R	200	95	o
3713	14	COND11	R	23.1	52.9	o
3713	14	DIC02	R	0.658	1.535	o
3713	14	DICE11	R	0.058	0.796	o
3713	14	DICI11	R	0.539	1.405	o
3713	14	DOC11	R	15.30	7.48	o
3713	14	FE11	R	0.261	0.616	o
3713	14	FTL11	R	0.0352	0.0630	o
3713	14	K11	R	0.152	0.660	o
3713	14	MG11	R	0.189	0.739	o
3713	14	MN11	R	0.025	0.018	o
3713	14	NA11	R	1.404	5.661	m
3713	14	NH411	R	0.010	0.035	o
3713	14	NO311	R	0.0087	0.3170	o
3713	14	PH02	R	4.55	6.51	o
3713	14	PHAC11	R	4.57	6.66	o
3713	14	PHAL11	R	4.50	6.59	o
3713	14	PHEQ11	R	4.42	6.99	o
3713	14	PTL11	R	0.0186	0.0120	o
3713	14	SIO211	R	0.935	5.054	o
3713	14	SO411	R	1.970	4.970	o
3713	14	TUR02	R	1.80	1.40	o
3713	15	NA11	R	0.033	0.349	m
3713	16	NA11	D	1.404	1.162	m
3713	17	NA11	R	11.726	12.669	m
3713	18	NA11	R	6.829	7.173	m
3713	19	NA11	R	5.242	5.296	m
3714	1	NA11	R	0.892	0.953	m
3714	2	NA11	LS3	0.039	0.041	m
3714	3	NA11	R	10.540	10.839	m
3714	4	NA11	FN9	2.628	2.734	m
3714	5	NA11	R	5.266	5.132	m
3714	6	NA11	R	7.317	7.243	m
3714	7	NA11	R	5.119	5.144	m
3714	8	NA11	LS1	0.702	0.813	m
3714	9	NA11	D	4.680	5.177	m
3714	10	NA11	LN8	0.062	0.587	m
3714	11	NA11	R	5.852	5.916	m
3714	12	NA11	R	11.713	12.505	m
3714	13	NA11	B	0.007	-0.012	m
3715	1	NA11	R	7.317	7.422	m
3715	2	NA11	R	1.016	1.030	m
3715	3	NA11	D	7.024	6.884	m
3715	4	NA11	R	0.559	0.727	m
3715	5	C0151D	R	860	86	f
3715	5	NA11	R	7.170	7.190	m
3715	6	NA11	FN7	1.602	2.102	m
3715	7	NA11	LN7	1.602	2.180	m

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3715	8	CA11	LS1	0.033	0.030	*b*
3715	8	CL11	LS1	26.400	19.150	*b*
3715	8	NA11	LS1	0.753	0.813	*m*
3715	9	NA11	R	1.456	1.404	*m*
3715	10	NA11	R	0.600	0.525	*m*
3715	11	NA11	B	0.007	0.004	*m*
3715	12	NA11	R	1.163	1.154	*m*
3715	13	NA11	R	2.335	2.262	*m*
3715	14	NA11	R	1.158	0.944	*m*
3715	15	NA11	R	4.826	5.038	*m*
3715	16	NA11	R	0.425	0.546	*m*
3715	17	NA11	R	2.335	6.915	*m*
3715	18	NA11	R	1.096	0.998	*m*
3715	19	NA11	R	1.456	1.659	*m*
3716	1	NA11	R	1.309	1.443	*m*
3716	2	NA11	R	1.096	0.916	*m*
3716	3	NA11	R	0.856	0.848	*m*
3716	4	NA11	R	7.170	7.526	*m*
3716	5	NA11	LS1	0.866	0.843	*m*
3716	6	NA11	R	0.231	0.485	*m*
3716	7	NA11	B	-0.007	0.000	*m*
3716	8	NA11	R	3.507	4.026	*m*
3716	9	NA11	R	1.456	1.763	*m*
3716	10	NA11	R	4.972	5.755	*m*
3716	11	NA11	R	6.877	7.164	*m*
3716	12	NA11	FN8	0.764	0.668	*m*
3716	13	NA11	R	1.163	1.332	*m*
3716	14	MN11	R	0.036	0.035	*f*
3716	14	NA11	R	0.074	0.358	*m*
3716	15	NA11	R	7.610	7.931	*m*
3716	16	NA11	D	7.317	7.805	*m*
3716	17	NA11	R	14.204	14.720	*m*
3716	18	NA11	R	2.481	2.524	*m*
3716	19	NA11	R	0.591	0.795	*m*
3717	1	CL11	LS1	24.880	30.000	*b*
3717	1	NA11	LS1	0.639	0.855	*m*
3717	2	NA11	R	1.276	1.315	*m*
3717	3	NA11	R	5.235	5.630	*m*
3717	4	NA11	R	2.000	2.006	*m*
3717	5	NA11	R	5.822	5.990	*m*
3717	6	NA11	LS3	0.023	0.098	*m*
3717	7	NA11	RWHE	0.373	0.437	*m*
3717	8	NA11	B	-0.006	0.033	*m*
3717	9	NA11	FN9	2.596	2.754	*m*
3717	10	NA11	R	5.528	5.513	*m*
3717	11	NA11	R	12.566	13.182	*m*
3717	12	NA11	R	5.151	5.147	*m*
3717	13	NA11	R	1.231	0.807	*m*
3717	14	NA11	D	5.404	5.578	*m*
3717	15	NA11	R	7.048	7.163	*m*
3717	16	NA11	R	1.863	1.914	*m*
3717	17	NA11	R	1.863	1.702	*m*
3718	1	NA11	R	10.660	10.870	*m*
3718	2	NA11	FN7	2.009	2.185	*m*
3718	3	NA11	R	0.569	0.964	*m*
3718	4	NA11	LS4	3.622	3.631	*m*
3718	5	NA11	R	6.554	6.878	*m*
3718	6	NA11	B	-0.002	0.016	*m*
3718	7	NA11	R	0.275	0.434	*m*
3718	8	NA11	R	2.009	2.350	*m*
3718	9	NA11	R	0.499	0.672	*m*
3718	10	NA11	R	2.009	2.102	*m*
3718	11	NA11	D	2.302	2.327	*m*

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3718	12	NA11	R	9.487	9.552	*m*
3718	13	NA11	R	7.874	7.959	*m*
3718	14	NA11	R	1.716	1.732	*m*
3718	15	NA11	R	6.994	7.205	*m*
3718	16	NA11	R	0.275	0.498	*m*
3718	17	NA11	R	6.848	6.915	*m*
3718	18	NA11	R	0.247	0.429	*m*
3718	19	NA11	R	0.457	0.659	*m*
3718	20	NA11	R	0.044	0.124	*m*
3718	21	NA11	R	0.331	0.920	*m*
3718	22	NA11	R	0.471	0.724	*m*
3719	1	NA11	R	0.331	0.485	*m*
3719	2	NA11	TB	0.011	0.003	*m*
3719	3	NA11	FN7	2.156	2.158	*m*
3719	4	NA11	D	0.983	0.924	*m*
3719	5	NA11	FN8	0.415	0.632	*m*
3719	6	NA11	R	6.701	6.728	*m*
3719	7	NA11	R	9.194	9.167	*m*
3719	8	K11	LN8	0.426	0.288	*b*
3719	8	NA11	LN8	0.429	0.594	*m*
3719	9	NA11	B	-0.001	0.025	*m*
3719	10	K11	FN10	0.316	0.206	*b*
3719	10	NA11	FN10	0.457	0.559	*m*
3719	11	NA11	R	0.695	0.924	*m*
3720	1	SIO211	R	9.280	7.280	*f*
3721	2	NA11	FN9	2.650	2.980	*b*
3721	8	NA11	LN7	2.079	2.541	*b*
3721	8	SO411	LN7	6.725	8.025	*b*
3722	1	NA11	R	7.522	7.413	*m*
3722	2	NA11	RWLE	0.173	0.255	*m*
3722	3	NA11	R	7.668	6.185	*m*
3722	4	NA11	LS1	0.624	0.913	*m*
3722	5	NA11	FN7	2.394	2.320	*m*
3722	6	NA11	R	9.426	9.582	*m*
3722	7	NA11	LN7	2.121	2.243	*m*
3722	7	NH411	LN7	0.071	0.131	*b*
3722	7	SO411	LN7	6.645	7.425	*b*
3722	8	NA11	D	7.962	9.632	*m*
3722	9	NA11	B	0.197	0.032	*m*
3722	10	NA11	R	3.420	3.243	*m*
3722	11	NA11	R	11.770	11.797	*m*
3722	12	NA11	R	5.471	5.276	*m*
3722	13	NA11	R	7.668	7.385	*m*
3723	3	NH411	LN8	0.076	0.167	*b*
3724	1	NA11	R	5.982	6.610	*m*
3724	2	NA11	LS2	10.675	11.662	*m*
3724	3	NA11	B	-0.002	-0.075	*m*
3724	4	NA11	FN8	0.789	0.627	*m*
3724	5	NA11	R	7.280	8.564	*m*
3724	6	NA11	LS5	1.688	1.819	*m*
3724	7	NA11	RWHL	0.337	0.423	*m*
3724	8	NA11	R	1.788	1.910	*m*
3724	9	NA11	R	6.980	8.208	*m*
3724	10	NA11	R	0.396	0.464	*m*
3724	11	NA11	R	7.180	8.062	*m*
3724	12	NA11	R	9.476	10.695	*m*
3724	13	NA11	R	14.869	17.944	*m*
3724	14	NA11	R	5.182	5.824	*m*
3724	15	NA11	D	6.880	7.977	*m*

(Continued)

Table A-1. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3725	1	NA11	LS5	1.788	1.811	*m*
3725	2	NA11	TB	0.002	-0.082	*m*
3725	3	NA11	R	9.177	10.584	*m*
3725	4	NA11	R	4.983	5.852	*m*
3725	5	NA11	B	-0.002	-0.092	*m*
3725	6	NA11	R	1.388	1.221	*m*
3725	7	NA11	R	4.983	5.831	*m*
3725	8	NA11	FN8	0.454	0.636	*m*
3725	9	NA11	D	1.088	1.211	*m*
3725	10	NA11	FN9	2.886	3.094	*m*
3725	11	NA11	R	2.486	2.601	*m*
3725	12	NA11	FN10	0.512	0.570	*m*
3725	13	NA11	R	5.182	5.655	*m*

[a] This change was made as the result of the extensive investigations of chloride, sulfate, and nitrate.
[b] Reanalysis result was removed because the reanalysis was not representative of the batch sample analyses.
[c] Laboratory entered wrong titration data for this sample. Titration data were re-entered and recalculated.
[d] Laboratory reported incorrect acid titrant concentration. Result was recalculated.
[e] This change was made as the result of errors found in the reported acid titrant concentrations. The alkalinity value included in the modified verified data set was calculated from the titration data using a calculated acid titrant concentration instead of the reported acid titrant concentration.
[f] Transcription error.
[g] No raw data to support official verified value. Value changed to match raw data.
[h] This correction of a sample switch was made during verification and was reflected in the LESC working data base and the validated data base but did not appear in the official verified data set. Therefore, the change had to be made in the modified verified data base since it was created from the official verified data base.
[i] This change was made as the result of an extensive investigation of batch 3602. This batch contains various types of errors including sample switches, transcription errors, calibration standards dilution errors, or a combination of these three.
[j] Extractable aluminum analysis was not required for split sample analysis. Zero set to missing.
[k] Sample result miscalculated by laboratory.
[l] Sample switch.
[m] The original AAS result was unacceptable. The ICPES result was substituted because it was of better quality.
[n] Analysis not required for rainwater audits. 0.0 set to missing.
[o] Lake switch.

Table A-2. Character and Numeric Changes Applied to the Official Verified Data Base to Create the Modified Verified Data Base (for Forms 1D and 02 Only)

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3523	2	WDIR1D	B	V	—	*a*
3523	3	WDIR1D	R	V	—	*a*
3600	1	DP_B1D	R	6.0	6.8	*a*
3600	2	PRECO1D	R	CURRENT	—	*a*
3600	3	PRECO1D	R	CURRENT	—	*a*
3600	7	PRECO1D	D	CURRENT	—	*a*
3600	11	PRECO1D	R	CURRENT	—	*a*
3600	12	PRECO1D	S	CURRENT	—	*a*
3600	13	PRECO1D	B	CURRENT	—	*a*
3600	16	PRECO1D	R	CURRENT	—	*a*
3601	9	PRECO1D	R	CURRENT	—	*a*
3601	12	PRECO1D	R	CURRENT	—	*a*
3601	27	WSPD1D	R	NO WIND	LIGHT	*a*
3601	28	WSPD1D	R	NO WIND	LIGHT	*a*
3601	29	PRECO1D	S	CURRENT	—	*a*
3602	1	PRECO1D	R	CURRENT	—	*a*
3602	5	PRECO1D	R	CURRENT	—	*a*
3602	7	DP_B1D	R	10.9	11.1	*a*
3602	10	DP_B1D	D	10.9	11.1	*a*
3602	12	ACCES1D	R	—	H	*a*
3602	22	ACCES1D	R	—	H	*a*
3602	23	DP_B1D	R	10.9	11.1	*a*
3602	24	PRECO1D	R	CURRENT	—	*a*
3602	26	PRECO1D	R	CURRENT	—	*a*
3602	27	PRECO1D	S	CURRENT	—	*a*
3602	28	DP_B1D	D	10.9	11.1	*a*
3602	29	DP_B1D	S	10.9	11.1	*a*
3603	5	PRECO1D	R	PREV	CURRENT	*a*
3603	12	PRECO1D	R	—	CURRENT	*a*
3603	19	PRECO1D	B	—	CURRENT	*a*
3603	20	PRECO1D	R	—	CURRENT	*a*
3604	1	PRECO1D	R	CURRENT	—	*a*
3604	2	PREC1D	R	NONE	RAIN	*a*
3604	2	PRECO1D	R	CURRENT	PREV	*a*
3604	4	PRECO1D	R	CURRENT	—	*a*
3604	17	PREC1D	R	—	RAIN	*a*
3604	20	PRECO1D	R	CURRENT	—	*a*
3604	21	PREC1D	R	—	RAIN	*a*
3604	25	PREC1D	R	NONE	RAIN	*a*
3604	25	PRECO1D	R	CURRENT	PREV	*a*
3605	3	PRECO1D	R	CURRENT	—	*a*
3605	4	PRECO1D	R	CURRENT	—	*a*
3605	5	PRECO1D	S	CURRENT	—	*a*
3605	11	PRECO1D	D	CURRENT	—	*a*
3605	12	PRECO1D	B	CURRENT	—	*a*
3605	13	PREC1D	R	—	RAIN	*a*
3605	15	ACCES1D	R	—	D	*a*
3605	15	PREC1D	R	—	RAIN	*a*
3605	19	ACCES1D	R	—	D	*a*
3605	19	PREC1D	R	—	RAIN	*a*
3605	20	PRECO1D	D	CURRENT	—	*a*
3605	25	PRECO1D	R	CURRENT	—	*a*
3605	26	PRECO1D	R	CURRENT	—	*a*
3605	28	PREC1D	R	—	RAIN	*a*
3606	1	PREC1D	R	—	RAIN	*a*
3606	4	ACCES1D	R	—	D	*a*
3606	6	ACCES1D	R	—	D	*a*
3606	6	RPREC1D	R	—	LIGHT	*a*

(Continued)

Table A-2. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3606	9	PREC1D	R	—	RAIN	a
3606	11	PREC1D	S	—	RAIN	a
3606	15	PREC1D	R	—	RAIN	a
3606	17	ACCES1D	R	—	D	a
3606	22	PREC1D	R	—	RAIN	a
3607	2	PRECO1D	R	—	CURRENT	a
3607	7	PRECO1D	S	—	CURRENT	a
3607	9	PREC1D	R	—	RAIN	a
3607	12	PREC1D	R	—	RAIN	a
3607	21	PRECO1D	R	—	CURRENT	a
3607	21	RPREC1D	R	—	LIGHT	a
3607	23	PREC1D	R	—	RAIN	a
3607	24	PREC1D	R	—	RAIN	a
3607	26	PRECO1D	R	—	CURRENT	a
3607	28	PRECO1D	R	—	CURRENT	a
3607	28	RPREC1D	R	—	LIGHT	a
3608	1	PRECO1D	R	CURRENT	—	a
3608	2	PRECO1D	R	CURRENT	—	a
3608	4	PREC1D	B	—	RAIN	a
3608	9	PREC1D	R	—	RAIN	a
3608	11	PREC1D	R	—	RAIN	a
3608	12	PREC1D	R	—	RAIN	a
3608	19	PREC1D	S	—	RAIN	a
3608	24	PRECO1D	D	CURRENT	—	a
3608	25	PREC1D	R	—	RAIN	a
3610	1	PRECO1D	R	CURRENT	—	a
3610	6	PRECO1D	R	CURRENT	—	a
3610	12	PRECO1D	B	CURRENT	—	a
3610	14	PRECO1D	R	CURRENT	—	a
3610	16	PRECO1D	R	CURRENT	—	a
3610	18	PRECO1D	R	CURRENT	—	a
3610	19	PRECO1D	R	CURRENT	—	a
3611	1	PRECO1D	R	CURRENT	—	a
3611	2	PRECO1D	R	CURRENT	—	a
3611	9	PRECO1D	R	CURRENT	—	a
3611	15	PRECO1D	R	CURRENT	—	a
3611	17	PRECO1D	R	CURRENT	—	a
3611	20	PRECO1D	R	CURRENT	—	a
3611	22	PRECO1D	R	CURRENT	—	a
3611	30	PRECO1D	S	CURRENT	—	a
3612	4	PRECO1D	R	CURRENT	—	a
3612	17	PRECO1D	R	CURRENT	—	a
3613	7	PREC1D	R	—	RAIN	a
3613	12	PRECO1D	R	CURRENT	—	a
3613	15	PREC1D	R	—	RAIN	a
3613	22	PRECO1D	R	CURRENT	—	a
3614	1	PRECO1D	R	CURRENT	—	a
3614	3	PRECO1D	R	PREV	CURRENT	a
3614	4	PREC1D	R	—	RAIN	a
3614	5	WSPD1D	R	NO WIND	LIGHT	a
3614	6	PRECO1D	R	PREV	CURRENT	a
3614	8	WSPD1D	D	NO WIND	LIGHT	a
3614	9	WSPD1D	R	NO WIND	LIGHT	a
3614	10	WSPD1D	B	NO WIND	LIGHT	a
3614	11	WSPD1D	D	NO WIND	LIGHT	a
3614	14	PREC1D	S	—	RAIN	a
3614	15	PREC1D	R	—	RAIN	a
3614	16	WSPD1D	S	NO WIND	LIGHT	a
3614	17	PRECO1D	R	CURRENT	—	a

(Continued)

Table A-2. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3616	1	PRECO1D	R	CURRENT	—	a
3616	2	PREC1D	R	—	RAIN	a
3616	4	PRECO1D	D	CURRENT	—	a
3616	5	PRECO1D	B	CURRENT	—	a
3616	6	PREC1D	R	—	RAIN	a
3616	7	PRECO1D	S	CURRENT	—	a
3650	2	PRECO1D	S	CURRENT	—	a
3650	3	ACCES1D	S	—	D	a
3651	3	ACCES1D	S	—	D	a
3651	3	PRECO1D	S	CURRENT	—	a
3652	3	PRECO1D	S	CURRENT	—	a
3654	1	PRECO1D	S	CURRENT	—	a
3655	2	PRECO1D	S	CURRENT	—	a
3656	3	ACCES1D	S	—	D	a
3656	3	PREC1D	S	—	RAIN	a
3657	2	ACCES1D	S	—	D	a
3657	2	PRECO1D	S	—	CURRENT	a
3658	1	PREC1D	S	—	RAIN	a
3661	3	PRECO1D	S	CURRENT	—	a
3662	3	ACCES1D	S	—	D	a
3664	2	WSPD1D	S	NO WIND	LIGHT	a
3664	3	PREC1D	S	—	RAIN	a
3666	1	PRECO1D	S	CURRENT	—	a
3711	1	DATSH02	LS5	26OCT1986	27OCT1986	b
3711	2	DATSH02	R	26OCT1986	27OCT1986	b
3711	3	DATSH02	R	26OCT1986	27OCT1986	b
3711	4	DATSH02	FN7	26OCT1986	27OCT1986	b
3711	5	DATSH02	FN8	26OCT1986	27OCT1986	b
3711	6	DATSH02	D	26OCT1986	27OCT1986	b
3711	7	DATSH02	RWLC	26OCT1986	27OCT1986	b
3711	8	DATSH02	R	26OCT1986	27OCT1986	b
3711	9	DATSH02	R	26OCT1986	27OCT1986	b
3711	10	DATSH02	R	26OCT1986	27OCT1986	b
3711	11	DATSH02	R	26OCT1986	27OCT1986	b
3711	12	DATSH02	R	26OCT1986	27OCT1986	b
3711	13	DATSH02	R	26OCT1986	27OCT1986	b
3711	14	DATSH02	R	26OCT1986	27OCT1986	b
3711	15	DATSH02	B	26OCT1986	27OCT1986	b
3711	16	DATSH02	R	26OCT1986	27OCT1986	b
3711	17	DATSH02	R	26OCT1986	27OCT1986	b
3711	18	DATSH02	R	26OCT1986	27OCT1986	b
3711	99	DATSH02	TD	26OCT1986	27OCT1986	b
3717	13	PRECO1D	R	CURRENT	—	a
3718	14	PRECO1D	R	CURRENT	—	a
3719	6	PRECO1D	R	CURRENT	—	a
3720	9	ACCES1D	R	—	H	a
3720	12	PRECO1D	D	CURRENT	—	a
3720	19	PRECO1D	R	CURRENT	—	a

(Continued)

Table A-2. Continued

Batch ID	Sample ID	Variable	Sample type	Official verified value	Modified verified value	Comment
3722	1	PRECO1D	R	—	O	a
3722	13	PRECO1D	R	—	PREV	a

[a] This change was made as the result of review of the field form information.
[b] This change was made as the result of a transcription error that occurred during the creation of the raw data base.

Table A-3. All X Flag[a] Changes Applied to the Official Verified Data Base to Create the Modified Verified Data Base (For Form 11 Only)

Batch ID	Sample ID	Variable	Sample type	Official verified flag[b]	Modified verified flag[b]	Comment
3508	4	CL11F	R	—	X0	c
3508	5	CL11F	R	—	X0	c
3508	6	CL11F	D	—	X0	c
3508	8	CL11F	LN8	—	X0	c
3515	5	CL11F	FL15	—	X0	c
3515	6	CL11F	R	—	X0	c
3717	6	ALKA11F	LS3	—	X0	c
3717	10	ALKA11F	R	—	X0	c
3721	8	ALKA11F	B	—	X0	c

[a] An X flag is applied when a value is deemed invalid. It is recommended that this value should not be used in statistical analyses.
[b] Only X flags are provided. Other flags which may be in the data bases are not shown.
[c] X flag added to modified verified data base.

Appendix B

Results of the Decision Process for Chloride, Sulfate, and Nitrate Assessment

Results of the decision process using the accuracy and precision estimates for chloride, sulfate, and nitrate are provided in tables B-1 through B-6.

The audit percent differences (accuracy estimates) were calculated using the following equation:

$$\% \text{ Relative Difference} = \left| \frac{(\text{reference} - \text{measured})}{\text{reference}} \right| \times 100$$

The reference concentration for a given audit sample is the median value of all the laboratory data and, where possible, the National Streams Survey (NSS-I) data. The measured value refers to the measured concentration of a given audit sample.

The percent differences for the routine/duplicate pairs (precision estimates) were calculated using the following equation:

$$\% \text{ Relative Difference} = \left| \frac{(\text{routine} - \text{duplicate})}{\text{routine}} \right| \times 100$$

The legend for tables B-1 through B-6 is presented below:

FN7 - Seventh Lake field natural audit sample.
FN8 - Big Moose Lake field natural audit sample.
FL - Field synthetic audit sample.
LL - Laboratory synthetic audit sample.

Analysis 1 - The first sample analysis, performed in March and April of 1986, consists of all the Spring Seasonal subsurvey chloride, sulfate, and nitrate determinations.
Analysis 2 - The second sample analysis, performed in May and June of 1986, consists of all the Spring Seasonal subsurvey chloride, sulfate, and nitrate determinations.
Analysis 3 - The third sample analysis, performed in May of 1987 (during data verification), consists of selected samples from the Spring Seasonal subsurvey chloride, sulfate, and nitrate determinations.
Indecisive - When a conclusive decision could not be made between the two (sometimes three) analyses, the Analysis 2 data remained in the data base.

Table B-1. Results of the Decision Process Using the Accuracy Estimates For Chloride Based on the Audit Sample Data; Spring Seasonal Subsurvey, Eastern Lake Survey-Phase II

Audit type	Batch ID	Reference value (mg/L)	Percent difference for Analysis 1	Percent difference for Analysis 2	Percent difference for Analysis 3	Decision based on accuracy[a]
FN7	3500	2.950	30.51	39.66	*b*	Indecisive
LN7	3501	2.950	67.76	85.39	*b*	Indecisive
FN7	3501	2.950	47.88	1.83	*b*	Indecisive
FL14	3502	0.330	100.00	20.00	*b*	Analysis 2
FN7	3503	2.950	44.04	197.93	44.10	Indecisive
FN7	3504	2.950	50.82	29.32	*b*	Indecisive
LN7	3504	2.950	48.13	84.30	*b*	Indecisive
FN8	3505	0.412	53.20	77.42	0.72	Analysis 3
LN8	3506	0.412	35.43	58.71	4.61	Analysis 3
FN8	3506	0.412	54.85	65.29	4.51	Analysis 3
FN7	3507	2.950	12.47	16.81	*b*	Indecisive
LN7	3507	2.950	16.47	5.11	*b*	Indecisive
FN8	3508	0.412	50.00	41.26	*b*	Indecisive
LN8	3508	0.412	59.70	32.76	*b*	Indecisive
FN7	3509	2.950	7.79	10.37	*b*	Indecisive
LN8	3510	0.412	50.00	7.52	*b*	Analysis 2
FN8	3510	0.412	40.29	12.62	*b*	Analysis 2
FL13	3511	0.330	55.15	0.00	*b*	Analysis 2
FL14	3512	0.330	34.84	20.90	*b*	Analysis 2
LL14	3512	0.330	35.75	6.97	*b*	Analysis 2
FL14	3513	0.330	43.33	16.36	*b*	Analysis 2
FN8	3514	0.412	50.00	9.95	*b*	Analysis 2
FL15	3515	0.330	78.18	10.60	*b*	Analysis 2
FL15	3516	0.330	23.63	26.97	*b*	Indecisive
LL15	3516	0.330	36.36	43.03	*b*	Indecisive
FL7	3517	2.950	14.16	3.89	*b*	Analysis 2
FN7	3518	2.950	12.20	51.69	*b*	Analysis 1
LN7	3518	2.950	10.23	2.16	*b*	Analysis 1
FN8	3519	0.412	8.73	11.16	*b*	Analysis 1
FL15	3520	0.330	16.97	104.24	*b*	Analysis 1
FN8	3521	0.412	5.82	45.63	31.55	Analysis 1
LN8	3521	0.412	3.88	77.42	0.72	Analysis 1
LN8	3522	0.412	47.57	23.78	*b*	Indecisive
FN8	3522	0.412	9.70	23.05	*b*	Indecisive
LL15	3523	0.330	13.33	6.97	*b*	Indecisive
FL15	3523	0.330	6.66	10.30	*b*	Indecisive
FN8	3524	0.412	16.99	15.53	*b*	Indecisive
LN8	3524	0.412	2.42	4.12	*b*	Indecisive
FN7	3525	2.950	1.15	2.37	*b*	Indecisive
LN7	3526	2.950	32.40	5.72	*b*	Analysis 2
FN7	3526	2.950	40.47	0.33	*b*	Analysis 2
FN7	3527	2.950	12.13	5.35	*b*	Analysis 2
FN8	3528	0.412	44.41	16.50	*b*	Analysis 2

[a] A decision based on accuracy estimates was made on a batch-by-batch basis.
[b] Reanalyses were not required for these batches.

Table B-2. Results of the Decision Process Using the Precision Estimates for Chloride Based on the Routine/Duplicate Paired Data, Spring Seasonal Subsurvey, Eastern Lake Survey-Phase II

Batch ID	Percent difference for Analysis 1	Percent difference for Analysis 2	Percent difference for Analysis 3	Decision based on precision
3500	0.86	31.51	[a]	Analysis 1
3501	33.66	1,104.77	[a]	Analysis 1
3502	36.64	24.64	[a]	Analysis 2
3503	475.28	126.29	3.19	Analysis 3
3504	2.01	43.52	[a]	Analysis 1
3505	61.85	58.10	15.95	Analysis 3
3506	49.08	53.28	17.12	Analysis 3
3507	10.85	21.04	[a]	Analysis 1
3508	33.51	7.18	[a]	Analysis 2
3509	10.86	3.20	[a]	Analysis 2
3510	16.52	0.54	[a]	Analysis 2
3511	2.64	6.80	[a]	Indecisive
3512	0.00	17.82	[a]	Analysis 1
3513	48.60	31.83	[a]	Analysis 2
3514	0.00	6.40	[a]	Analysis 1
3515	0.00	0.00	[a]	Indecisive
3516	0.48	0.33	[a]	Indecisive
3517	370.00	40.06	[a]	Analysis 2
3518	2.21	40.00	[a]	Analysis 1
3519	0.35	4.46	[a]	Indecisive
3520	4.76	25.95	[a]	Analysis 1
3521	5.55	38.83	36.96	Analysis 1
3522	42.83	6.13	[a]	Analysis 2
3523	0.89	3.60	[a]	Indecisive
3524	3.84	4.99	[a]	Indecisive
3525	7.38	1.99	[a]	Analysis 2
3526	23.43	71.05	[a]	Analysis 1
3527	0.00	7.77	[a]	Analysis 1
3528	6.51	4.95	[a]	Indecisive

[a] Reanalyses were not required for these batches.

Table B-3. Results of the Decision Process Using the Accuracy Estimates For Sulfate Based on the Audit Sample Data; Spring Seasonal Subsurvey, Eastern Lake Survey-Phase II

Audit type	Batch ID	Reference value (mg/L)	Percent difference for Analysis 1	Percent difference for Analysis 2	Percent difference for Analysis 3	Decision based on accuracy[a]
FN7	3500	6.850	26.42	4.65	*b*	Analysis 2
LN7	3501	6.850	67.88	8.75	*b*	Analysis 2
FN7	3501	6.850	15.29	5.91	*b*	Analysis 2
FL14	3502	2.235	82.99	5.54	*b*	Analysis 2
FN7	3503	6.850	0.90	5.34	*b*	Analysis 1
FN7	3504	6.850	1.19	11.19	*b*	Analysis 1
LN7	3504	6.850	4.29	15.25	*b*	Analysis 1
FN8	3505	6.335	11.94	22.71	*b*	Analysis 1
LN8	3506	6.335	10.29	3.33	*b*	Analysis 2
FN8	3506	6.335	9.39	3.66	*b*	Analysis 2
FN7	3507	6.850	8.47	20.52	*b*	Indecisive
LN7	3507	6.850	10.91	0.37	*b*	Indecisive
FN8	3508	6.335	11.22	9.18	*b*	Indecisive
LN8	3508	6.335	8.08	23.55	*b*	Indecisive
FN7	3509	6.850	5.96	8.94	*b*	Analysis 1
LN8	3510	6.335	11.46	17.60	8.19	Analysis 3
FN8	3510	6.335	12.45	18.50	7.35	Analysis 3
FL13	3511	2.235	12.98	11.67	*b*	Indecisive
FL14	3512	2.235	34.04	4.29	*b*	Analysis 2
LL14	3512	2.235	36.24	3.62	*b*	Analysis 2
FL14	3513	2.235	36.64	5.68	*b*	Analysis 2
FN8	3514	6.335	5.03	5.82	*b*	Indecisive
FL15	3515	2.235	11.89	2.01	*b*	Analysis 2
FL15	3516	2.235	13.91	7.33	*b*	Indecisive
LL15	3516	2.235	5.14	9.61	*b*	Indecisive
FN7	3517	6.850	8.67	4.05	*b*	Analysis 2
FN7	3518	6.850	5.19	18.05	*b*	Analysis 1
LN7	3518	6.850	3.62	42.18	*b*	Analysis 1
FN8	3519	6.335	2.95	7.19	*b*	Analysis 1
FL15	3520	2.235	6.21	4.34	*b*	Analysis 2
FN8	3521	6.335	4.56	2.20	8.19	Analysis 1
LN8	3521	6.335	3.99	42.38	5.66	Analysis 1
LN8	3522	6.335	60.56	20.91	*b*	Analysis 2
FN8	3522	6.335	0.67	21.62	*b*	Analysis 2
LL15	3523	2.235	4.87	7.20	*b*	Analysis 1
FL15	3523	2.235	5.68	10.69	*b*	Analysis 1
FN8	3524	6.335	4.65	0.12	*b*	Analysis 2
LN8	3524	6.335	12.39	0.59	*b*	Analysis 2
FN7	3525	6.850	23.35	0.01	*b*	Analysis 2
LN7	3526	6.850	8.26	3.85	*b*	Analysis 2
FN7	3526	6.850	8.05	1.97	*b*	Analysis 2
FN7	3527	6.850	11.76	3.40	*b*	Analysis 2
FN8	3528	6.335	42.71	4.62	*b*	Analysis 2

[a] A decision based on accuracy estimates was made on a batch-by-batch basis.
[b] Reanalyses were not required for these batches.

Table B-4. Results of the Decision Process Using the Precision Estimates for Sulfate Based on the Routine/Duplicate Paired Data, Spring Seasonal Subsurvey, Eastern Lake Survey-Phase II

Batch ID	Percent difference for Analysis 1	Percent difference for Analysis 2	Percent difference for Analysis 3	Decision based on precision
3500	11.17	1.18	[a]	Analysis 2
3501	3.79	1.13	[a]	Analysis 2
3502	35.00	0.19	[a]	Analysis 2
3503	8.12	12.50	[a]	Analysis 1
3504	1.18	8.58	[a]	Analysis 1
3505	2.13	15.69	[a]	Analysis 1
3506	2.88	0.29	[a]	Analysis 2
3507	2.46	16.03	[a]	Analysis 1
3508	0.94	18.94	[a]	Analysis 1
3509	0.67	0.22	[a]	Indecisive
3510	8.01	10.37	0.88	Analysis 3
3511	7.28	1.37	[a]	Analysis 2
3512	16.54	2.03	[a]	Analysis 2
3513	4.38	0.42	[a]	Analysis 2
3514	1.76	0.83	[a]	Indecisive
3515	1.13	0.62	[a]	Indecisive
3516	2.39	7.67	[a]	Analysis 1
3517	0.50	1.91	[a]	Indecisive
3518	0.42	26.09	[a]	Analysis 1
3519	0.52	0.93	[a]	Indecisive
3520	1.53	3.66	[a]	Indecisive
3521	3.33	37.80	1.69	Analysis 3
3522	176.80	23.46	[a]	Analysis 2
3523	0.30	4.24	[a]	Analysis 1
3524	1.29	4.56	[a]	Analysis 1
3525	4.52	1.87	[a]	Analysis 2
3526	0.68	0.93	[a]	Indecisive
3527	1.32	1.13	[a]	Indecisive
3528	1.45	0.39	[a]	Indecisive

[a] Reanalyses were not required for these batches.

Table B-5. Results of the Decision Process Using the Accuracy Estimates For Nitrate Based on the Audit Sample Data; Spring Seasonal Subsurvey, Eastern Lake Survey-Phase II

Audit type	Batch ID	Reference value (mg/L)	Percent difference for Analysis 1	Percent difference for Analysis 2	Percent difference for Analysis 3	Decision based on accuracy[a]
FN7	3500	1.264	17.48	8.63	*b*	Analysis 2
LN7	3501	1.264	10.75	8.38	20.25	Analysis 2
FN7	3501	1.264	32.04	6.45	10.98	Analysis 2
FL14	3502	0.471	16.77	10.25	*b*	Analysis 2
FN7	3503	1.264	0.63	8.06	*b*	Analysis 1
FN7	3504	1.264	3.71	11.36	*b*	Analysis 1
LN7	3504	1.264	2.05	34.59	*b*	Analysis 1
FN8	3505	1.200	28.34	26.60	*b*	Indecisive
LN8	3506	1.200	12.40	3.28	*b*	Analysis 2
FN8	3506	1.200	12.05	3.66	*b*	Analysis 2
FN7	3507	1.264	12.68	20.93	*b*	Indecisive
LN7	3507	1.264	14.77	0.15	*b*	Indecisive
FN8	3508	1.200	15.55	7.75	*b*	Indecisive
LN8	3508	1.200	14.03	22.29	*b*	Indecisive
FN7	3509	1.264	8.33	13.73	*b*	Analysis 1
LN8	3510	1.200	14.93	20.85	*b*	Analysis 1
FN8	3510	1.200	16.25	23.51	*b*	Analysis 1
FL13	3511	0.471	16.26	0.97	*b*	Analysis 2
FL14	3512	0.471	30.74	0.59	*b*	Analysis 2
LL14	3512	0.471	41.74	28.59	*b*	Analysis 2
FL14	3513	0.471	57.36	27.24	*b*	Analysis 2
FN8	3514	1.200	7.00	8.70	*b*	Indecisive
FL15	3515	0.471	21.86	49.66	*b*	Analysis 1
FL15	3516	0.471	22.25	5.20	*b*	Indecisive
LL15	3516	0.471	20.00	35.32	*b*	Indecisive
FN7	3517	1.264	10.53	166.66	*b*	Analysis 1
FN7	3518	1.264	9.09	40.78	*b*	Analysis 1
LN7	3518	1.264	10.17	30.75	*b*	Analysis 1
FN8	3519	1.200	8.86	13.59	*b*	Analysis 1
FL15	3520	0.471	11.88	59.15	*b*	Analysis 1
FN8	3521	1.200	9.43	2.07	15.06	Analysis 1
LN8	3521	1.200	9.88	66.37	8.75	Analysis 1
LN8	3522	1.200	70.61	23.87	*b*	Indecisive
FN8	3522	1.200	1.00	22.63	*b*	Indecisive
LL15	3523	0.471	13.80	7.43	*b*	Analysis 2
FL15	3523	0.471	10.10	7.43	*b*	Analysis 2
FN8	3524	1.200	6.11	12.83	*b*	Indecisive
LN8	3524	1.200	11.80	7.99	*b*	Indecisive
FN7	3525	1.264	21.83	10.96	*b*	Analysis 2
LN7	3526	1.264	11.42	2.86	*b*	Analysis 2
FN7	3526	1.264	9.52	7.58	*b*	Analysis 2
FN7	3527	1.264	13.40	2.86	*b*	Analysis 2
FN8	3528	1.200	38.02	2.65	*b*	Analysis 2

[a] A decision based on accuracy estimates was made on a batch-by-batch basis.
[b] Reanalyses were not required for these batches.

Table B-6. Results of the Decision Process Using the Precision Estimates for Nitrate Based on the Routine/Duplicate Paired Data, Spring Seasonal Subsurvey, Eastern Lake Survey-Phase II

Batch ID	Percent difference for Analysis 1	Percent difference for Analysis 2	Percent difference for Analysis 3	Decision based on precision
3500	3.89	1.96	0.00	Indecisive
3501	12.40	2.42	[a]	Analysis 2
3502	15.91	0.00	[a]	Analysis 2
3503	0.00	3,709.09	[a]	Analysis 1
3504	0.00	0.00	[a]	Indecisive
3505	0.00	0.00	[a]	Indecisive
3506	2.86	4.77	[a]	Indecisive
3507	1.98	19.84	[a]	Analysis 1
3508	7.63	28.34	[a]	Analysis 1
3609	10.13	1.40	[a]	Analysis 2
3510	39.00	19.54	[a]	Analysis 2
3511	34.28	5.16	[a]	Analysis 2
3512	36.75	2.84	[a]	Analysis 2
3513	25.17	4.40	[a]	Analysis 2
3514	6.55	0.60	[a]	Analysis 2
3515	45.00	5.16	[a]	Analysis 2
3516	22.22	9.20	[a]	Analysis 2
3517	0.16	0.67	[a]	Indecisive
3518	2.73	50.36	[a]	Analysis 1
3519	0.70	0.94	[a]	Indecisive
3520	0.93	2.54	[a]	Indecisive
3521	1.51	16.63	0.00	Indecisive
3522	0.00	0.00	[a]	Indecisive
3523	0.00	0.00	[a]	Indecisive
3524	0.00	0.00	[a]	Indecisive
3525	0.00	0.00	[a]	Indecisive
3526	12.87	34.46	[a]	Analysis 1
3527	14.92	82.47	[a]	Analysis 1
3528	3.69	5.48	[a]	Indecisive

[a] Reanalyses were not required for these batches.

Appendix C

Summary Statistics for Natural Audit Sample Data

Summary statistics for estimates of accuracy and precision based on the natural audit samples are provided in tables C-1 through C-6. These tables present estimates for all 30 (6 processing laboratory and 24 analytical laboratory) analytes. The processing laboratory, by design, does not analyze laboratory natural audit samples. Therefore, there are no lab target values for processing laboratory variables (Al-dis, Al-org, DIC-closed, pH-closed, true color, and turbidity) in tables C-1, C-3, C-4, and C-6. For the same reason there are also no summary statistics for laboratory natural audits for processing laboratory variables.

Terms and abbreviations used in tables C-1 through C-6 are defined as follows:

Field target: These reference values[a] for Seventh Lake and Big Moose Lake are the medians of all the available Seventh Lake and Big Moose Lake field natural audit sample data, respectively.

Lab target: These reference values[a] for Seventh Lake and Big Moose Lake are the medians of all the available Seventh Lake and Big Moose Lake laboratory natural audit sample data, respectively.

N - Number of audit samples
Median - Median of N data points
Mean - Mean of N data points
Std - Standard deviation of N data points
Q1 - Lower quartile or 25th percentile: the value below which 25% of all data falls.
Q3 - Upper quartile or 75th percentile: the value below which 75% of all data falls.
P10 - 10th percentile: the value below which 10% of all data falls.
P90 - 90th percentile: the value below which 90% of all data falls.

Subsurvey-lab:

Spring-1 = Spring Seasonal subsurvey analysis performed by Laboratory 1.

Summer-1 = Summer Seasonal subsurvey analysis performed by Laboratory 1.

Summer-2 = Summer Seasonal subsurvey analysis performed by Laboratory 2.

Summer-1+2 = Summer Seasonal subsurvey analyses; Laboratory 1 and Laboratory 2 data combined.

Fall-2 = Fall Seasonal subsurvey analysis performed by Laboratory 2.

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[a] Reference values were generated from all the ELS-II data (including the Spring Variability Pilot Study) for the Seventh Lake natural audit data. Reference values for Big Moose Lake audit data were determined from the ELS-II and NSS-I data.

Spring-PL = Spring Seasonal subsurvey analysis performed by the processing laboratory.

Summer-PL = Summer Seasonal subsurvey analysis performed by the processing laboratory.

Fall-PL = Fall Seasonal subsurvey analysis performed by the processing laboratory.

Table C-1. Summary Statistics for Seventh Lake Field Natural Audits, Eastern Lake Survey - Phase II

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Al-ext	(mg/L)	Spring-1	0.0163	0.0302	11	0.0227	0.0205	0.0074	0.0114	0.0260	0.0095	0.0289
Al-ext	(mg/L)	Summer-1	0.0163	0.0302	3	-0.0025	-0.0006	0.0036	-0.0029	0.0035	-0.0029	0.0035
Al-ext	(mg/L)	Summer-2	0.0163	0.0302	4	0.0163	0.0160	0.0017	0.0142	0.0174	0.0137	0.0175
Al-ext	(mg/L)	Summer-1+2	0.0163	0.0302	7	0.0137	0.0089	0.0092	-0.0025	0.0171	-0.0029	0.0175
Al-ext	(mg/L)	Fall-2	0.0163	0.0302	11	0.0117	0.0132	0.0043	0.0103	0.0170	0.0069	0.0199
Al-total	(mg/L)	Spring-1	0.0627	0.0682	11	0.0651	0.0578	0.0165	0.0410	0.0706	0.0324	0.0768
Al-total	(mg/L)	Summer-1	0.0627	0.0682	3	0.0875	0.1408	0.1126	0.0648	0.2702	0.0648	0.2702
Al-total	(mg/L)	Summer-2	0.0627	0.0682	4	0.0517	0.0502	0.0176	0.0330	0.0660	0.0306	0.0670
Al-total	(mg/L)	Summer-1+2	0.0627	0.0682	7	0.0648	0.0891	0.0820	0.0404	0.0875	0.0306	0.2702
Al-total	(mg/L)	Fall-2	0.0627	0.0682	11	0.0607	0.0699	0.0419	0.0478	0.0720	0.0353	0.1678
Al-dis	(mg/L)	Spring-PL	0.0212	—	8	0.0226	0.0225	0.0050	0.0179	0.0272	0.0149	0.0294
Al-dis	(mg/L)	Summer-PL	0.0212	—	7	0.0200	0.0209	0.0058	0.0174	0.0264	0.0129	0.0304
Al-dis	(mg/L)	Fall-PL	0.0212	—	11	0.0259	0.0246	0.0034	0.0216	0.0270	0.0196	0.0291
Al-org	(mg/L)	Spring-PL	0.0165	—	8	0.0223	0.0226	0.0063	0.0184	0.0250	0.0129	0.0347
Al-org	(mg/L)	Summer-PL	0.0165	—	7	0.0055	0.0088	0.0095	0.0027	0.0151	-0.0003	0.0272
Al-org	(mg/L)	Fall-PL	0.0165	—	11	0.0150	0.0153	0.0034	0.0125	0.0183	0.0100	0.0196
ANC	(μeq/L)	Spring-1	155.0	151.1	11	148.3	150.0	17.7	139.3	153.7	125.4	185.7
ANC	(μeq/L)	Summer-1	155.0	151.1	3	155.2	153.1	6.2	146.1	158.0	146.1	158.0
ANC	(μeq/L)	Summer-2	155.0	151.1	4	153.6	165.8	27.2	150.5	193.4	149.6	206.5
ANC	(μeq/L)	Summer-1+2	155.0	151.1	7	154.0	160.4	20.7	149.6	158.0	146.1	206.5
ANC	(μeq/L)	Fall-2	155.0	151.1	11	155.7	158.9	8.7	154.4	170.3	147.8	172.5
BNC	(μeq/L)	Spring-1	36.1	35.6	11	51.2	66.5	58.5	42.4	60.9	26.5	205.8
BNC	(μeq/L)	Summer-1	36.1	35.6	3	36.1	36.0	5.2	30.7	41.1	30.7	41.1
BNC	(μeq/L)	Summer-2	36.1	35.6	4	36.5	37.5	7.2	31.1	44.9	30.0	47.0
BNC	(μeq/L)	Summer-1+2	36.1	35.6	7	36.1	36.9	6.0	30.7	41.1	30.0	47.0
BNC	(μeq/L)	Fall-2	36.1	35.6	11	32.8	35.0	7.6	28.1	43.4	25.0	46.6
Ca	(mg/L)	Spring-1	5.050	4.842	11	4.908	4.909	0.116	4.817	4.928	4.783	5.157
Ca	(mg/L)	Summer-1	5.050	4.842	3	5.023	4.990	0.171	4.804	5.142	4.804	5.142
Ca	(mg/L)	Summer-2	5.050	4.842	4	4.993	5.007	0.079	4.938	5.089	4.930	5.110
Ca	(mg/L)	Summer-1+2	5.050	4.842	7	5.023	4.999	0.114	4.930	5.110	4.804	5.142
Ca	(mg/L)	Fall-2	5.050	4.842	11	5.158	5.165	0.095	5.101	5.231	5.026	5.304
Cl^-	(mg/L)	Spring-1	2.940	2.943	11	2.940	3.175	1.103	2.582	4.251	1.571	5.137
Cl^-	(mg/L)	Summer-1	2.940	2.943	3	2.393	2.366	0.079	2.277	2.428	2.277	2.428
Cl^-	(mg/L)	Summer-2	2.940	2.943	4	2.915	2.910	0.025	2.885	2.930	2.875	2.935
Cl^-	(mg/L)	Summer-1+2	2.940	2.943	7	2.875	2.677	0.295	2.393	2.915	2.277	2.935
Cl^-	(mg/L)	Fall-2	2.940	2.943	11	2.970	2.913	0.181	2.920	2.975	2.485	3.043

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Table C-1. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Cond	(µS/cm)	Spring-1	47.0	47.3	11	48.2	48.2	0.7	47.6	48.4	47.2	49.6
Cond	(µS/cm)	Summer-1	47.0	47.3	3	48.5	48.5	0.2	48.3	48.6	48.3	48.6
Cond	(µS/cm)	Summer-2	47.0	47.3	4	46.4	46.3	0.5	45.8	46.7	45.7	46.7
Cond	(µS/cm)	Summer-1+2	47.0	47.3	7	46.7	47.2	1.2	46.2	48.5	45.7	48.6
Cond	(µS/cm)	Fall-2	47.0	47.3	11	46.4	46.2	1.6	46.2	47.0	42.5	47.3
DIC-closed	(mg/L)	Spring-PL	2.047	—	11	2.081	2.052	0.069	1.982	2.105	1.968	2.154
DIC-closed	(mg/L)	Summer-PL	2.047	—	7	2.014	2.004	0.105	1.921	2.073	1.823	2.144
DIC-closed	(mg/L)	Fall-PL	2.047	—	11	2.036	1.980	0.362	1.996	2.099	1.155	2.360
DIC-eq	(mg/L)	Spring-1	1.725	1.668	11	2.225	2.157	0.213	1.950	2.328	1.864	2.465
DIC-eq	(mg/L)	Summer-1	1.725	1.668	3	2.390	2.451	0.110	2.386	2.578	2.386	2.578
DIC-eq	(mg/L)	Summer-2	1.725	1.668	4	1.617	1.627	0.058	1.578	1.686	1.574	1.700
DIC-eq	(mg/L)	Summer-1+2	1.725	1.668	7	1.700	1.980	0.447	1.589	2.390	1.574	2.578
DIC-eq	(mg/L)	Fall-2	1.725	1.668	11	1.554	1.561	0.111	1.490	1.644	1.390	1.756
DIC-initial	(mg/L)	Spring-1	2.018	1.965	11	2.289	2.252	0.134	2.120	2.367	2.030	2.417
DIC-initial	(mg/L)	Summer-1	2.018	1.965	3	2.421	2.454	0.125	2.349	2.593	2.349	2.593
DIC-initial	(mg/L)	Summer-2	2.018	1.965	4	1.852	1.854	0.142	1.718	1.992	1.689	2.023
DIC-initial	(mg/L)	Summer-1+2	2.018	1.965	7	2.023	2.111	0.344	1.806	2.421	1.689	2.593
DIC-initial	(mg/L)	Fall-2	2.018	1.965	11	1.873	1.900	0.099	1.845	1.983	1.765	2.069
DOC	(mg/L)	Spring-1	3.56	3.56	11	3.53	3.52	0.33	3.37	3.77	2.82	3.94
DOC	(mg/L)	Summer-1	3.56	3.56	3	3.72	3.73	0.07	3.67	3.81	3.67	3.81
DOC	(mg/L)	Summer-2	3.56	3.56	4	3.59	3.59	0.09	3.51	3.67	3.49	3.70
DOC	(mg/L)	Summer-1+2	3.56	3.56	7	3.67	3.65	0.11	3.58	3.72	3.49	3.81
DOC	(mg/L)	Fall-2	3.56	3.56	11	3.55	3.51	0.13	3.49	3.60	3.23	3.64
F^--total	(mg/L)	Spring-1	0.0661	0.0639	11	0.0585	0.0604	0.0116	0.0538	0.0624	0.0498	0.0669
F^--total	(mg/L)	Summer-1	0.0661	0.0639	3	0.0683	0.0674	0.0043	0.0627	0.0712	0.0627	0.0712
F^--total	(mg/L)	Summer-2	0.0661	0.0639	4	0.0665	0.0678	0.0058	0.0631	0.0737	0.0622	0.0759
F^--total	(mg/L)	Summer-1+2	0.0661	0.0639	7	0.0673	0.0676	0.0048	0.0627	0.0712	0.0622	0.0759
F^--total	(mg/L)	Fall-2	0.0661	0.0639	11	0.0686	0.0698	0.0042	0.0670	0.0732	0.0658	0.0784
Fe	(mg/L)	Spring-1	0.026	0.027	11	0.029	0.027	0.004	0.024	0.030	0.021	0.032
Fe	(mg/L)	Summer-1	0.026	0.027	3	0.027	0.028	0.002	0.026	0.030	0.026	0.030
Fe	(mg/L)	Summer-2	0.026	0.027	4	0.026	0.026	0.003	0.023	0.028	0.022	0.028
Fe	(mg/L)	Summer-1+2	0.026	0.027	7	0.027	0.026	0.003	0.024	0.028	0.022	0.030
Fe	(mg/L)	Fall-2	0.026	0.027	11	0.022	0.022	0.002	0.019	0.023	0.018	0.026
K	(mg/L)	Spring-1	0.490	0.503	11	0.490	0.492	0.015	0.480	0.506	0.471	0.511
K	(mg/L)	Summer-1	0.490	0.503	3	0.506	0.507	0.009	0.499	0.517	0.499	0.517
K	(mg/L)	Summer-2	0.490	0.503	4	0.489	0.495	0.027	0.474	0.522	0.469	0.533
K	(mg/L)	Summer-1+2	0.490	0.503	7	0.499	0.500	0.021	0.489	0.517	0.469	0.533
K	(mg/L)	Fall-2	0.490	0.503	11	0.483	0.464	0.058	0.424	0.514	0.354	0.516

(Continued)

Table C-1. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Mg	(mg/L)	Spring-1	0.824	0.800	11	0.829	0.824	0.016	0.810	0.834	0.796	0.845
Mg	(mg/L)	Summer-1	0.824	0.800	3	0.825	0.830	0.011	0.822	0.843	0.822	0.843
Mg	(mg/L)	Summer-2	0.824	0.800	4	0.795	0.793	0.012	0.781	0.803	0.777	0.805
Mg	(mg/L)	Summer-1+2	0.824	0.800	7	0.805	0.809	0.023	0.794	0.825	0.777	0.843
Mg	(mg/L)	Fall-2	0.824	0.800	11	0.822	0.824	0.012	0.815	0.826	0.814	0.852
Mn	(mg/L)	Spring-1	0.005	0.005	11	0.005	0.004	0.003	0.004	0.005	0.000	0.009
Mn	(mg/L)	Summer-1	0.005	0.005	3	0.005	0.005	0.000	0.005	0.005	0.005	0.005
Mn	(mg/L)	Summer-2	0.005	0.005	4	0.001	0.001	0.001	0.000	0.002	0.000	0.003
Mn	(mg/L)	Summer-1+2	0.005	0.005	7	0.003	0.003	0.002	0.001	0.005	0.000	0.005
Mn	(mg/L)	Fall-2	0.005	0.005	11	0.005	0.005	0.001	0.004	0.006	0.003	0.008
Na	(mg/L)	Spring-1	2.176	2.181	11	2.150	2.138	0.082	2.033	2.200	2.007	2.238
Na	(mg/L)	Summer-1	2.176	2.181	3	2.142	2.142	0.039	2.104	2.181	2.104	2.181
Na	(mg/L)	Summer-2	2.176	2.181	4	2.158	2.277	0.322	2.061	2.613	2.044	2.750
Na	(mg/L)	Summer-1+2	2.176	2.181	7	2.142	2.220	0.240	2.104	2.203	2.044	2.750
Na	(mg/L)	Fall-2	2.176	2.181	11	2.185	2.203	0.067	2.158	2.277	2.110	2.313
NH_4^+	(mg/L)	Spring-1	0.010	0.019	11	0.010	0.009	0.016	-0.006	0.019	-0.011	0.037
NH_4^+	(mg/L)	Summer-1	0.010	0.019	3	0.017	0.019	0.004	0.017	0.023	0.017	0.023
NH_4^+	(mg/L)	Summer-2	0.010	0.019	4	0.021	0.021	0.012	0.010	0.033	0.008	0.035
NH_4^+	(mg/L)	Summer-1+2	0.010	0.019	7	0.017	0.020	0.009	0.015	0.028	0.008	0.035
NH_4^+	(mg/L)	Fall-2	0.010	0.019	11	0.013	0.016	0.017	0.002	0.019	-0.002	0.051
NO_3^-	(mg/L)	Spring-1	1.2725	1.2853	11	1.2720	1.2557	0.1085	1.1490	1.3599	1.1090	1.3967
NO_3^-	(mg/L)	Summer-1	1.2725	1.2853	3	1.3118	1.3131	0.0391	1.2746	1.3528	1.2746	1.3528
NO_3^-	(mg/L)	Summer-2	1.2725	1.2853	4	1.2663	1.2682	0.0130	1.2568	1.2815	1.2557	1.2845
NO_3^-	(mg/L)	Summer-1+2	1.2725	1.2853	7	1.2746	1.2874	0.0342	1.2602	1.3118	1.2557	1.3528
NO_3^-	(mg/L)	Fall-2	1.2725	1.2853	11	1.2645	1.2416	0.0739	1.2500	1.2736	1.0644	1.2764
P-total	(mg/L)	Spring-1	0.0022	0.0012	11	0.0030	0.0030	0.0024	0.0010	0.0050	0.0000	0.0074
P-total	(mg/L)	Summer-1	0.0022	0.0012	3	0.0023	0.0028	0.0014	0.0018	0.0044	0.0018	0.0044
P-total	(mg/L)	Summer-2	0.0022	0.0012	4	0.0016	0.0020	0.0012	0.0012	0.0033	0.0011	0.0038
P-total	(mg/L)	Summer-1+2	0.0022	0.0012	7	0.0018	0.0024	0.0012	0.0015	0.0038	0.0011	0.0044
P-total	(mg/L)	Fall-2	0.0022	0.0012	11	0.0025	0.0025	0.0010	0.0021	0.0031	0.0008	0.0044
pH-ANC	(pH units)	Spring-1	7.02	6.97	11	7.09	7.04	0.10	6.93	7.13	6.91	7.16
pH-ANC	(pH units)	Summer-1	7.02	6.97	3	6.97	6.98	0.03	6.95	7.01	6.95	7.01
pH-ANC	(pH units)	Summer-2	7.02	6.97	4	7.03	7.03	0.08	6.96	7.11	6.94	7.13
pH-ANC	(pH units)	Summer-1+2	7.02	6.97	7	7.01	7.01	0.06	6.95	7.04	6.94	7.13
pH-ANC	(pH units)	Fall-2	7.02	6.97	11	7.00	7.00	0.08	6.99	7.03	6.82	7.09

(Continued)

Table C-1. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
pH-BNC	(pH units)	Spring-1	7.07	7.01	11	7.07	7.05	0.14	6.91	7.18	6.85	7.21
pH-BNC	(pH units)	Summer-1	7.07	7.01	3	6.94	6.96	0.05	6.92	7.01	6.92	7.01
pH-BNC	(pH units)	Summer-2	7.07	7.01	4	7.10	7.09	0.10	6.99	7.18	6.97	7.19
pH-BNC	(pH units)	Summer-1+2	7.07	7.01	7	7.01	7.03	0.10	6.94	7.14	6.92	7.19
pH-BNC	(pH units)	Fall-2	7.07	7.01	11	7.05	7.05	0.09	6.97	7.12	6.92	7.19
pH-closed	(pH units)	Spring-PL	6.89	—	11	6.92	6.91	0.03	6.89	6.94	6.87	6.96
pH-closed	(pH units)	Summer-PL	6.89	—	7	6.68	6.68	0.09	6.62	6.74	6.52	6.81
pH-closed	(pH units)	Fall-PL	6.89	—	11	6.90	6.90	0.04	6.87	6.92	6.83	6.95
pH-eq	(pH units)	Spring-1	7.28	7.28	11	7.28	7.28	0.06	7.27	7.33	7.18	7.36
pH-eq	(pH units)	Summer-1	7.28	7.28	3	7.19	7.22	0.12	7.11	7.35	7.11	7.35
pH-eq	(pH units)	Summer-2	7.28	7.28	4	7.34	7.37	0.13	7.26	7.50	7.25	7.54
pH-eq	(pH units)	Summer-1+2	7.28	7.28	7	7.31	7.30	0.14	7.19	7.38	7.11	7.54
pH-eq	(pH units)	Fall-2	7.28	7.28	11	7.05	7.07	0.14	7.01	7.16	6.81	7.29
SiO_2	(mg/L)	Spring-1	4.820	4.738	11	4.820	4.760	0.194	4.630	4.880	4.346	4.956
SiO_2	(mg/L)	Summer-1	4.820	4.738	3	4.733	4.793	0.158	4.673	4.972	4.673	4.972
SiO_2	(mg/L)	Summer-2	4.820	4.738	4	4.863	4.856	0.044	4.811	4.894	4.798	4.900
SiO_2	(mg/L)	Summer-1+2	4.820	4.738	7	4.849	4.829	0.102	4.733	4.900	4.673	4.972
SiO_2	(mg/L)	Fall-2	4.820	4.738	11	4.776	4.641	0.453	4.735	4.820	3.549	4.903
SO_4^{2-}	(mg/L)	Spring-1	6.850	6.730	11	6.849	6.798	0.321	6.494	7.128	6.303	7.238
SO_4^{2-}	(mg/L)	Summer-1	6.850	6.730	3	7.072	6.791	0.739	5.952	7.348	5.952	7.348
SO_4^{2-}	(mg/L)	Summer-2	6.850	6.730	4	6.895	6.942	0.232	6.750	7.182	6.720	7.260
SO_4^{2-}	(mg/L)	Summer-1+2	6.850	6.730	7	6.950	6.877	0.464	6.720	7.260	5.952	7.348
SO_4^{2-}	(mg/L)	Fall-2	6.850	6.730	11	6.770	6.456	0.904	6.615	6.930	4.346	6.982
True color	(PCU)	Spring-PL	15.0	—	11	15.0	15.0	4.5	10.0	20.0	10.0	20.0
True color	(PCU)	Summer-PL	15.0	—	7	20.0	19.3	3.5	15.0	20.0	15.0	25.0
True color	(PCU)	Fall-PL	15.0	—	10	15.0	16.0	3.2	15.0	20.0	10.5	20.0
Turbidity	(NTU)	Spring-PL	0.100	—	11	0.160	0.212	0.198	0.120	0.180	0.104	0.684
Turbidity	(NTU)	Summer-PL	0.100	—	7	0.100	0.100	0.058	0.100	0.100	0.000	0.200
Turbidity	(NTU)	Fall-PL	0.100	—	10	0.100	0.120	0.042	0.100	0.125	0.100	0.200

Table C-2. Summary Statistics for Seventh Lake Lab Natural Audits, Eastern Lake Survey - Phase II

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Al-ext	(mg/L)	Spring-1	0.0163	0.0302	5	0.0335	0.0328	0.0050	0.0280	0.0372	0.0258	0.0390
Al-ext	(mg/L)	Summer-1	0.0163	0.0302	2	0.0152	0.0152	0.0081	0.0095	0.0210	0.0095	0.0210
Al-ext	(mg/L)	Summer-2	0.0163	0.0302	4	0.0277	0.0278	0.0008	0.0272	0.0287	0.0271	0.0289
Al-ext	(mg/L)	Summer-1+2	0.0163	0.0302	6	0.0272	0.0236	0.0075	0.0181	0.0282	0.0095	0.0289
Al-ext	(mg/L)	Fall-2	0.0163	0.0302	6	0.0259	0.0258	0.0025	0.0233	0.0280	0.0228	0.0294
Al-total	(mg/L)	Spring-1	0.0627	0.0682	5	0.0640	0.0603	0.0174	0.0454	0.0732	0.0326	0.0798
Al-total	(mg/L)	Summer-1	0.0627	0.0682	10	0.0725	0.0817	0.0257	0.0698	0.0821	0.0625	0.1441
Al-total	(mg/L)	Summer-2	0.0627	0.0682	8	0.0584	0.0571	0.0104	0.0470	0.0670	0.0439	0.0700
Al-total	(mg/L)	Summer-1+2	0.0627	0.0682	18	0.0698	0.0708	0.0235	0.0597	0.0728	0.0466	0.1062
Al-total	(mg/L)	Fall-2	0.0627	0.0682	6	0.0553	0.0557	0.0171	0.0426	0.0711	0.0295	0.0788
ANC	(μeq/L)	Spring-1	155.0	151.1	5	145.1	146.2	6.6	140.2	152.6	137.7	154.4
ANC	(μeq/L)	Summer-1	155.0	151.1	10	138.9	138.9	8.7	133.6	143.8	123.5	153.4
ANC	(μeq/L)	Summer-2	155.0	151.1	8	153.6	154.7	3.4	152.1	156.3	151.5	162.0
ANC	(μeq/L)	Summer-1+2	155.0	151.1	18	149.5	145.9	10.5	136.9	153.9	130.9	157.0
ANC	(μeq/L)	Fall-2	155.0	151.1	6	156.5	168.5	24.4	155.7	182.1	154.3	216.7
BNC	(μeq/L)	Spring-1	36.1	35.6	5	51.6	49.6	14.8	35.3	62.9	34.3	70.5
BNC	(μeq/L)	Summer-1	36.1	35.6	10	35.7	35.3	3.4	34.1	38.1	27.6	38.9
BNC	(μeq/L)	Summer-2	36.1	35.6	8	36.9	37.9	5.5	33.3	43.2	31.6	46.8
BNC	(μeq/L)	Summer-1+2	36.1	35.6	18	35.7	36.5	4.5	34.1	38.5	31.1	44.8
BNC	(μeq/L)	Fall-2	36.1	35.6	6	35.4	35.1	11.2	25.6	42.4	20.2	53.1
Ca	(mg/L)	Spring-1	5.050	4.842	5	4.808	4.801	0.036	4.765	4.832	4.747	4.834
Ca	(mg/L)	Summer-1	5.050	4.842	10	4.778	4.786	0.043	4.747	4.817	4.739	4.860
Ca	(mg/L)	Summer-2	5.050	4.842	8	4.877	4.887	0.072	4.825	4.928	4.818	5.034
Ca	(mg/L)	Summer-1+2	5.050	4.842	18	4.821	4.831	0.076	4.763	4.875	4.740	4.946
Ca	(mg/L)	Fall-2	5.050	4.842	6	4.991	5.014	0.122	4.899	5.145	4.897	5.171
Cl^-	(mg/L)	Spring-1	2.940	2.943	5	2.464	2.196	0.938	1.240	3.016	0.951	3.252
Cl^-	(mg/L)	Summer-1	2.940	2.943	10	2.880	3.547	3.139	1.597	3.669	1.394	11.309
Cl^-	(mg/L)	Summer-2	2.940	2.943	8	2.965	2.979	0.099	2.897	3.075	2.840	3.130
Cl^-	(mg/L)	Summer-1+2	2.940	2.943	18	2.918	3.294	2.303	2.825	3.100	1.399	4.610
Cl^-	(mg/L)	Fall-2	2.940	2.943	6	2.952	2.945	0.059	2.880	2.994	2.880	3.025
Cond	(μS/cm)	Spring-1	47.0	47.3	5	47.7	47.7	0.4	47.3	48.0	47.0	48.1
Cond	(μS/cm)	Summer-1	47.0	47.3	10	48.4	48.3	0.5	47.9	48.5	47.4	49.1
Cond	(μS/cm)	Summer-2	47.0	47.3	5	46.7	46.1	1.2	44.9	46.9	44.1	47.0
Cond	(μS/cm)	Summer-1+2	47.0	47.3	15	48.0	47.5	1.3	46.8	48.5	45.1	48.9
Cond	(μS/cm)	Fall-2	47.0	47.3	6	47.1	47.1	0.3	46.8	47.3	46.7	47.4

(Continued)

Table C-2. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
DIC-eq	(mg/L)	Spring-1	1.725	1.668	5	2.117	2.184	0.223	1.997	2.404	1.974	2.518
DIC-eq	(mg/L)	Summer-1	1.725	1.668	10	2.475	2.291	0.748	2.350	2.584	0.421	2.840
DIC-eq	(mg/L)	Summer-2	1.725	1.668	8	1.562	1.570	0.073	1.500	1.633	1.484	1.692
DIC-eq	(mg/L)	Summer-1+2	1.725	1.668	18	2.016	1.971	0.659	1.554	2.503	1.356	2.708
DIC-eq	(mg/L)	Fall-2	1.725	1.668	6	1.616	1.611	0.080	1.537	1.683	1.508	1.706
DIC-initial	(mg/L)	Spring-1	2.018	1.965	5	2.280	2.280	0.085	2.197	2.363	2.170	2.370
DIC-initial	(mg/L)	Summer-1	2.018	1.965	10	2.580	2.373	0.824	2.487	2.731	0.299	2.835
DIC-initial	(mg/L)	Summer-2	2.018	1.965	8	1.931	1.909	0.079	1.862	1.966	1.745	1.982
DIC-initial	(mg/L)	Summer-1+2	2.018	1.965	18	2.231	2.167	0.646	1.918	2.657	1.576	2.786
DIC-initial	(mg/L)	Fall-2	2.018	1.965	6	1.923	1.906	0.068	1.870	1.946	1.779	1.978
DOC	(mg/L)	Spring-1	3.56	3.56	5	3.50	4.13	1.72	3.19	5.38	3.18	7.18
DOC	(mg/L)	Summer-1	3.56	3.56	10	3.49	3.43	0.23	3.19	3.61	3.05	3.72
DOC	(mg/L)	Summer-2	3.56	3.56	8	3.56	3.61	0.18	3.49	3.66	3.47	4.02
DOC	(mg/L)	Summer-1+2	3.56	3.56	18	3.55	3.51	0.23	3.40	3.62	3.15	3.75
DOC	(mg/L)	Fall-2	3.56	3.56	6	3.61	3.63	0.10	3.54	3.70	3.52	3.80
F^--total	(mg/L)	Spring-1	0.0661	0.0639	5	0.0576	0.0586	0.0047	0.0543	0.0635	0.0536	0.0640
F^--total	(mg/L)	Summer-1	0.0661	0.0639	10	0.0642	0.0640	0.0043	0.0602	0.0659	0.0596	0.0730
F^--total	(mg/L)	Summer-2	0.0661	0.0639	8	0.0642	0.0668	0.0078	0.0638	0.0658	0.0620	0.0859
F^--total	(mg/L)	Summer-1+2	0.0661	0.0639	18	0.0642	0.0653	0.0061	0.0616	0.0657	0.0600	0.0749
F^--total	(mg/L)	Fall-2	0.0661	0.0639	6	0.0673	0.0684	0.0057	0.0639	0.0730	0.0620	0.0777
Fe	(mg/L)	Spring-1	0.026	0.027	5	0.030	0.030	0.003	0.028	0.033	0.027	0.035
Fe	(mg/L)	Summer-1	0.026	0.027	10	0.021	0.022	0.005	0.018	0.028	0.016	0.029
Fe	(mg/L)	Summer-2	0.026	0.027	8	0.027	0.027	0.002	0.026	0.028	0.025	0.031
Fe	(mg/L)	Summer-1+2	0.026	0.027	18	0.026	0.024	0.005	0.020	0.028	0.017	0.029
Fe	(mg/L)	Fall-2	0.026	0.027	6	0.023	0.025	0.005	0.021	0.029	0.021	0.035
K	(mg/L)	Spring-1	0.490	0.503	5	0.484	0.490	0.015	0.480	0.501	0.480	0.516
K	(mg/L)	Summer-1	0.490	0.503	10	0.517	0.516	0.006	0.517	0.517	0.501	0.522
K	(mg/L)	Summer-2	0.490	0.503	8	0.495	0.491	0.016	0.480	0.502	0.462	0.512
K	(mg/L)	Summer-1+2	0.490	0.503	18	0.514	0.505	0.017	0.496	0.517	0.477	0.518
K	(mg/L)	Fall-2	0.490	0.503	6	0.483	0.475	0.018	0.452	0.490	0.450	0.490
Mg	(mg/L)	Spring-1	0.824	0.800	5	0.801	0.812	0.017	0.800	0.830	0.800	0.836
Mg	(mg/L)	Summer-1	0.824	0.800	10	0.799	0.799	0.012	0.791	0.808	0.778	0.817
Mg	(mg/L)	Summer-2	0.824	0.800	8	0.797	0.791	0.015	0.777	0.801	0.766	0.810
Mg	(mg/L)	Summer-1+2	0.824	0.800	18	0.797	0.795	0.013	0.786	0.805	0.775	0.811
Mg	(mg/L)	Fall-2	0.824	0.800	6	0.799	0.802	0.011	0.794	0.811	0.791	0.821

(Continued)

Table C-2. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Mn	(mg/L)	Spring-1	0.005	0.005	5	0.005	0.004	0.002	0.002	0.005	0.000	0.006
Mn	(mg/L)	Summer-1	0.005	0.005	10	0.005	0.005	0.000	0.005	0.005	0.004	0.006
Mn	(mg/L)	Summer-2	0.005	0.005	8	0.001	0.001	0.001	0.000	0.001	0.000	0.002
Mn	(mg/L)	Summer-1+2	0.005	0.005	18	0.004	0.003	0.002	0.001	0.005	0.000	0.005
Mn	(mg/L)	Fall-2	0.005	0.005	6	0.006	0.005	0.001	0.005	0.006	0.005	0.006
Na	(mg/L)	Spring-1	2.176	2.181	5	2.200	2.146	0.116	2.021	2.244	2.000	2.245
Na	(mg/L)	Summer-1	2.176	2.181	10	2.181	2.169	0.032	2.142	2.181	2.108	2.215
Na	(mg/L)	Summer-2	2.176	2.181	8	2.208	2.296	0.221	2.163	2.517	2.044	2.673
Na	(mg/L)	Summer-1+2	2.176	2.181	18	2.181	2.225	0.157	2.148	2.211	2.098	2.603
Na	(mg/L)	Fall-2	2.176	2.181	6	2.217	2.278	0.159	2.164	2.431	2.118	2.541
NH_4^+	(mg/L)	Spring-1	0.010	0.019	5	0.001	0.006	0.020	-0.012	0.026	-0.013	0.033
NH_4^+	(mg/L)	Summer-1	0.010	0.019	10	0.014	0.014	0.007	0.012	0.018	-0.002	0.023
NH_4^+	(mg/L)	Summer-2	0.010	0.019	8	0.019	0.023	0.020	0.007	0.034	0.004	0.064
NH_4^+	(mg/L)	Summer-1+2	0.010	0.019	18	0.015	0.018	0.014	0.012	0.022	0.003	0.041
NH_4^+	(mg/L)	Fall-2	0.010	0.019	6	0.068	0.073	0.033	0.047	0.097	0.038	0.131
NO_3^-	(mg/L)	Spring-1	1.2725	1.2853	5	1.2380	1.2242	0.1191	1.1063	1.3351	1.0772	1.3700
NO_3^-	(mg/L)	Summer-1	1.2725	1.2853	10	1.3049	1.2994	0.0417	1.2917	1.3203	1.2029	1.3445
NO_3^-	(mg/L)	Summer-2	1.2725	1.2853	8	1.2483	1.2373	0.0412	1.1913	1.2751	1.1879	1.2847
NO_3^-	(mg/L)	Summer-1+2	1.2725	1.2853	18	1.2853	1.2718	0.0513	1.2286	1.3087	1.1910	1.3421
NO_3^-	(mg/L)	Fall-2	1.2725	1.2853	6	1.2736	1.2650	0.0239	1.2518	1.2807	1.2184	1.2812
P-total	(mg/L)	Spring-1	0.0022	0.0012	5	0.0010	0.0014	0.0011	0.0005	0.0025	0.0000	0.0030
P-total	(mg/L)	Summer-1	0.0022	0.0012	10	0.0016	0.0019	0.0014	0.0007	0.0027	0.0002	0.0045
P-total	(mg/L)	Summer-2	0.0022	0.0012	8	0.0008	0.0012	0.0013	0.0005	0.0025	-0.0004	0.0035
P-total	(mg/L)	Summer-1+2	0.0022	0.0012	18	0.0010	0.0016	0.0014	0.0007	0.0026	0.0001	0.0039
P-total	(mg/L)	Fall-2	0.0022	0.0012	6	0.0029	0.0029	0.0010	0.0021	0.0038	0.0016	0.0043
pH-ANC	(pH units)	Spring-1	7.02	6.97	5	7.01	7.01	0.06	6.95	7.07	6.95	7.10
pH-ANC	(pH units)	Summer-1	7.02	6.97	10	6.94	6.96	0.05	6.92	7.01	6.88	7.05
pH-ANC	(pH units)	Summer-2	7.02	6.97	8	6.94	6.94	0.03	6.91	6.97	6.91	6.98
pH-ANC	(pH units)	Summer-1+2	7.02	6.97	18	6.94	6.95	0.04	6.92	6.98	6.91	7.02
pH-ANC	(pH units)	Fall-2	7.02	6.97	6	7.01	7.04	0.07	6.99	7.12	6.98	7.16
pH-BNC	(pH units)	Spring-1	7.07	7.01	5	7.01	7.04	0.09	6.97	7.11	6.96	7.18
pH-BNC	(pH units)	Summer-1	7.07	7.01	10	6.99	6.97	0.08	6.90	7.03	6.84	7.05
pH-BNC	(pH units)	Summer-2	7.07	7.01	8	7.00	7.01	0.02	7.00	7.03	6.97	7.03
pH-BNC	(pH units)	Summer-1+2	7.07	7.01	18	7.00	6.98	0.06	6.96	7.03	6.85	7.03
pH-BNC	(pH units)	Fall-2	7.07	7.01	6	7.10	7.09	0.09	7.00	7.17	6.98	7.22

(Continued)

Table C-2. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
pH-eq	(pH units)	Spring-1	7.28	7.28	5	7.27	7.27	0.05	7.22	7.31	7.20	7.33
pH-eq	(pH units)	Summer-1	7.28	7.28	10	7.30	7.27	0.11	7.20	7.36	7.04	7.37
pH-eq	(pH units)	Summer-2	7.28	7.28	8	7.14	7.10	0.21	6.92	7.28	6.73	7.31
pH-eq	(pH units)	Summer-1+2	7.28	7.28	18	7.27	7.20	0.18	7.10	7.32	6.86	7.36
pH-eq	(pH units)	Fall-2	7.28	7.28	6	7.05	7.06	0.06	7.00	7.11	6.98	7.16
SiO_2	(mg/L)	Spring-1	4.820	4.738	5	4.840	4.832	0.164	4.705	4.955	4.590	5.050
SiO_2	(mg/L)	Summer-1	4.820	4.738	10	4.643	4.610	0.170	4.558	4.668	4.254	4.868
SiO_2	(mg/L)	Summer-2	4.820	4.738	8	4.638	4.651	0.119	4.543	4.757	4.511	4.815
SiO_2	(mg/L)	Summer-1+2	4.820	4.738	18	4.643	4.628	0.147	4.552	4.724	4.431	4.822
SiO_2	(mg/L)	Fall-2	4.820	4.738	6	4.856	4.835	0.071	4.766	4.899	4.720	4.899
SO_4^{2-}	(mg/L)	Spring-1	6.850	6.730	5	6.602	6.777	0.527	6.344	7.297	6.103	7.450
SO_4^{2-}	(mg/L)	Summer-1	6.850	6.730	10	6.444	6.405	0.145	6.370	6.496	6.056	6.510
SO_4^{2-}	(mg/L)	Summer-2	6.850	6.730	8	6.565	6.586	0.354	6.300	6.899	6.080	7.040
SO_4^{2-}	(mg/L)	Summer-1+2	6.850	6.730	18	6.444	6.485	0.267	6.351	6.573	6.075	6.914
SO_4^{2-}	(mg/L)	Fall-2	6.850	6.730	6	6.950	7.166	0.482	6.879	7.575	6.710	8.025

Table C-3. Summary Statistics for Seventh Lake Field and Lab Natural Audits Pooled, Eastern Lake Survey - Phase II

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Al-ext	(mg/L)	Spring-1	0.0163	0.0302	16	0.0259	0.0243	0.0088	0.0177	0.0300	0.0098	0.0365
Al-ext	(mg/L)	Summer-1	0.0163	0.0302	5	0.0035	0.0057	0.0099	-0.0027	0.0152	-0.0029	0.0210
Al-ext	(mg/L)	Summer-2	0.0163	0.0302	8	0.0223	0.0219	0.0065	0.0160	0.0278	0.0137	0.0289
Al-ext	(mg/L)	Summer-1+2	0.0163	0.0302	13	0.0171	0.0157	0.0112	0.0065	0.0272	-0.0027	0.0285
Al-ext	(mg/L)	Fall-2	0.0163	0.0302	17	0.0170	0.0177	0.0072	0.0108	0.0242	0.0091	0.0279
Al-total	(mg/L)	Spring-1	0.0627	0.0682	16	0.0645	0.0585	0.0163	0.0420	0.0702	0.0324	0.0787
Al-total	(mg/L)	Summer-1	0.0627	0.0682	13	0.0726	0.0953	0.0573	0.0698	0.0945	0.0629	0.2216
Al-total	(mg/L)	Summer-2	0.0627	0.0682	12	0.0584	0.0548	0.0128	0.0446	0.0663	0.0335	0.0694
Al-total	(mg/L)	Summer-1+2	0.0627	0.0682	25	0.0679	0.0759	0.0463	0.0578	0.0730	0.0425	0.1204
Al-total	(mg/L)	Fall-2	0.0627	0.0682	17	0.0574	0.0649	0.0352	0.0474	0.0703	0.0319	0.1012
Al-dis	(mg/L)	Spring-PL	0.0212	—	8	0.0226	0.0225	0.0050	0.0179	0.0272	0.0149	0.0294
Al-dis	(mg/L)	Summer-PL	0.0212	—	7	0.0200	0.0209	0.0058	0.0174	0.0264	0.0129	0.0304
Al-dis	(mg/L)	Fall-PL	0.0212	—	11	0.0259	0.0246	0.0034	0.0216	0.0270	0.0196	0.0291
Al-org	(mg/L)	Spring-PL	0.0165	—	8	0.0223	0.0226	0.0063	0.0184	0.0250	0.0129	0.0347
Al-org	(mg/L)	Summer-PL	0.0165	—	7	0.0055	0.0088	0.0095	0.0027	0.0151	-0.0003	0.0272
Al-org	(mg/L)	Fall-PL	0.0165	—	11	0.0150	0.0153	0.0034	0.0125	0.0183	0.0100	0.0196
ANC	(μeq/L)	Spring-1	155.0	151.1	16	147.9	148.8	14.9	139.6	153.6	132.3	175.3
ANC	(μeq/L)	Summer-1	155.0	151.1	13	142.4	142.2	10.1	135.1	150.8	126.3	156.9
ANC	(μeq/L)	Summer-2	155.0	151.1	12	153.6	158.4	15.4	152.1	156.3	150.2	193.1
ANC	(μeq/L)	Summer-1+2	155.0	151.1	25	151.8	150.0	15.1	141.5	154.6	133.2	159.6
ANC	(μeq/L)	Fall-2	155.0	151.1	17	156.5	162.3	16.0	154.7	170.4	149.9	181.5
BNC	(μeq/L)	Spring-1	36.1	35.6	16	51.4	61.2	49.0	37.9	59.8	30.1	127.5
BNC	(μeq/L)	Summer-1	36.1	35.6	13	35.7	35.5	3.7	33.8	38.1	28.5	40.3
BNC	(μeq/L)	Summer-2	36.1	35.6	12	36.9	37.8	5.8	33.3	43.2	30.5	46.9
BNC	(μeq/L)	Summer-1+2	36.1	35.6	25	35.7	36.6	4.8	33.8	38.8	30.4	45.5
BNC	(μeq/L)	Fall-2	36.1	35.6	17	34.3	35.0	8.7	27.7	41.1	23.6	48.1
Ca	(mg/L)	Spring-1	5.050	4.842	16	4.839	4.875	0.110	4.799	4.921	4.770	5.065
Ca	(mg/L)	Summer-1	5.050	4.842	13	4.804	4.833	0.119	4.752	4.849	4.739	5.094
Ca	(mg/L)	Summer-2	5.050	4.842	12	4.916	4.927	0.092	4.840	5.008	4.820	5.088
Ca	(mg/L)	Summer-1+2	5.050	4.842	25	4.835	4.878	0.116	4.797	4.950	4.746	5.065
Ca	(mg/L)	Fall-2	5.050	4.842	17	5.114	5.112	0.126	5.035	5.219	4.899	5.295
Cl^-	(mg/L)	Spring-1	2.940	2.943	16	2.813	2.869	1.125	2.153	3.295	1.301	4.653
Cl^-	(mg/L)	Summer-1	2.940	2.943	13	2.781	3.274	2.767	1.970	3.275	1.396	8.797
Cl^-	(mg/L)	Summer-2	2.940	2.943	12	2.927	2.956	0.087	2.896	3.016	2.850	3.118
Cl^-	(mg/L)	Summer-1+2	2.940	2.943	25	2.915	3.121	1.964	2.604	3.002	1.558	3.690
Cl^-	(mg/L)	Fall-2	2.940	2.943	17	2.970	2.925	0.147	2.900	2.979	2.778	3.041

(Continued)

Table C-3. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Cond	(µS/cm)	Spring-1	47.0	47.3	16	47.9	48.0	0.7	47.6	48.3	47.1	49.1
Cond	(µS/cm)	Summer-1	47.0	47.3	13	48.4	48.3	0.4	48.0	48.5	47.5	48.9
Cond	(µS/cm)	Summer-2	47.0	47.3	9	46.6	46.2	0.9	45.7	46.7	44.1	47.0
Cond	(µS/cm)	Summer-1+2	47.0	47.3	22	47.8	47.4	1.3	46.7	48.5	45.7	48.7
Cond	(µS/cm)	Fall-2	47.0	47.3	17	46.9	46.5	1.3	46.3	47.1	44.8	47.3
DIC-closed	(mg/L)	Spring-PL	2.047	—	11	2.081	2.052	0.069	1.982	2.105	1.968	2.154
DIC-closed	(mg/L)	Summer-PL	2.047	—	7	2.014	2.004	0.105	1.921	2.073	1.823	2.144
DIC-closed	(mg/L)	Fall-PL	2.047	—	11	2.036	1.980	0.362	1.996	2.099	1.155	2.360
DIC-eq	(mg/L)	Spring-1	1.725	1.668	16	2.181	2.165	0.209	1.977	2.319	1.874	2.489
DIC-eq	(mg/L)	Summer-1	1.725	1.668	13	2.453	2.328	0.653	2.370	2.563	1.061	2.791
DIC-eq	(mg/L)	Summer-2	1.725	1.668	12	1.577	1.589	0.071	1.549	1.650	1.484	1.698
DIC-eq	(mg/L)	Summer-1+2	1.725	1.668	25	1.700	1.974	0.598	1.571	2.475	1.485	2.624
DIC-eq	(mg/L)	Fall-2	1.725	1.668	17	1.572	1.579	0.102	1.501	1.668	1.445	1.720
DIC-initial	(mg/L)	Spring-1	2.018	1.965	16	2.284	2.261	0.119	2.162	2.366	2.080	2.393
DIC-initial	(mg/L)	Summer-1	2.018	1.965	13	2.515	2.392	0.716	2.450	2.702	0.974	2.817
DIC-initial	(mg/L)	Summer-2	2.018	1.965	12	1.913	1.891	0.101	1.816	1.966	1.706	2.011
DIC-initial	(mg/L)	Summer-1+2	2.018	1.965	25	2.023	2.151	0.571	1.901	2.554	1.723	2.741
DIC-initial	(mg/L)	Fall-2	2.018	1.965	17	1.900	1.902	0.087	1.849	1.956	1.774	2.010
DOC	(mg/L)	Spring-1	3.56	3.56	16	3.51	3.71	0.97	3.35	3.74	3.03	4.94
DOC	(mg/L)	Summer-1	3.56	3.56	13	3.57	3.50	0.24	3.27	3.70	3.09	3.78
DOC	(mg/L)	Summer-2	3.56	3.56	12	3.58	3.61	0.15	3.50	3.66	3.47	3.92
DOC	(mg/L)	Summer-1+2	3.56	3.56	25	3.58	3.55	0.21	3.47	3.68	3.19	3.76
DOC	(mg/L)	Fall-2	3.56	3.56	17	3.56	3.55	0.13	3.52	3.63	3.30	3.70
F^--total	(mg/L)	Spring-1	0.0661	0.0639	16	0.0580	0.0598	0.0098	0.0538	0.0626	0.0518	0.0727
F^--total	(mg/L)	Summer-1	0.0661	0.0639	13	0.0643	0.0648	0.0044	0.0604	0.0676	0.0598	0.0727
F^--total	(mg/L)	Summer-2	0.0661	0.0639	12	0.0645	0.0672	0.0069	0.0638	0.0670	0.0621	0.0829
F^--total	(mg/L)	Summer-1+2	0.0661	0.0639	25	0.0644	0.0659	0.0058	0.0624	0.0671	0.0602	0.0746
F^--total	(mg/L)	Fall-2	0.0661	0.0639	17	0.0686	0.0693	0.0046	0.0658	0.0723	0.0641	0.0781
Fe	(mg/L)	Spring-1	0.026	0.027	16	0.029	0.028	0.004	0.026	0.030	0.022	0.034
Fe	(mg/L)	Summer-1	0.026	0.027	13	0.024	0.023	0.005	0.018	0.028	0.016	0.030
Fe	(mg/L)	Summer-2	0.026	0.027	12	0.027	0.027	0.002	0.025	0.028	0.023	0.030
Fe	(mg/L)	Summer-1+2	0.026	0.027	25	0.026	0.025	0.004	0.022	0.028	0.018	0.029
Fe	(mg/L)	Fall-2	0.026	0.027	17	0.023	0.023	0.004	0.021	0.023	0.018	0.028
K	(mg/L)	Spring-1	0.490	0.503	16	0.485	0.491	0.015	0.480	0.506	0.475	0.512
K	(mg/L)	Summer-1	0.490	0.503	13	0.517	0.514	0.008	0.511	0.517	0.499	0.521
K	(mg/L)	Summer-2	0.490	0.503	12	0.489	0.492	0.019	0.480	0.502	0.464	0.527
K	(mg/L)	Summer-1+2	0.490	0.503	25	0.506	0.504	0.018	0.489	0.517	0.475	0.519
K	(mg/L)	Fall-2	0.490	0.503	17	0.483	0.468	0.048	0.452	0.495	0.366	0.516

(Continued)

Table C-3. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Mg	(mg/L)	Spring-1	0.824	0.800	16	0.825	0.820	0.017	0.803	0.833	0.798	0.844
Mg	(mg/L)	Summer-1	0.824	0.800	13	0.804	0.806	0.018	0.794	0.820	0.781	0.836
Mg	(mg/L)	Summer-2	0.824	0.800	12	0.796	0.792	0.013	0.778	0.801	0.769	0.808
Mg	(mg/L)	Summer-1+2	0.824	0.800	25	0.797	0.799	0.017	0.789	0.808	0.776	0.823
Mg	(mg/L)	Fall-2	0.824	0.800	17	0.817	0.816	0.016	0.804	0.824	0.794	0.838
Mn	(mg/L)	Spring-1	0.005	0.005	16	0.005	0.004	0.003	0.004	0.005	0.000	0.007
Mn	(mg/L)	Summer-1	0.005	0.005	13	0.005	0.005	0.000	0.005	0.005	0.004	0.006
Mn	(mg/L)	Summer-2	0.005	0.005	12	0.001	0.001	0.001	0.000	0.001	0.000	0.003
Mn	(mg/L)	Summer-1+2	0.005	0.005	25	0.004	0.003	0.002	0.001	0.005	0.000	0.005
Mn	(mg/L)	Fall-2	0.005	0.005	17	0.005	0.005	0.001	0.005	0.006	0.004	0.007
Na	(mg/L)	Spring-1	2.176	2.181	16	2.160	2.141	0.090	2.035	2.215	2.000	2.244
Na	(mg/L)	Summer-1	2.176	2.181	13	2.181	2.163	0.034	2.142	2.181	2.104	2.204
Na	(mg/L)	Summer-2	2.176	2.181	12	2.205	2.290	0.243	2.122	2.517	2.044	2.727
Na	(mg/L)	Summer-1+2	2.176	2.181	25	2.181	2.224	0.179	2.142	2.208	2.080	2.626
Na	(mg/L)	Fall-2	2.176	2.181	17	2.190	2.230	0.110	2.165	2.281	2.115	2.423
NH_4^+	(mg/L)	Spring-1	0.010	0.019	16	0.009	0.008	0.017	-0.008	0.020	-0.012	0.035
NH_4^+	(mg/L)	Summer-1	0.010	0.019	13	0.014	0.015	0.007	0.013	0.019	0.002	0.023
NH_4^+	(mg/L)	Summer-2	0.010	0.019	12	0.019	0.023	0.017	0.010	0.033	0.004	0.056
NH_4^+	(mg/L)	Summer-1+2	0.010	0.019	25	0.017	0.019	0.013	0.013	0.023	0.005	0.036
NH_4^+	(mg/L)	Fall-2	0.010	0.019	17	0.019	0.036	0.036	0.008	0.058	-0.001	0.095
NO_3^-	(mg/L)	Spring-1	1.2725	1.2853	16	1.2550	1.2458	0.1089	1.1388	1.3563	1.0957	1.3820
NO_3^-	(mg/L)	Summer-1	1.2725	1.2853	13	1.3084	1.3025	0.0399	1.2898	1.3275	1.2261	1.3496
NO_3^-	(mg/L)	Summer-2	1.2725	1.2853	12	1.2583	1.2476	0.0369	1.2036	1.2759	1.1889	1.2846
NO_3^-	(mg/L)	Summer-1+2	1.2725	1.2853	25	1.2845	1.2762	0.0470	1.2560	1.3091	1.1914	1.3430
NO_3^-	(mg/L)	Fall-2	1.2725	1.2853	17	1.2695	1.2499	0.0610	1.2539	1.2758	1.1793	1.2806
P-total	(mg/L)	Spring-1	0.0022	0.0012	16	0.0020	0.0025	0.0022	0.0010	0.0037	0.0000	0.0059
P-total	(mg/L)	Summer-1	0.0022	0.0012	13	0.0020	0.0021	0.0014	0.0009	0.0031	0.0004	0.0045
P-total	(mg/L)	Summer-2	0.0022	0.0012	12	0.0010	0.0015	0.0013	0.0008	0.0028	-0.0002	0.0037
P-total	(mg/L)	Summer-1+2	0.0022	0.0012	25	0.0015	0.0018	0.0014	0.0008	0.0027	0.0003	0.0040
P-total	(mg/L)	Fall-2	0.0022	0.0012	17	0.0026	0.0027	0.0010	0.0021	0.0032	0.0014	0.0044
pH-ANC	(pH units)	Spring-1	7.02	6.97	16	7.03	7.03	0.09	6.94	7.12	6.92	7.14
pH-ANC	(pH units)	Summer-1	7.02	6.97	13	6.95	6.97	0.05	6.93	7.01	6.89	7.04
pH-ANC	(pH units)	Summer-2	7.02	6.97	12	6.94	6.97	0.07	6.92	7.02	6.91	7.10
pH-ANC	(pH units)	Summer-1+2	7.02	6.97	25	6.95	6.97	0.06	6.93	7.01	6.91	7.04
pH-ANC	(pH units)	Fall-2	7.02	6.97	17	7.00	7.01	0.08	6.99	7.05	6.94	7.12

(Continued)

Table C-3. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
pH-BNC	(pH units)	Spring-1	7.07	7.01	16	7.03	7.04	0.12	6.96	7.18	6.87	7.21
pH-BNC	(pH units)	Summer-1	7.07	7.01	13	6.98	6.96	0.07	6.92	7.02	6.84	7.04
pH-BNC	(pH units)	Summer-2	7.07	7.01	12	7.01	7.04	0.07	7.00	7.06	6.97	7.17
pH-BNC	(pH units)	Summer-1+2	7.07	7.01	25	7.00	7.00	0.08	6.95	7.03	6.89	7.10
pH-BNC	(pH units)	Fall-2	7.07	7.01	17	7.06	7.06	0.09	6.99	7.12	6.92	7.21
pH-closed	(pH units)	Spring-PL	6.89	—	11	6.92	6.91	0.03	6.89	6.94	6.87	6.96
pH-closed	(pH units)	Summer-PL	6.89	—	7	6.68	6.68	0.09	6.62	6.74	6.52	6.81
pH-closed	(pH units)	Fall-PL	6.89	—	11	6.90	6.90	0.04	6.87	6.92	6.83	6.95
pH-eq	(pH units)	Spring-1	7.28	7.28	16	7.28	7.28	0.05	7.25	7.32	7.19	7.35
pH-eq	(pH units)	Summer-1	7.28	7.28	13	7.28	7.26	0.11	7.19	7.35	7.06	7.37
pH-eq	(pH units)	Summer-2	7.28	7.28	12	7.26	7.19	0.22	7.08	7.31	6.77	7.49
pH-eq	(pH units)	Summer-1+2	7.28	7.28	25	7.28	7.23	0.17	7.15	7.34	6.96	7.37
pH-eq	(pH units)	Fall-2	7.28	7.28	17	7.05	7.07	0.12	7.01	7.15	6.94	7.20
SiO_2	(mg/L)	Spring-1	4.820	4.738	16	4.820	4.782	0.183	4.662	4.875	4.497	4.987
SiO_2	(mg/L)	Summer-1	4.820	4.738	13	4.653	4.652	0.180	4.613	4.723	4.320	4.937
SiO_2	(mg/L)	Summer-2	4.820	4.738	12	4.756	4.719	0.140	4.560	4.840	4.519	4.893
SiO_2	(mg/L)	Summer-1+2	4.820	4.738	25	4.673	4.685	0.162	4.583	4.806	4.488	4.891
SiO_2	(mg/L)	Fall-2	4.820	4.738	17	4.814	4.709	0.373	4.740	4.856	4.268	4.903
SO_4^{2-}	(mg/L)	Spring-1	6.850	6.730	16	6.782	6.792	0.378	6.517	7.140	6.219	7.313
SO_4^{2-}	(mg/L)	Summer-1	6.850	6.730	13	6.451	6.494	0.368	6.355	6.506	5.982	7.238
SO_4^{2-}	(mg/L)	Summer-2	6.850	6.730	12	6.800	6.705	0.354	6.362	6.937	6.140	7.194
SO_4^{2-}	(mg/L)	Summer-1+2	6.850	6.730	25	6.495	6.595	0.370	6.365	6.897	6.058	7.147
SO_4^{2-}	(mg/L)	Fall-2	6.850	6.730	17	6.924	6.707	0.840	6.727	6.960	5.142	7.545
True color	(PCU)	Spring-PL	15.0	—	11	15.0	15.0	4.5	10.0	20.0	10.0	20.0
True color	(PCU)	Summer-PL	15.0	—	7	20.0	19.3	3.5	15.0	20.0	15.0	25.0
True color	(PCU)	Fall-PL	15.0	—	10	15.0	16.0	3.2	15.0	20.0	10.5	20.0
Turbidity	(NTU)	Spring-PL	0.100	—	11	0.160	0.212	0.198	0.120	0.180	0.104	0.684
Turbidity	(NTU)	Summer-PL	0.100	—	7	0.100	0.100	0.058	0.100	0.100	0.000	0.200
Turbidity	(NTU)	Fall-PL	0.100	—	10	0.100	0.120	0.042	0.100	0.125	0.100	0.200

Table C-4. Summary Statistics for Big Moose Lake Field Natural Audits, Eastern Lake Survey - Phase II

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Al-ext	(mg/L)	Spring-1	0.1658	0.2106	8	0.1540	0.1417	0.0297	0.1072	0.1652	0.0950	0.1659
Al-ext	(mg/L)	Summer-1	0.1658	0.2106	5	0.1407	0.1159	0.0661	0.0529	0.1664	0.0093	0.1699
Al-ext	(mg/L)	Summer-2	0.1658	0.2106	6	0.1728	0.1729	0.0229	0.1491	0.1969	0.1453	0.1998
Al-ext	(mg/L)	Summer-1+2	0.1658	0.2106	11	0.1630	0.1470	0.0538	0.1407	0.1800	0.0268	0.1990
Al-ext	(mg/L)	Fall-2	0.1658	0.2106	10	0.1362	0.1372	0.0170	0.1230	0.1519	0.1152	0.1654
Al-total	(mg/L)	Spring-1	0.2650	0.2641	8	0.2849	0.2844	0.0218	0.2796	0.3023	0.2365	0.3038
Al-total	(mg/L)	Summer-1	0.2650	0.2641	5	0.2522	0.2607	0.0189	0.2450	0.2807	0.2406	0.2844
Al-total	(mg/L)	Summer-2	0.2650	0.2641	6	0.2406	0.2333	0.0284	0.1996	0.2591	0.1984	0.2620
Al-total	(mg/L)	Summer-1+2	0.2650	0.2641	11	0.2494	0.2458	0.0274	0.2320	0.2620	0.1987	0.2829
Al-total	(mg/L)	Fall-2	0.2650	0.2641	10	0.2427	0.2458	0.0366	0.2179	0.2674	0.1996	0.3167
Al-dis	(mg/L)	Spring-PL	0.1931	—	10	0.1964	0.1995	0.0126	0.1875	0.2130	0.1840	0.2192
Al-dis	(mg/L)	Summer-PL	0.1931	—	12	0.1858	0.1783	0.0195	0.1628	0.1942	0.1408	0.1947
Al-dis	(mg/L)	Fall-PL	0.1931	—	11	0.1940	0.1963	0.0081	0.1920	0.1960	0.1884	0.2130
Al-org	(mg/L)	Spring-PL	0.0554	—	10	0.0618	0.0604	0.0088	0.0531	0.0682	0.0443	0.0705
Al-org	(mg/L)	Summer-PL	0.0554	—	12	0.0255	0.0224	0.0136	0.0095	0.0315	0.0023	0.0430
Al-org	(mg/L)	Fall-PL	0.0554	—	11	0.0530	0.0526	0.0080	0.0490	0.0578	0.0366	0.0640
ANC	(μeq/L)	Spring-1	-3.3	-3.4	10	-4.9	-4.2	3.9	-6.2	-2.2	-9.5	4.1
ANC	(μeq/L)	Summer-1	-3.3	-3.4	5	0.7	1.0	3.2	-1.6	3.8	-3.3	5.6
ANC	(μeq/L)	Summer-2	-3.3	-3.4	7	-5.2	-5.4	0.8	-6.1	-4.6	-6.6	-4.5
ANC	(μeq/L)	Summer-1+2	-3.3	-3.4	12	-4.5	-2.7	3.9	-5.6	0.5	-6.4	4.5
ANC	(μeq/L)	Fall-2	-3.3	-3.4	11	-2.1	-2.1	1.8	-3.5	-1.2	-5.1	0.5
BNC	(μeq/L)	Spring-1	73.1	73.6	10	78.7	80.1	14.1	65.7	95.7	63.8	100.7
BNC	(μeq/L)	Summer-1	73.1	73.6	5	73.0	68.5	9.6	58.9	75.8	53.6	75.8
BNC	(μeq/L)	Summer-2	73.1	73.6	7	72.8	73.9	5.0	70.8	76.5	68.8	83.7
BNC	(μeq/L)	Summer-1+2	73.1	73.6	12	72.9	71.7	7.4	69.3	75.8	56.8	81.5
BNC	(μeq/L)	Fall-2	73.1	73.6	11	76.7	77.3	9.1	71.1	86.7	62.3	88.5
Ca	(mg/L)	Spring-1	1.921	1.875	10	1.935	1.928	0.041	1.884	1.963	1.881	1.992
Ca	(mg/L)	Summer-1	1.921	1.875	5	1.942	1.919	0.053	1.862	1.963	1.852	1.965
Ca	(mg/L)	Summer-2	1.921	1.875	7	1.911	1.905	0.023	1.883	1.917	1.868	1.937
Ca	(mg/L)	Summer-1+2	1.921	1.875	12	1.913	1.911	0.037	1.875	1.941	1.857	1.964
Ca	(mg/L)	Fall-2	1.921	1.875	11	1.960	1.968	0.041	1.943	1.993	1.915	2.048
Cl^-	(mg/L)	Spring-1	0.411	0.409	10	0.433	0.408	0.077	0.357	0.467	0.249	0.480
Cl^-	(mg/L)	Summer-1	0.411	0.409	5	0.350	0.375	0.049	0.337	0.426	0.328	0.447
Cl^-	(mg/L)	Summer-2	0.411	0.409	7	0.402	0.404	0.010	0.397	0.412	0.394	0.423
Cl^-	(mg/L)	Summer-1+2	0.411	0.409	12	0.400	0.392	0.034	0.361	0.410	0.333	0.440
Cl^-	(mg/L)	Fall-2	0.411	0.409	11	0.413	0.411	0.009	0.409	0.415	0.393	0.420

(Continued)

Table C-4. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Cond	(µS/cm)	Spring-1	25.2	25.2	10	24.6	24.8	0.6	24.5	24.9	24.2	26.0
Cond	(µS/cm)	Summer-1	25.2	25.2	5	25.9	25.9	0.3	25.7	26.2	25.6	26.4
Cond	(µS/cm)	Summer-2	25.2	25.2	7	24.9	24.8	0.2	24.6	25.0	24.6	25.0
Cond	(µS/cm)	Summer-1+2	25.2	25.2	12	25.0	25.3	0.6	24.7	25.9	24.6	26.3
Cond	(µS/cm)	Fall-2	25.2	25.2	11	25.3	25.3	0.2	25.2	25.5	24.9	25.5
DIC-closed	(mg/L)	Spring-PL	0.549	—	10	0.547	0.545	0.033	0.513	0.580	0.498	0.590
DIC-closed	(mg/L)	Summer-PL	0.549	—	12	0.583	0.574	0.066	0.544	0.632	0.451	0.641
DIC-closed	(mg/L)	Fall-PL	0.549	—	11	0.582	0.568	0.050	0.519	0.600	0.507	0.655
DIC-eq	(mg/L)	Spring-1	0.121	0.162	10	0.182	0.250	0.142	0.171	0.305	0.153	0.578
DIC-eq	(mg/L)	Summer-1	0.121	0.162	5	0.332	0.363	0.198	0.179	0.562	0.134	0.607
DIC-eq	(mg/L)	Summer-2	0.121	0.162	7	0.073	0.085	0.043	0.045	0.128	0.029	0.129
DIC-eq	(mg/L)	Summer-1+2	0.121	0.162	12	0.128	0.201	0.189	0.065	0.305	0.034	0.580
DIC-eq	(mg/L)	Fall-2	0.121	0.162	11	0.075	0.085	0.042	0.055	0.116	0.028	0.162
DIC-initial	(mg/L)	Spring-1	0.338	0.424	10	0.438	0.459	0.097	0.407	0.496	0.320	0.666
DIC-initial	(mg/L)	Summer-1	0.338	0.424	5	0.341	0.612	0.522	0.310	1.049	0.286	1.524
DIC-initial	(mg/L)	Summer-2	0.338	0.424	7	0.455	0.449	0.050	0.420	0.483	0.358	0.512
DIC-initial	(mg/L)	Summer-1+2	0.338	0.424	12	0.447	0.517	0.328	0.345	0.505	0.301	1.239
DIC-initial	(mg/L)	Fall-2	0.338	0.424	11	0.468	0.451	0.051	0.394	0.482	0.386	0.522
DOC	(mg/L)	Spring-1	3.55	3.50	10	3.53	3.49	0.20	3.27	3.65	3.19	3.80
DOC	(mg/L)	Summer-1	3.55	3.50	5	3.60	3.50	0.25	3.30	3.65	3.06	3.66
DOC	(mg/L)	Summer-2	3.55	3.50	7	3.41	3.42	0.09	3.35	3.52	3.30	3.56
DOC	(mg/L)	Summer-1+2	3.55	3.50	12	3.49	3.46	0.17	3.35	3.59	3.13	3.65
DOC	(mg/L)	Fall-2	3.55	3.50	11	3.41	3.37	0.15	3.21	3.50	3.14	3.53
F^--total	(mg/L)	Spring-1	0.0740	0.0740	10	0.0718	0.0715	0.0051	0.0685	0.0748	0.0625	0.0794
F^--total	(mg/L)	Summer-1	0.0740	0.0740	5	0.0781	0.0769	0.0056	0.0716	0.0815	0.0693	0.0843
F^--total	(mg/L)	Summer-2	0.0740	0.0740	7	0.0776	0.0641	0.0261	0.0451	0.0800	0.0120	0.0801
F^--total	(mg/L)	Summer-1+2	0.0740	0.0740	12	0.0778	0.0694	0.0207	0.0705	0.0797	0.0219	0.0830
F^--total	(mg/L)	Fall-2	0.0740	0.0740	11	0.0798	0.0794	0.0047	0.0761	0.0802	0.0714	0.0881
Fe	(mg/L)	Spring-1	0.047	0.051	10	0.051	0.054	0.007	0.048	0.062	0.046	0.064
Fe	(mg/L)	Summer-1	0.047	0.051	5	0.045	0.044	0.003	0.041	0.046	0.040	0.048
Fe	(mg/L)	Summer-2	0.047	0.051	7	0.046	0.045	0.006	0.045	0.049	0.033	0.051
Fe	(mg/L)	Summer-1+2	0.047	0.051	12	0.045	0.045	0.005	0.043	0.048	0.035	0.050
Fe	(mg/L)	Fall-2	0.047	0.051	11	0.039	0.037	0.004	0.033	0.040	0.031	0.044
K	(mg/L)	Spring-1	0.411	0.409	10	0.401	0.406	0.014	0.396	0.418	0.388	0.426
K	(mg/L)	Summer-1	0.411	0.409	5	0.414	0.414	0.010	0.404	0.423	0.401	0.426
K	(mg/L)	Summer-2	0.411	0.409	7	0.408	0.413	0.022	0.394	0.437	0.394	0.449
K	(mg/L)	Summer-1+2	0.411	0.409	12	0.408	0.413	0.017	0.399	0.424	0.394	0.445
K	(mg/L)	Fall-2	0.411	0.409	11	0.383	0.379	0.043	0.350	0.405	0.298	0.442

(Continued)

Table C-4. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Mg	(mg/L)	Spring-1	0.326	0.320	10	0.329	0.326	0.010	0.317	0.334	0.313	0.339
Mg	(mg/L)	Summer-1	0.326	0.320	5	0.326	0.327	0.004	0.323	0.331	0.322	0.332
Mg	(mg/L)	Summer-2	0.326	0.320	7	0.316	0.314	0.004	0.309	0.317	0.306	0.317
Mg	(mg/L)	Summer-1+2	0.326	0.320	12	0.317	0.319	0.008	0.314	0.325	0.307	0.331
Mg	(mg/L)	Fall-2	0.326	0.320	11	0.331	0.332	0.013	0.319	0.342	0.313	0.350
Mn	(mg/L)	Spring-1	0.073	0.072	10	0.069	0.072	0.005	0.069	0.076	0.067	0.080
Mn	(mg/L)	Summer-1	0.073	0.072	5	0.072	0.072	0.002	0.070	0.074	0.070	0.075
Mn	(mg/L)	Summer-2	0.073	0.072	7	0.068	0.068	0.001	0.067	0.069	0.066	0.070
Mn	(mg/L)	Summer-1+2	0.073	0.072	12	0.069	0.070	0.003	0.068	0.072	0.066	0.074
Mn	(mg/L)	Fall-2	0.073	0.072	11	0.075	0.075	0.004	0.071	0.079	0.070	0.080
Na	(mg/L)	Spring-1	0.606	0.612	10	0.594	0.608	0.040	0.580	0.637	0.558	0.673
Na	(mg/L)	Summer-1	0.606	0.612	5	0.606	0.605	0.016	0.591	0.617	0.580	0.624
Na	(mg/L)	Summer-2	0.606	0.612	7	0.598	0.595	0.025	0.579	0.606	0.552	0.634
Na	(mg/L)	Summer-1+2	0.606	0.612	12	0.601	0.599	0.022	0.583	0.610	0.560	0.631
Na	(mg/L)	Fall-2	0.606	0.612	11	0.632	0.623	0.041	0.587	0.662	0.557	0.668
NH_4^+	(mg/L)	Spring-1	0.057	0.058	10	0.039	0.039	0.016	0.026	0.056	0.014	0.059
NH_4^+	(mg/L)	Summer-1	0.057	0.058	5	0.059	0.059	0.009	0.052	0.066	0.046	0.072
NH_4^+	(mg/L)	Summer-2	0.057	0.058	7	0.044	0.042	0.020	0.035	0.049	0.003	0.071
NH_4^+	(mg/L)	Summer-1+2	0.057	0.058	12	0.048	0.049	0.018	0.042	0.060	0.013	0.071
NH_4^+	(mg/L)	Fall-2	0.057	0.058	11	0.051	0.056	0.025	0.038	0.061	0.031	0.111
NO_3^-	(mg/L)	Spring-1	1.2231	1.2156	10	1.0664	1.0834	0.1392	0.9858	1.2348	0.8856	1.2984
NO_3^-	(mg/L)	Summer-1	1.2231	1.2156	5	1.2348	1.2363	0.0140	1.2255	1.2477	1.2253	1.2598
NO_3^-	(mg/L)	Summer-2	1.2231	1.2156	7	1.2120	1.2006	0.0293	1.1892	1.2209	1.1412	1.2290
NO_3^-	(mg/L)	Summer-1+2	1.2231	1.2156	12	1.2231	1.2155	0.0296	1.2028	1.2333	1.1556	1.2525
NO_3^-	(mg/L)	Fall-2	1.2231	1.2156	11	1.2003	1.2038	0.0311	1.1860	1.2164	1.1557	1.2653
P-total	(mg/L)	Spring-1	0.0016	0.0016	10	0.0010	0.0041	0.0081	0.0010	0.0032	0.0001	0.0247
P-total	(mg/L)	Summer-1	0.0016	0.0016	5	0.0023	0.0023	0.0005	0.0018	0.0026	0.0016	0.0030
P-total	(mg/L)	Summer-2	0.0016	0.0016	7	0.0016	0.0043	0.0061	0.0013	0.0066	-0.0008	0.0171
P-total	(mg/L)	Summer-1+2	0.0016	0.0016	12	0.0022	0.0034	0.0046	0.0016	0.0029	-0.0002	0.0139
P-total	(mg/L)	Fall-2	0.0016	0.0016	11	0.0012	0.0015	0.0010	0.0006	0.0026	0.0002	0.0029
pH-ANC	(pH units)	Spring-1	5.12	5.09	10	5.13	5.16	0.09	5.08	5.22	5.07	5.30
pH-ANC	(pH units)	Summer-1	5.12	5.09	5	5.13	5.12	0.02	5.10	5.14	5.09	5.14
pH-ANC	(pH units)	Summer-2	5.12	5.09	7	5.05	5.05	0.02	5.04	5.05	5.02	5.08
pH-ANC	(pH units)	Summer-1+2	5.12	5.09	12	5.06	5.08	0.04	5.05	5.12	5.03	5.14
pH-ANC	(pH units)	Fall-2	5.12	5.09	11	5.11	5.11	0.02	5.10	5.12	5.08	5.14

(Continued)

Table C-4. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
pH-BNC	(pH units)	Spring-1	5.15	5.12	10	5.16	5.18	0.06	5.13	5.21	5.09	5.30
pH-BNC	(pH units)	Summer-1	5.15	5.12	5	5.12	5.12	0.03	5.09	5.14	5.09	5.16
pH-BNC	(pH units)	Summer-2	5.15	5.12	7	5.07	5.08	0.02	5.07	5.09	5.05	5.11
pH-BNC	(pH units)	Summer-1+2	5.15	5.12	12	5.09	5.09	0.03	5.07	5.12	5.06	5.15
pH-BNC	(pH units)	Fall-2	5.15	5.12	11	5.17	5.19	0.07	5.14	5.21	5.12	5.33
pH-closed	(pH units)	Spring-PL	5.13	—	10	5.15	5.16	0.04	5.14	5.18	5.09	5.25
pH-closed	(pH units)	Summer-PL	5.13	—	12	5.11	5.11	0.06	5.08	5.15	5.01	5.22
pH-closed	(pH units)	Fall-PL	5.13	—	11	5.13	5.13	0.03	5.09	5.15	5.09	5.19
pH-eq	(pH units)	Spring-1	5.16	5.15	10	5.14	5.17	0.09	5.12	5.19	5.10	5.39
pH-eq	(pH units)	Summer-1	5.16	5.15	5	5.15	5.14	0.09	5.06	5.20	4.99	5.21
pH-eq	(pH units)	Summer-2	5.16	5.15	7	5.12	5.41	0.76	5.10	5.20	5.08	7.14
pH-eq	(pH units)	Summer-1+2	5.16	5.15	12	5.13	5.30	0.58	5.10	5.20	5.02	6.56
pH-eq	(pH units)	Fall-2	5.16	5.15	11	5.01	5.03	0.04	5.01	5.07	4.99	5.10
SiO_2	(mg/L)	Spring-1	4.386	4.347	10	4.440	4.385	0.122	4.260	4.482	4.194	4.526
SiO_2	(mg/L)	Summer-1	4.386	4.347	5	4.372	4.408	0.097	4.322	4.511	4.312	4.521
SiO_2	(mg/L)	Summer-2	4.386	4.347	7	4.376	4.394	0.075	4.343	4.461	4.289	4.505
SiO_2	(mg/L)	Summer-1+2	4.386	4.347	12	4.374	4.400	0.081	4.335	4.491	4.296	4.516
SiO_2	(mg/L)	Fall-2	4.386	4.347	11	4.407	4.317	0.418	4.374	4.468	3.337	4.629
SO_4^{2-}	(mg/L)	Spring-1	6.363	6.360	10	6.097	6.082	0.570	5.612	6.601	5.026	6.791
SO_4^{2-}	(mg/L)	Summer-1	6.363	6.360	5	6.536	6.454	0.247	6.240	6.627	6.049	6.708
SO_4^{2-}	(mg/L)	Summer-2	6.363	6.360	7	6.320	6.529	0.635	6.255	6.425	6.105	7.950
SO_4^{2-}	(mg/L)	Summer-1+2	6.363	6.360	12	6.400	6.498	0.494	6.259	6.543	6.066	7.577
SO_4^{2-}	(mg/L)	Fall-2	6.363	6.360	11	6.335	6.364	0.228	6.145	6.545	6.091	6.737
True color	(PCU)	Spring-PL	15.0	—	10	12.5	13.0	4.8	10.0	16.3	5.5	20.0
True color	(PCU)	Summer-PL	15.0	—	11	15.0	17.3	4.1	15.0	20.0	11.0	24.0
True color	(PCU)	Fall-PL	15.0	—	11	15.0	16.4	3.9	15.0	20.0	10.0	20.0
Turbidity	(NTU)	Spring-PL	0.130	—	10	0.175	0.189	0.083	0.120	0.225	0.111	0.375
Turbidity	(NTU)	Summer-PL	0.130	—	11	0.100	0.091	0.030	0.100	0.100	0.020	0.100
Turbidity	(NTU)	Fall-PL	0.130	—	11	0.100	0.127	0.047	0.100	0.200	0.100	0.200

Table C-5. Summary Statistics for Big Moose Lake Lab Natural Audits, Eastern Lake Survey - Phase II

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Al-ext	(mg/L)	Spring-1	0.1658	0.2106	5	0.1682	0.1706	0.0109	0.1638	0.1786	0.1599	0.1890
Al-ext	(mg/L)	Summer-1	0.1658	0.2106	3	0.1649	0.1223	0.1422	-0.0364	0.2383	-0.0364	0.2383
Al-ext	(mg/L)	Summer-2	0.1658	0.2106	2	0.2038	0.2038	0.0095	0.1971	0.2106	0.1971	0.2106
Al-ext	(mg/L)	Summer-1+2	0.1658	0.2106	5	0.1971	0.1549	0.1102	0.0642	0.2244	-0.0364	0.2383
Al-ext	(mg/L)	Fall-2	0.1658	0.2106	6	0.1983	0.1783	0.0682	0.1532	0.2204	0.0415	0.2206
Al-total	(mg/L)	Spring-1	0.2650	0.2641	6	0.2847	0.2359	0.1034	0.1607	0.3015	0.0395	0.3050
Al-total	(mg/L)	Summer-1	0.2650	0.2641	8	0.2638	0.2352	0.0601	0.2006	0.2741	0.1055	0.2755
Al-total	(mg/L)	Summer-2	0.2650	0.2641	5	0.2223	0.2256	0.0129	0.2154	0.2374	0.2098	0.2445
Al-total	(mg/L)	Summer-1+2	0.2650	0.2641	13	0.2378	0.2315	0.0467	0.2154	0.2687	0.1386	0.2751
Al-total	(mg/L)	Fall-2	0.2650	0.2641	6	0.2694	0.2760	0.0528	0.2331	0.3099	0.2195	0.3700
ANC	(μeq/L)	Spring-1	-3.3	-3.4	6	-2.6	-1.9	5.8	-7.3	3.2	-8.1	7.3
ANC	(μeq/L)	Summer-1	-3.3	-3.4	9	-0.4	-0.8	3.7	-3.4	1.5	-7.3	5.5
ANC	(μeq/L)	Summer-2	-3.3	-3.4	7	-5.8	-5.6	0.9	-6.2	-4.9	-6.8	-4.3
ANC	(μeq/L)	Summer-1+2	-3.3	-3.4	16	-4.4	-2.9	3.7	-5.9	-0.2	-6.9	2.9
ANC	(μeq/L)	Fall-2	-3.3	-3.4	6	-2.7	-2.3	1.5	-3.3	-0.8	-4.0	0.0
BNC	(μeq/L)	Spring-1	73.1	73.6	6	76.0	77.2	9.8	67.1	88.3	66.7	89.0
BNC	(μeq/L)	Summer-1	73.1	73.6	9	73.3	78.8	11.4	70.2	90.9	67.3	98.2
BNC	(μeq/L)	Summer-2	73.1	73.6	7	75.5	76.5	4.9	71.2	81.1	69.8	82.2
BNC	(μeq/L)	Summer-1+2	73.1	73.6	16	75.1	77.8	9.0	71.4	81.9	68.1	93.2
BNC	(μeq/L)	Fall-2	73.1	73.6	6	69.4	68.7	5.3	63.2	72.6	61.9	76.4
Ca	(mg/L)	Spring-1	1.921	1.875	6	1.887	1.885	0.041	1.841	1.924	1.836	1.939
Ca	(mg/L)	Summer-1	1.921	1.875	9	1.821	1.824	0.028	1.808	1.835	1.780	1.881
Ca	(mg/L)	Summer-2	1.921	1.875	7	1.869	1.866	0.036	1.829	1.904	1.818	1.911
Ca	(mg/L)	Summer-1+2	1.921	1.875	16	1.829	1.842	0.038	1.818	1.878	1.799	1.906
Ca	(mg/L)	Fall-2	1.921	1.875	6	1.944	1.937	0.055	1.877	1.982	1.873	2.015
Cl^-	(mg/L)	Spring-1	0.411	0.409	5	0.395	0.390	0.047	0.347	0.429	0.314	0.431
Cl^-	(mg/L)	Summer-1	0.411	0.409	9	0.344	0.382	0.180	0.264	0.444	0.189	0.790
Cl^-	(mg/L)	Summer-2	0.411	0.409	7	0.439	0.440	0.021	0.423	0.454	0.414	0.475
Cl^-	(mg/L)	Summer-1+2	0.411	0.409	16	0.418	0.407	0.135	0.336	0.452	0.210	0.600
Cl^-	(mg/L)	Fall-2	0.411	0.409	6	0.405	0.418	0.038	0.398	0.431	0.391	0.493
Cond	(μS/cm)	Spring-1	25.2	25.2	6	25.0	25.7	1.8	24.6	27.0	24.2	29.0
Cond	(μS/cm)	Summer-1	25.2	25.2	9	26.2	25.7	1.1	25.5	26.4	23.1	26.6
Cond	(μS/cm)	Summer-2	25.2	25.2	7	24.7	24.6	0.6	23.8	25.0	23.8	25.2
Cond	(μS/cm)	Summer-1+2	25.2	25.2	16	25.3	25.2	1.0	24.5	26.2	23.6	26.5
Cond	(μS/cm)	Fall-2	25.2	25.2	6	25.1	25.3	0.6	24.9	25.6	24.9	26.4

(Continued)

Table C-5. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
DIC-eq	(mg/L)	Spring-1	0.121	0.162	6	0.237	0.236	0.046	0.199	0.272	0.169	0.302
DIC-eq	(mg/L)	Summer-1	0.121	0.162	9	0.295	0.285	0.086	0.211	0.354	0.162	0.423
DIC-eq	(mg/L)	Summer-2	0.121	0.162	7	0.128	0.124	0.052	0.056	0.162	0.054	0.188
DIC-eq	(mg/L)	Summer-1+2	0.121	0.162	16	0.194	0.214	0.109	0.134	0.314	0.055	0.380
DIC-eq	(mg/L)	Fall-2	0.121	0.162	6	0.101	0.097	0.033	0.066	0.129	0.046	0.131
DIC-initial	(mg/L)	Spring-1	0.338	0.424	6	0.447	0.488	0.152	0.405	0.549	0.355	0.785
DIC-initial	(mg/L)	Summer-1	0.338	0.424	9	0.520	0.484	0.090	0.401	0.542	0.326	0.589
DIC-initial	(mg/L)	Summer-2	0.338	0.424	7	0.457	0.462	0.042	0.434	0.470	0.420	0.547
DIC-initial	(mg/L)	Summer-1+2	0.338	0.424	16	0.466	0.474	0.071	0.435	0.541	0.350	0.560
DIC-initial	(mg/L)	Fall-2	0.338	0.424	6	0.473	0.455	0.054	0.406	0.496	0.365	0.503
DOC	(mg/L)	Spring-1	3.55	3.50	6	3.34	3.27	0.22	3.01	3.46	2.95	3.48
DOC	(mg/L)	Summer-1	3.55	3.50	9	3.58	3.41	0.40	3.20	3.72	2.51	3.76
DOC	(mg/L)	Summer-2	3.55	3.50	7	3.49	3.50	0.19	3.42	3.67	3.15	3.68
DOC	(mg/L)	Summer-1+2	3.55	3.50	16	3.54	3.45	0.32	3.25	3.67	2.96	3.76
DOC	(mg/L)	Fall-2	3.55	3.50	6	3.38	3.40	0.16	3.29	3.48	3.23	3.69
F^--total	(mg/L)	Spring-1	0.0740	0.0740	6	0.0715	0.0710	0.0029	0.0690	0.0729	0.0660	0.0744
F^--total	(mg/L)	Summer-1	0.0740	0.0740	9	0.0724	0.0751	0.0071	0.0709	0.0772	0.0704	0.0925
F^--total	(mg/L)	Summer-2	0.0740	0.0740	7	0.0766	0.0653	0.0289	0.0711	0.0787	0.0000	0.0788
F^--total	(mg/L)	Summer-1+2	0.0740	0.0740	16	0.0731	0.0708	0.0197	0.0711	0.0786	0.0493	0.0833
F^--total	(mg/L)	Fall-2	0.0740	0.0740	6	0.0804	0.0813	0.0038	0.0789	0.0837	0.0773	0.0883
Fe	(mg/L)	Spring-1	0.047	0.051	6	0.061	0.059	0.009	0.050	0.067	0.048	0.070
Fe	(mg/L)	Summer-1	0.047	0.051	9	0.051	0.107	0.163	0.046	0.066	0.045	0.540
Fe	(mg/L)	Summer-2	0.047	0.051	7	0.052	0.051	0.002	0.049	0.054	0.049	0.054
Fe	(mg/L)	Summer-1+2	0.047	0.051	16	0.051	0.083	0.122	0.048	0.054	0.046	0.218
Fe	(mg/L)	Fall-2	0.047	0.051	6	0.046	0.046	0.004	0.041	0.050	0.040	0.050
K	(mg/L)	Spring-1	0.411	0.409	6	0.393	0.389	0.011	0.382	0.397	0.369	0.397
K	(mg/L)	Summer-1	0.411	0.409	9	0.420	0.419	0.006	0.416	0.423	0.407	0.426
K	(mg/L)	Summer-2	0.411	0.409	7	0.398	0.405	0.024	0.388	0.427	0.367	0.437
K	(mg/L)	Summer-1+2	0.411	0.409	16	0.420	0.413	0.018	0.400	0.425	0.382	0.430
K	(mg/L)	Fall-2	0.411	0.409	6	0.374	0.360	0.040	0.327	0.389	0.288	0.396
Mg	(mg/L)	Spring-1	0.326	0.320	6	0.316	0.317	0.009	0.309	0.325	0.308	0.326
Mg	(mg/L)	Summer-1	0.326	0.320	9	0.317	0.318	0.004	0.314	0.321	0.313	0.323
Mg	(mg/L)	Summer-2	0.326	0.320	7	0.316	0.314	0.005	0.309	0.317	0.309	0.321
Mg	(mg/L)	Summer-1+2	0.326	0.320	16	0.317	0.316	0.004	0.313	0.320	0.309	0.322
Mg	(mg/L)	Fall-2	0.326	0.320	6	0.326	0.326	0.010	0.315	0.336	0.313	0.338

(Continued)

Table C-5. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Mn	(mg/L)	Spring-1	0.073	0.072	6	0.069	0.073	0.007	0.067	0.081	0.066	0.082
Mn	(mg/L)	Summer-1	0.073	0.072	9	0.072	0.072	0.001	0.071	0.073	0.070	0.073
Mn	(mg/L)	Summer-2	0.073	0.072	7	0.068	0.068	0.002	0.067	0.070	0.067	0.071
Mn	(mg/L)	Summer-1+2	0.073	0.072	16	0.071	0.071	0.002	0.068	0.073	0.067	0.073
Mn	(mg/L)	Fall-2	0.073	0.072	6	0.072	0.073	0.003	0.070	0.076	0.069	0.076
Na	(mg/L)	Spring-1	0.606	0.612	6	0.603	0.613	0.028	0.590	0.644	0.590	0.649
Na	(mg/L)	Summer-1	0.606	0.612	9	0.624	0.620	0.015	0.610	0.632	0.589	0.637
Na	(mg/L)	Summer-2	0.606	0.612	7	0.598	0.599	0.016	0.583	0.616	0.576	0.616
Na	(mg/L)	Summer-1+2	0.606	0.612	16	0.616	0.610	0.019	0.593	0.624	0.581	0.633
Na	(mg/L)	Fall-2	0.606	0.612	6	0.590	0.600	0.033	0.570	0.636	0.569	0.647
NH_4^+	(mg/L)	Spring-1	0.057	0.058	6	0.048	0.038	0.025	0.010	0.058	0.003	0.059
NH_4^+	(mg/L)	Summer-1	0.057	0.058	9	0.051	0.097	0.143	0.043	0.064	0.026	0.476
NH_4^+	(mg/L)	Summer-2	0.057	0.058	7	0.046	0.049	0.033	0.035	0.070	-0.003	0.105
NH_4^+	(mg/L)	Summer-1+2	0.057	0.058	16	0.051	0.076	0.109	0.040	0.065	0.017	0.216
NH_4^+	(mg/L)	Fall-2	0.057	0.058	6	0.111	0.113	0.037	0.082	0.143	0.066	0.167
NO_3^-	(mg/L)	Spring-1	1.2231	1.2156	6	1.0565	1.0971	0.1441	0.9940	1.2535	0.9135	1.2959
NO_3^-	(mg/L)	Summer-1	1.2231	1.2156	9	1.2586	1.3071	0.1348	1.2445	1.3027	1.2354	1.6604
NO_3^-	(mg/L)	Summer-2	1.2231	1.2156	7	1.2126	1.2018	0.0444	1.1616	1.2312	1.1403	1.2720
NO_3^-	(mg/L)	Summer-1+2	1.2231	1.2156	16	1.2445	1.2610	0.1157	1.2127	1.2692	1.1552	1.4184
NO_3^-	(mg/L)	Fall-2	1.2231	1.2156	6	1.1808	1.1846	0.0225	1.1654	1.2055	1.1590	1.2180
P-total	(mg/L)	Spring-1	0.0016	0.0016	6	0.0015	0.0062	0.0112	0.0010	0.0095	0.0010	0.0290
P-total	(mg/L)	Summer-1	0.0016	0.0016	9	0.0028	0.0031	0.0032	0.0004	0.0044	-0.0004	0.0101
P-total	(mg/L)	Summer-2	0.0016	0.0016	7	0.0014	0.0016	0.0014	0.0005	0.0033	-0.0004	0.0036
P-total	(mg/L)	Summer-1+2	0.0016	0.0016	16	0.0019	0.0024	0.0026	0.0005	0.0034	-0.0004	0.0068
P-total	(mg/L)	Fall-2	0.0016	0.0016	6	0.0021	0.0021	0.0003	0.0019	0.0023	0.0016	0.0023
pH-ANC	(pH units)	Spring-1	5.12	5.09	6	5.17	5.15	0.07	5.07	5.22	5.06	5.24
pH-ANC	(pH units)	Summer-1	5.12	5.09	9	5.08	5.07	0.05	5.02	5.10	4.97	5.15
pH-ANC	(pH units)	Summer-2	5.12	5.09	7	5.02	5.03	0.02	5.02	5.05	5.02	5.06
pH-ANC	(pH units)	Summer-1+2	5.12	5.09	16	5.04	5.05	0.05	5.02	5.09	5.00	5.11
pH-ANC	(pH units)	Fall-2	5.12	5.09	6	5.10	5.12	0.05	5.10	5.14	5.09	5.22
pH-BNC	(pH units)	Spring-1	5.15	5.12	6	5.18	5.18	0.05	5.13	5.22	5.12	5.27
pH-BNC	(pH units)	Summer-1	5.15	5.12	9	5.05	5.05	0.05	4.99	5.09	4.98	5.11
pH-BNC	(pH units)	Summer-2	5.15	5.12	7	5.07	5.08	0.02	5.07	5.10	5.05	5.10
pH-BNC	(pH units)	Summer-1+2	5.15	5.12	16	5.07	5.06	0.04	5.05	5.10	4.99	5.11
pH-BNC	(pH units)	Fall-2	5.15	5.12	6	5.16	5.18	0.06	5.14	5.21	5.13	5.31

(Continued)

Table C-5. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
pH-eq	(pH units)	Spring-1	5.16	5.15	6	5.13	5.22	0.21	5.12	5.30	5.11	5.65
pH-eq	(pH units)	Summer-1	5.16	5.15	9	5.15	5.15	0.06	5.14	5.19	5.00	5.19
pH-eq	(pH units)	Summer-2	5.16	5.15	7	5.12	5.09	0.13	5.07	5.14	4.81	5.21
pH-eq	(pH units)	Summer-1+2	5.16	5.15	16	5.14	5.12	0.10	5.12	5.19	4.94	5.20
pH-eq	(pH units)	Fall-2	5.16	5.15	6	5.04	5.05	0.05	5.01	5.09	5.00	5.15
SiO_2	(mg/L)	Spring-1	4.386	4.347	6	4.305	4.330	0.113	4.230	4.447	4.230	4.470
SiO_2	(mg/L)	Summer-1	4.386	4.347	9	4.292	4.343	0.147	4.262	4.395	4.192	4.685
SiO_2	(mg/L)	Summer-2	4.386	4.347	7	4.371	4.354	0.120	4.216	4.477	4.183	4.495
SiO_2	(mg/L)	Summer-1+2	4.386	4.347	16	4.322	4.348	0.132	4.257	4.445	4.189	4.552
SiO_2	(mg/L)	Fall-2	4.386	4.347	6	4.424	4.427	0.048	4.388	4.463	4.363	4.503
SO_4^{2-}	(mg/L)	Spring-1	6.363	6.360	6	6.227	6.115	0.649	5.620	6.623	5.010	6.854
SO_4^{2-}	(mg/L)	Summer-1	6.363	6.360	9	6.148	6.194	0.301	5.922	6.514	5.895	6.654
SO_4^{2-}	(mg/L)	Summer-2	6.363	6.360	7	6.265	6.219	0.169	6.060	6.360	5.940	6.430
SO_4^{2-}	(mg/L)	Summer-1+2	6.363	6.360	16	6.210	6.205	0.245	5.949	6.403	5.902	6.625
SO_4^{2-}	(mg/L)	Fall-2	6.363	6.360	6	6.439	6.341	0.314	6.212	6.497	5.720	6.610

Table C-6. Summary Statistics for Big Moose Lake Field and Lab Natural Audits Pooled, Eastern Lake Survey - Phase II

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Al-ext	(mg/L)	Spring-1	0.1658	0.2106	13	0.1633	0.1528	0.0277	0.1439	0.1680	0.0957	0.1807
Al-ext	(mg/L)	Summer-1	0.1658	0.2106	8	0.1518	0.1183	0.0910	0.0311	0.1686	-0.0364	0.2383
Al-ext	(mg/L)	Summer-2	0.1658	0.2106	8	0.1880	0.1806	0.0244	0.1542	0.1991	0.1453	0.2106
Al-ext	(mg/L)	Summer-1+2	0.1658	0.2106	16	0.1653	0.1494	0.0720	0.1418	0.1968	-0.0044	0.2189
Al-ext	(mg/L)	Fall-2	0.1658	0.2106	16	0.1447	0.1526	0.0463	0.1241	0.1963	0.0927	0.2205
Al-total	(mg/L)	Spring-1	0.2650	0.2641	14	0.2849	0.2636	0.0706	0.2681	0.3014	0.1203	0.3044
Al-total	(mg/L)	Summer-1	0.2650	0.2641	13	0.2630	0.2451	0.0489	0.2392	0.2750	0.1386	0.2815
Al-total	(mg/L)	Summer-2	0.2650	0.2641	11	0.2303	0.2298	0.0220	0.2098	0.2493	0.1987	0.2612
Al-total	(mg/L)	Summer-1+2	0.2650	0.2641	24	0.2469	0.2381	0.0390	0.2213	0.2643	0.1933	0.2763
Al-total	(mg/L)	Fall-2	0.2650	0.2641	16	0.2578	0.2571	0.0443	0.2198	0.2762	0.2087	0.3364
Al-dis	(mg/L)	Spring-PL	0.1931	—	10	0.1964	0.1995	0.0126	0.1875	0.2130	0.1840	0.2192
Al-dis	(mg/L)	Summer-PL	0.1931	—	12	0.1858	0.1783	0.0195	0.1628	0.1942	0.1408	0.1947
Al-dis	(mg/L)	Fall-PL	0.1931	—	11	0.1940	0.1963	0.0081	0.1920	0.1960	0.1884	0.2130
Al-org	(mg/L)	Spring-PL	0.0554	—	10	0.0618	0.0604	0.0088	0.0531	0.0682	0.0443	0.0705
Al-org	(mg/L)	Summer-PL	0.0554	—	12	0.0255	0.0224	0.0136	0.0095	0.0315	0.0023	0.0430
Al-org	(mg/L)	Fall-PL	0.0554	—	11	0.0530	0.0526	0.0080	0.0490	0.0578	0.0366	0.0640
ANC	(μeq/L)	Spring-1	-3.3	-3.4	16	-4.6	-3.3	4.6	-6.3	-1.3	-8.6	5.5
ANC	(μeq/L)	Summer-1	-3.3	-3.4	14	-0.1	-0.2	3.5	-2.5	1.9	-5.9	5.5
ANC	(μeq/L)	Summer-2	-3.3	-3.4	14	-5.4	-5.5	0.8	-6.1	-4.8	-6.7	-4.4
ANC	(μeq/L)	Summer-1+2	-3.3	-3.4	28	-4.5	-2.8	3.7	-5.8	-0.0	-6.6	2.4
ANC	(μeq/L)	Fall-2	-3.3	-3.4	17	-2.3	-2.2	1.6	-3.3	-1.1	-4.3	0.4
BNC	(μeq/L)	Spring-1	73.1	73.6	16	78.3	79.0	12.4	66.8	88.8	64.1	100.6
BNC	(μeq/L)	Summer-1	73.1	73.6	14	73.1	75.1	11.6	68.1	79.6	58.9	94.6
BNC	(μeq/L)	Summer-2	73.1	73.6	14	74.5	75.2	4.9	70.8	80.6	69.3	82.9
BNC	(μeq/L)	Summer-1+2	73.1	73.6	28	73.7	75.2	8.7	70.8	79.5	67.0	90.9
BNC	(μeq/L)	Fall-2	73.1	73.6	17	75.9	74.2	8.8	66.4	80.9	61.9	87.3
Ca	(mg/L)	Spring-1	1.921	1.875	16	1.904	1.912	0.045	1.884	1.946	1.841	1.978
Ca	(mg/L)	Summer-1	1.921	1.875	14	1.835	1.857	0.060	1.816	1.896	1.793	1.963
Ca	(mg/L)	Summer-2	1.921	1.875	14	1.894	1.886	0.036	1.863	1.913	1.823	1.927
Ca	(mg/L)	Summer-1+2	1.921	1.875	28	1.871	1.872	0.050	1.826	1.911	1.809	1.944
Ca	(mg/L)	Fall-2	1.921	1.875	17	1.958	1.957	0.047	1.928	1.983	1.877	2.024
Cl^-	(mg/L)	Spring-1	0.411	0.409	15	0.428	0.402	0.067	0.371	0.448	0.285	0.478
Cl^-	(mg/L)	Summer-1	0.411	0.409	14	0.348	0.379	0.144	0.323	0.415	0.204	0.654
Cl^-	(mg/L)	Summer-2	0.411	0.409	14	0.418	0.422	0.024	0.401	0.441	0.395	0.464
Cl^-	(mg/L)	Summer-1+2	0.411	0.409	28	0.403	0.401	0.103	0.347	0.437	0.300	0.479
Cl^-	(mg/L)	Fall-2	0.411	0.409	17	0.411	0.413	0.022	0.401	0.415	0.393	0.435

(Continued)

Table C-6. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Cond	(µS/cm)	Spring-1	25.2	25.2	16	24.8	25.1	1.2	24.5	25.2	24.2	27.2
Cond	(µS/cm)	Summer-1	25.2	25.2	14	25.9	25.8	0.9	25.6	26.4	24.2	26.5
Cond	(µS/cm)	Summer-2	25.2	25.2	14	24.8	24.7	0.4	24.6	25.0	23.8	25.1
Cond	(µS/cm)	Summer-1+2	25.2	25.2	28	25.1	25.2	0.9	24.7	26.0	23.8	26.4
Cond	(µS/cm)	Fall-2	25.2	25.2	17	25.3	25.3	0.4	25.0	25.5	24.9	25.7
DIC-closed	(mg/L)	Spring-PL	0.549	—	10	0.547	0.545	0.033	0.513	0.580	0.498	0.590
DIC-closed	(mg/L)	Summer-PL	0.549	—	12	0.583	0.574	0.066	0.544	0.632	0.451	0.641
DIC-closed	(mg/L)	Fall-PL	0.549	—	11	0.582	0.568	0.050	0.519	0.600	0.507	0.655
DIC-eq	(mg/L)	Spring-1	0.121	0.162	16	0.210	0.245	0.113	0.176	0.273	0.155	0.453
DIC-eq	(mg/L)	Summer-1	0.121	0.162	14	0.307	0.313	0.134	0.217	0.377	0.148	0.562
DIC-eq	(mg/L)	Summer-2	0.121	0.162	14	0.127	0.104	0.050	0.055	0.135	0.037	0.175
DIC-eq	(mg/L)	Summer-1+2	0.121	0.162	28	0.162	0.209	0.145	0.127	0.314	0.053	0.432
DIC-eq	(mg/L)	Fall-2	0.121	0.162	17	0.075	0.089	0.039	0.062	0.122	0.041	0.145
DIC-initial	(mg/L)	Spring-1	0.338	0.424	16	0.438	0.470	0.116	0.415	0.487	0.342	0.714
DIC-initial	(mg/L)	Summer-1	0.338	0.424	14	0.509	0.530	0.305	0.339	0.550	0.306	1.056
DIC-initial	(mg/L)	Summer-2	0.338	0.424	14	0.456	0.455	0.045	0.430	0.477	0.389	0.529
DIC-initial	(mg/L)	Summer-1+2	0.338	0.424	28	0.460	0.493	0.217	0.420	0.533	0.334	0.576
DIC-initial	(mg/L)	Fall-2	0.338	0.424	17	0.468	0.453	0.050	0.397	0.492	0.380	0.521
DOC	(mg/L)	Spring-1	3.55	3.50	16	3.43	3.41	0.23	3.27	3.57	3.01	3.73
DOC	(mg/L)	Summer-1	3.55	3.50	14	3.59	3.44	0.35	3.20	3.66	2.79	3.76
DOC	(mg/L)	Summer-2	3.55	3.50	14	3.46	3.46	0.15	3.36	3.58	3.22	3.67
DOC	(mg/L)	Summer-1+2	3.55	3.50	28	3.50	3.45	0.26	3.35	3.65	3.14	3.69
DOC	(mg/L)	Fall-2	3.55	3.50	17	3.41	3.38	0.15	3.27	3.49	3.14	3.56
F^--total	(mg/L)	Spring-1	0.0740	0.0740	16	0.0717	0.0713	0.0043	0.0690	0.0739	0.0648	0.0780
F^--total	(mg/L)	Summer-1	0.0740	0.0740	14	0.0733	0.0757	0.0065	0.0711	0.0789	0.0698	0.0884
F^--total	(mg/L)	Summer-2	0.0740	0.0740	14	0.0771	0.0647	0.0265	0.0646	0.0787	0.0060	0.0800
F^--total	(mg/L)	Summer-1+2	0.0740	0.0740	28	0.0754	0.0702	0.0197	0.0711	0.0788	0.0418	0.0805
F^--total	(mg/L)	Fall-2	0.0740	0.0740	17	0.0798	0.0801	0.0044	0.0781	0.0817	0.0748	0.0885
Fe	(mg/L)	Spring-1	0.047	0.051	16	0.053	0.056	0.008	0.049	0.064	0.046	0.067
Fe	(mg/L)	Summer-1	0.047	0.051	14	0.047	0.084	0.131	0.045	0.052	0.041	0.310
Fe	(mg/L)	Summer-2	0.047	0.051	14	0.049	0.048	0.005	0.046	0.052	0.039	0.054
Fe	(mg/L)	Summer-1+2	0.047	0.051	28	0.048	0.066	0.093	0.045	0.052	0.042	0.057
Fe	(mg/L)	Fall-2	0.047	0.051	17	0.040	0.040	0.006	0.036	0.044	0.031	0.050
K	(mg/L)	Spring-1	0.411	0.409	16	0.397	0.400	0.015	0.391	0.413	0.382	0.425
K	(mg/L)	Summer-1	0.411	0.409	14	0.420	0.417	0.008	0.411	0.421	0.404	0.426
K	(mg/L)	Summer-2	0.411	0.409	14	0.403	0.409	0.023	0.394	0.429	0.377	0.443
K	(mg/L)	Summer-1+2	0.411	0.409	28	0.417	0.413	0.017	0.399	0.425	0.393	0.437
K	(mg/L)	Fall-2	0.411	0.409	17	0.377	0.372	0.042	0.345	0.394	0.288	0.433

(Continued)

Table C-6. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
Mg	(mg/L)	Spring-1	0.326	0.320	16	0.324	0.323	0.010	0.314	0.333	0.309	0.337
Mg	(mg/L)	Summer-1	0.326	0.320	14	0.321	0.321	0.006	0.316	0.324	0.313	0.331
Mg	(mg/L)	Summer-2	0.326	0.320	14	0.316	0.314	0.004	0.309	0.317	0.307	0.319
Mg	(mg/L)	Summer-1+2	0.326	0.320	28	0.317	0.317	0.006	0.313	0.322	0.309	0.326
Mg	(mg/L)	Fall-2	0.326	0.320	17	0.328	0.329	0.012	0.318	0.339	0.313	0.346
Mn	(mg/L)	Spring-1	0.073	0.072	16	0.069	0.072	0.006	0.068	0.079	0.067	0.081
Mn	(mg/L)	Summer-1	0.073	0.072	14	0.072	0.072	0.001	0.071	0.073	0.070	0.074
Mn	(mg/L)	Summer-2	0.073	0.072	14	0.068	0.068	0.001	0.067	0.069	0.066	0.070
Mn	(mg/L)	Summer-1+2	0.073	0.072	28	0.070	0.070	0.002	0.068	0.072	0.067	0.073
Mn	(mg/L)	Fall-2	0.073	0.072	17	0.073	0.074	0.004	0.071	0.077	0.070	0.079
Na	(mg/L)	Spring-1	0.606	0.612	16	0.594	0.610	0.035	0.584	0.639	0.570	0.671
Na	(mg/L)	Summer-1	0.606	0.612	14	0.619	0.614	0.017	0.602	0.626	0.584	0.634
Na	(mg/L)	Summer-2	0.606	0.612	14	0.598	0.597	0.020	0.582	0.611	0.564	0.625
Na	(mg/L)	Summer-1+2	0.606	0.612	28	0.606	0.605	0.020	0.592	0.623	0.579	0.632
Na	(mg/L)	Fall-2	0.606	0.612	17	0.627	0.615	0.039	0.579	0.649	0.564	0.667
NH_4^+	(mg/L)	Spring-1	0.057	0.058	16	0.039	0.039	0.019	0.026	0.058	0.010	0.059
NH_4^+	(mg/L)	Summer-1	0.057	0.058	14	0.056	0.083	0.114	0.046	0.064	0.033	0.274
NH_4^+	(mg/L)	Summer-2	0.057	0.058	14	0.045	0.046	0.027	0.035	0.056	-0.000	0.088
NH_4^+	(mg/L)	Summer-1+2	0.057	0.058	28	0.050	0.065	0.083	0.041	0.062	0.024	0.075
NH_4^+	(mg/L)	Fall-2	0.057	0.058	17	0.061	0.076	0.040	0.045	0.109	0.032	0.141
NO_3^-	(mg/L)	Spring-1	1.2231	1.2156	16	1.0637	1.0885	0.1363	1.0071	1.2375	0.9037	1.2984
NO_3^-	(mg/L)	Summer-1	1.2231	1.2156	14	1.2494	1.2818	0.1118	1.2352	1.2684	1.2255	1.4875
NO_3^-	(mg/L)	Summer-2	1.2231	1.2156	14	1.2122	1.2012	0.0362	1.1766	1.2229	1.1407	1.2516
NO_3^-	(mg/L)	Summer-1+2	1.2231	1.2156	28	1.2301	1.2415	0.0912	1.2121	1.2574	1.1596	1.2932
NO_3^-	(mg/L)	Fall-2	1.2231	1.2156	17	1.1985	1.1970	0.0292	1.1773	1.2122	1.1570	1.2353
P-total	(mg/L)	Spring-1	0.0016	0.0016	16	0.0010	0.0049	0.0091	0.0010	0.0030	0.0007	0.0276
P-total	(mg/L)	Summer-1	0.0016	0.0016	14	0.0023	0.0028	0.0026	0.0014	0.0031	-0.0001	0.0077
P-total	(mg/L)	Summer-2	0.0016	0.0016	14	0.0015	0.0030	0.0045	0.0011	0.0034	-0.0006	0.0118
P-total	(mg/L)	Summer-1+2	0.0016	0.0016	28	0.0022	0.0029	0.0036	0.0013	0.0032	-0.0004	0.0069
P-total	(mg/L)	Fall-2	0.0016	0.0016	17	0.0020	0.0017	0.0009	0.0007	0.0023	0.0002	0.0028
pH-ANC	(pH units)	Spring-1	5.12	5.09	16	5.15	5.16	0.08	5.08	5.20	5.07	5.30
pH-ANC	(pH units)	Summer-1	5.12	5.09	14	5.09	5.09	0.05	5.07	5.13	4.99	5.14
pH-ANC	(pH units)	Summer-2	5.12	5.09	14	5.04	5.04	0.02	5.02	5.05	5.02	5.07
pH-ANC	(pH units)	Summer-1+2	5.12	5.09	28	5.05	5.06	0.05	5.02	5.10	5.02	5.14
pH-ANC	(pH units)	Fall-2	5.12	5.09	17	5.10	5.11	0.03	5.10	5.12	5.09	5.16

(Continued)

Table C-6. Continued

Analyte	Units	Subsurvey-lab	Field target	Lab target	N	Median	Mean	Std	Q1	Q3	P10	P90
pH-BNC	(pH units)	Spring-1	5.15	5.12	16	5.17	5.18	0.06	5.14	5.21	5.11	5.28
pH-BNC	(pH units)	Summer-1	5.15	5.12	14	5.08	5.07	0.05	5.04	5.11	4.98	5.14
pH-BNC	(pH units)	Summer-2	5.15	5.12	14	5.07	5.08	0.02	5.07	5.09	5.05	5.10
pH-BNC	(pH units)	Summer-1+2	5.15	5.12	28	5.07	5.07	0.04	5.05	5.10	5.00	5.12
pH-BNC	(pH units)	Fall-2	5.15	5.12	17	5.17	5.19	0.06	5.14	5.20	5.13	5.32
pH-closed	(pH units)	Spring-PL	5.13	—	10	5.15	5.16	0.04	5.14	5.18	5.09	5.25
pH-closed	(pH units)	Summer-PL	5.13	—	12	5.11	5.11	0.06	5.08	5.15	5.01	5.22
pH-closed	(pH units)	Fall-PL	5.13	—	11	5.13	5.13	0.03	5.09	5.15	5.09	5.19
pH-eq	(pH units)	Spring-1	5.16	5.15	16	5.14	5.19	0.14	5.12	5.18	5.11	5.47
pH-eq	(pH units)	Summer-1	5.16	5.15	14	5.15	5.14	0.07	5.13	5.19	4.99	5.20
pH-eq	(pH units)	Summer-2	5.16	5.15	14	5.12	5.25	0.55	5.09	5.15	4.94	6.17
pH-eq	(pH units)	Summer-1+2	5.16	5.15	28	5.14	5.20	0.39	5.11	5.19	5.00	5.21
pH-eq	(pH units)	Fall-2	5.16	5.15	17	5.03	5.04	0.04	5.01	5.07	5.00	5.12
SiO_2	(mg/L)	Spring-1	4.386	4.347	16	4.400	4.364	0.118	4.230	4.467	4.218	4.502
SiO_2	(mg/L)	Summer-1	4.386	4.347	14	4.322	4.366	0.131	4.287	4.469	4.222	4.603
SiO_2	(mg/L)	Summer-2	4.386	4.347	14	4.373	4.374	0.098	4.321	4.465	4.199	4.500
SiO_2	(mg/L)	Summer-1+2	4.386	4.347	28	4.348	4.370	0.114	4.292	4.460	4.214	4.507
SiO_2	(mg/L)	Fall-2	4.386	4.347	17	4.420	4.356	0.336	4.378	4.459	4.104	4.536
SO_4^{2-}	(mg/L)	Spring-1	6.363	6.360	16	6.115	6.094	0.579	5.674	6.562	4.996	6.817
SO_4^{2-}	(mg/L)	Summer-1	6.363	6.360	14	6.311	6.287	0.302	5.967	6.562	5.900	6.681
SO_4^{2-}	(mg/L)	Summer-2	6.363	6.360	14	6.267	6.374	0.474	6.187	6.387	6.000	7.190
SO_4^{2-}	(mg/L)	Summer-1+2	6.363	6.360	28	6.267	6.331	0.393	6.071	6.431	5.936	6.659
SO_4^{2-}	(mg/L)	Fall-2	6.363	6.360	17	6.430	6.356	0.252	6.170	6.538	6.016	6.643
True color	(PCU)	Spring-PL	15.0	—	10	12.5	13.0	4.8	10.0	16.3	5.5	20.0
True color	(PCU)	Summer-PL	15.0	—	11	15.0	17.3	4.1	15.0	20.0	11.0	24.0
True color	(PCU)	Fall-PL	15.0	—	11	15.0	16.4	3.9	15.0	20.0	10.0	20.0
Turbidity	(NTU)	Spring-PL	0.130	—	10	0.175	0.189	0.083	0.120	0.225	0.111	0.375
Turbidity	(NTU)	Summer-PL	0.130	—	11	0.100	0.091	0.030	0.100	0.100	0.020	0.100
Turbidity	(NTU)	Fall-PL	0.130	—	11	0.100	0.127	0.047	0.100	0.200	0.100	0.200

Appendix D

Confidence Interval and Scatter Plots for Natural Audit Sample Data

Plots illustrating the 95% confidence intervals and the scatter of the Seventh Lake (FN7) and Big Moose Lake (FN8) field natural audit sample data are presented in figures D-1 through D-60. Plots are provided for all 30 (6 processing laboratory and 24 analytical laboratory) analytes. These plots can be used in conjunction with the summary statistics provided for the field natural audit data in Appendix C. The legend for the plots is as follows:

o = analytical result for a single audit sample, Spring Seasonal subsurvey.

□ = analytical result for a single audit sample, Summer Seasonal subsurvey.

Δ = analytical result for a single audit sample, Fall Seasonal subsurvey.

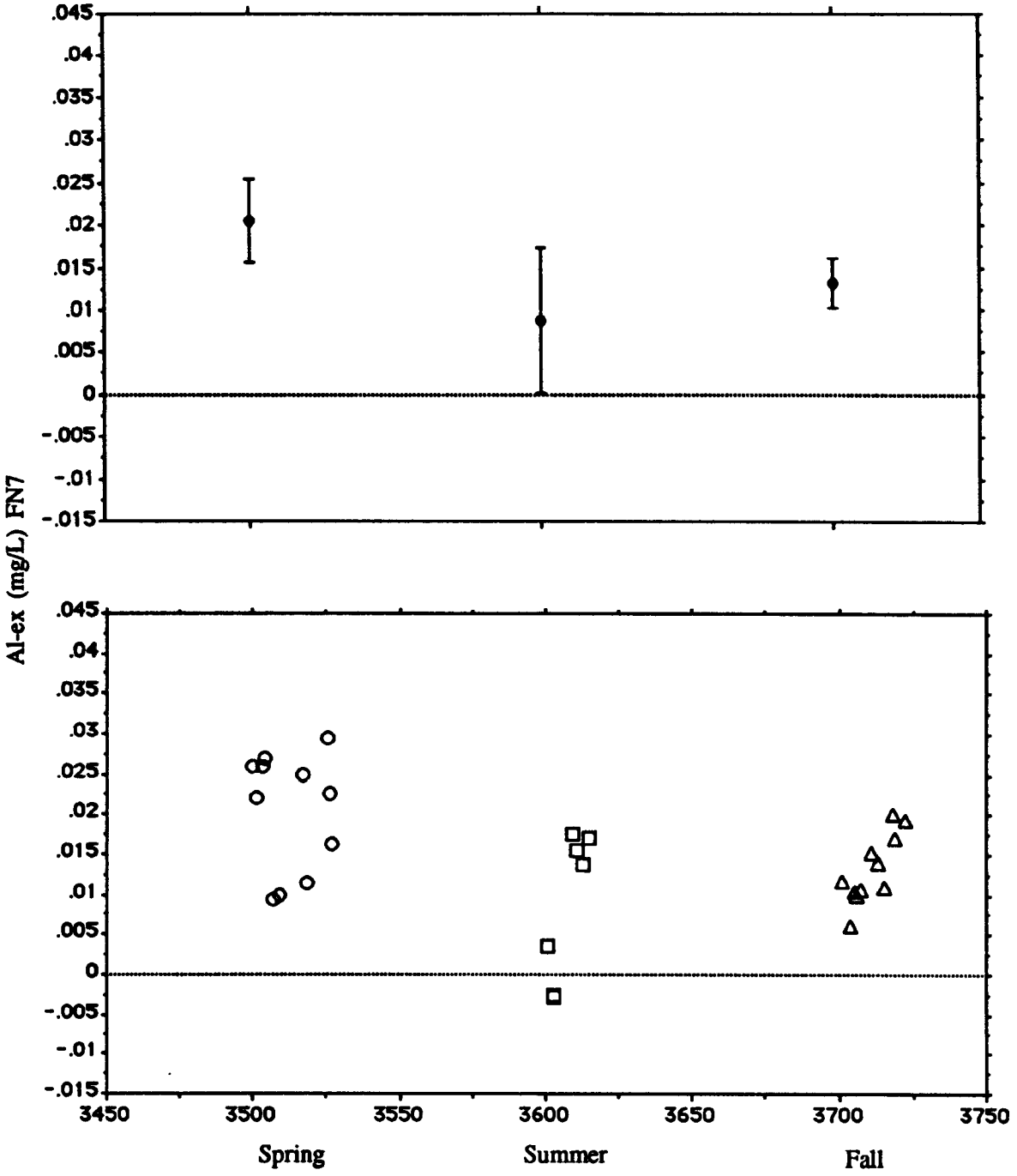

Figure D-1. Extractable aluminum (Al-ext), Seventh Lake audit samples.

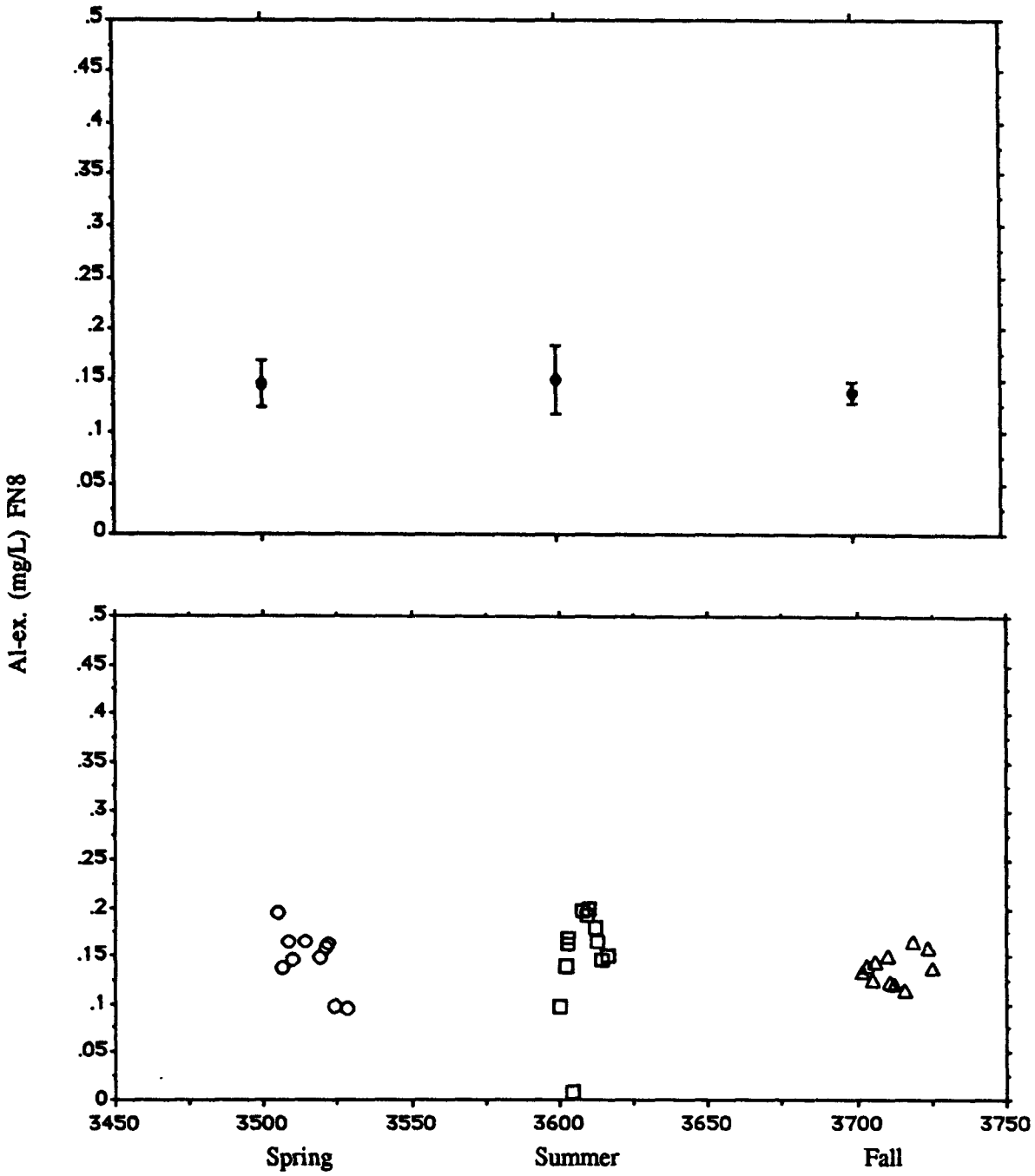

Figure D-2. Extractable aluminum (Al-ext), Big Moose Lake audit samples.

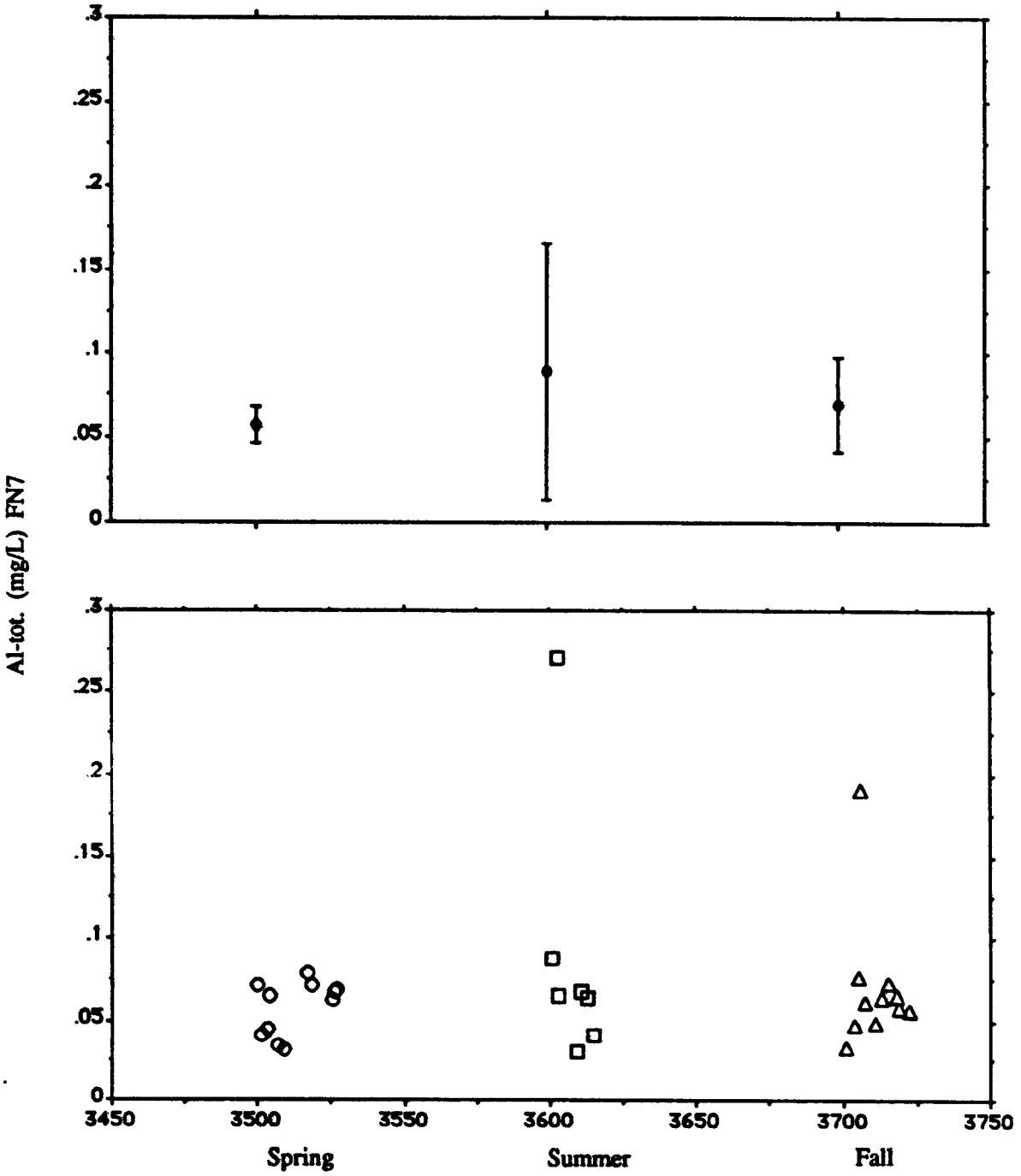

Figure D-3. Total aluminum (Al-total), Seventh Lake audit samples.

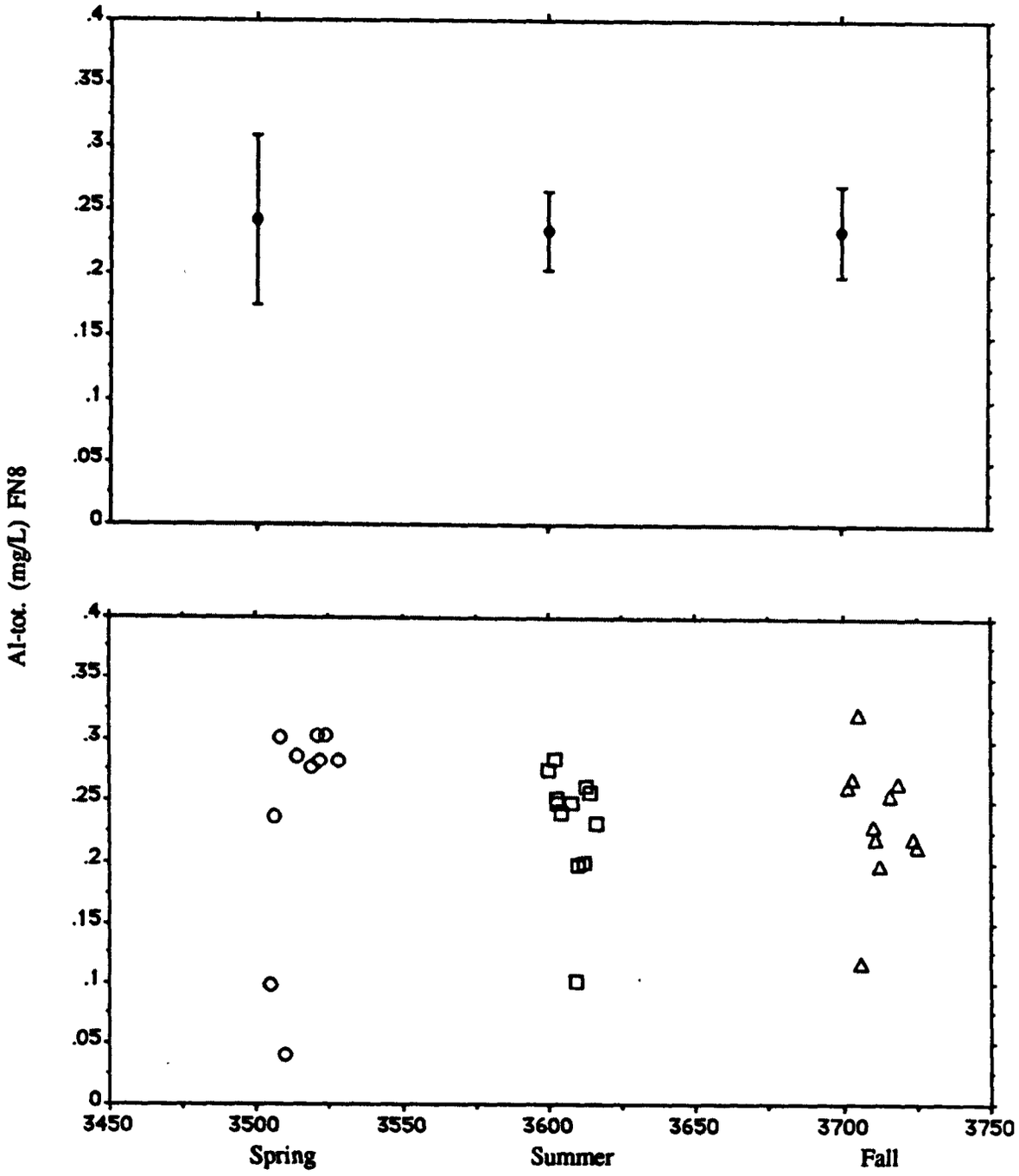

Figure D-4. Total aluminum (Al-total), Big Moose Lake audit samples.

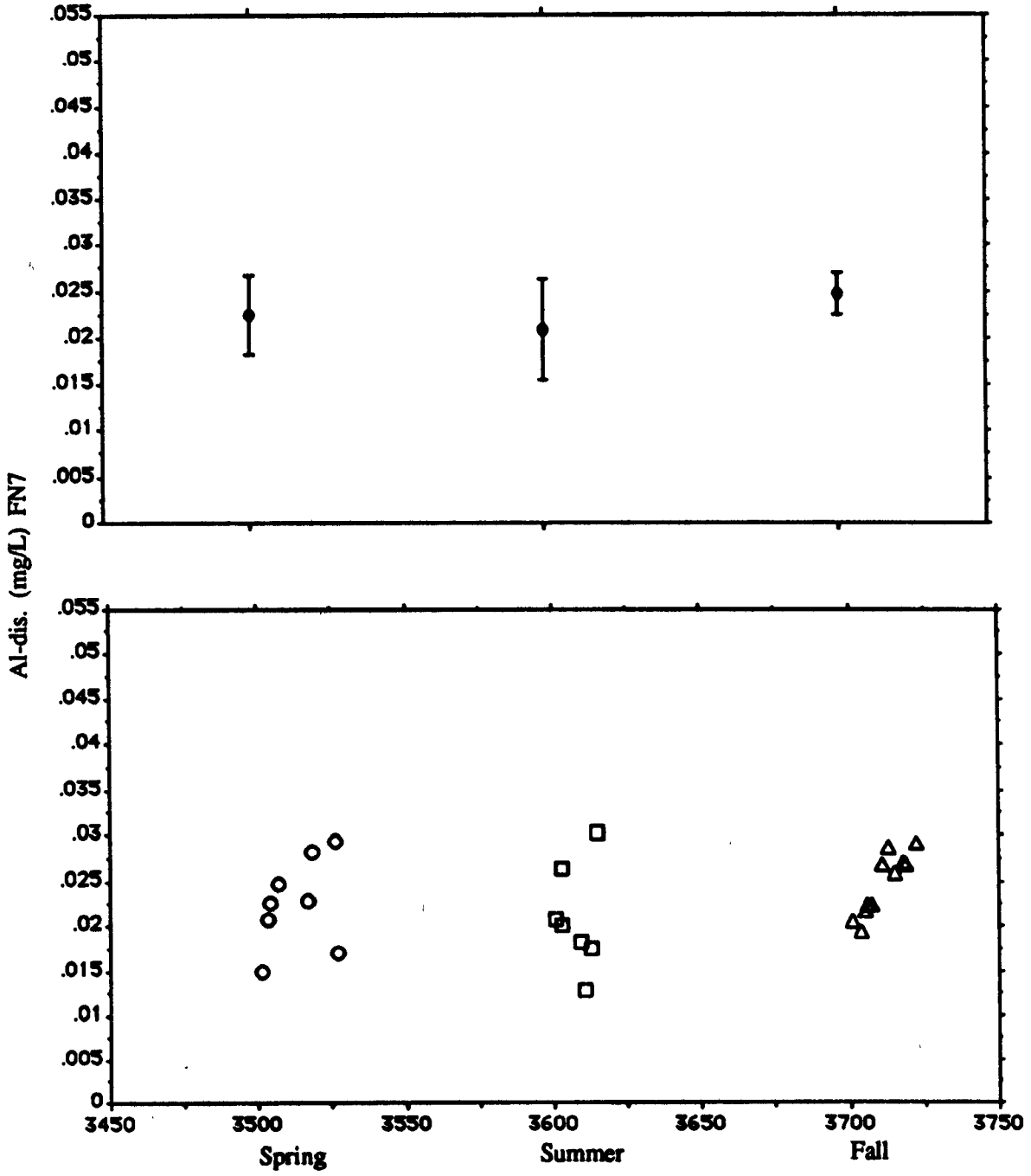

Figure D-5. Dissolved monomeric aluminum (Al-dis), Seventh Lake audit samples.

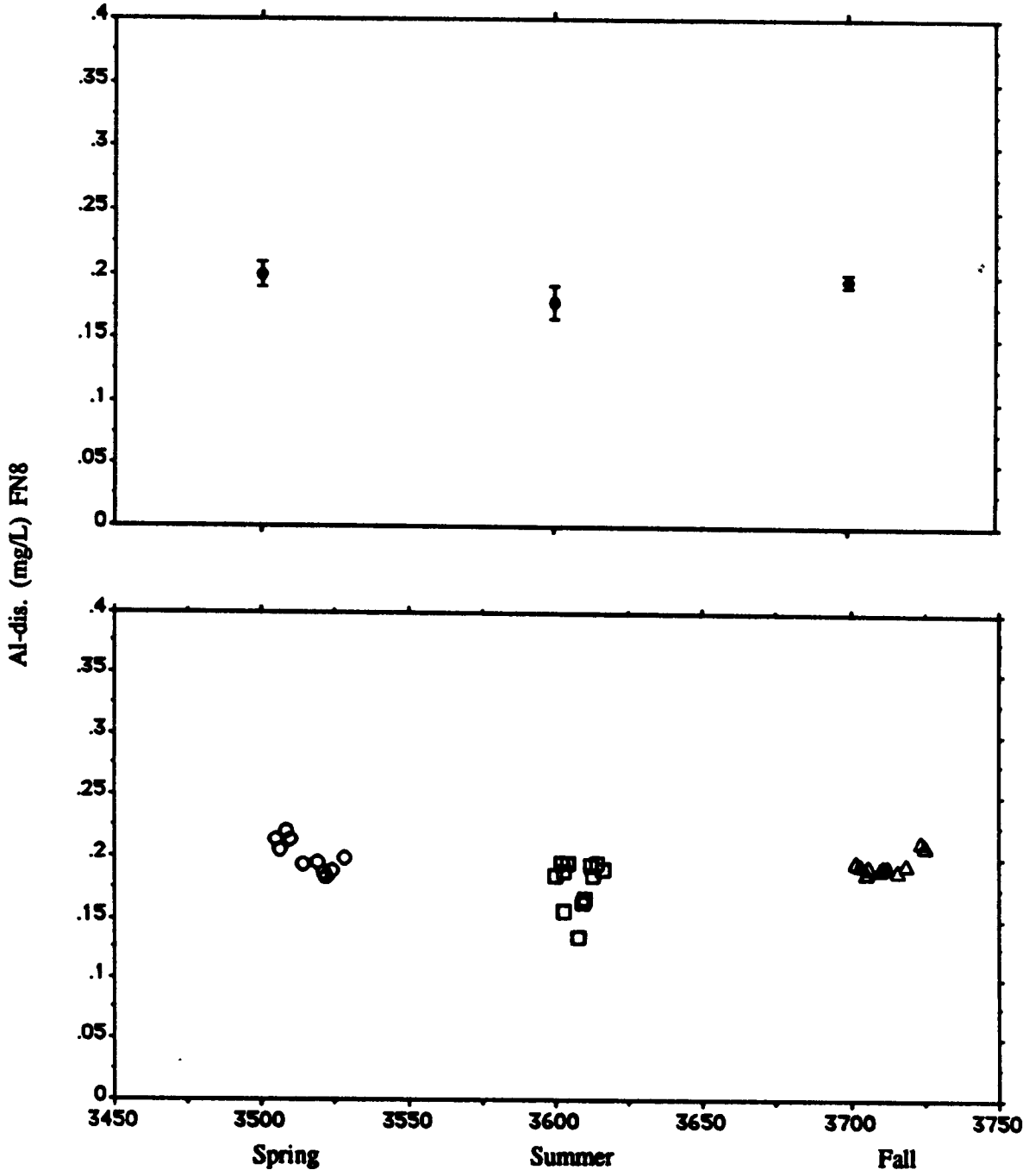

Figure D-6. Dissolved monomeric aluminum (Al-dis), Big Moose Lake audit samples.

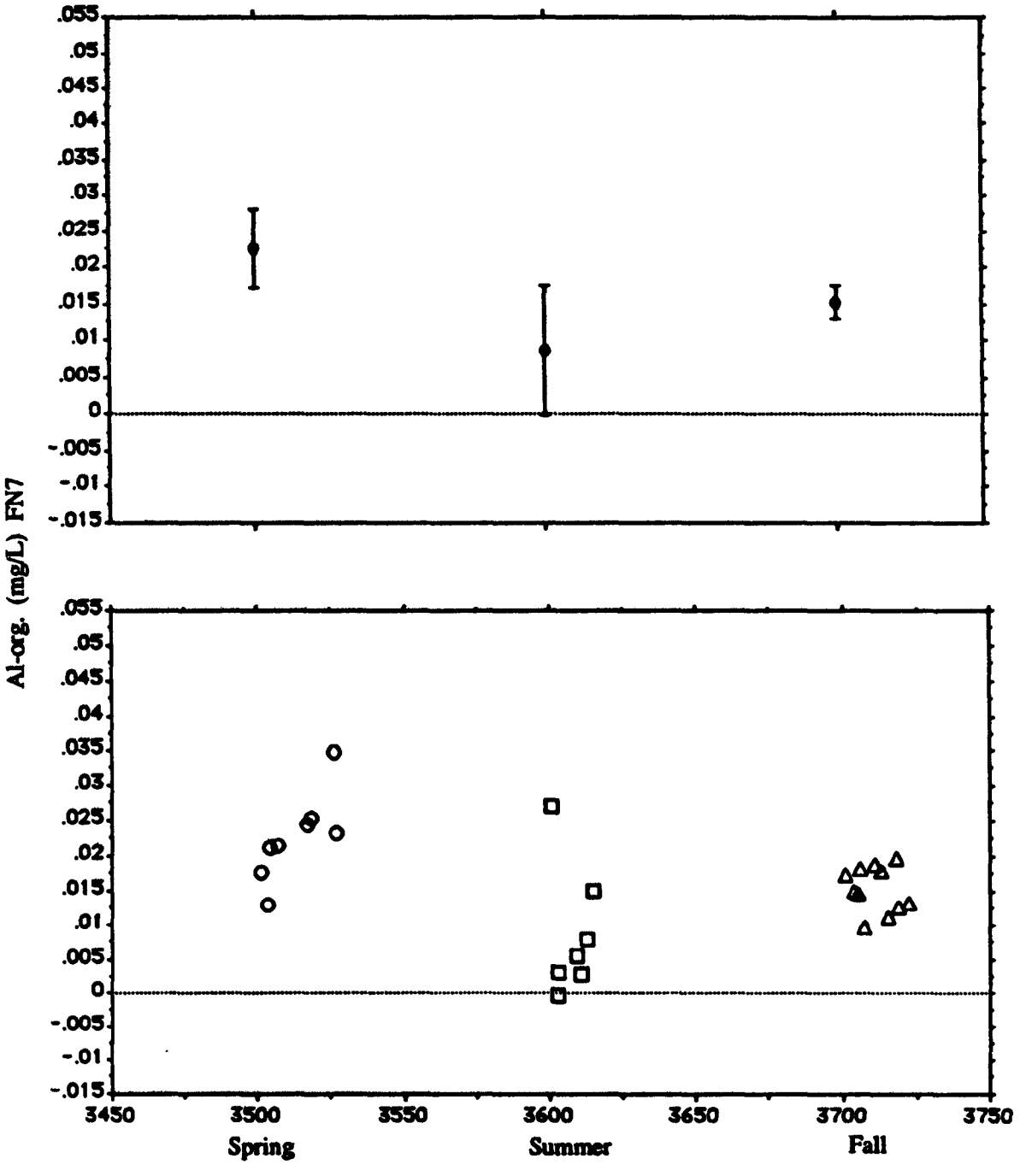

Figure D-7. Nonexchangeable monomeric aluminum (Al-org), Seventh Lake audit samples.

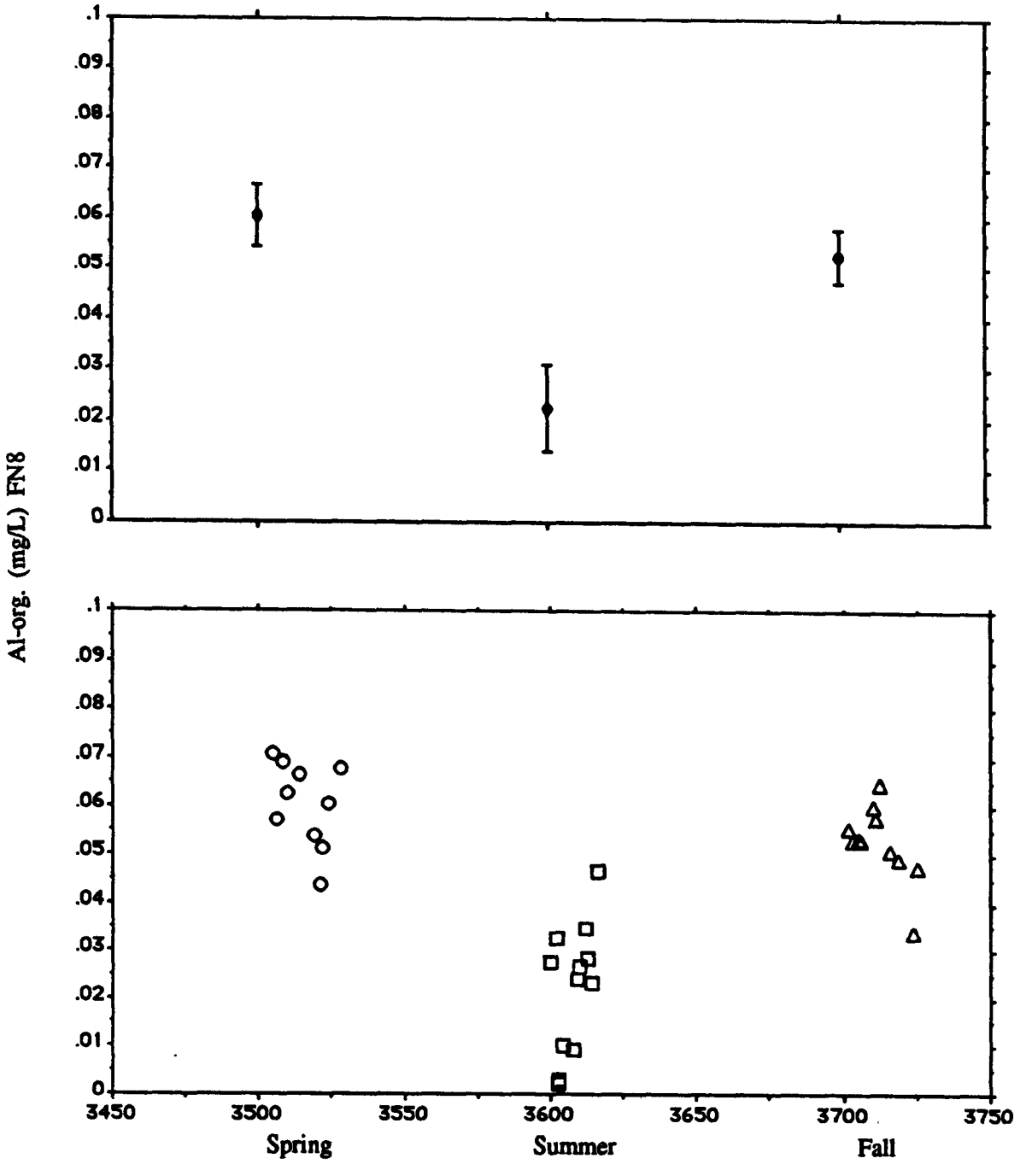

Figure D-8. Nonexchangeable monomeric aluminum (Al-org), Big Moose Lake audit samples.

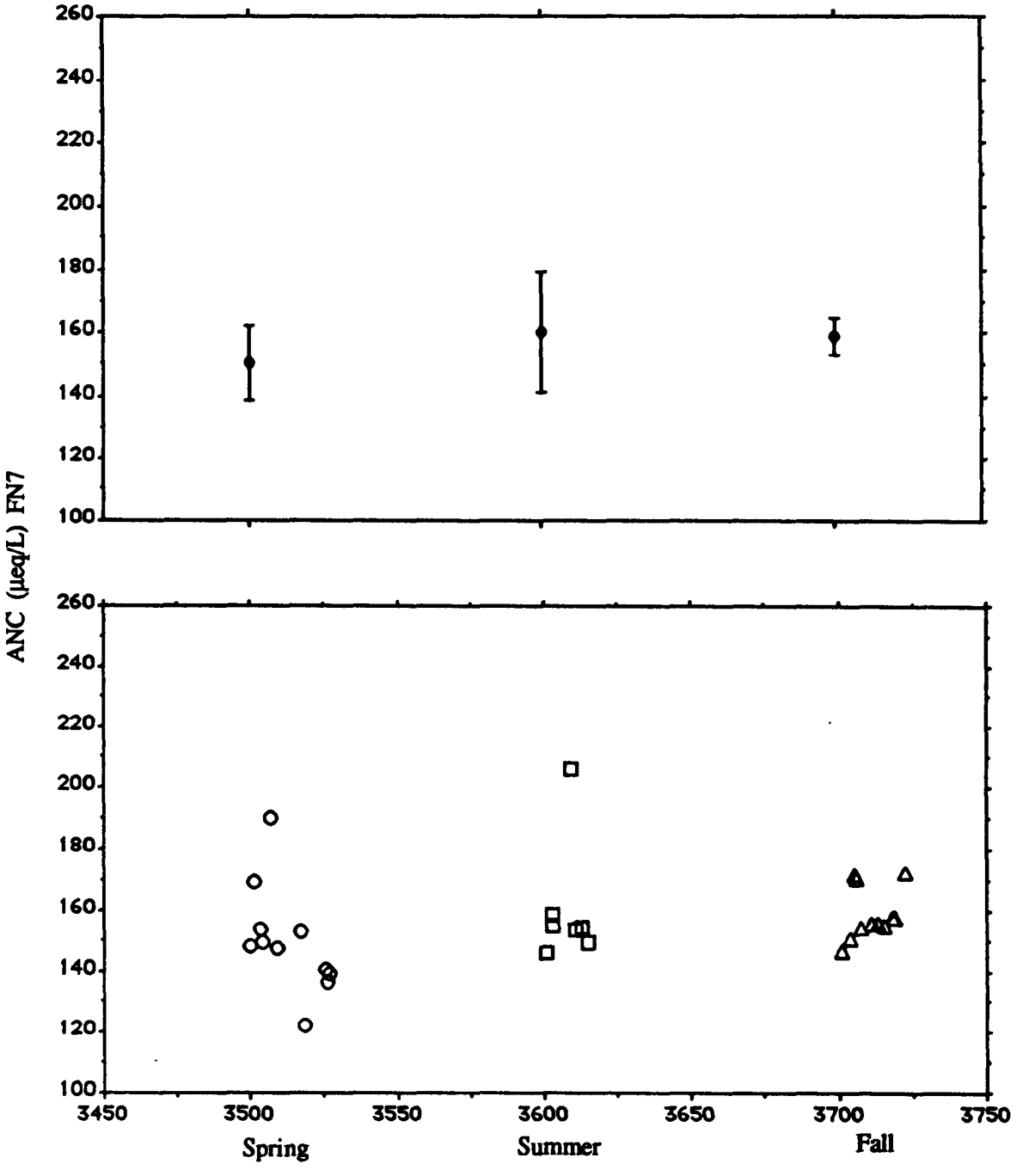

Figure D-9. Acid neutralizing capacity (ANC), Seventh Lake audit samples.

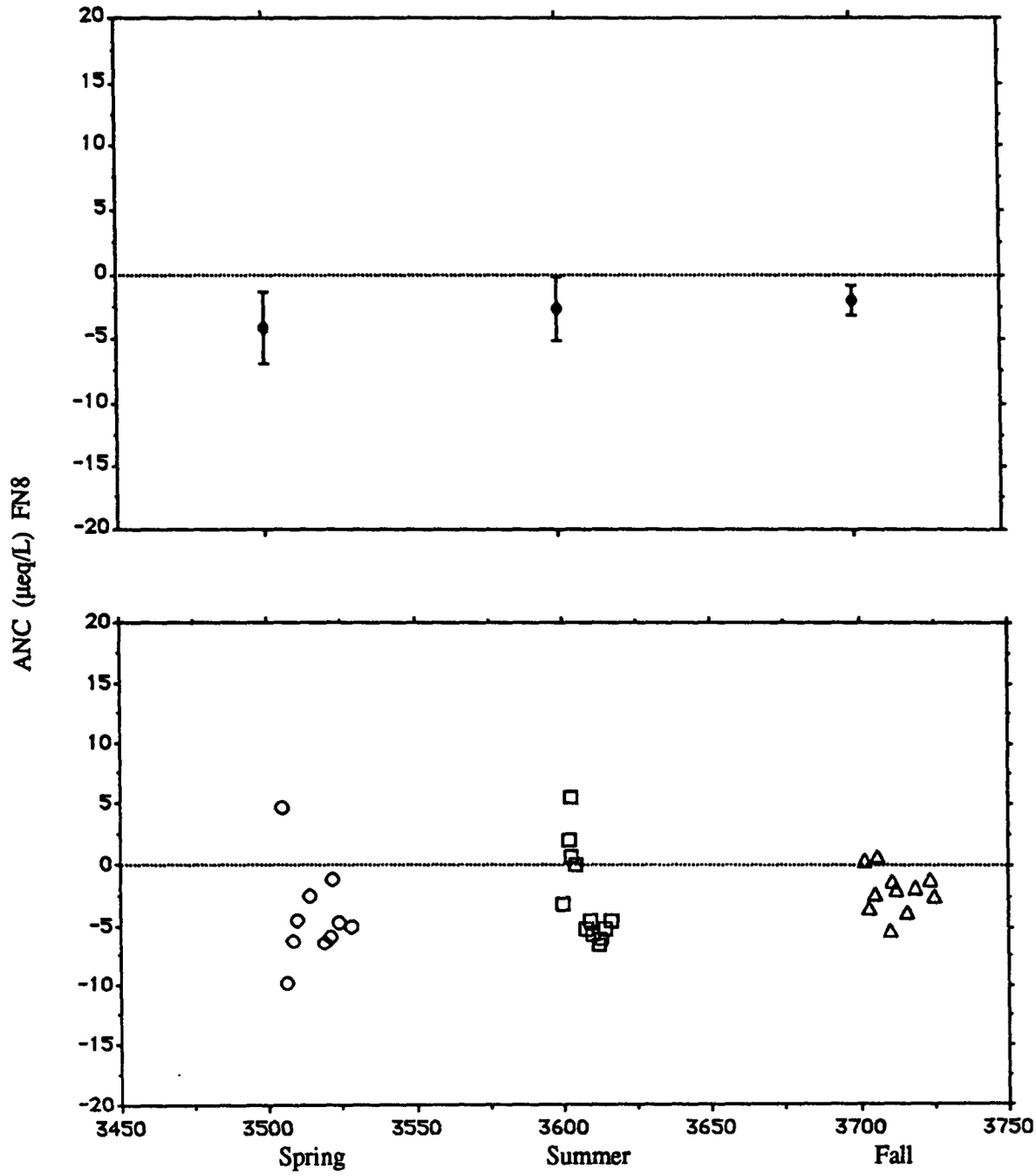

Figure D-10. Acid neutralizing capacity (ANC), Big Moose Lake audit samples.

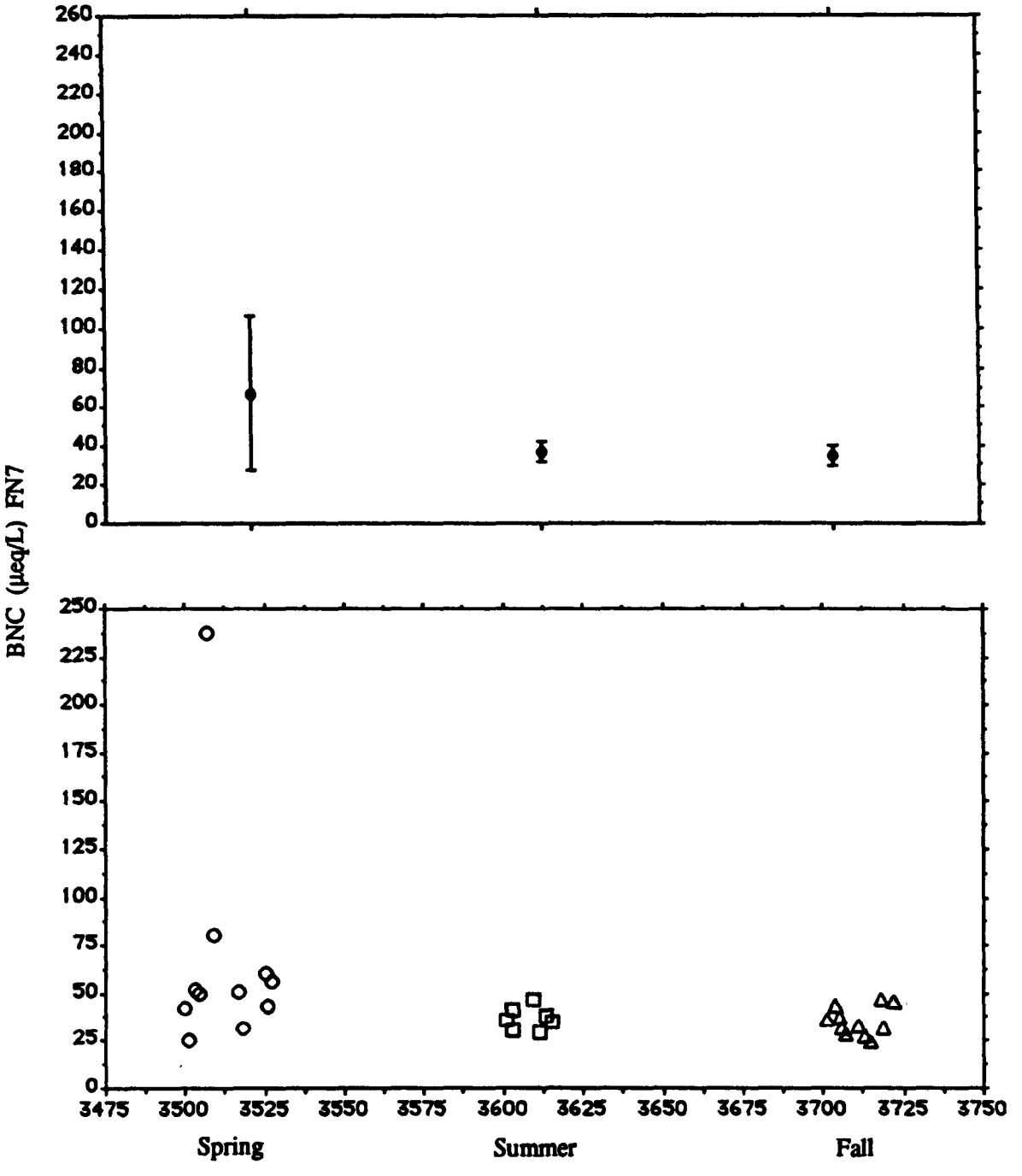

Figure D-11. Base neutralizing capacity (BNC), Seventh Lake audit samples.

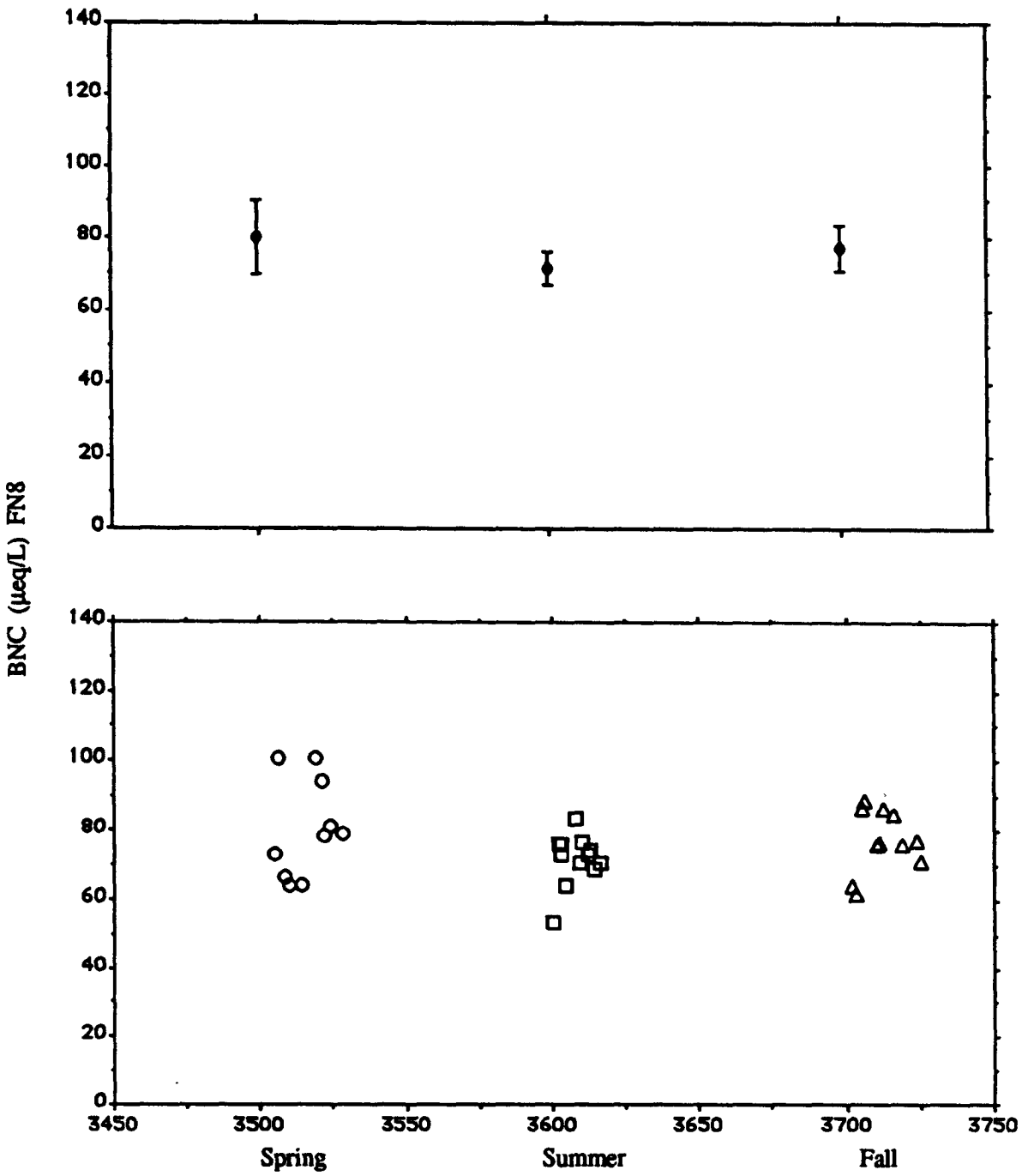

Figure D-12. Base neutralizing capacity (BNC), Big Moose Lake audit samples.

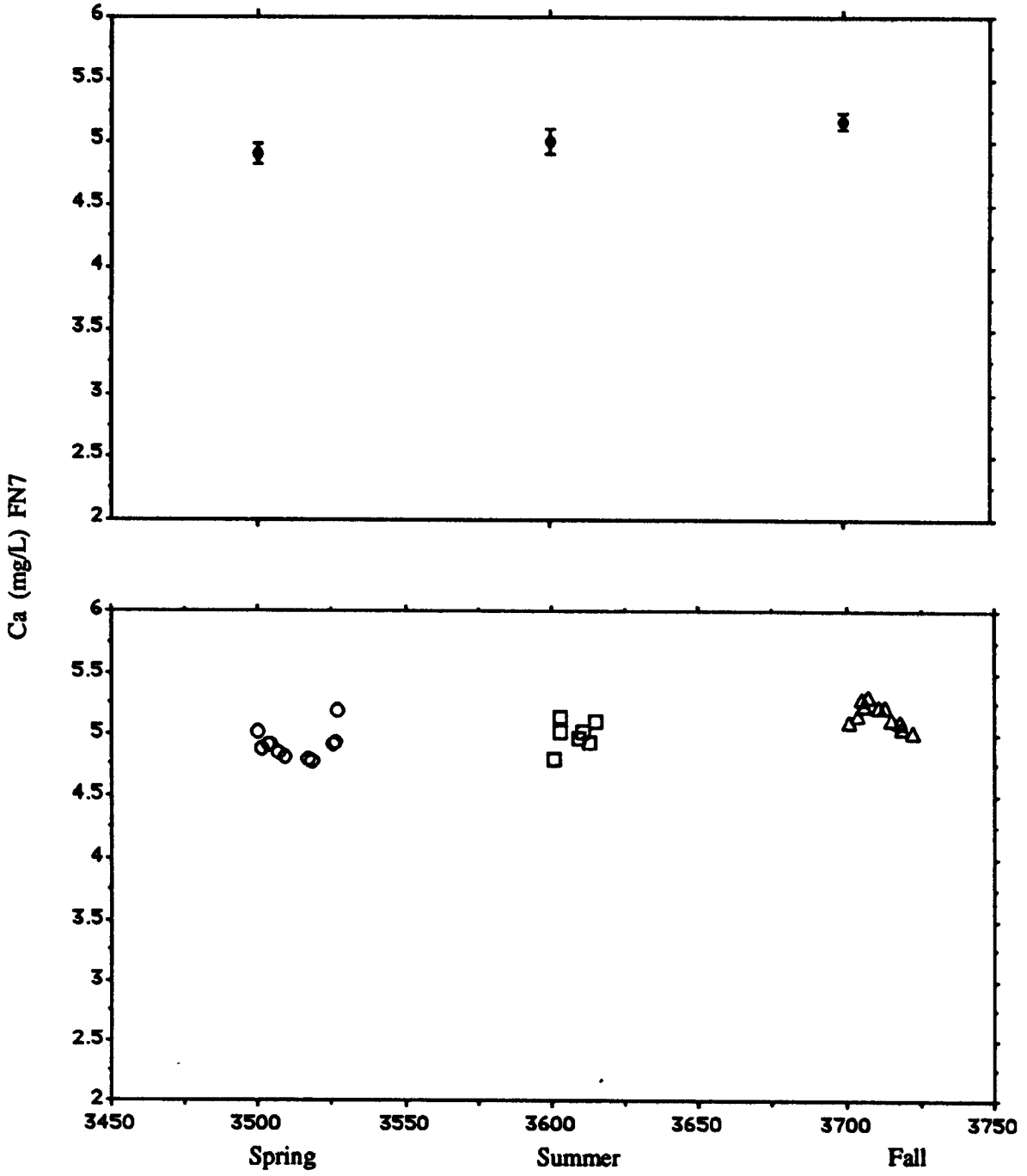

Figure D-13. Calcium (Ca), Seventh Lake audit samples.

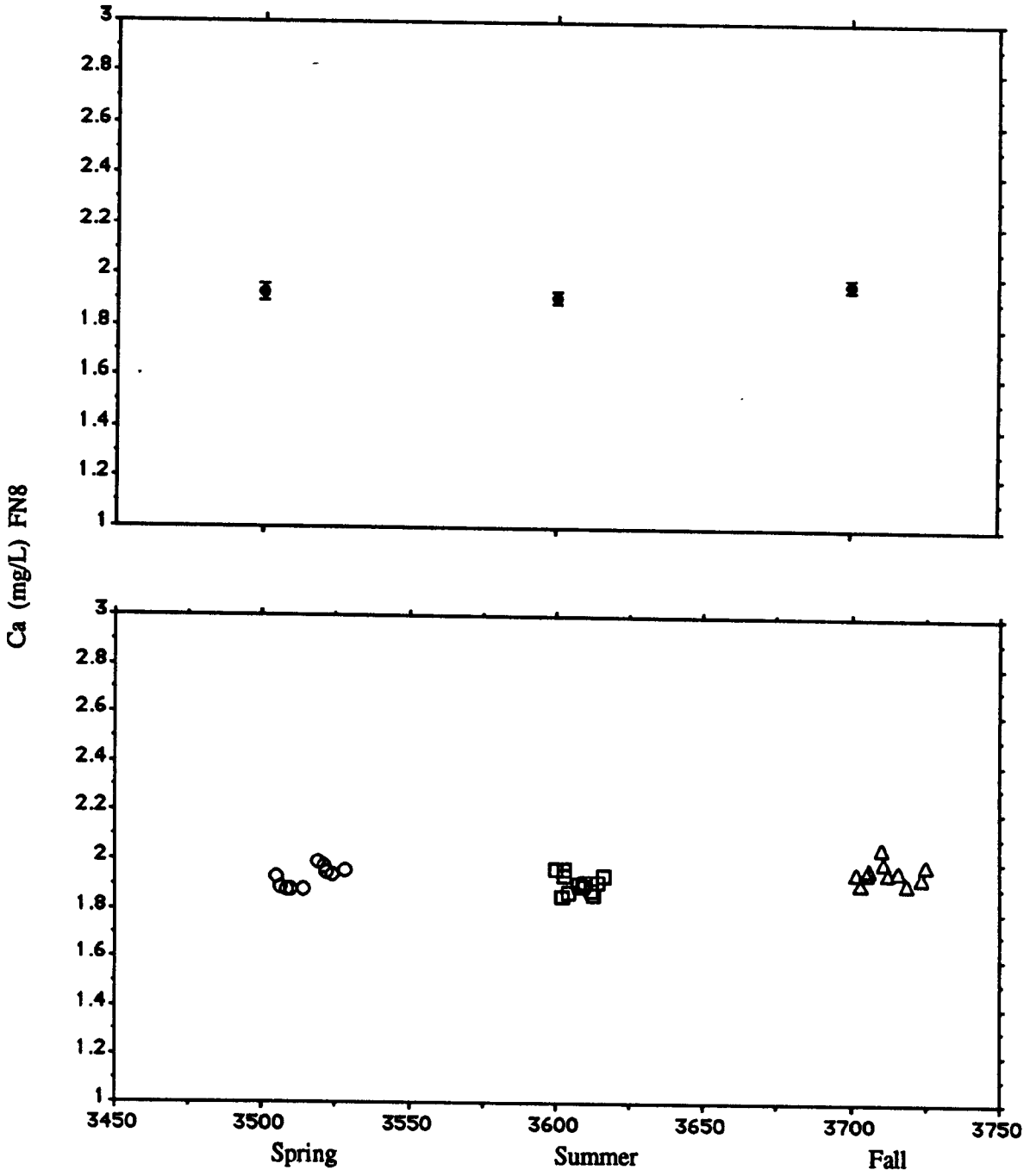

Figure D-14. Calcium (Ca), Big Moose Lake audit samples.

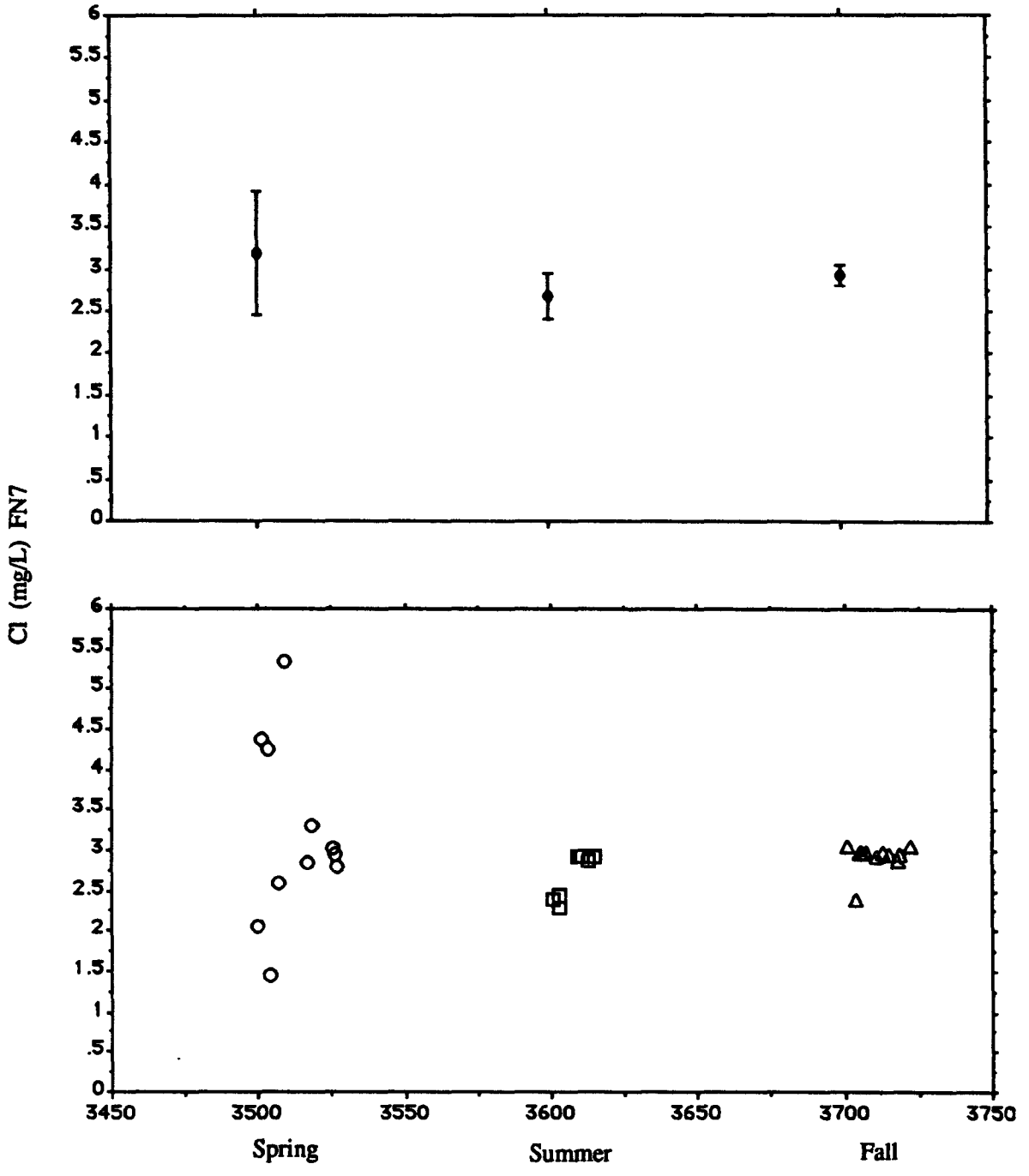

Figure D-15. Chloride (Cl^-), Seventh Lake audit samples.

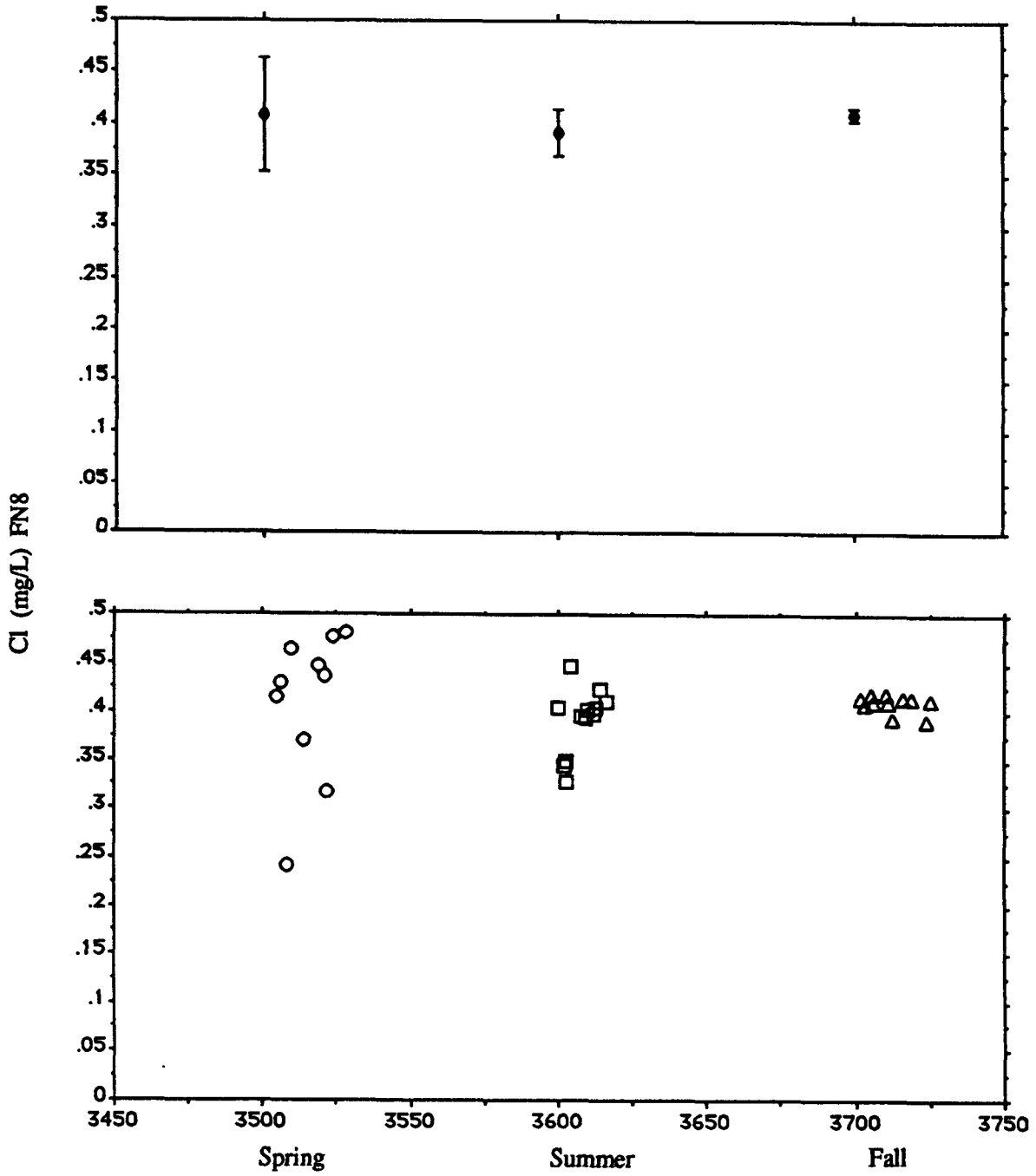

Figure D-16. Chloride (Cl^-), Big Moose Lake audit samples.

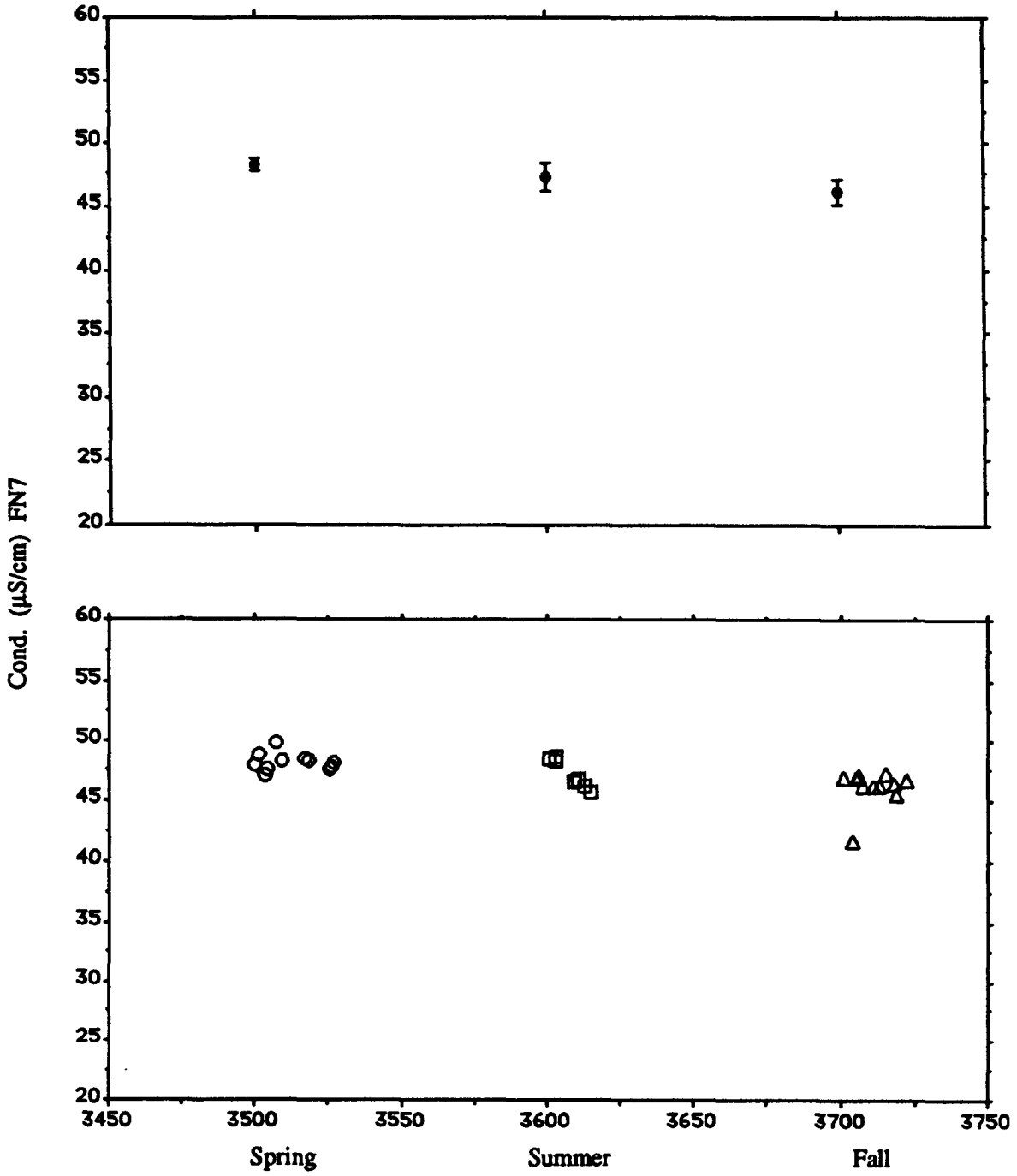

Figure D-17. Conductivity (Cond), Seventh Lake audit samples.

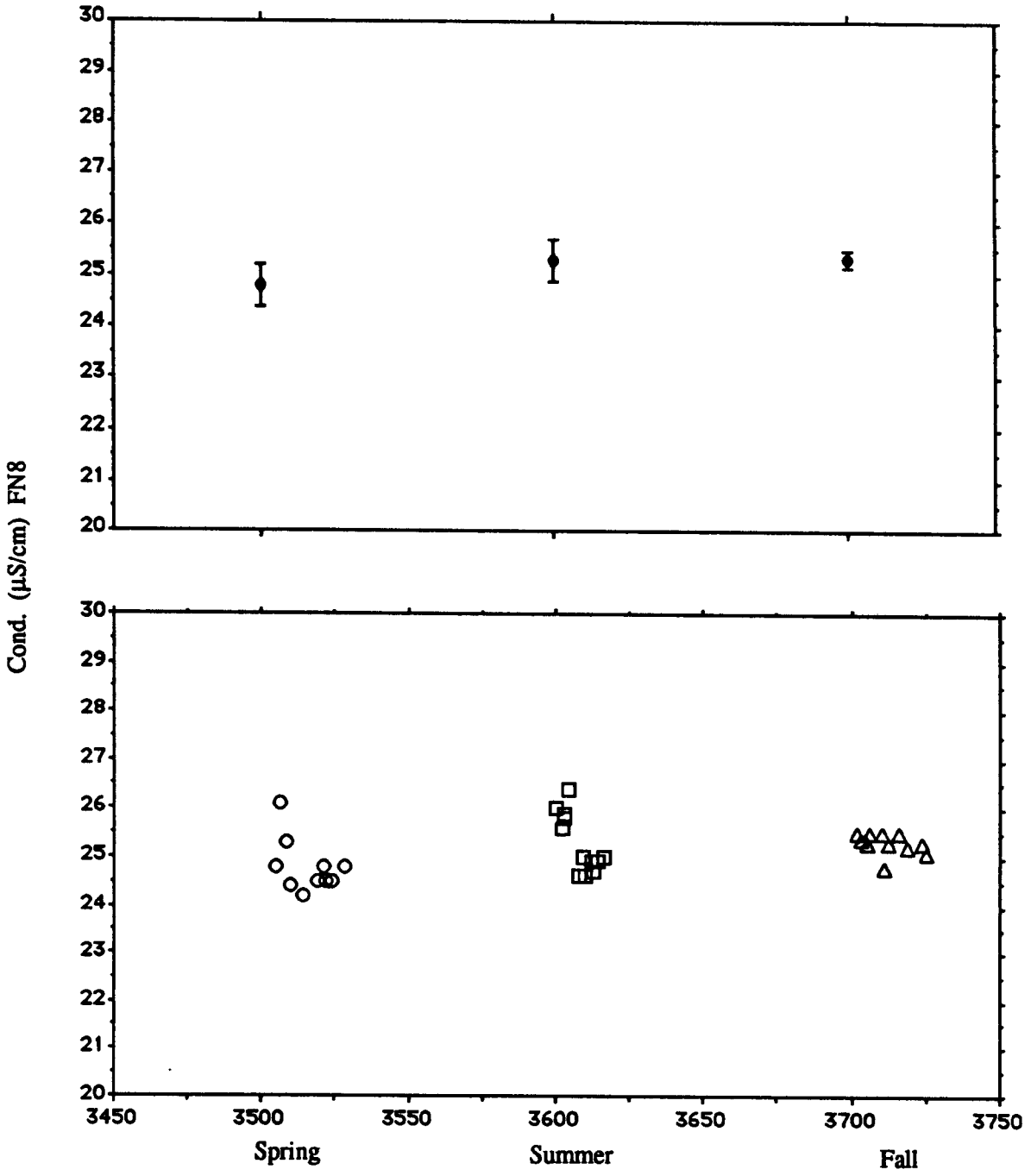

Figure D-18. Conductivity (Cond), Big Moose Lake audit samples.

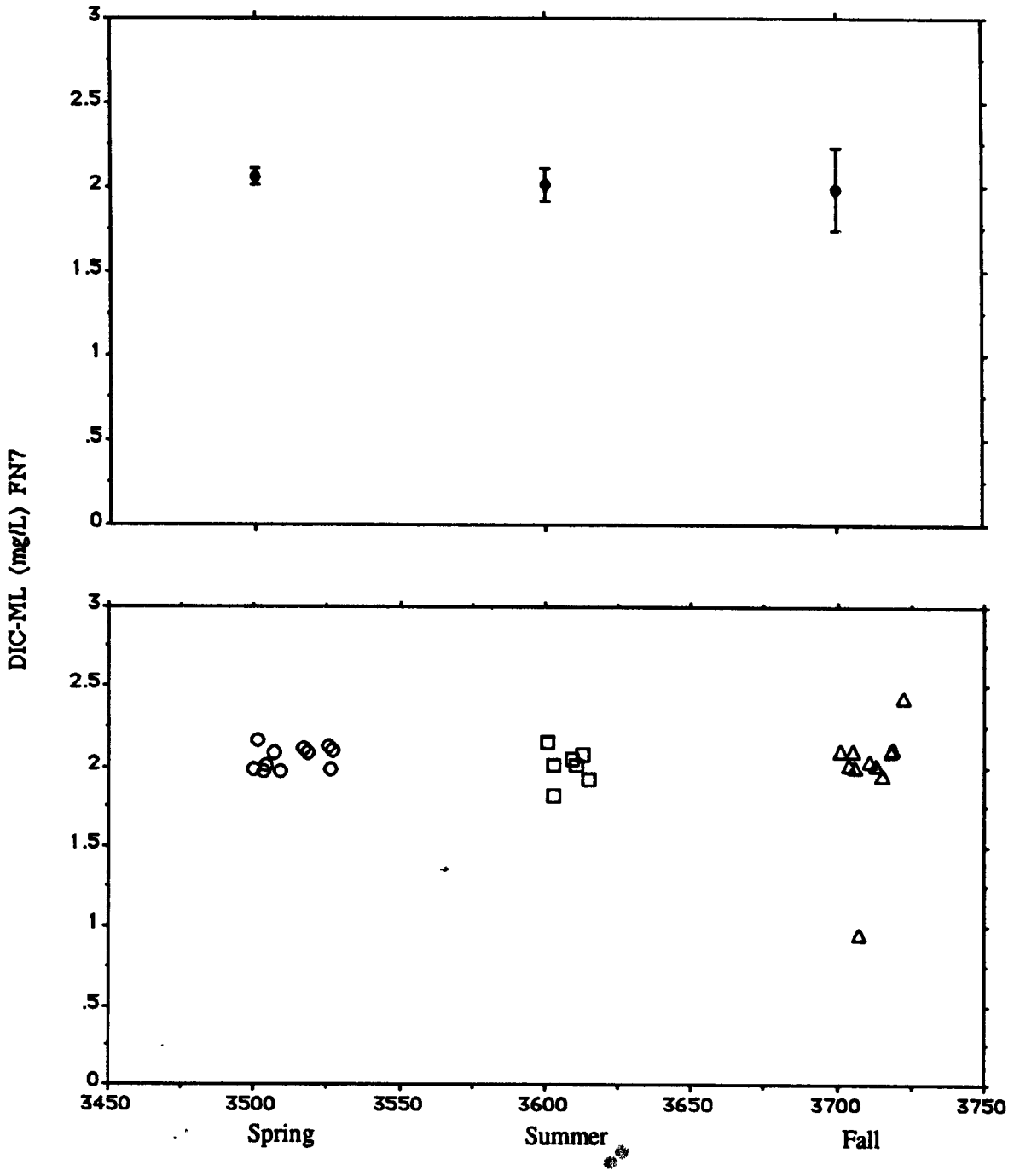

Figure D-19. Dissolved inorganic carbon-closed (DIC-closed), Seventh Lake audit samples.

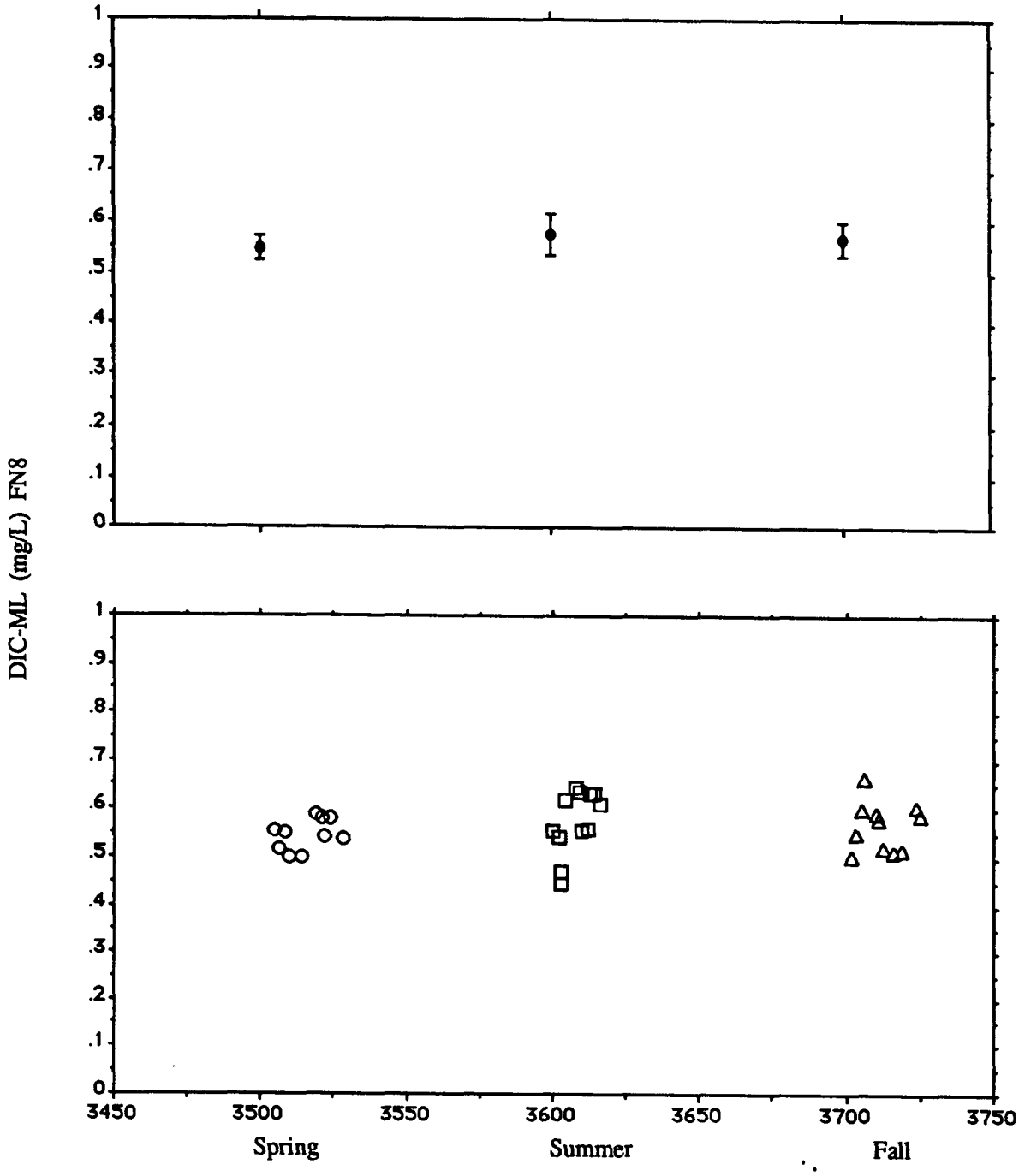

Figure D-20. Dissolved inorganic carbon-closed system (DIC-closed), Big Moose Lake audit samples.

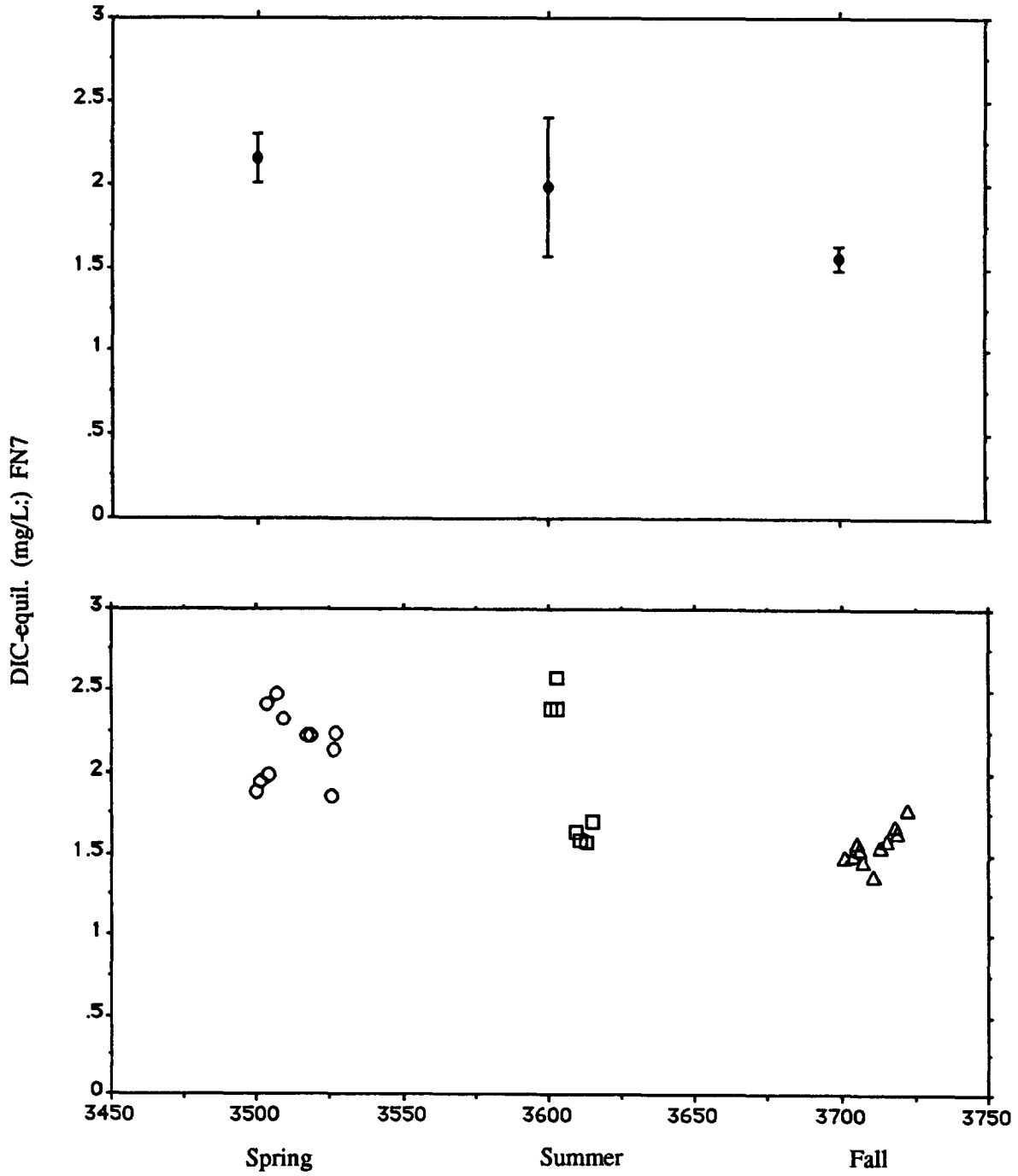

Figure D-21. Dissolved inorganic carbon-equilibrated (DIC-eq), Seventh Lake audit samples.

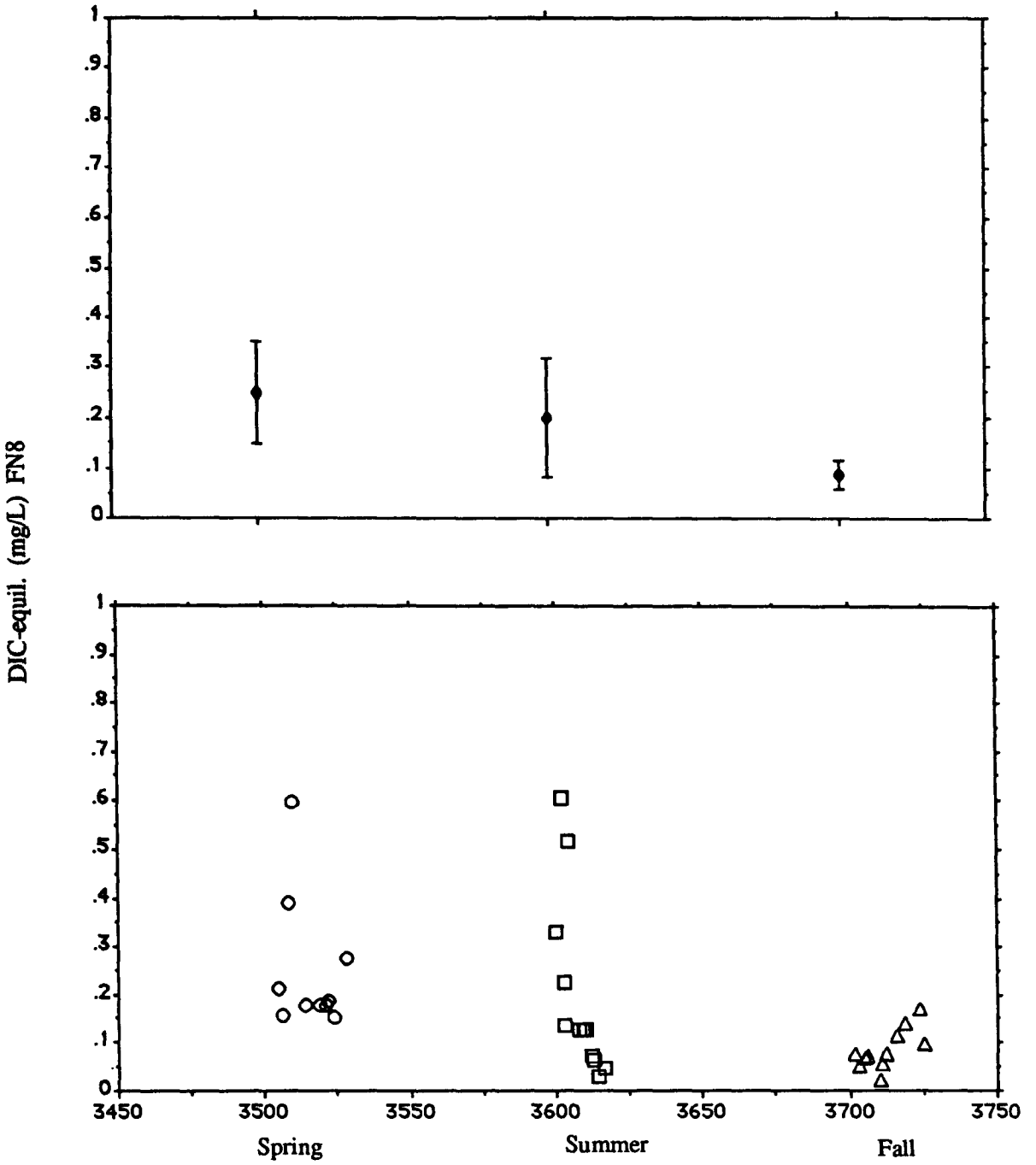

Figure D-22. Dissolved inorganic carbon-equilibrated (DIC-eq), Big Moose Lake audit samples.

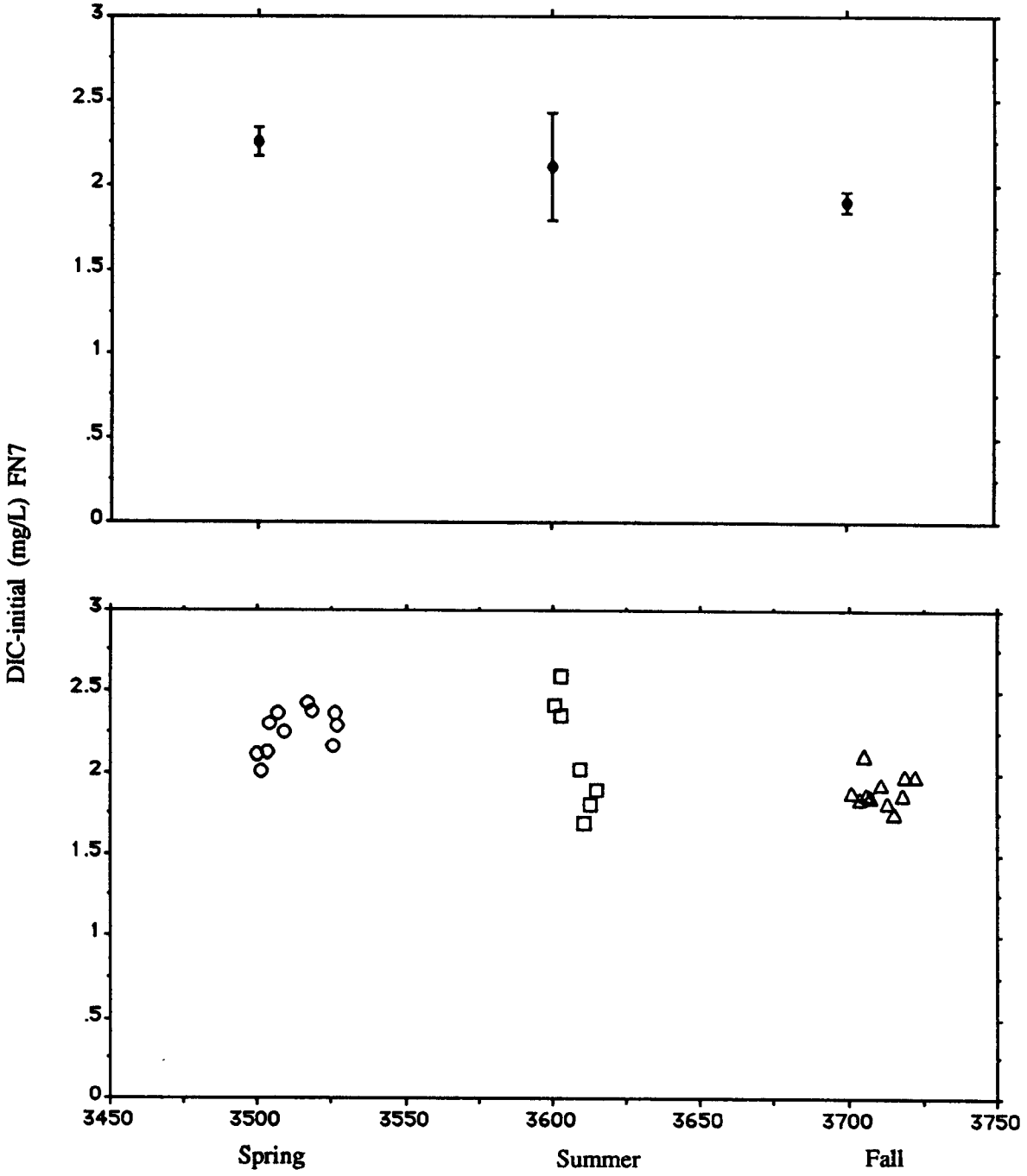

Figure D-23. Dissolved inorganic carbon-initial (DIC-initial), Seventh Lake audit samples.

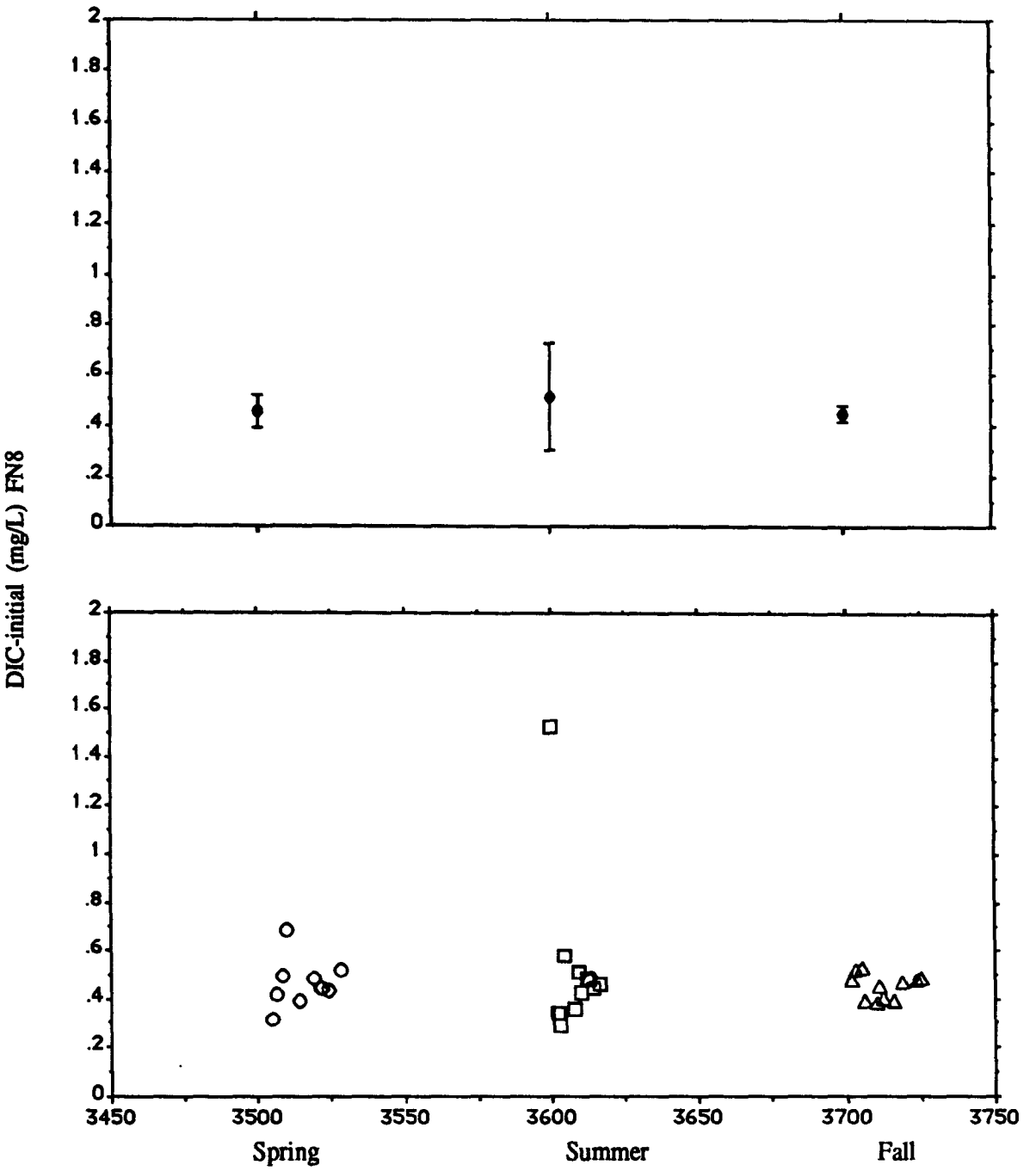

Figure D-24. Dissolved inorganic carbon-initial (DIC-initial), Big Moose Lake audit samples.

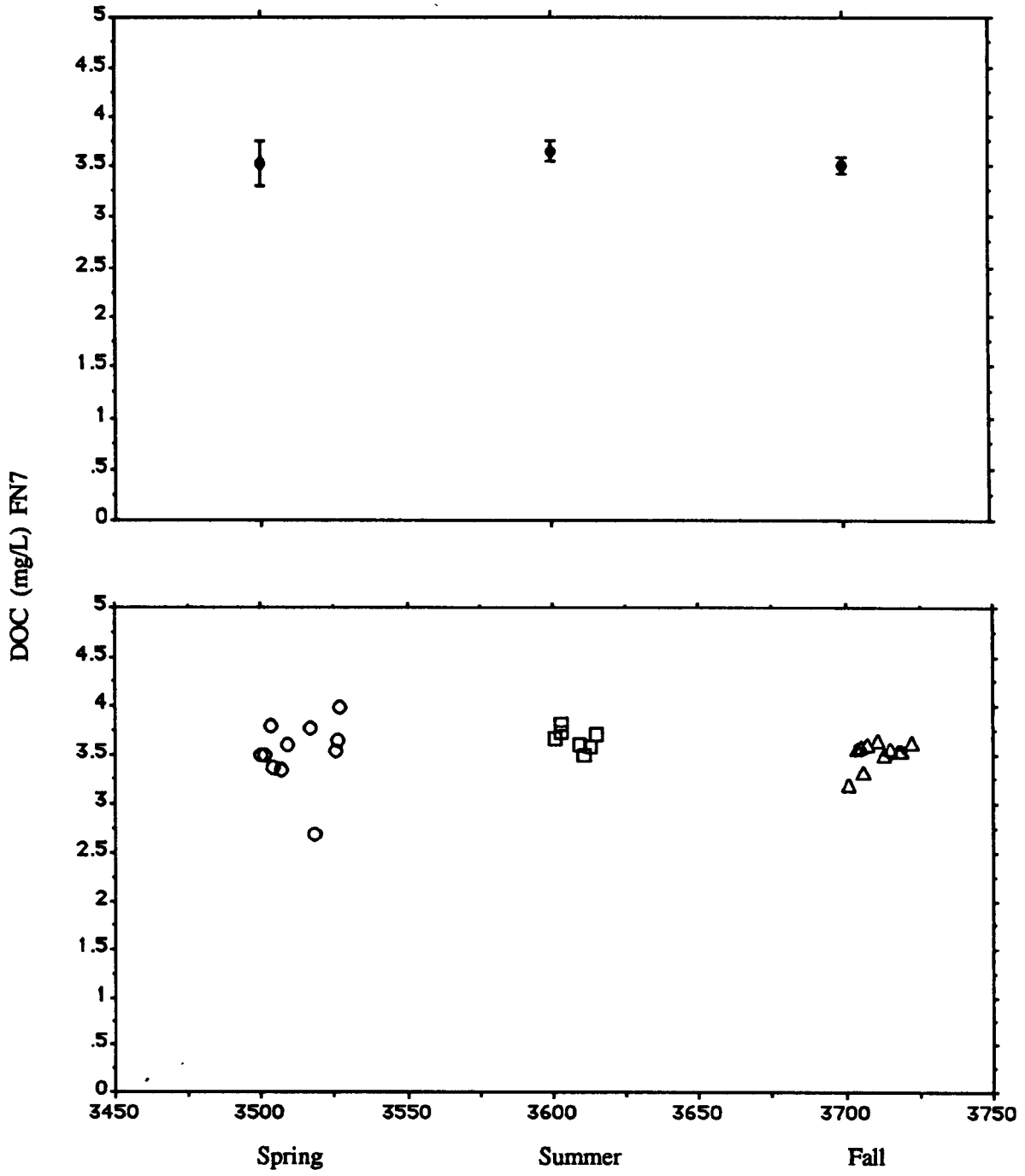

Figure D-25. Dissoved organic carbon (DOC), Seventh Lake audit samples.

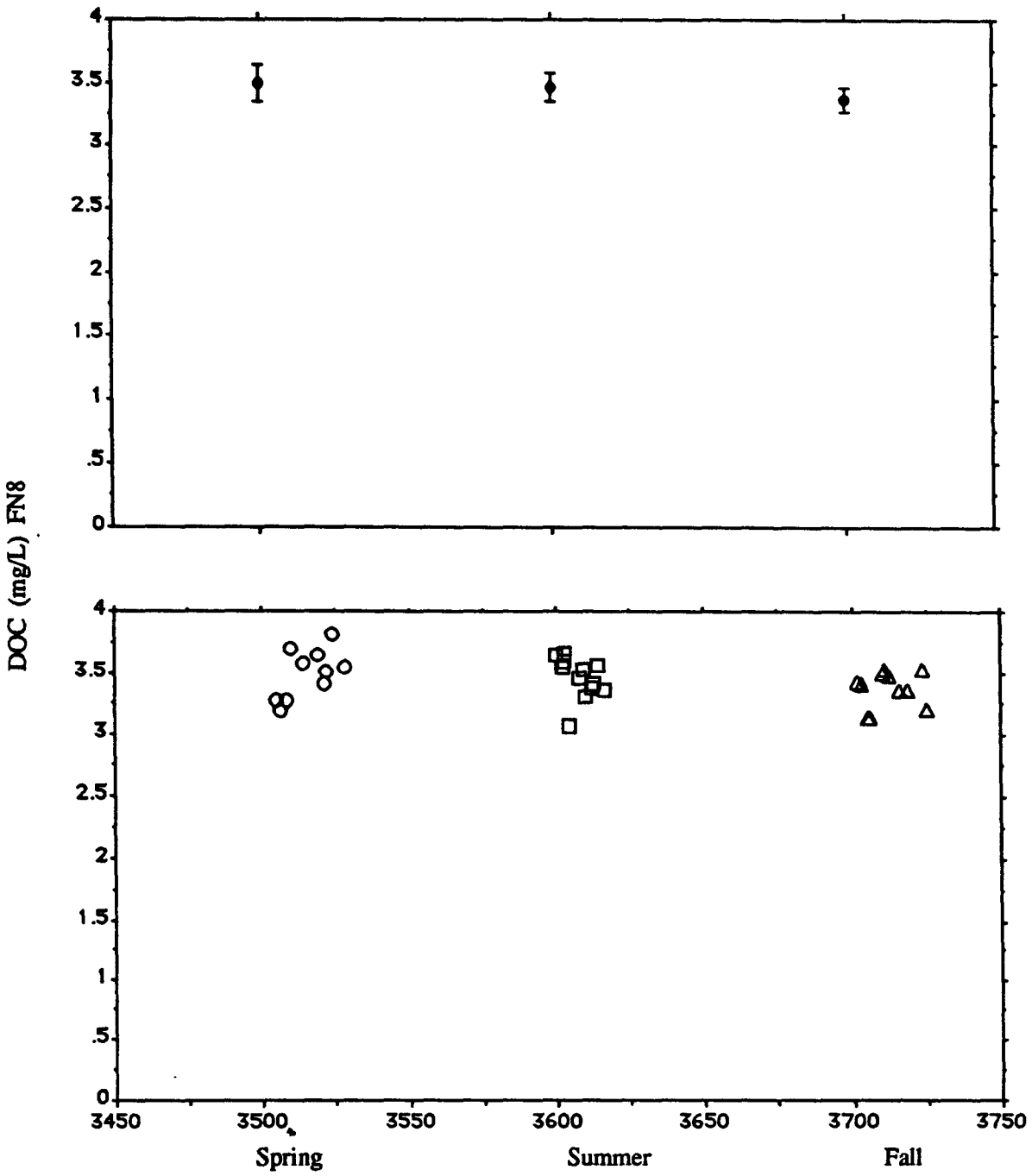

Figure D-26. Dissolved organic carbon (DOC), Big Moose Lake audit samples.

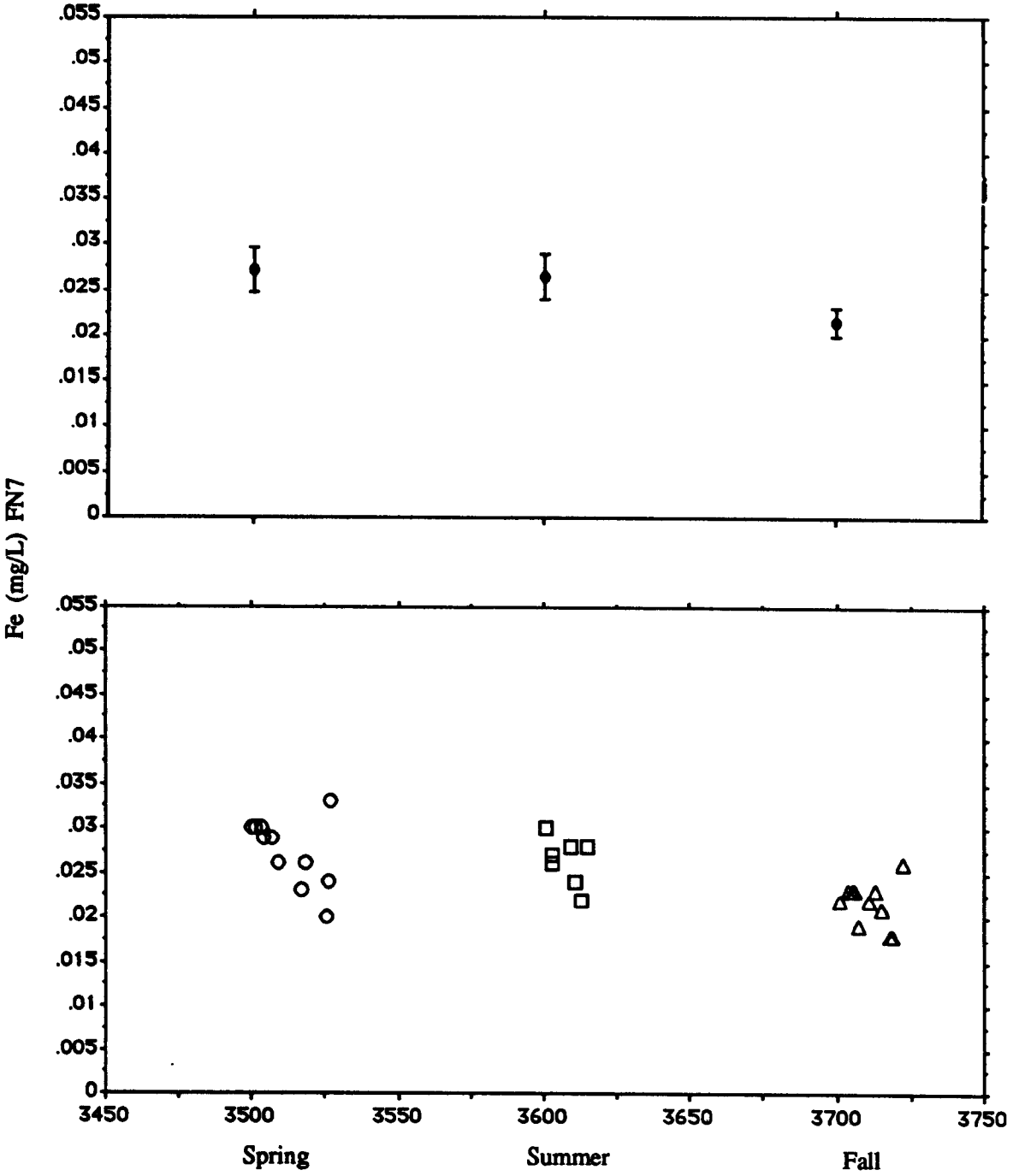

Figure D-27. Iron (Fe), Seventh Lake audit samples.

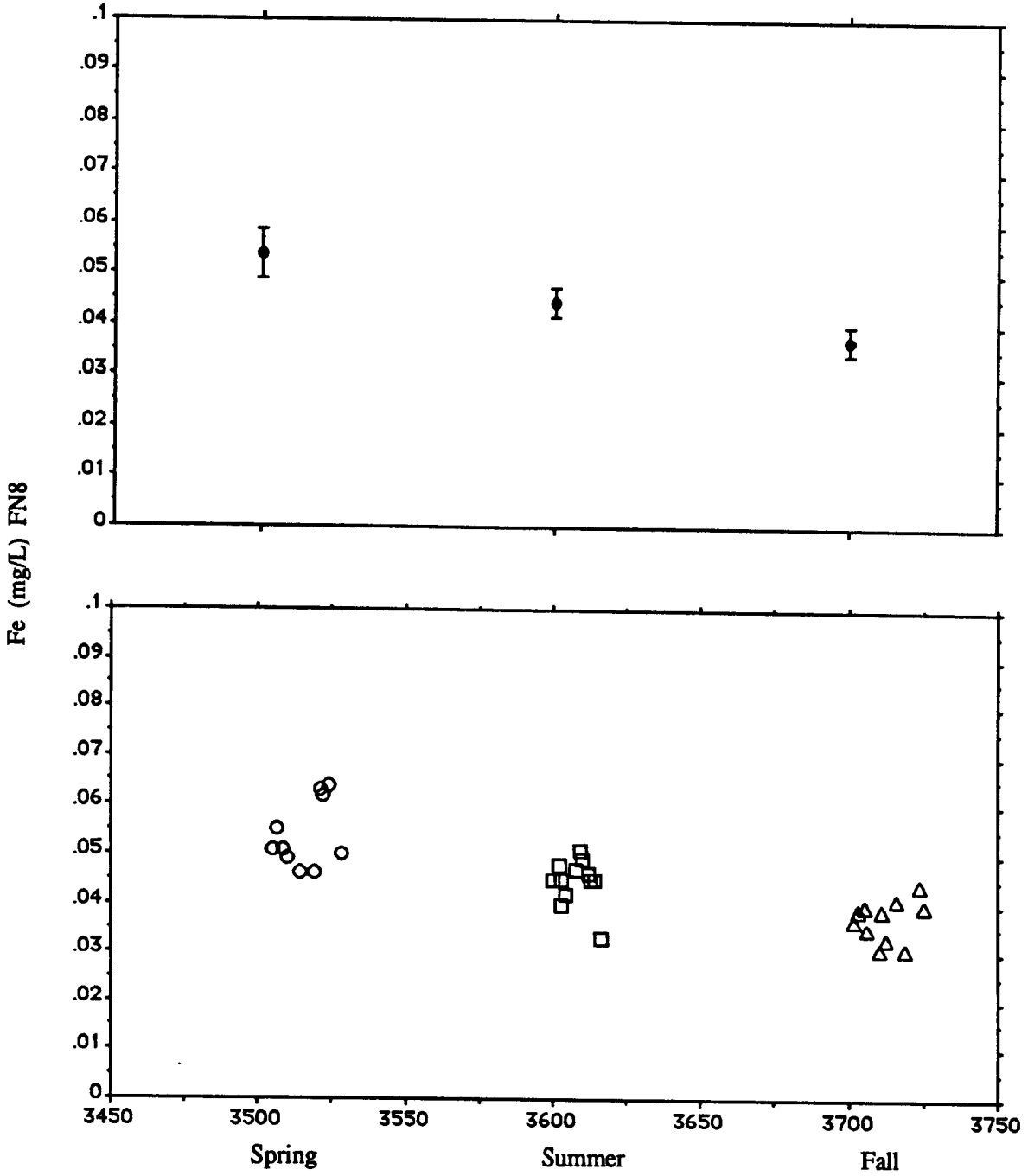

Figure D-28. Iron (Fe), Big Moose Lake audit samples.

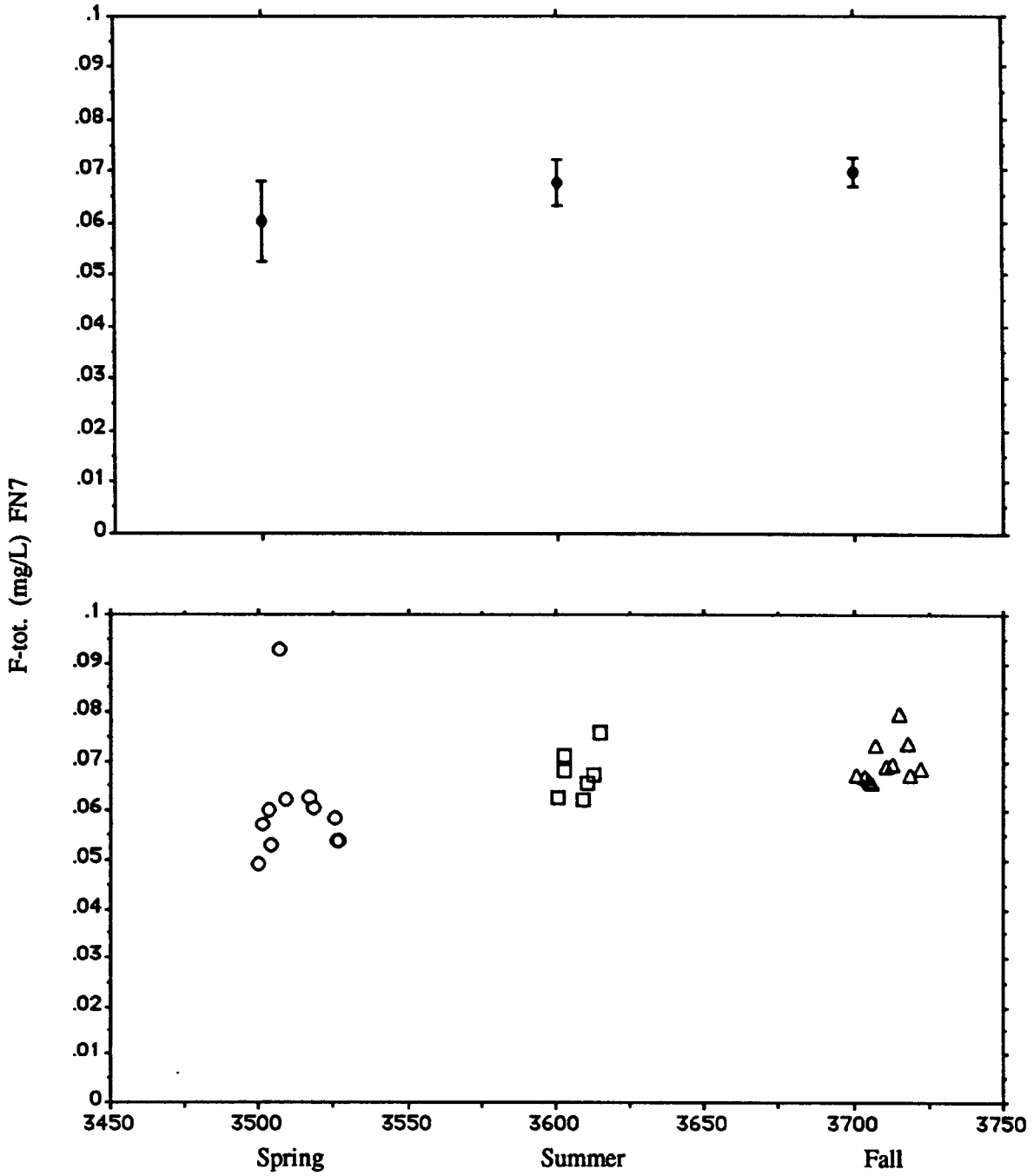

Figure D-29. Total fluoride (F^--total), Seventh Lake audit samples.

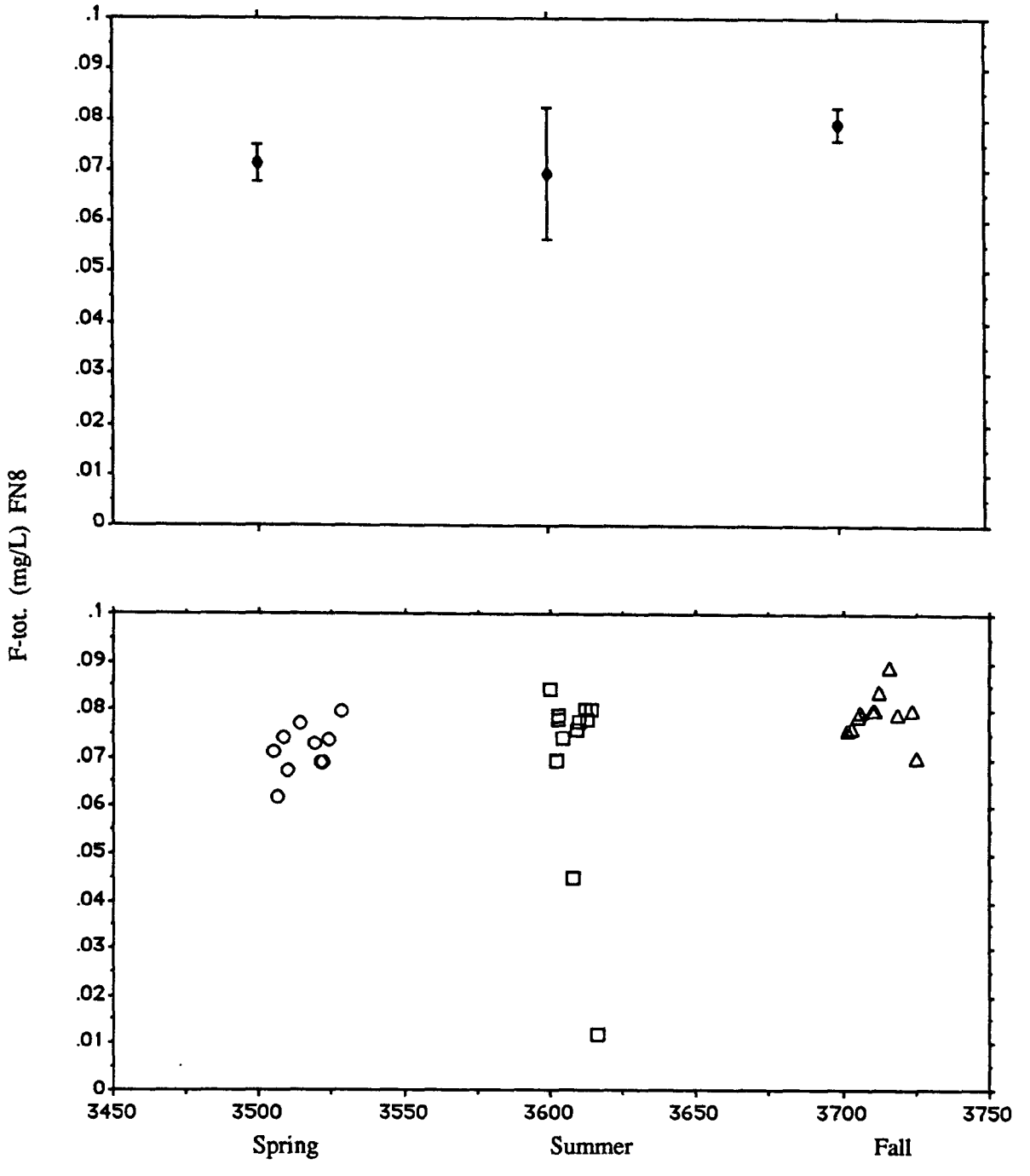

Figure D-30. Total fluoride (F^--total), Big Moose Lake audit samples.

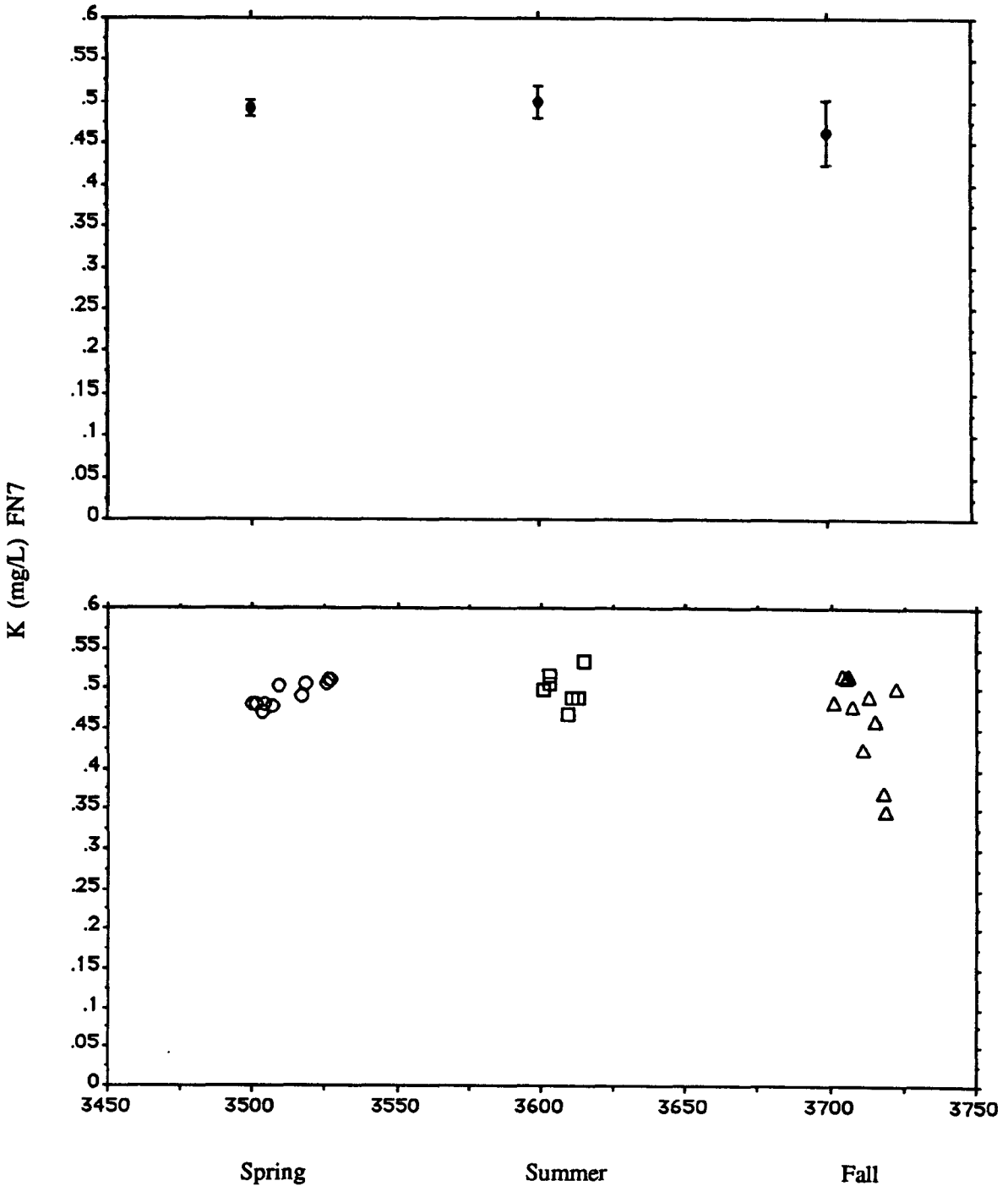

Figure D-31. Potassium (K), Seventh Lake audit samples.

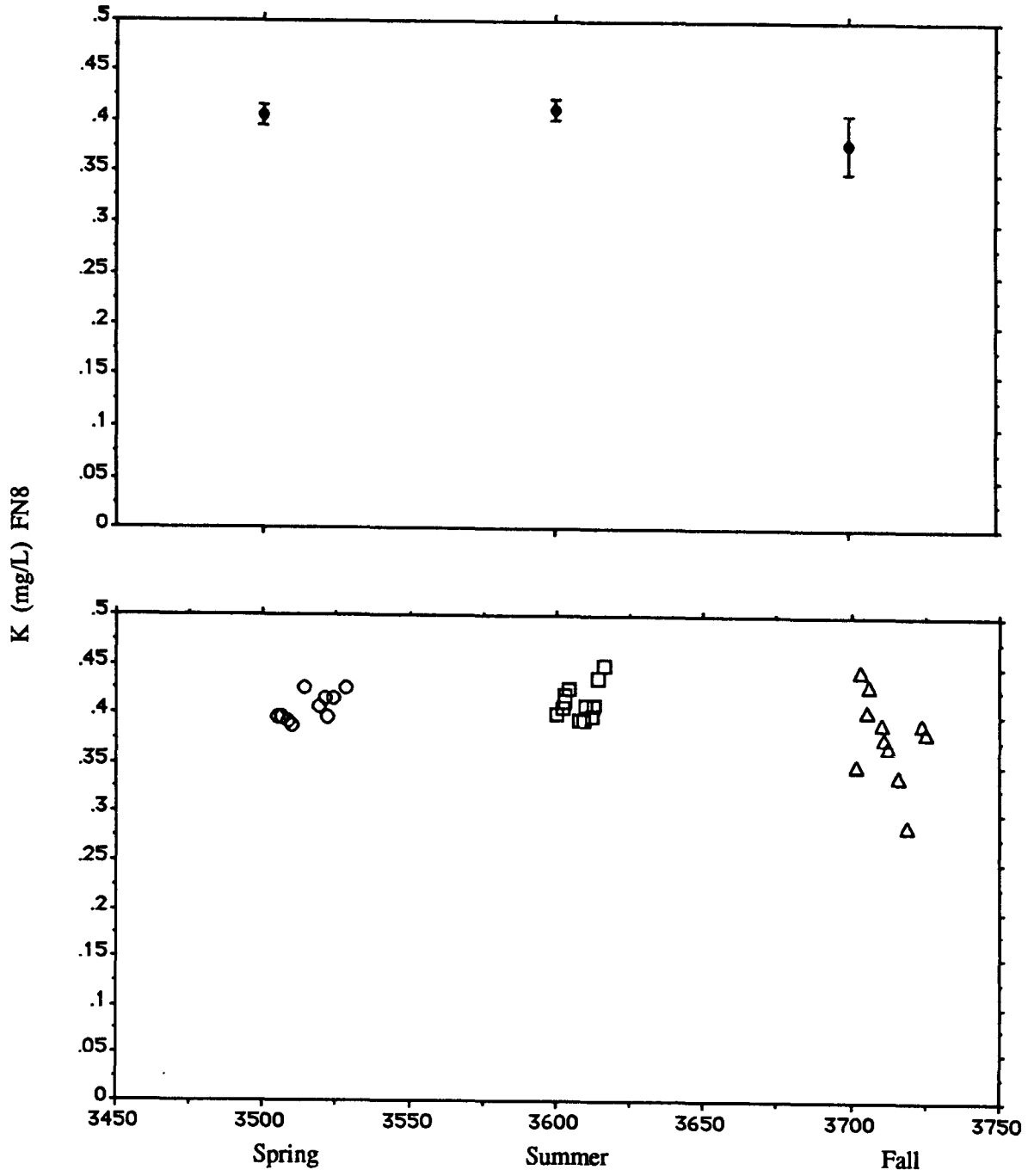

Figure D-32. Potassium (K), Big Moose Lake audit samples.

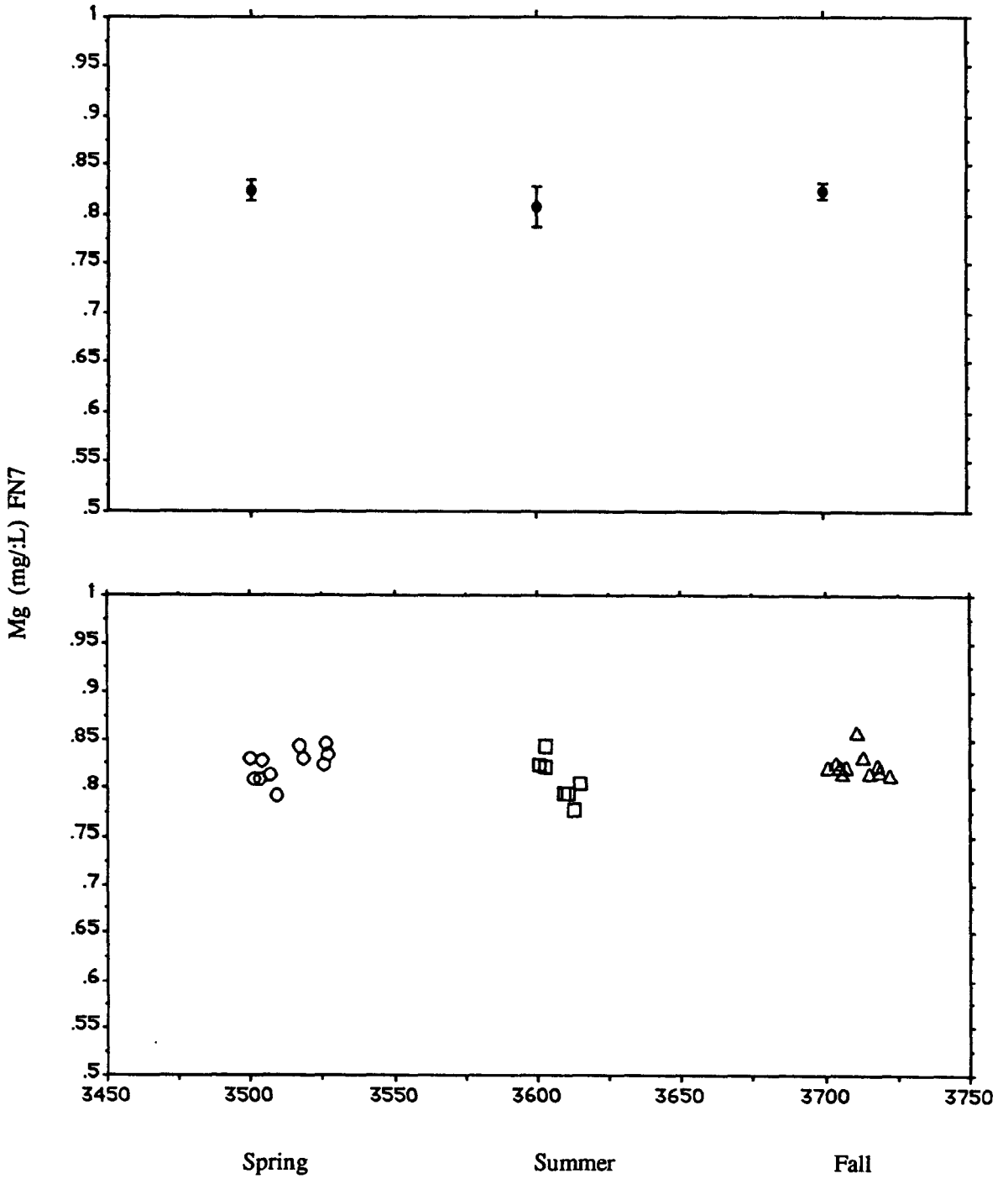

Figure D-33. Magnesium (Mg), Seventh Lake audit samples.

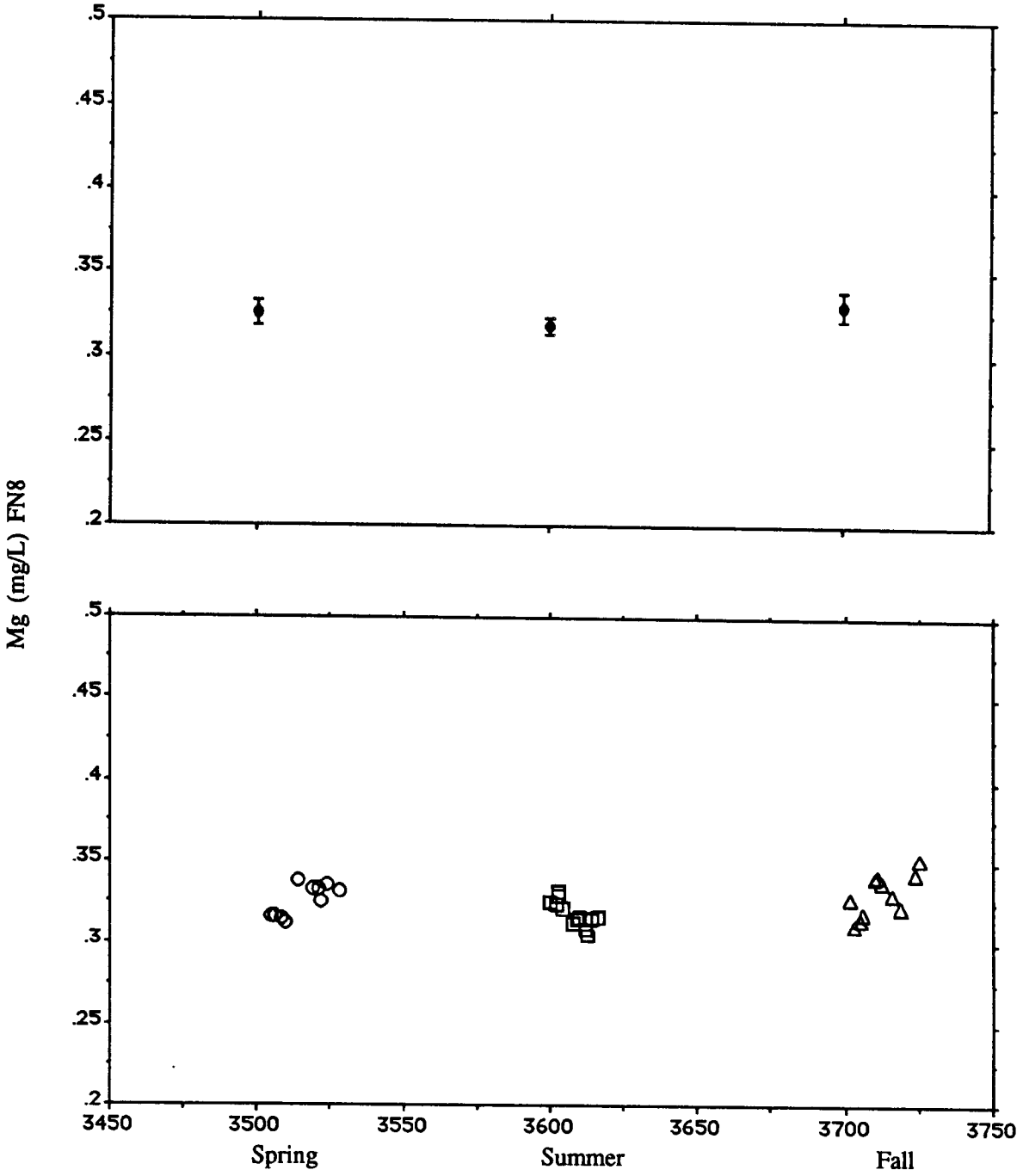

Figure D-34. Magnesium (Mg), Big Moose Lake audit samples.

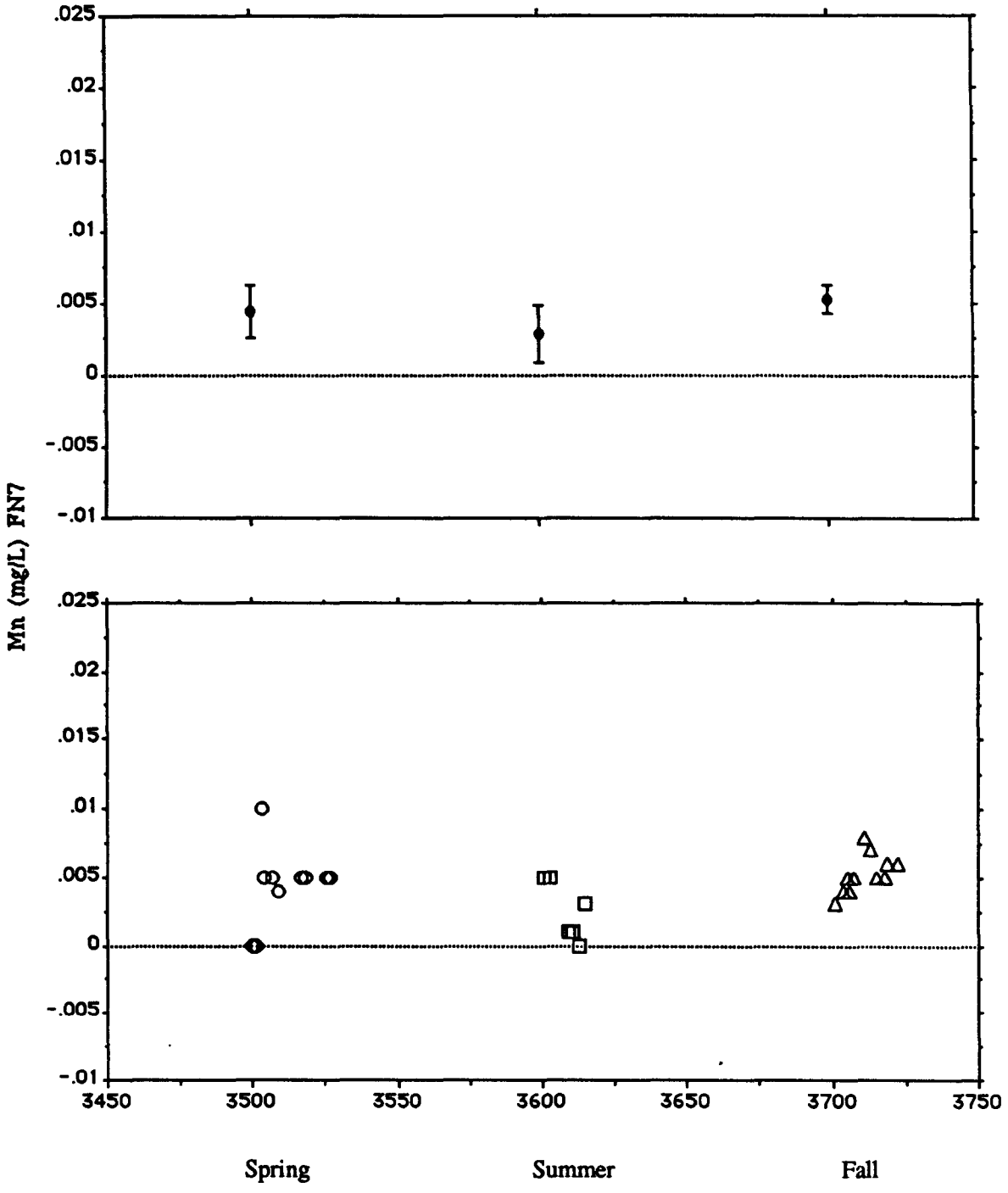

Figure D-35. Manganese (Mn), Seventh Lake audit samples.

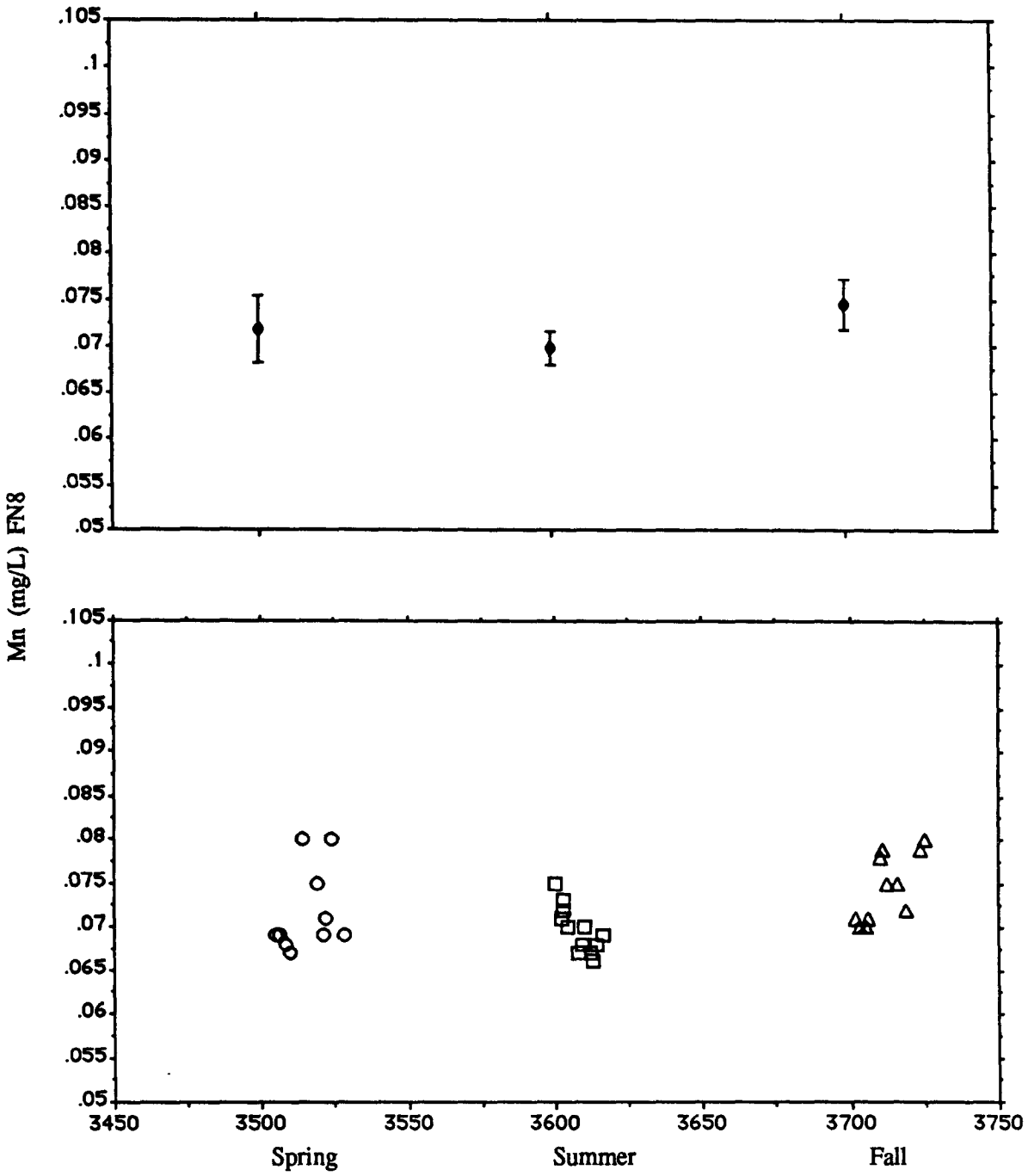

Figure D-36. Manganese (Mn), Big Moose Lake audit samples.

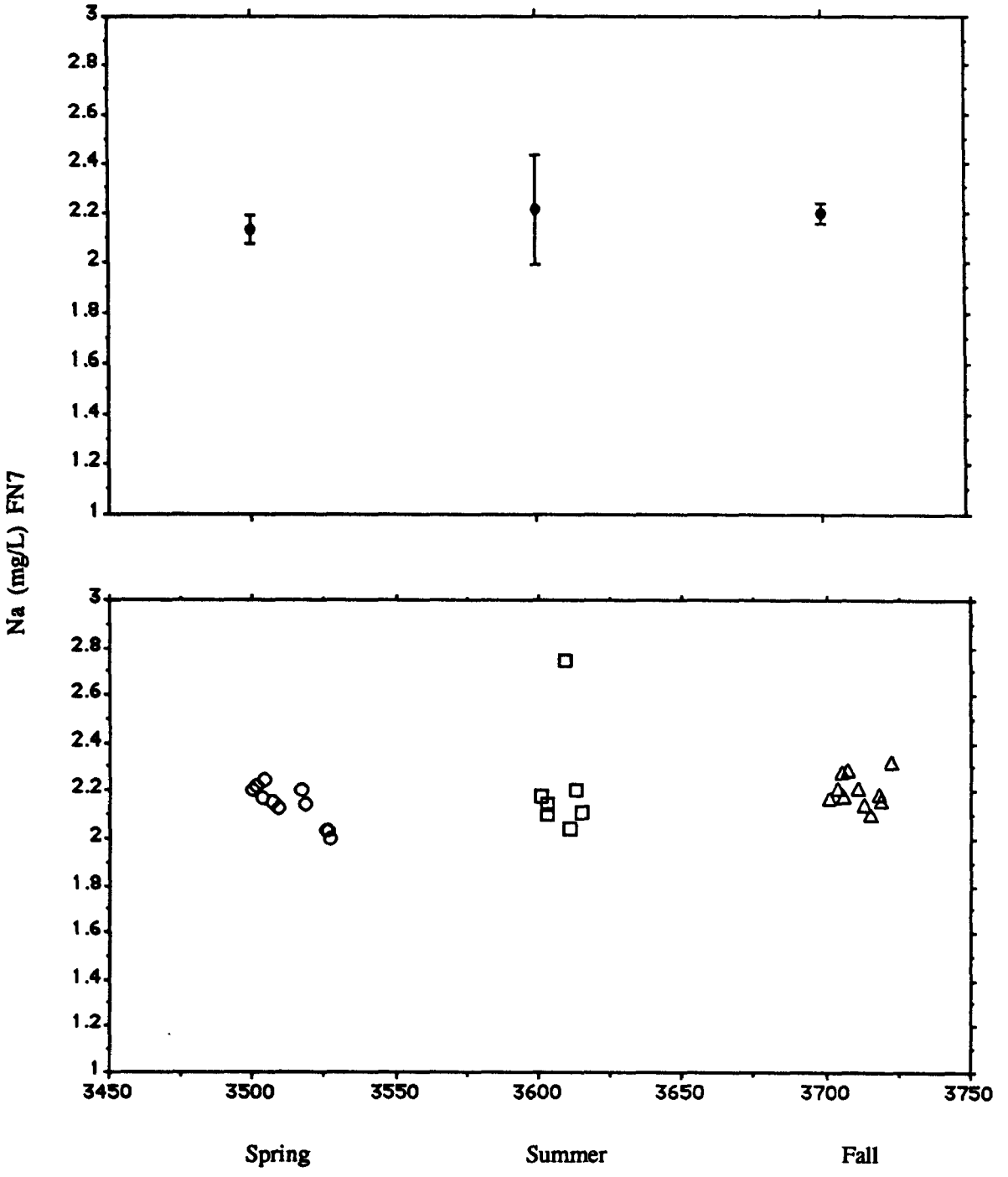

Figure D-37. Sodium (Na), Seventh Lake audit samples.

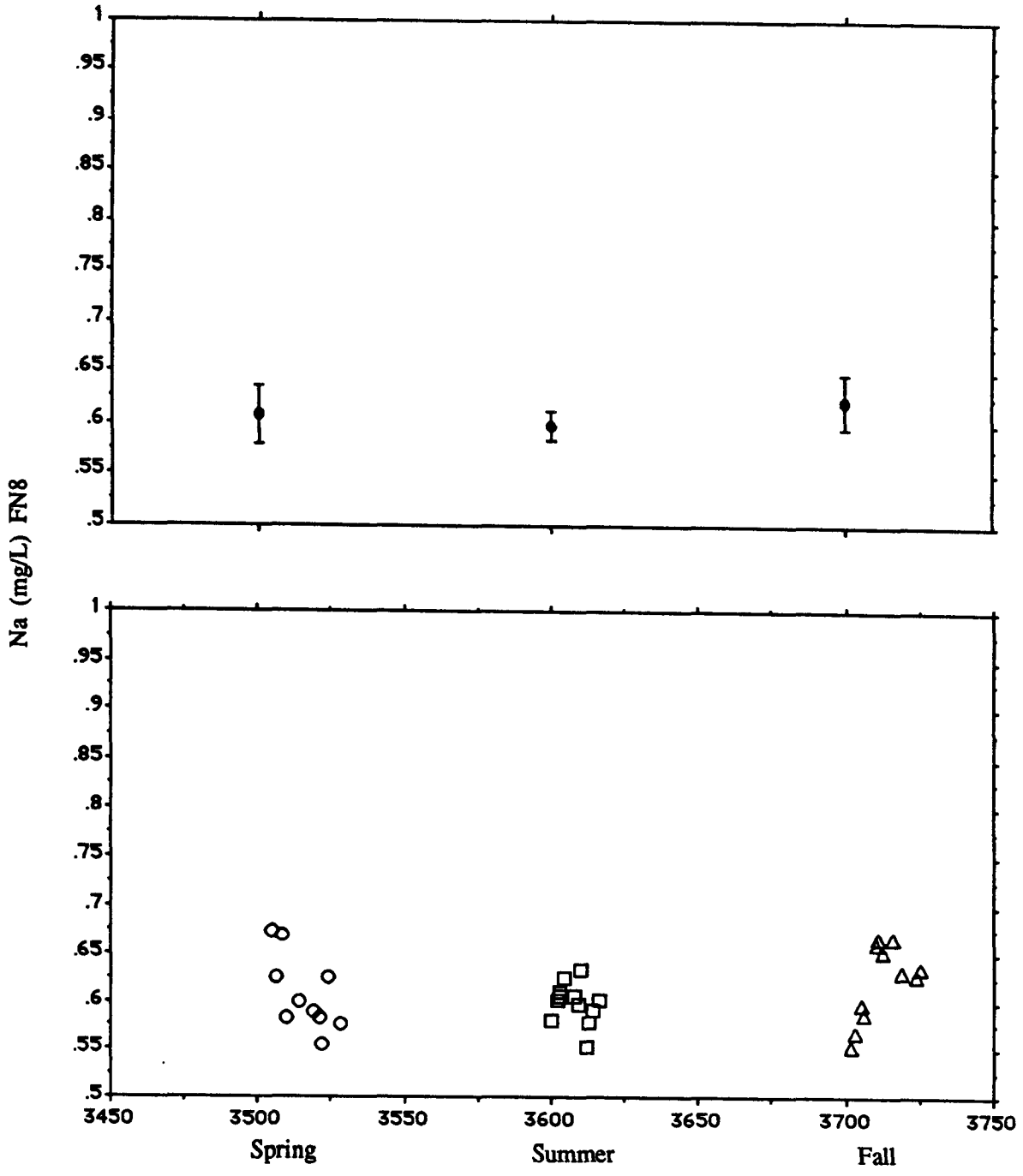

Figure D-38. Sodium (Na), Big Moose Lake audit samples.

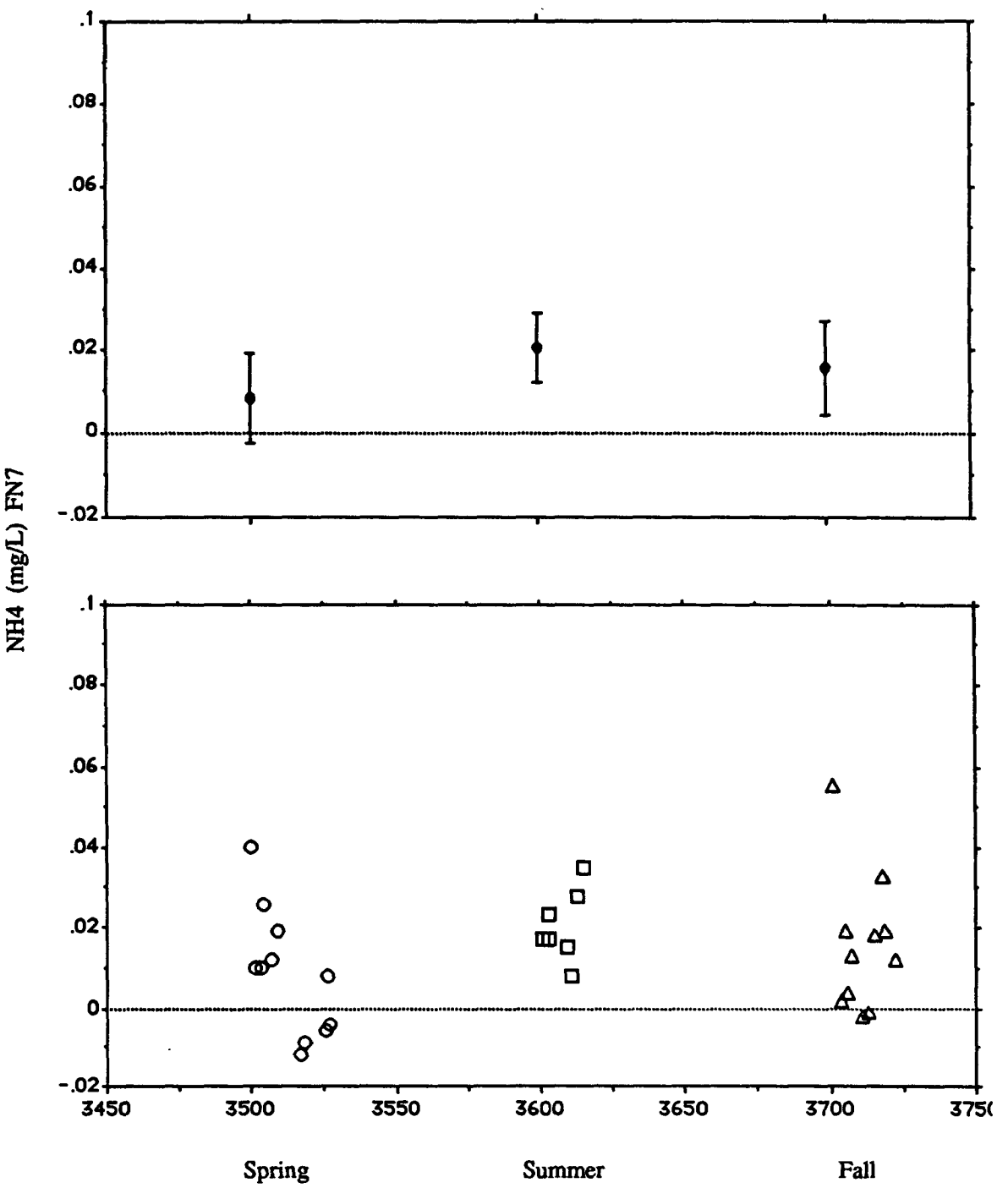

Figure D-39. Ammonium (NH_4^+), Seventh Lake audit samples.

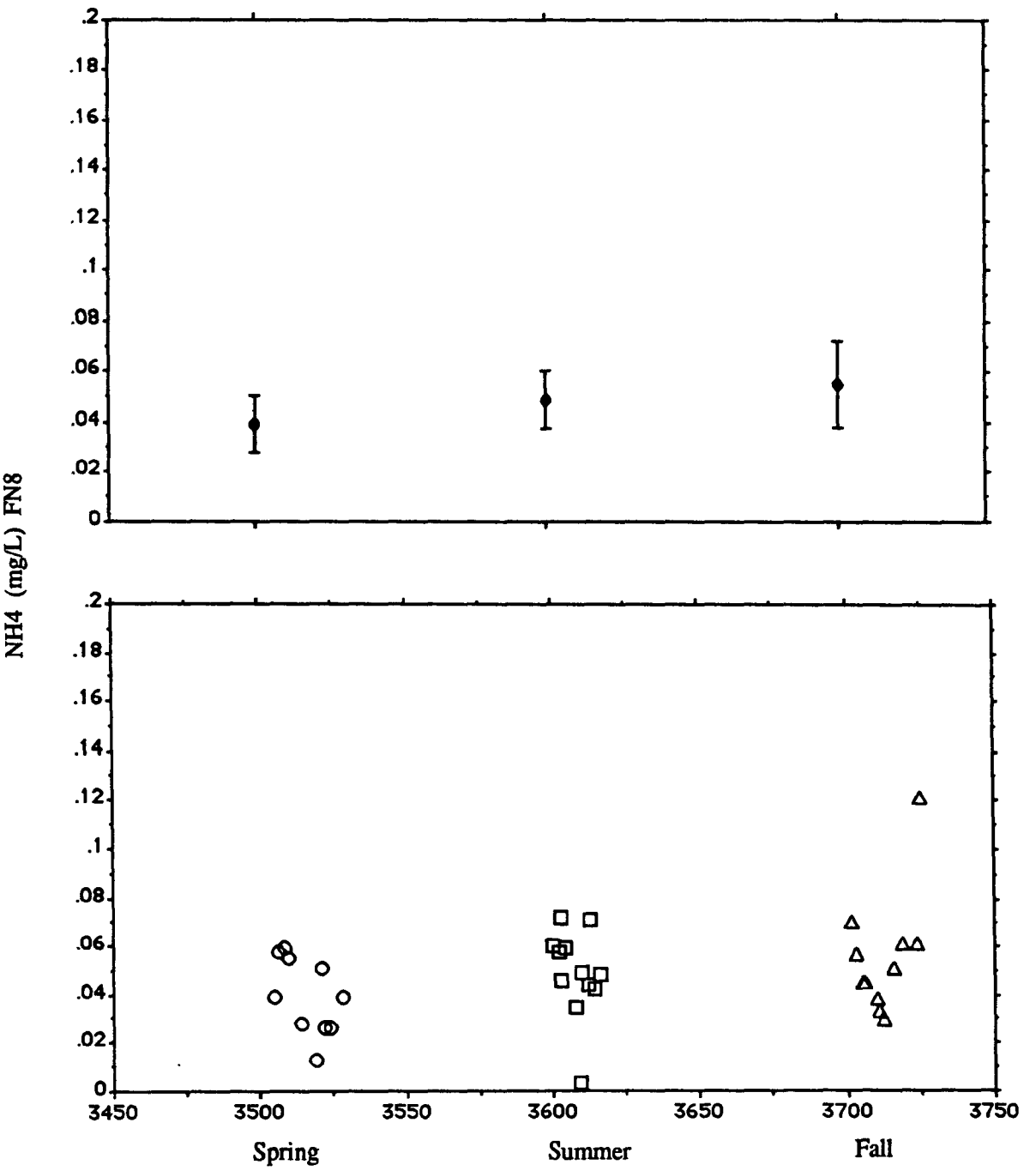

Figure D-40. Ammonium (NH_4^+), Big Moose Lake audit samples.

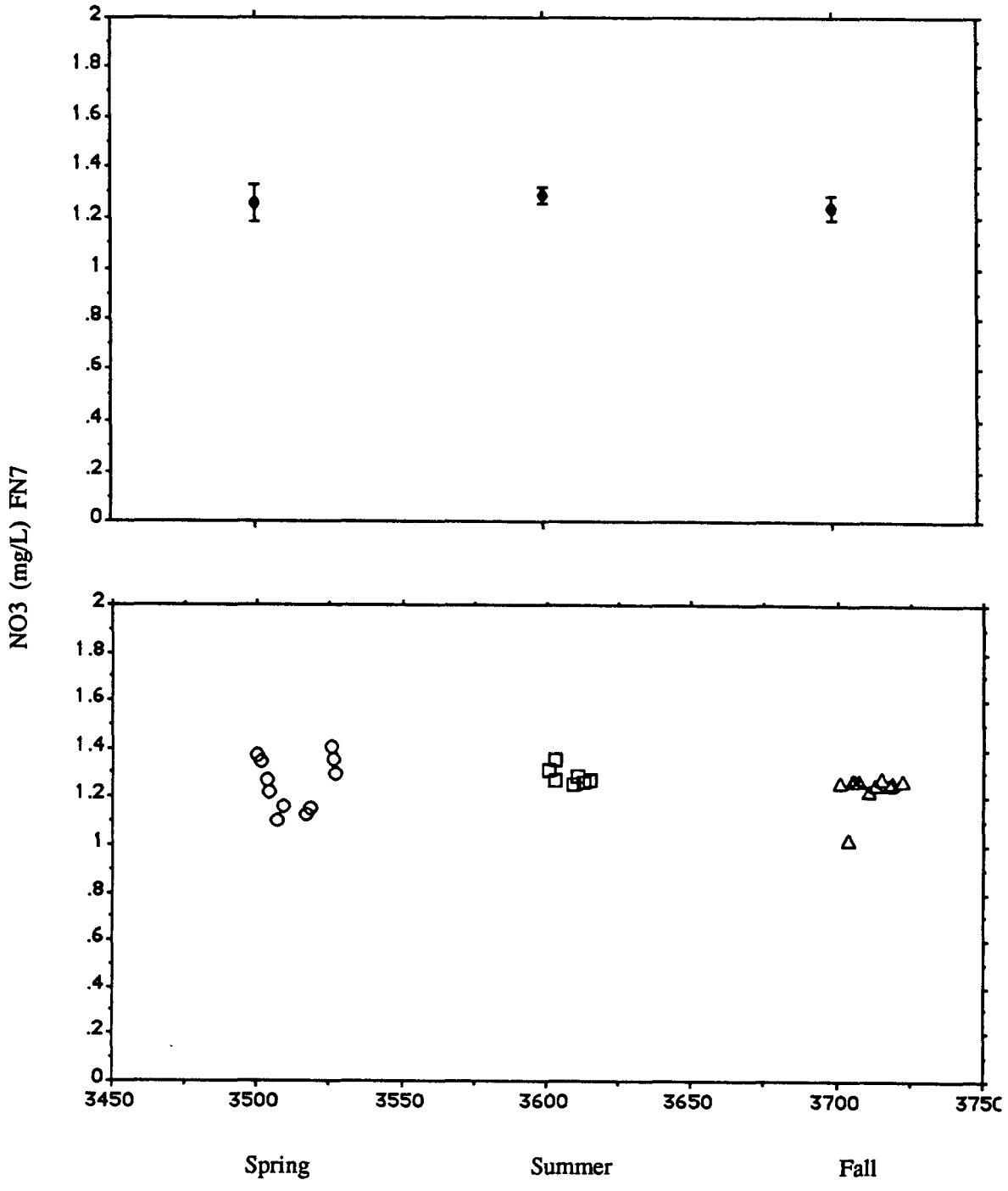

Figure D-41. Nitrate (NO_3^-), Seventh Lake audit samples.

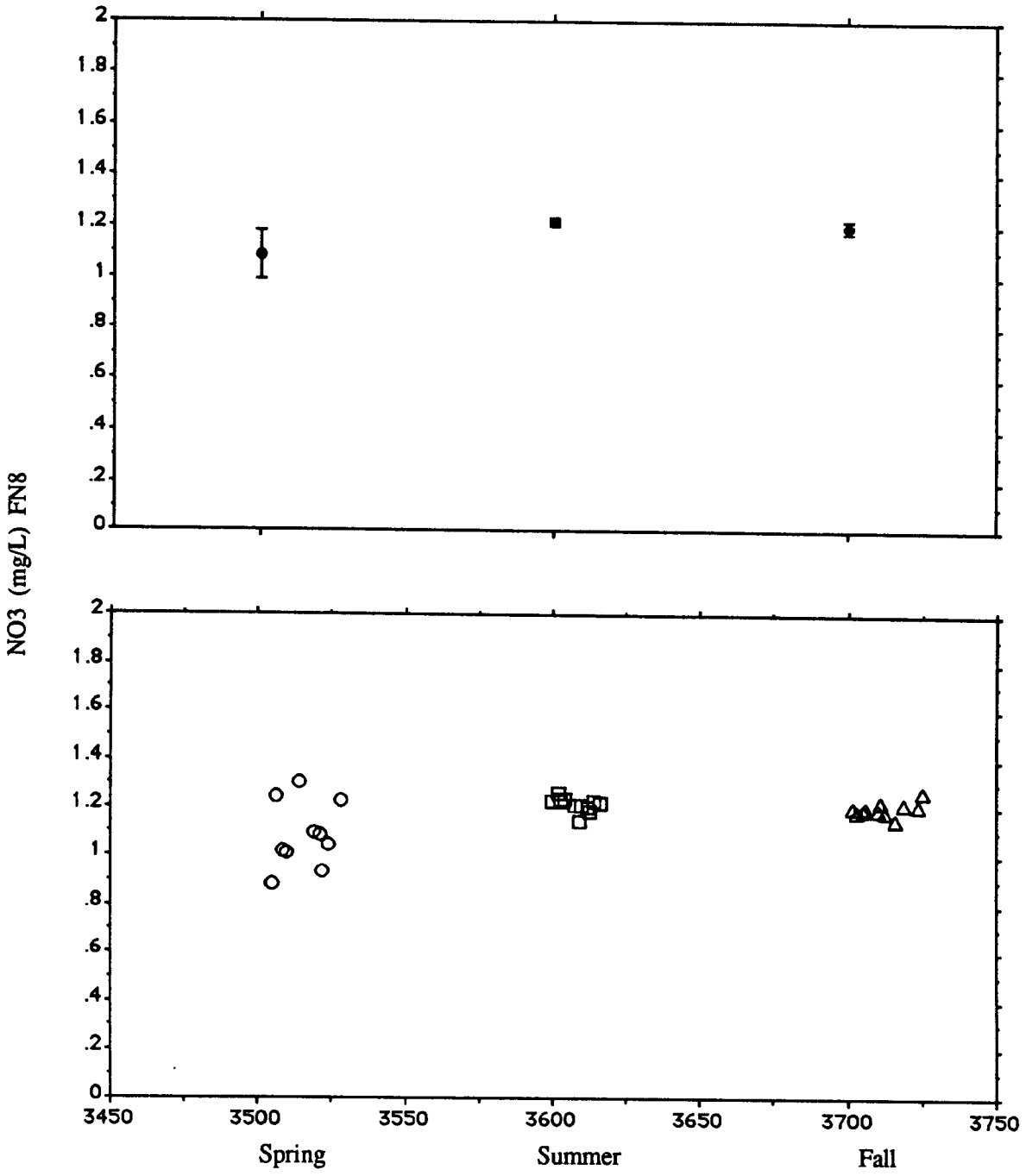

Figure D-42. Nitrate (NO_3^-), Big Moose Lake audit samples.

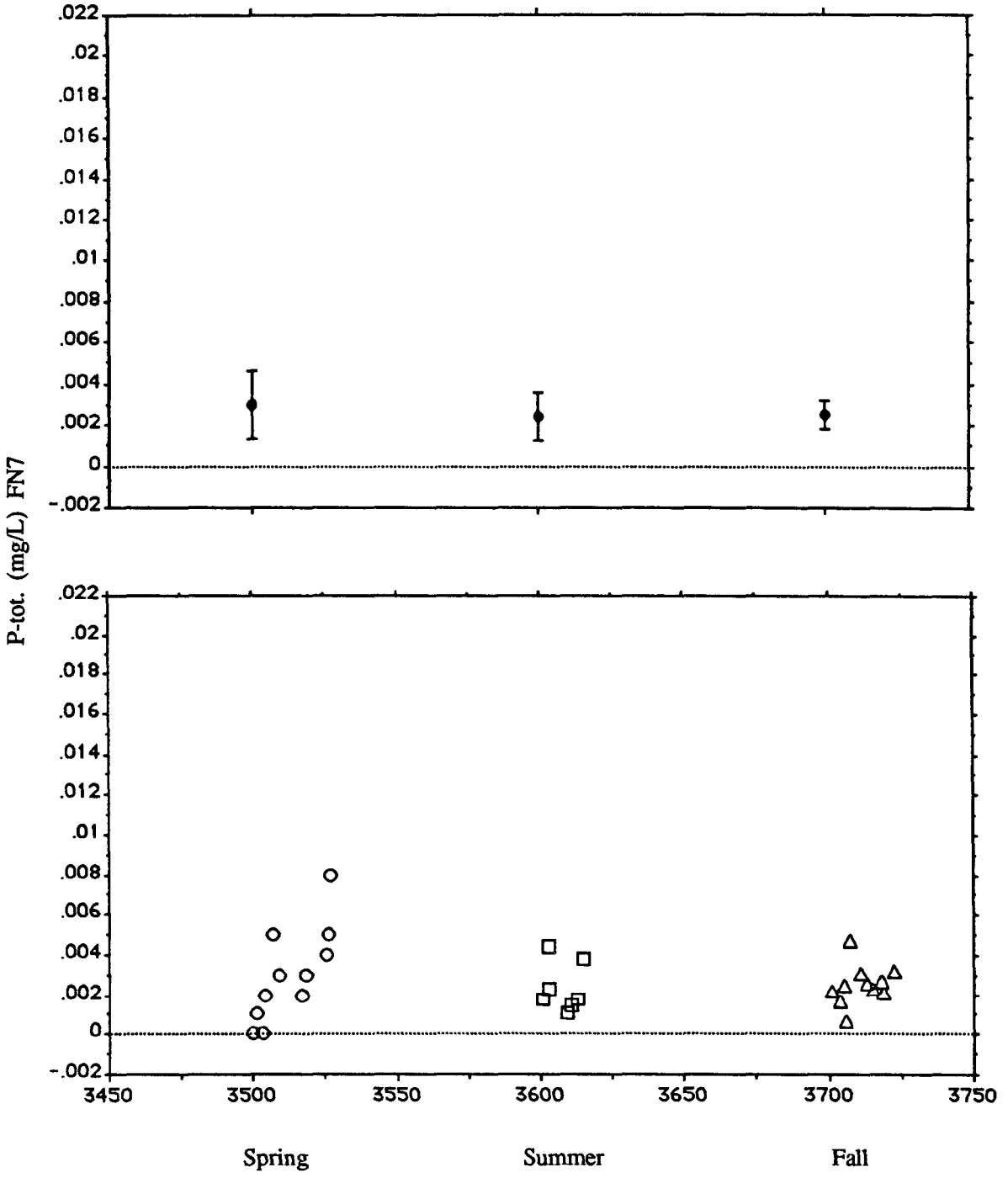

Figure D-43. Total dissolved phosphorus (P-total), Seventh Lake audit samples.

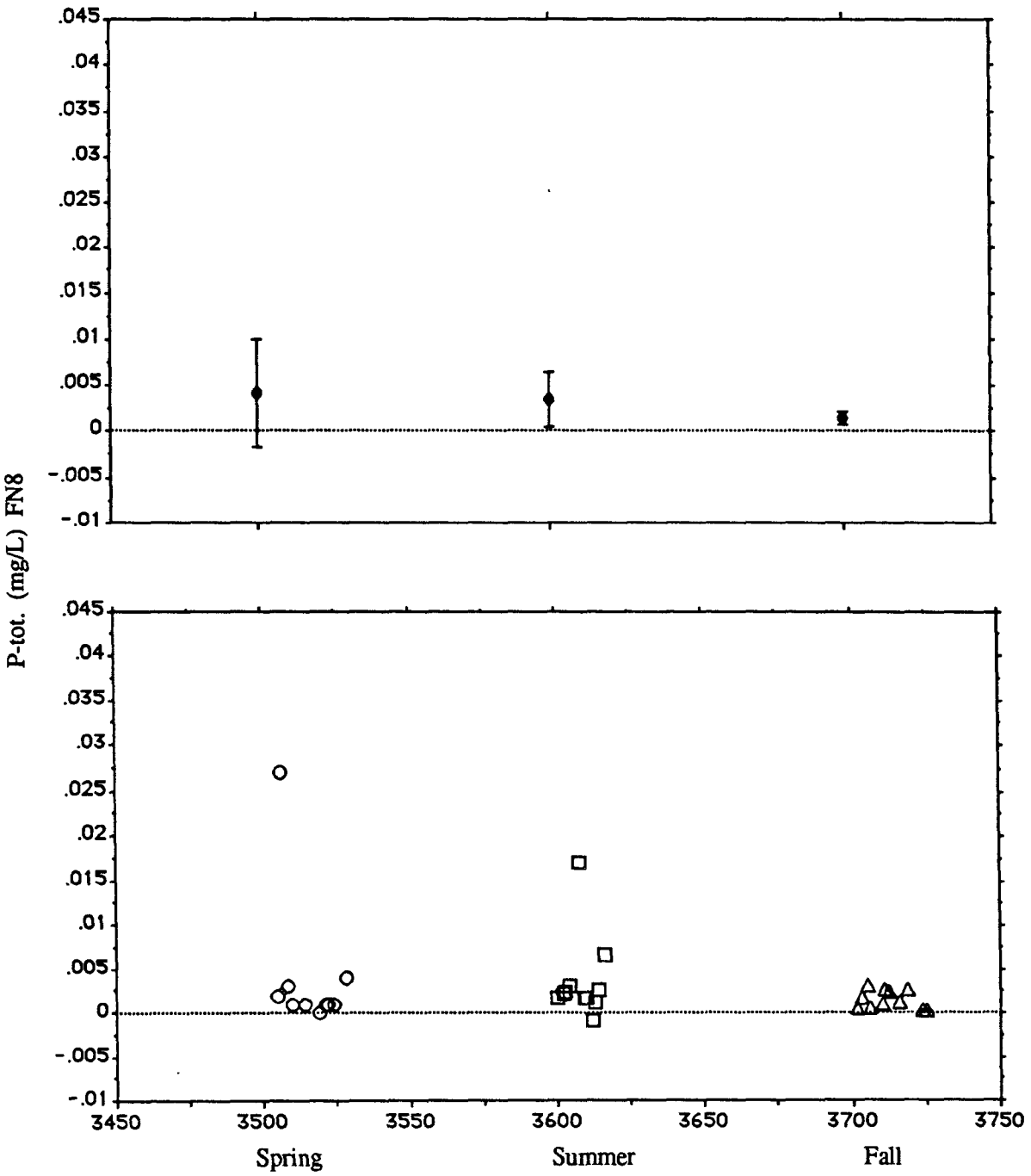

Figure D-44. Total dissolved phosphorus (P-total), Big Moose Lake audit samples.

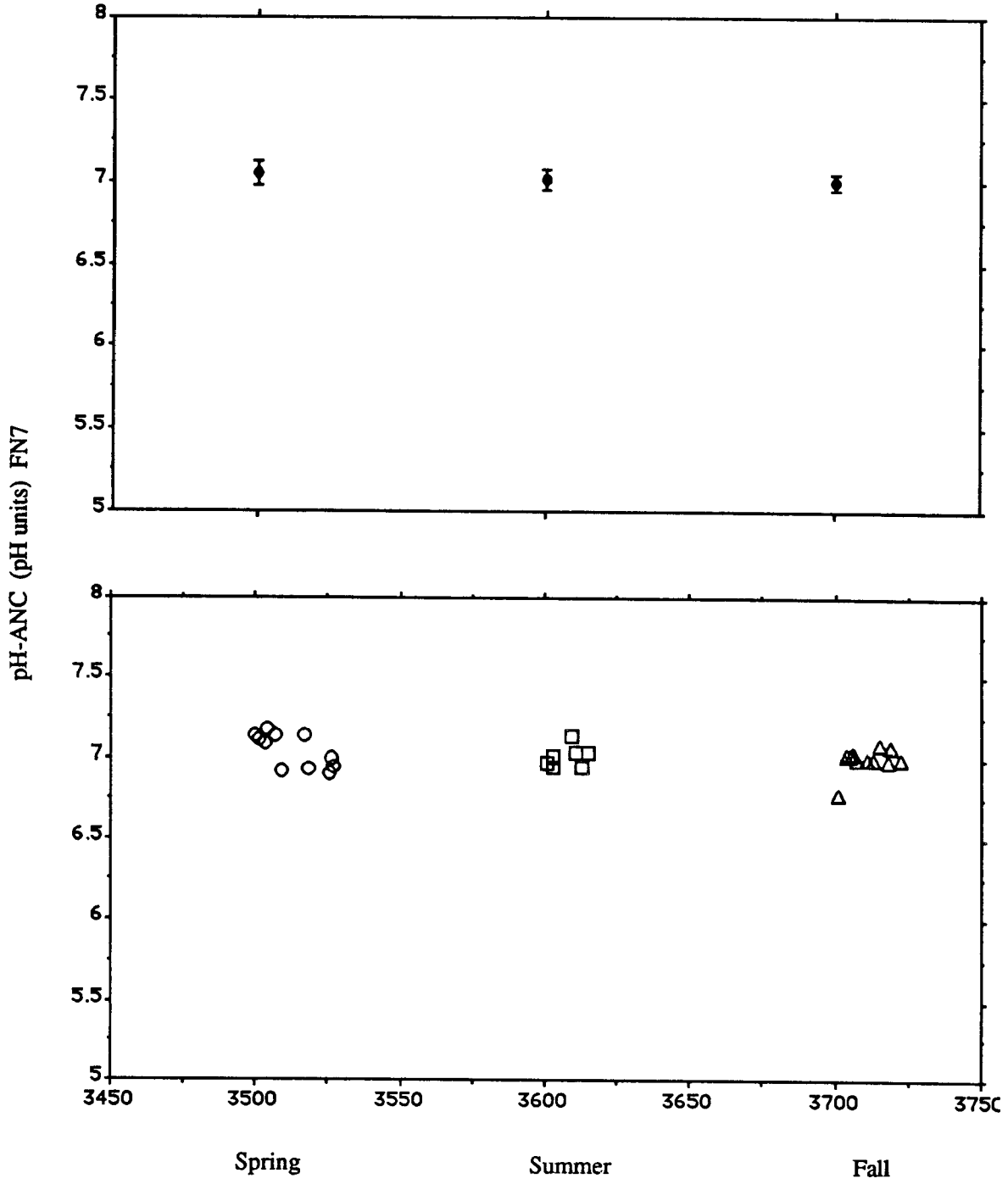

Figure D-45. pH, initial for acid titration for ANC (pH-ANC), Seventh Lake audit samples.

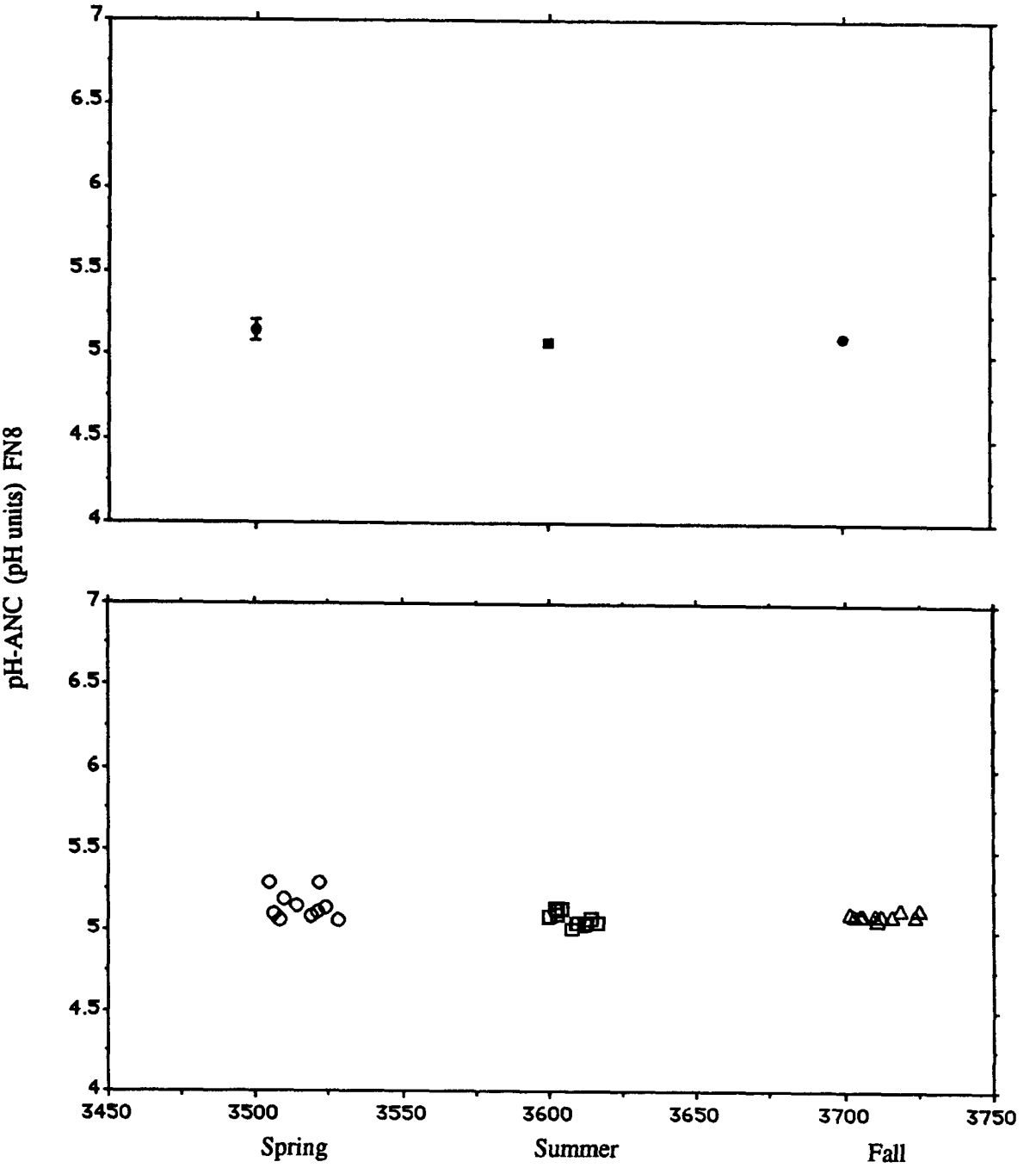

Figure D-46. pH, initial for acid titration for ANC (pH-ANC), Big Moose Lake audit samples.

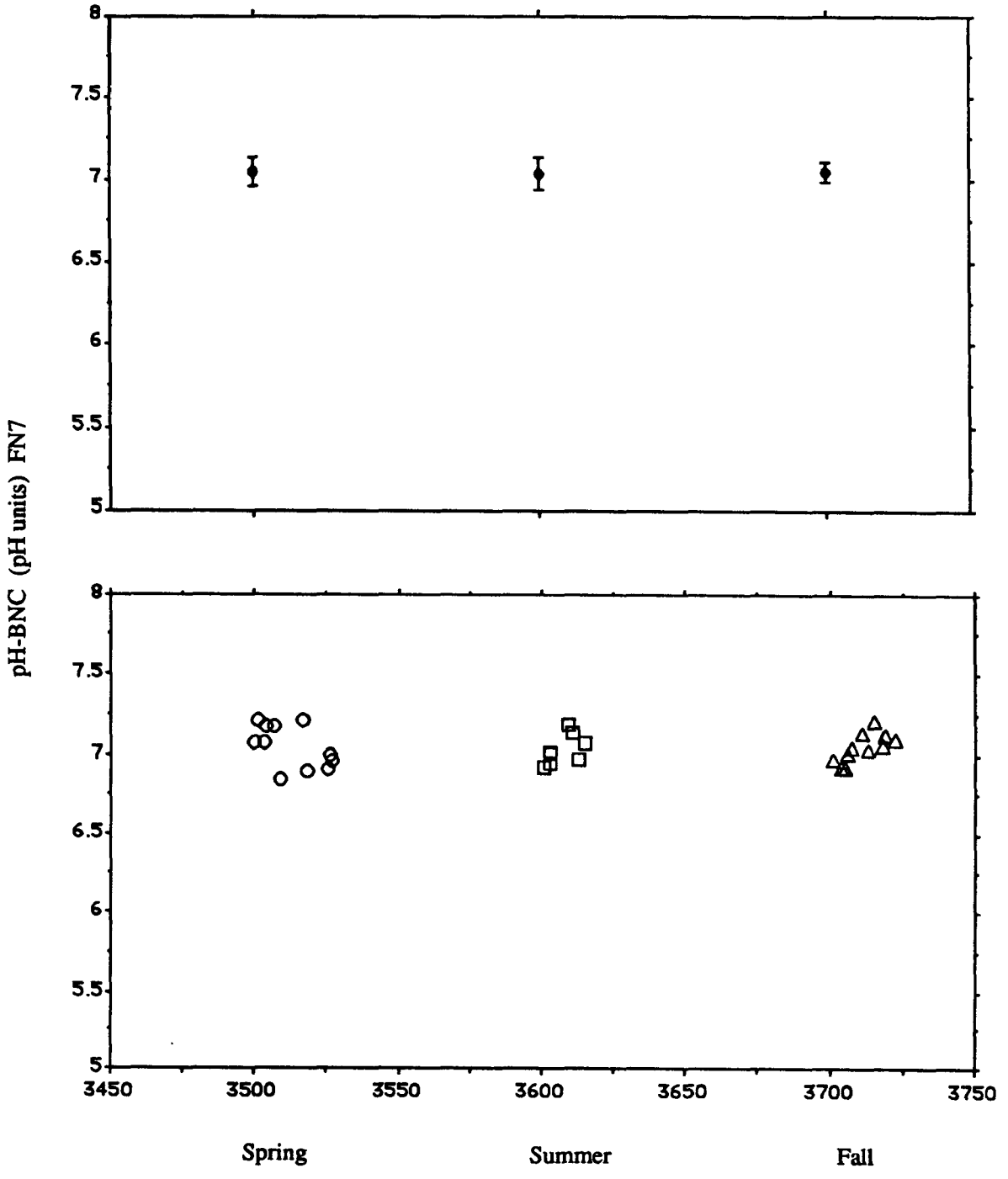

Figure D-47. pH, initial for acid titration for BNC (pH-BNC), Seventh Lake audit samples.

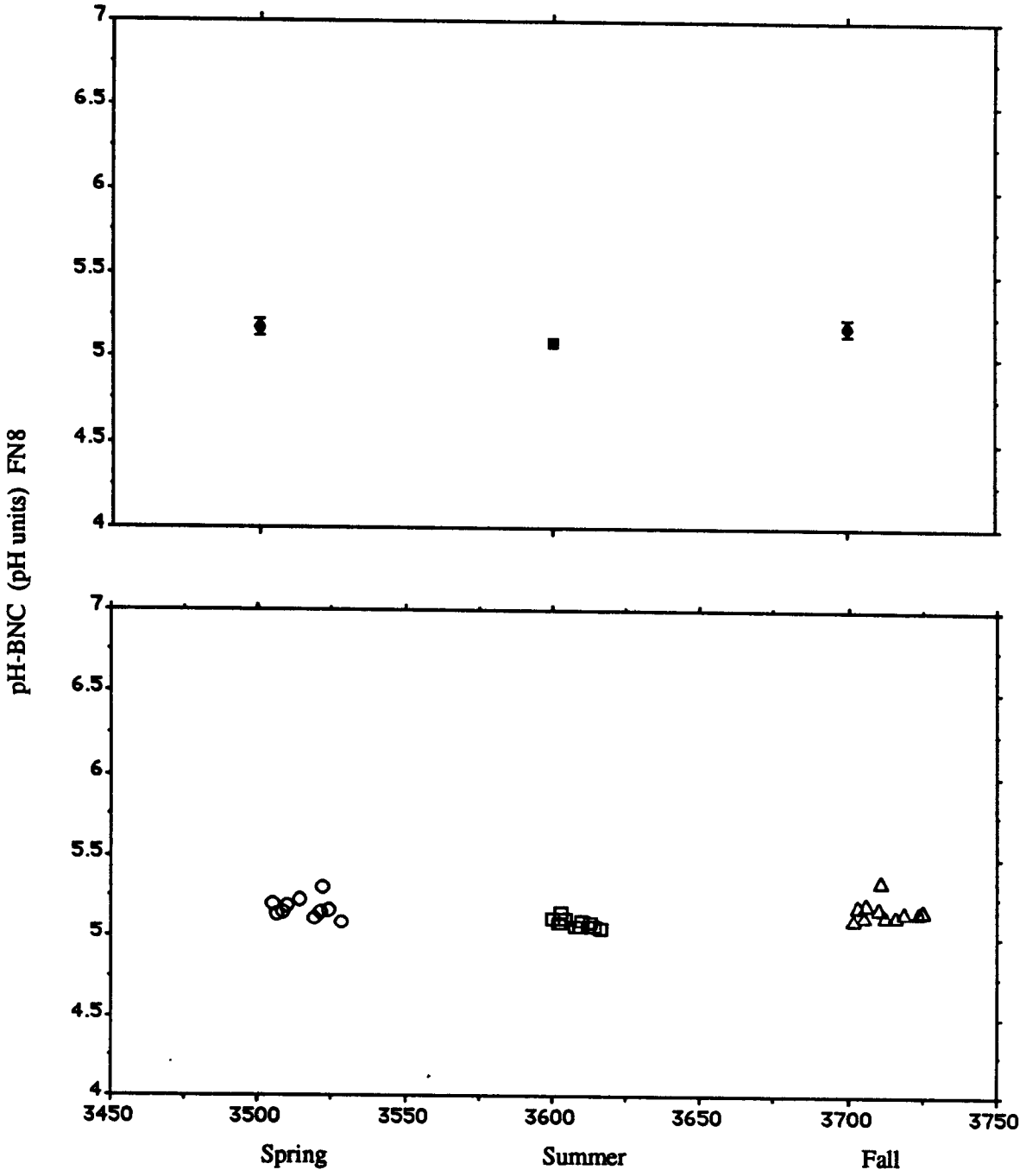

Figure D-48. pH, initial for acid titration for BNC (pH-BNC), Big Moose Lake audit samples.

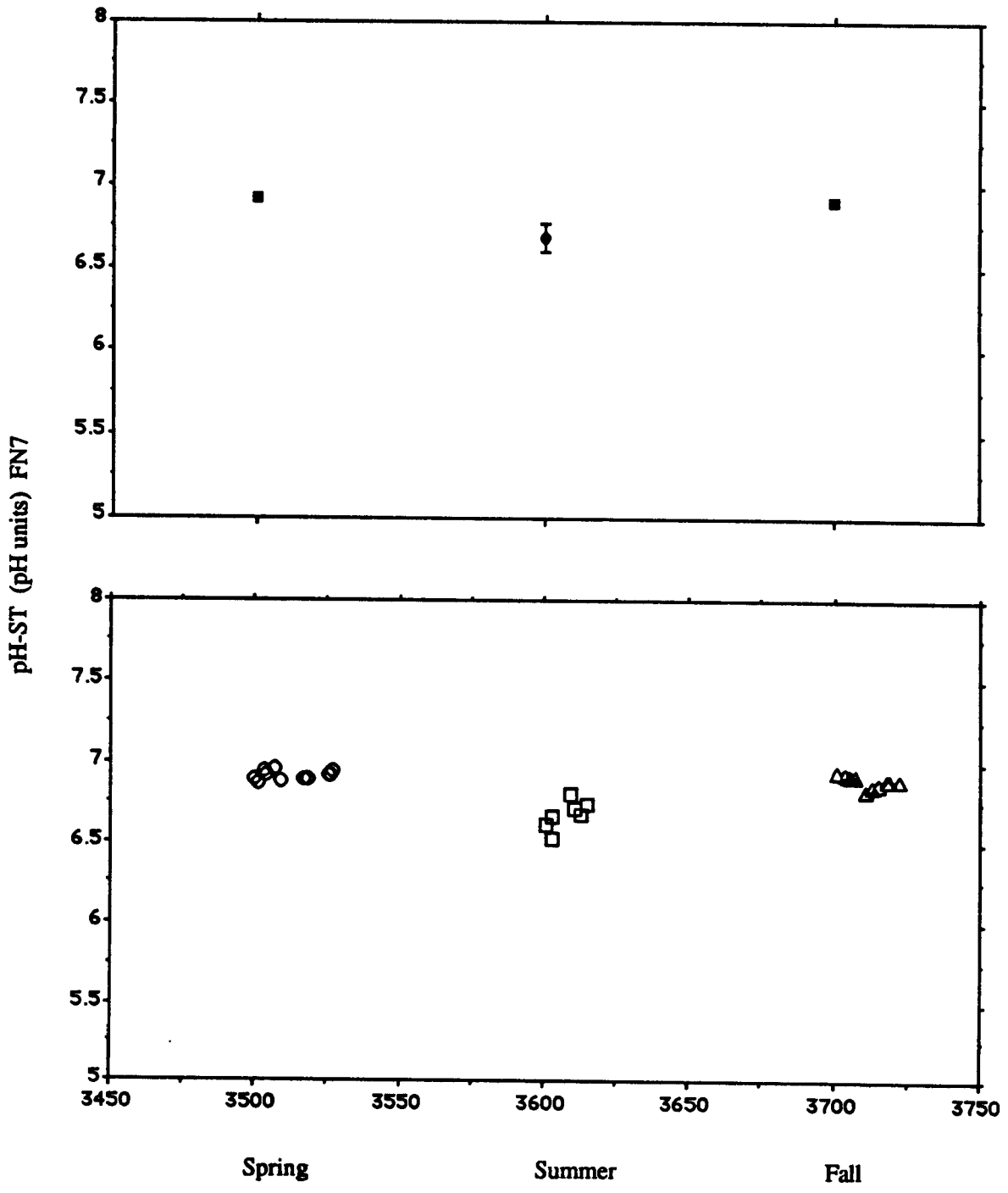

Figure D-49. pH-closed system (pH-closed), Seventh Lake audit samples.

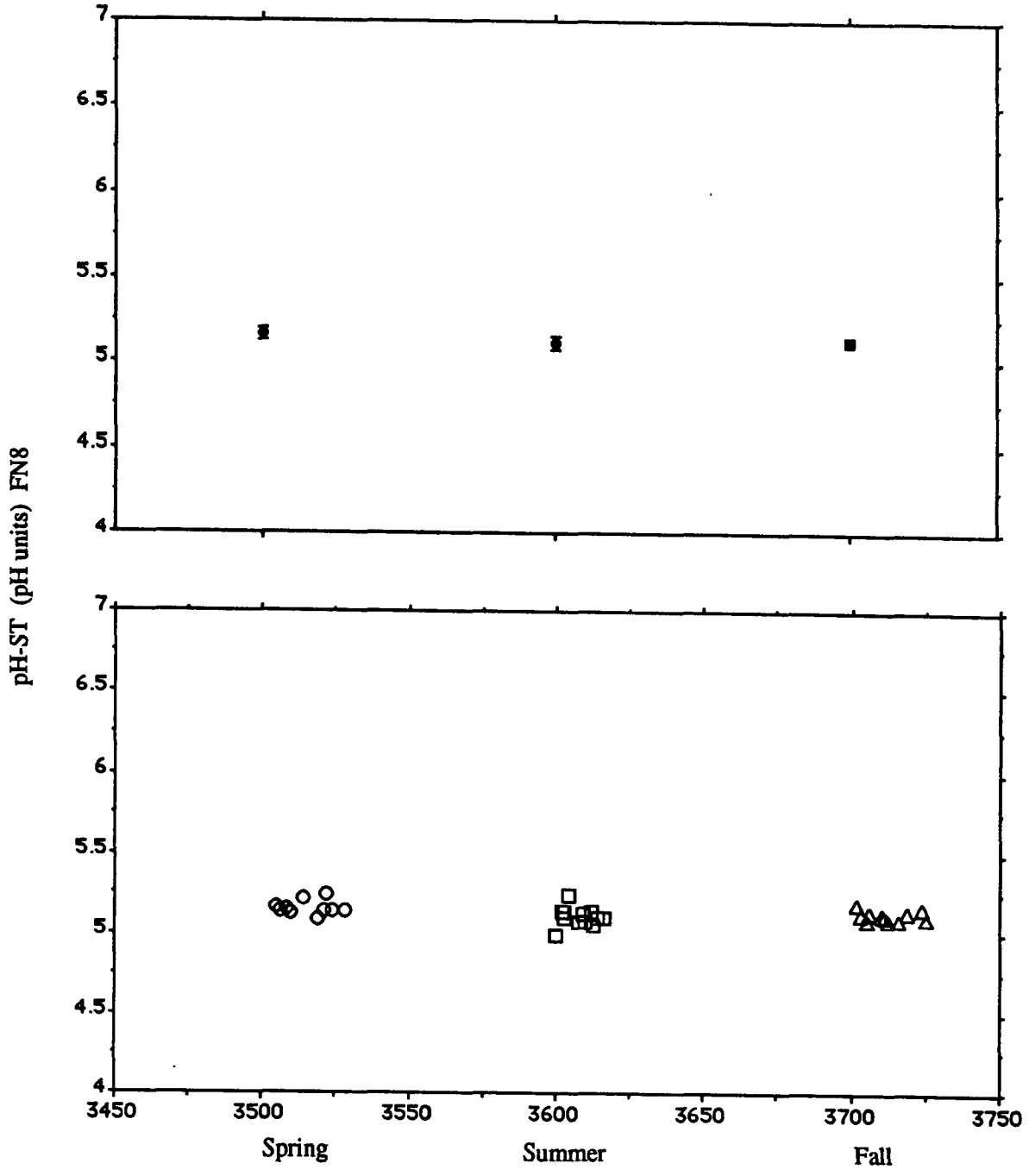

Figure D-50. pH-closed system (pH-closed), Big Moose Lake audit samples.

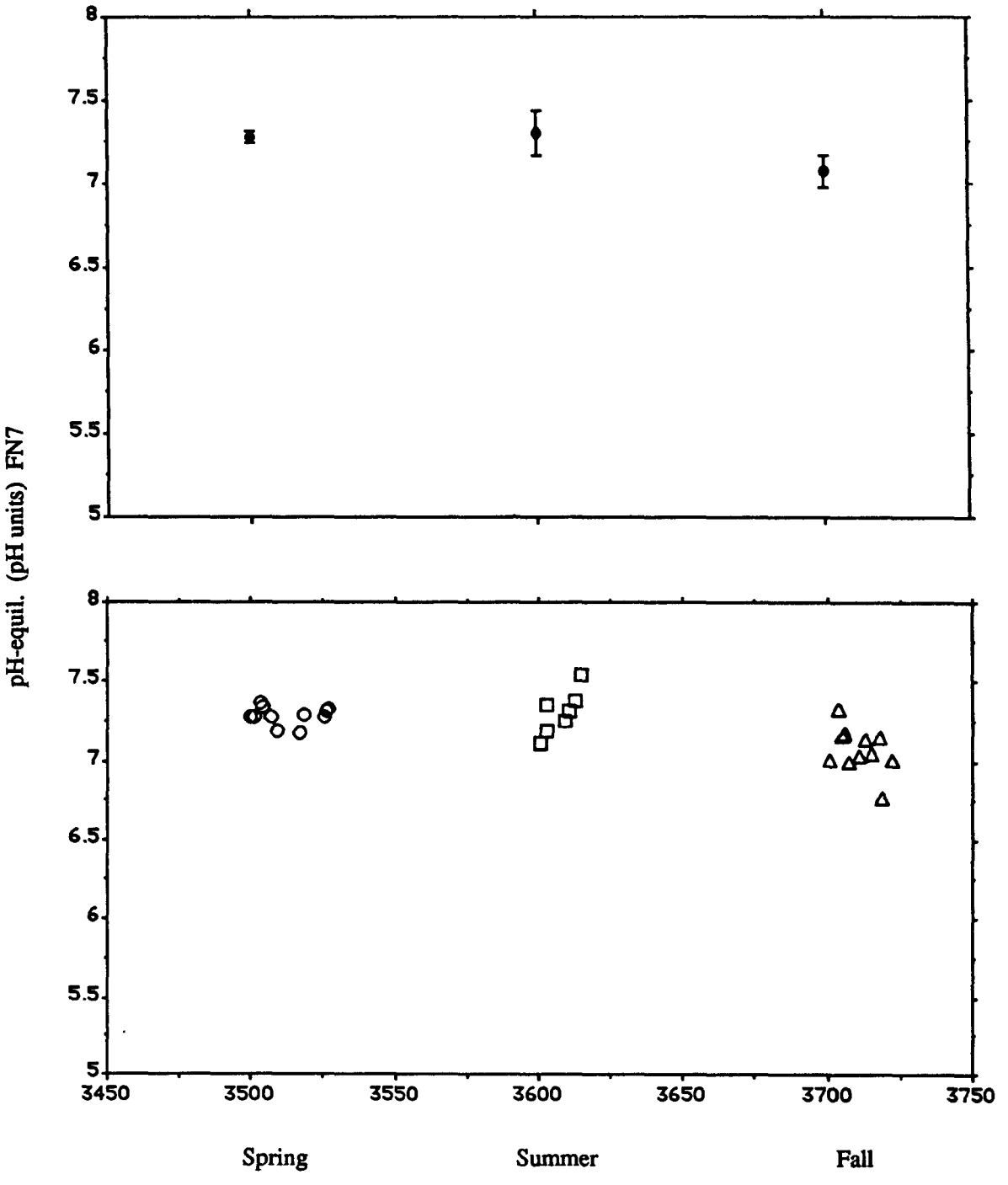

Figure D-51. pH-equilibrated (pH-eq), Seventh Lake audit samples.

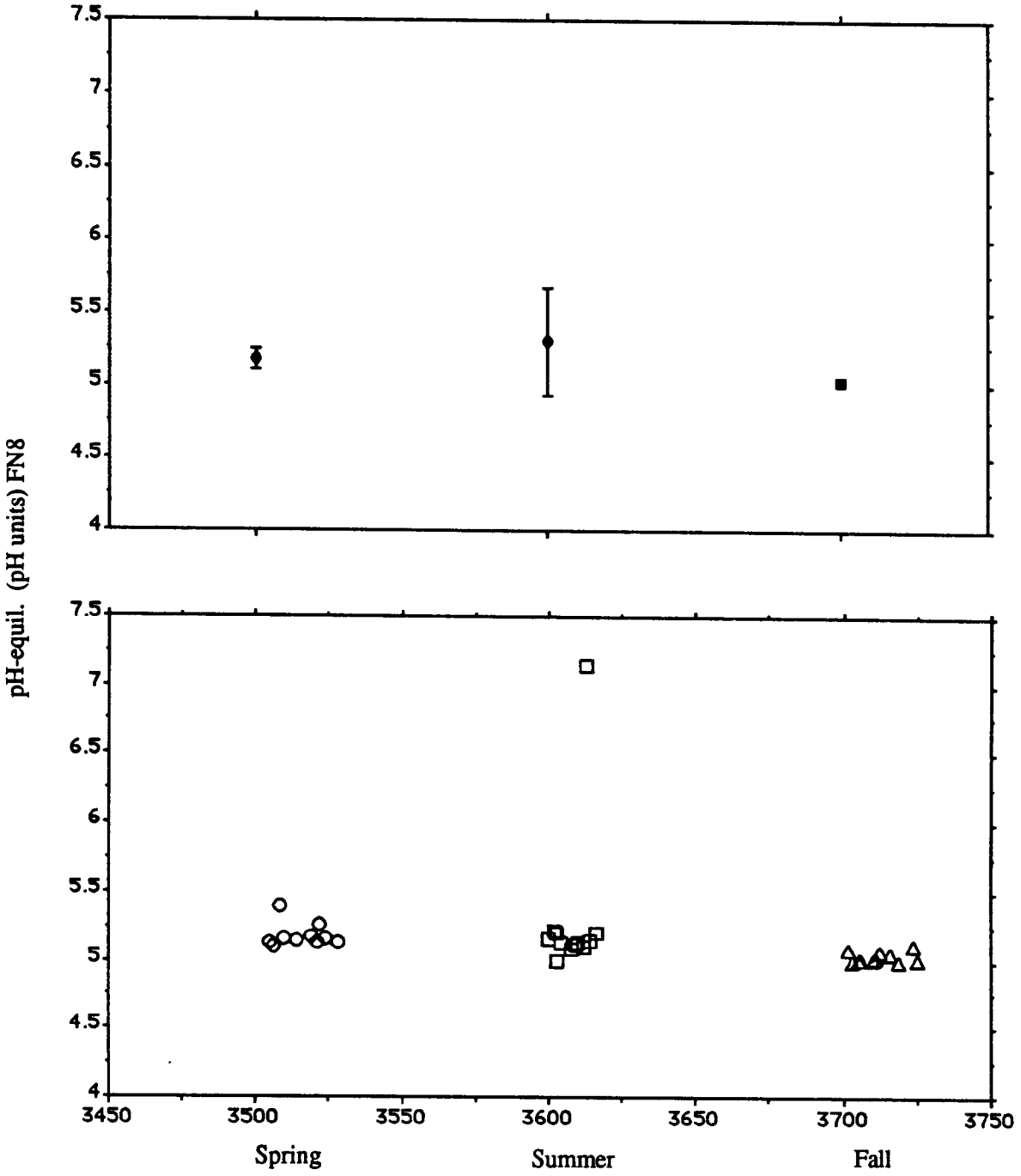

Figure D-52. pH-equilibrated (pH-eq), Big Moose Lake audit samples.

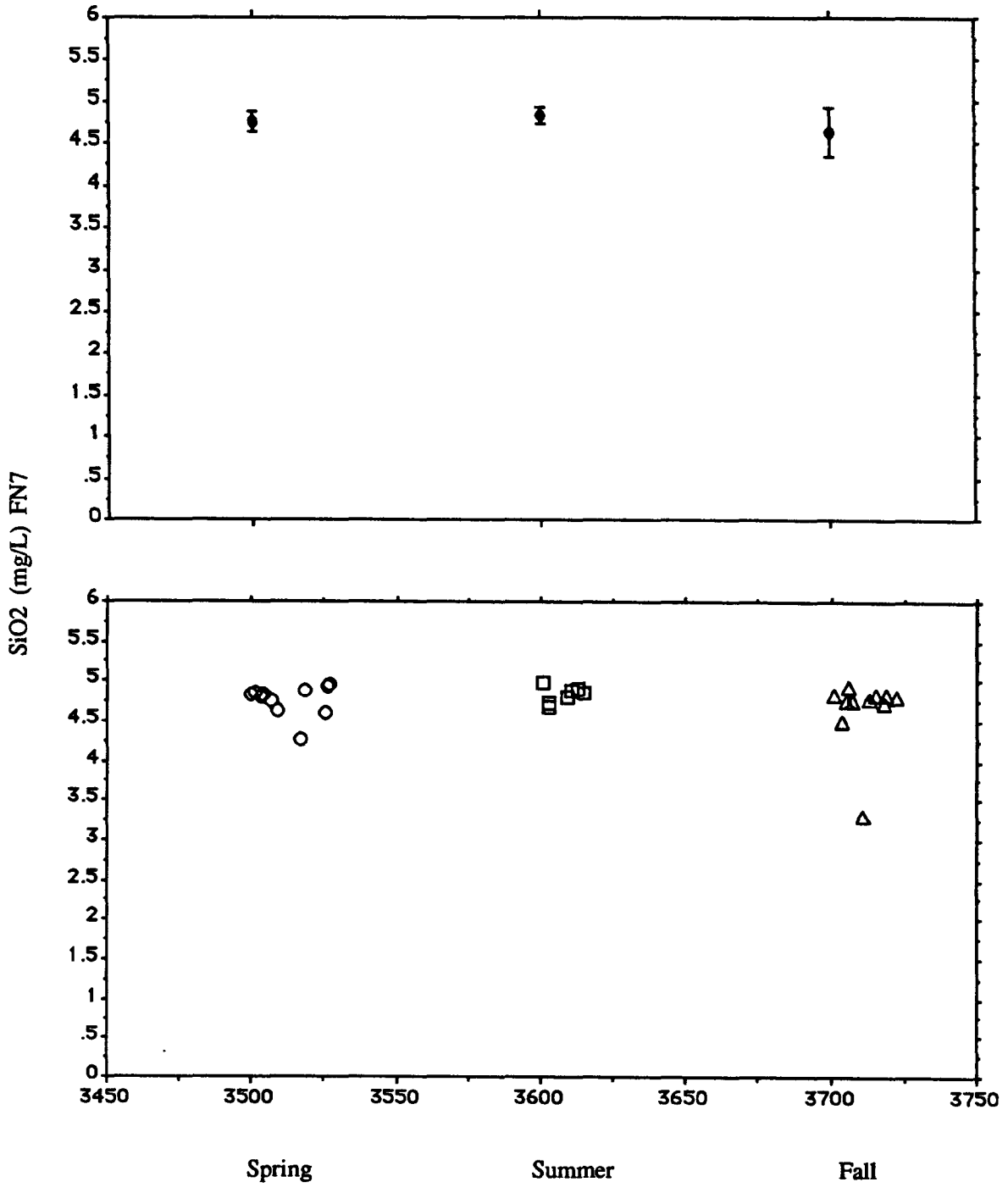

Figure D-53. Silica (SiO_2), Seventh Lake audit samples.

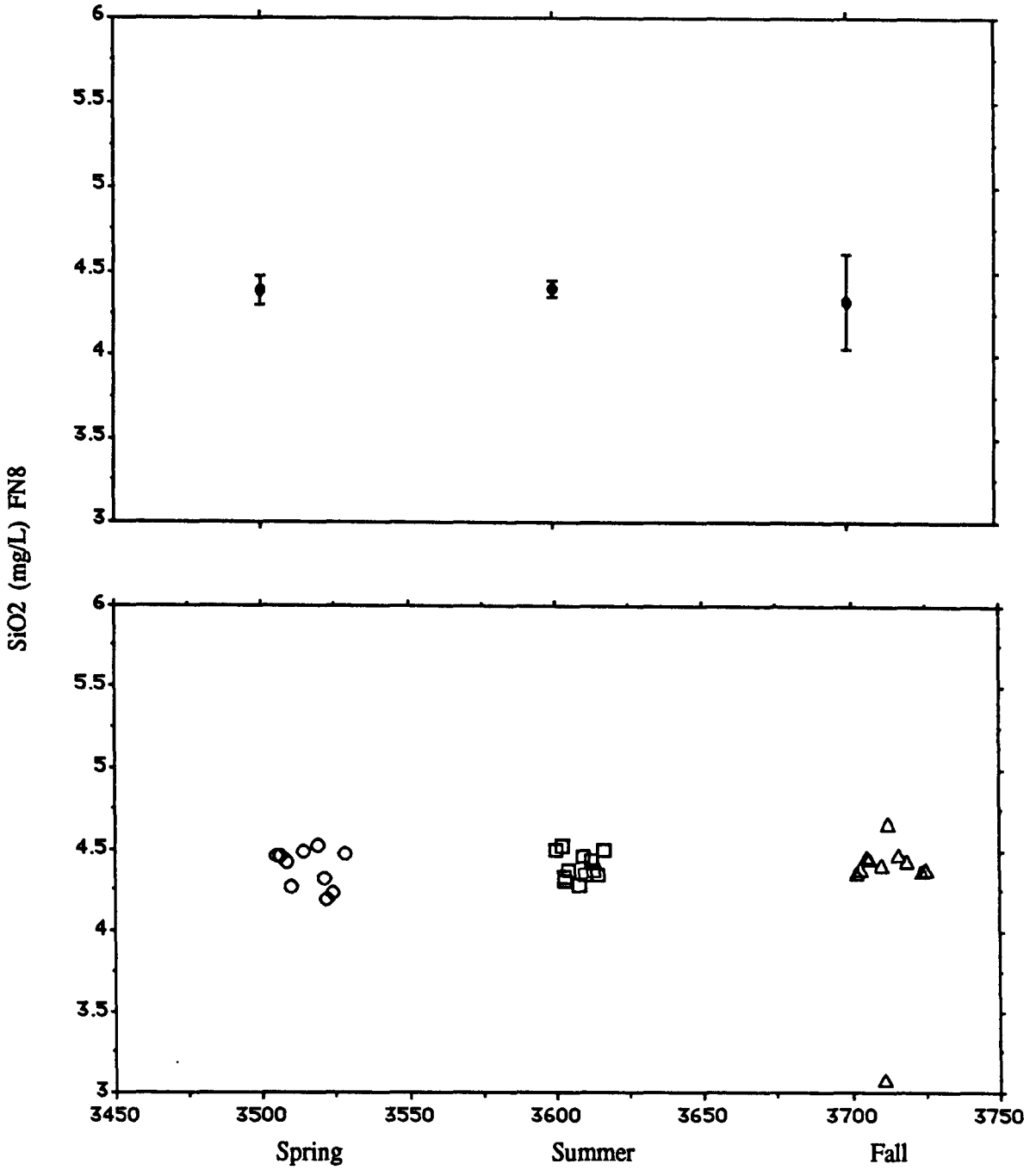

Figure D-54. Silica (SiO_2), Big Moose Lake audit samples.

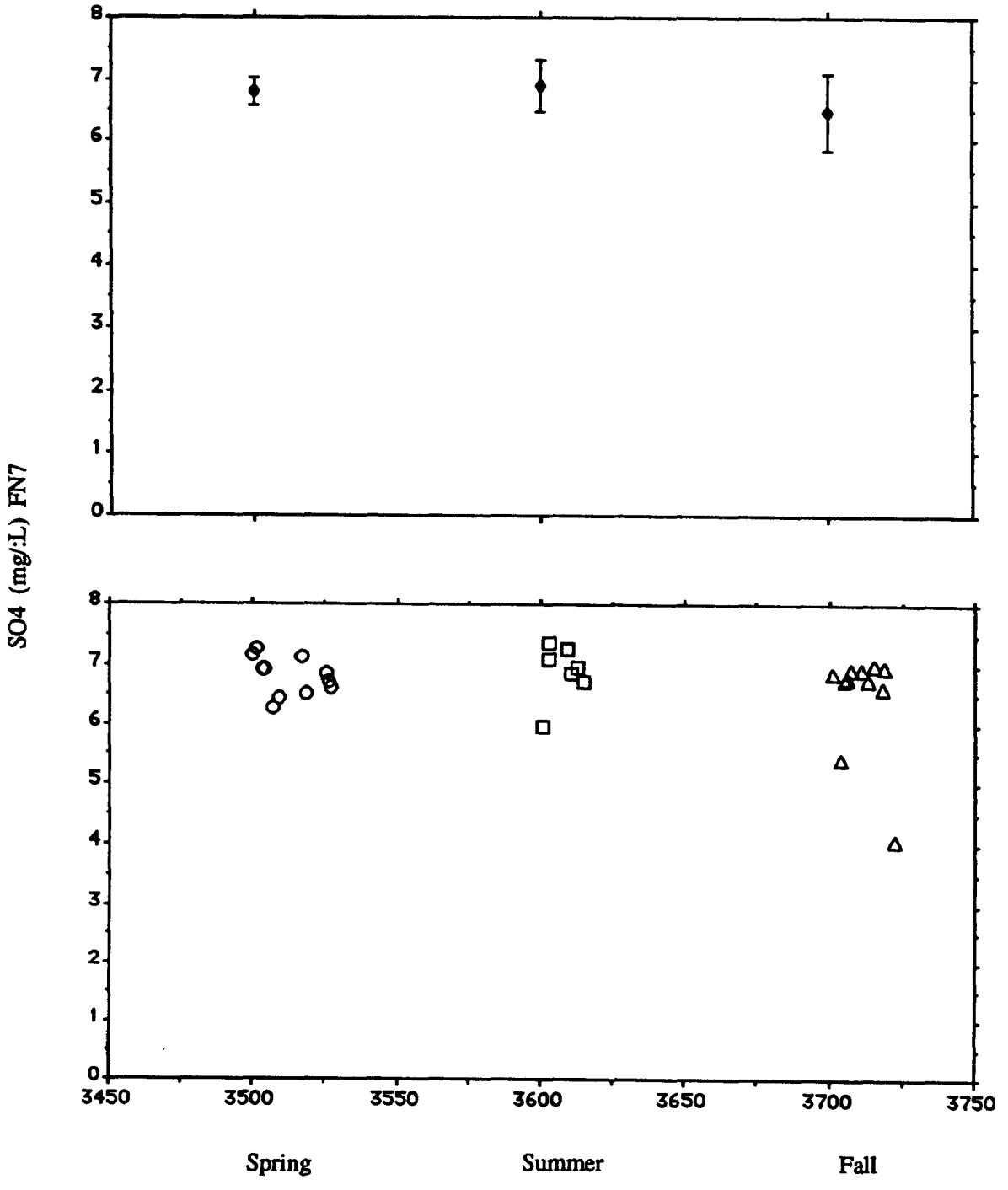

Figure D-55. Sulfate (SO_4^{2-}), Seventh Lake audit samples.

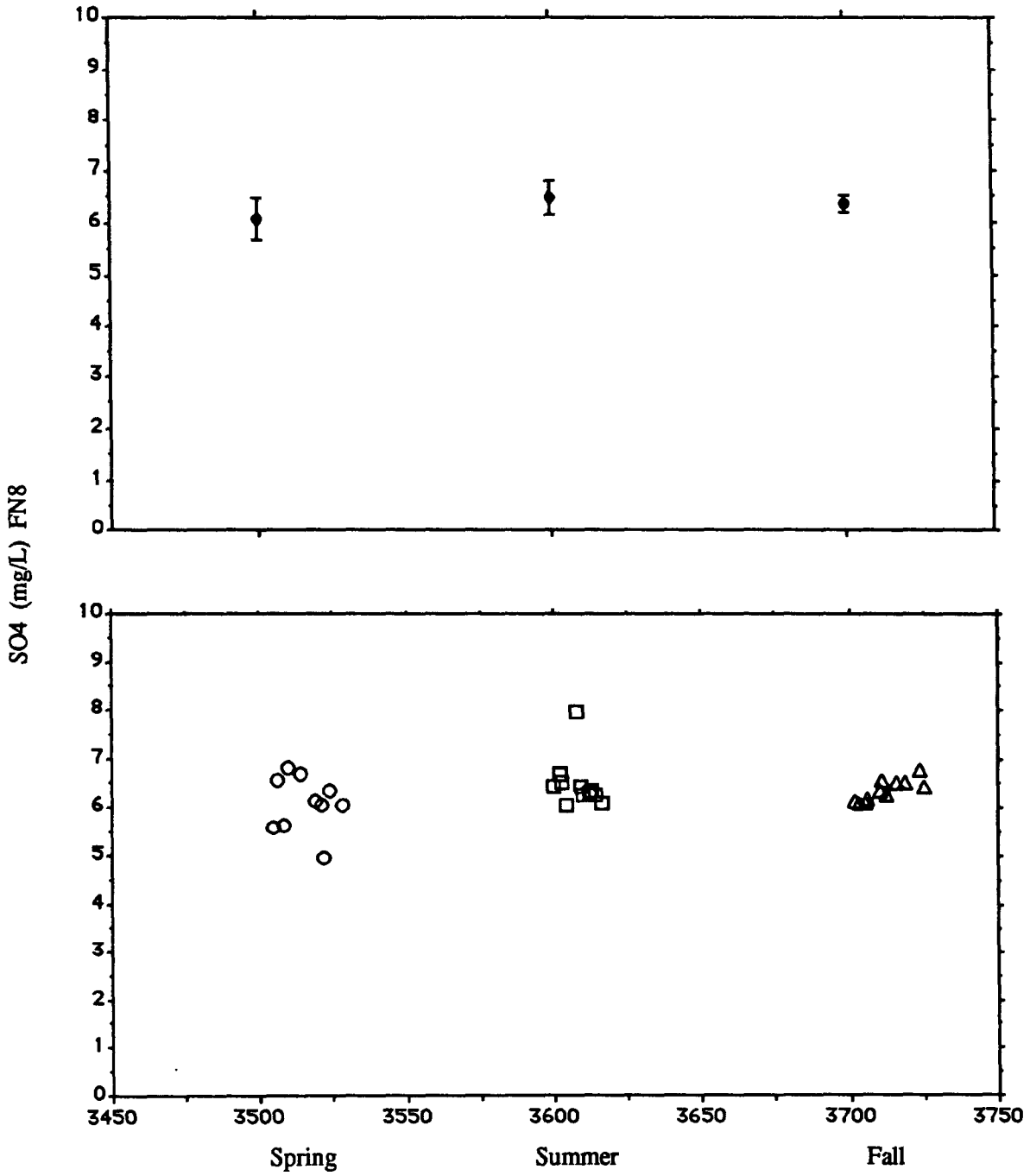

Figure D-56. Sulfate (SO_4^{2-}), Big Moose Lake audit samples.

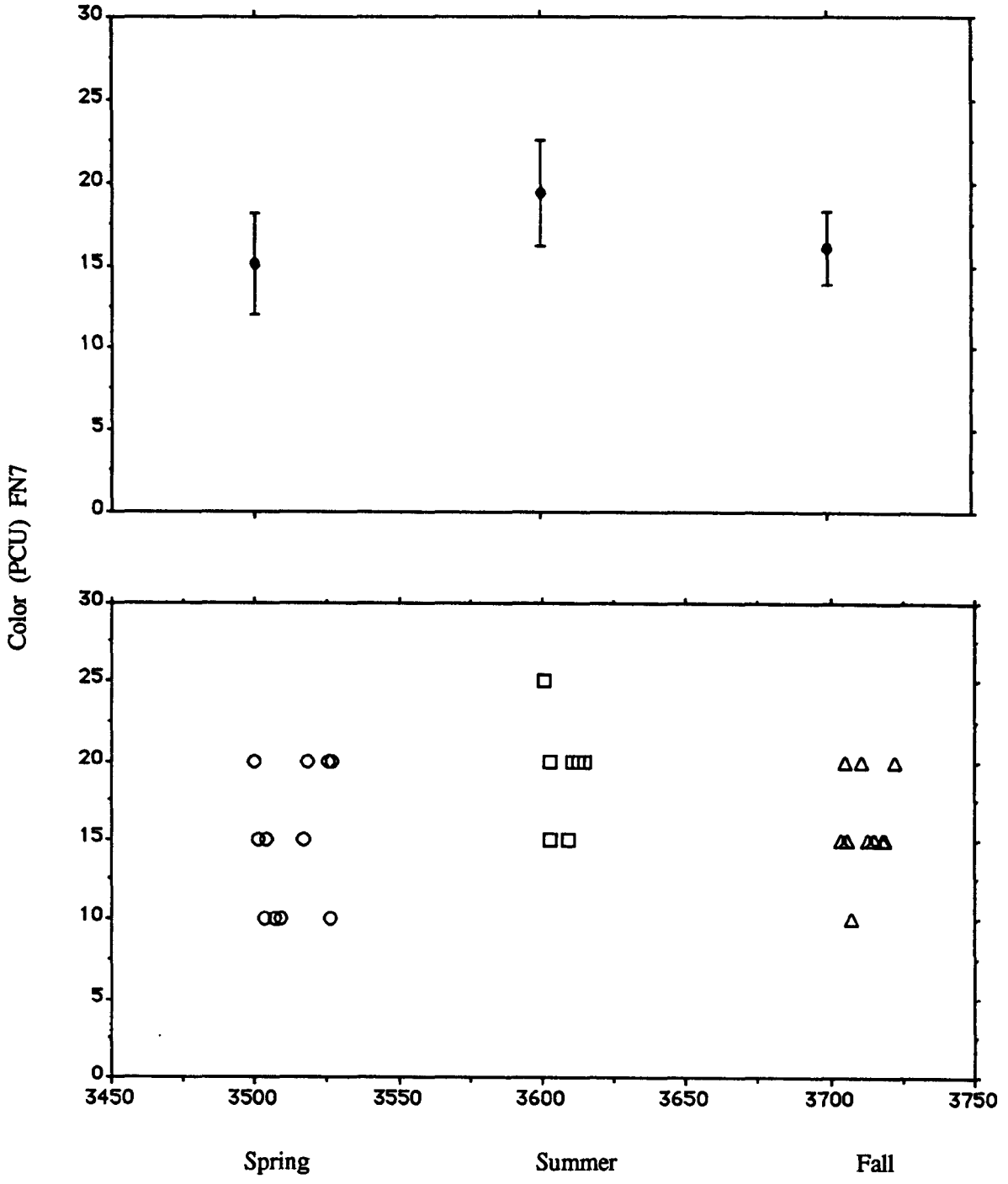

Figure D-57. True Color, Seventh Lake audit samples.

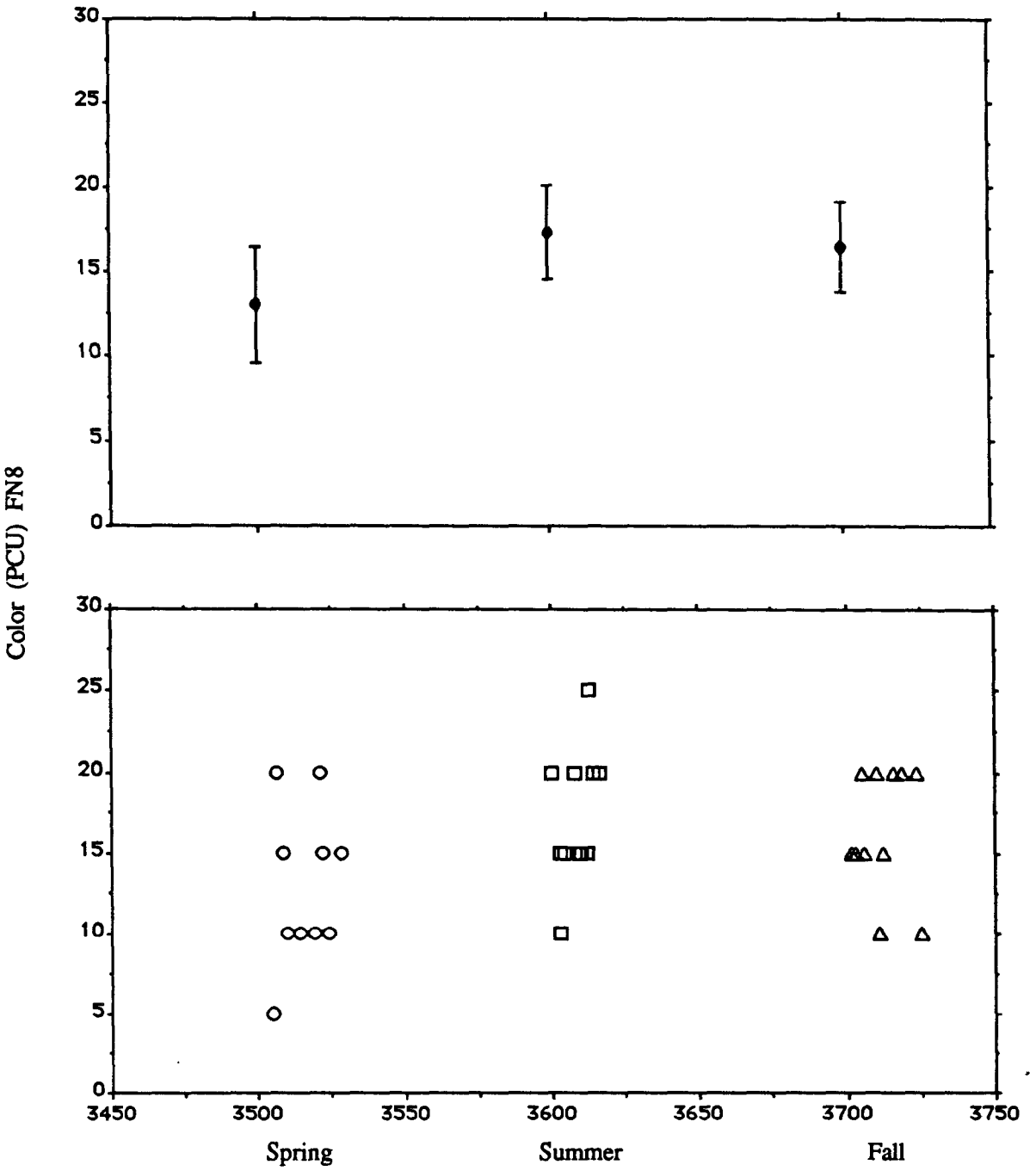

Figure D-58. True Color, Big Moose Lake audit samples.

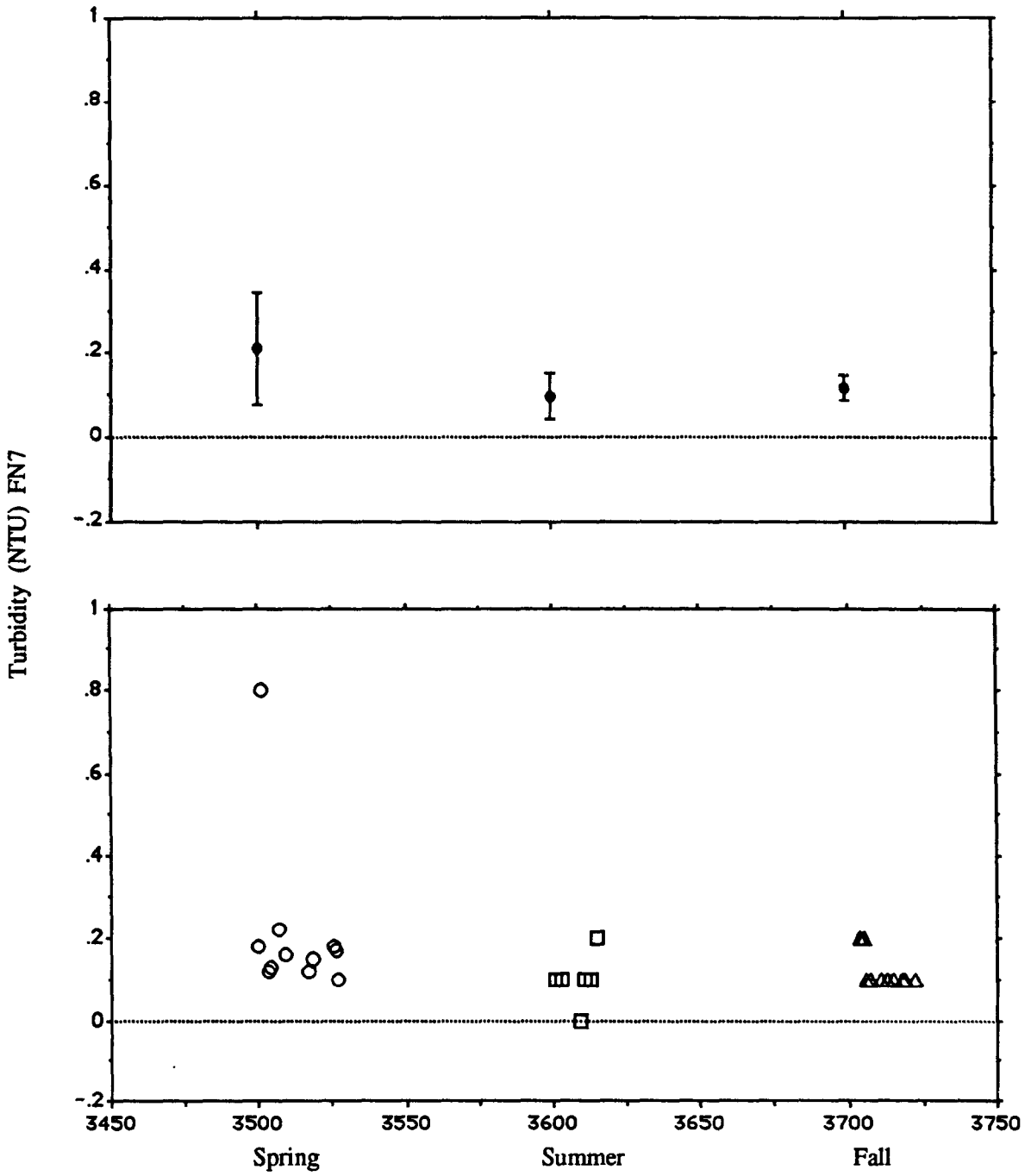

Figure D-59. Turbidity, Seventh Lake audit samples.

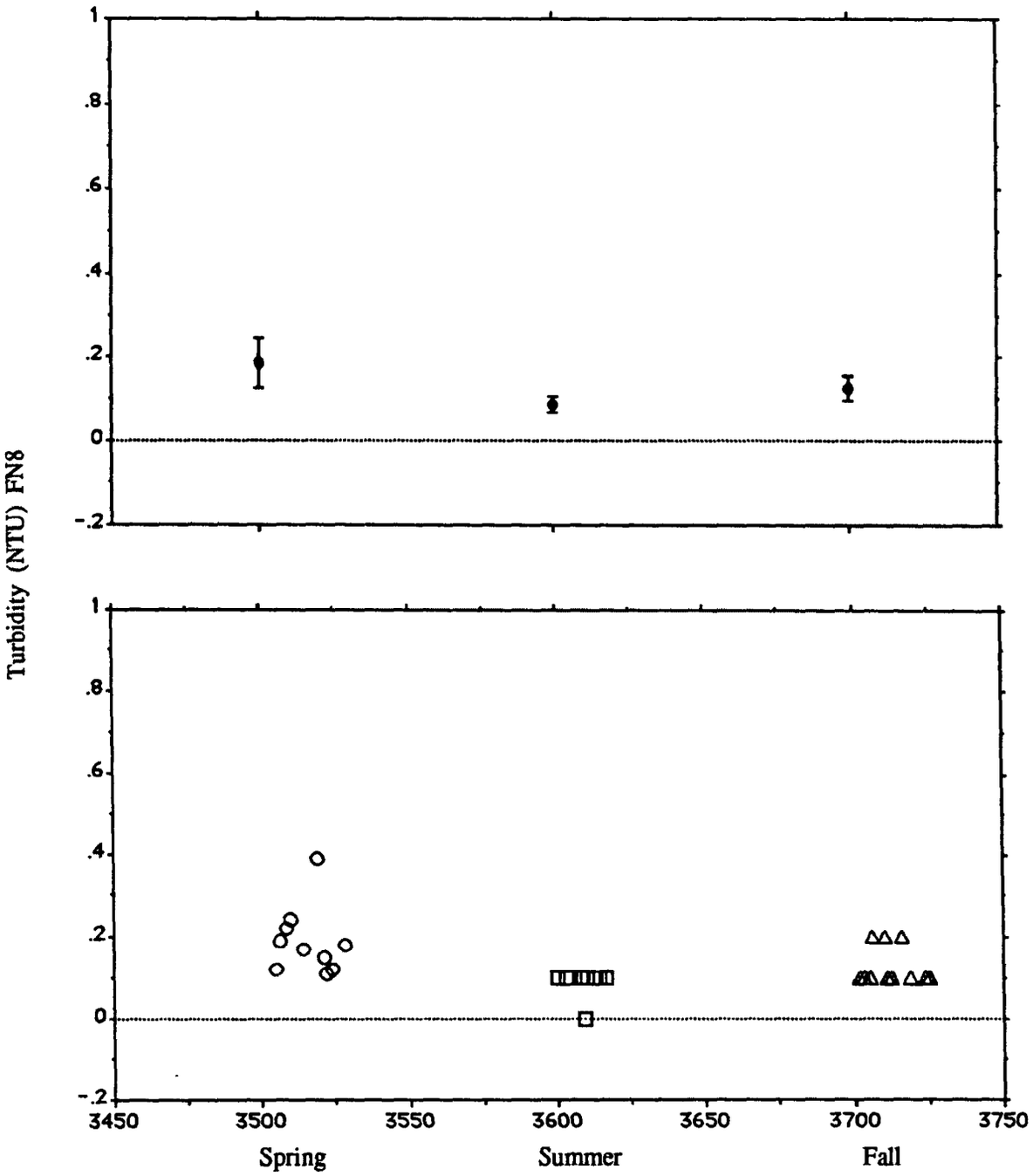

Figure D-60. Turbidity, Big Moose Lake audit samples.

Appendix E

Summary Statistics and Plots for Field Routine-Duplicate Sample Data

System-level precision estimates based on field routine-duplicate pair sample data are presented in Table E-1. Precision estimates are provided for various concentration ranges because of concentration-dependent effects. Figures E-1 through E-30 present all the field duplicate pair sample mean concentrations plotted against the relative standard deviation or standard deviation of the pair. The statistics presented in Table E-1 are defined below.

The pooled standard deviation (S_p) is calculated by:

$$S_p = \sqrt{\sum_{i=1}^{n} s_i^2/n}$$

where:

S_p = pooled standard deviation,
n = number of field routine-duplicate pairs, and
S_i^2 = variance of the field routine-duplicate pair.

The percent relative standard deviation ($\%RSD_p$) is calculated by dividing S_p by the grand mean of the sample pairs and multipying by 100 and is expressed as:

$$\%RSD_p = \left(\frac{S_p}{\sum_{i=1}^{n} \bar{x}_i/n} \right) 100$$

where:

S_p = pooled standard deviation,
$\bar{x}_i$ = mean of a sample pair, and
n = number of field routine-duplicate pairs.

A detailed discussion of these formulas and statistical approach can be found in Taylor (1987).

The following terms are used in the tables in this appendix:

Subsurvey-lab:

Spring-1 = Spring Seasonal subsurvey analysis performed by Laboratory 1.

Spring-PL = Spring Seasonal subsurvey analysis performed by processing laboratory.

Summer-1 = Summer Seasonal subsurvey analysis performed by Laboratory 1.

Summer-2 = Summer Seasonal subsurvey analysis performed by Laboratory 2.

Summer-1+2 = Summer Seasonal subsurvey analyses; Laboratory 1 and Laboratory 2 data combined.

Summer-PL = Summer Seasonal subsurvey analysis performed by processing laboratory.

Fall-2 = Fall Seasonal subsurvey analysis performed by Laboratory 2.

Fall-PL = Fall Seasonal subsurvey analysis performed by processing laboratory.

The following symbols are used in the plots in this appendix:

Δ = Analytical result for a single mean concentration for a field routine-duplicate pair measured by Laboratory 1.
□ = Analytical result for a single mean concentration for a field routine-duplicate pair measured by Laboratory 2.
⊙ = Analytical result for a single mean concentration for a field routine-duplicate pair measured by processing laboratory.
X = Indicates % RSD for Laboratory 1 results is out of range.
+ = Indicates % RSD for Laboratory 2 results is out of range.
Y = Indicates % RSD for processing laboratory results is out of range.

Table E-1. Summary Statistics for Field Routine-Duplicate Pair Sample Data, Eastern Lake Survey - Phase II

Subsurvey-Lab	Concentration ranges	Number of pairs	Grand mean	Pooled S_p	$\%RSD_p$
		Al-dis (mg/L)			
Spring-PL	< 0.02	4	0.014	0.001	5.035
	0.02 - 0.05	13	0.030	0.001	4.140
	> 0.05	11	0.125	0.004	3.537
	All data	28	0.065	0.003	4.466
Summer-PL	< 0.02	10	0.014	0.002	16.750
	0.02 - 0.05	5	0.026	0.001	2.651
	> 0.05	2	0.210	0.006	2.708
	All data	17	0.041	0.003	6.572
Fall-PL	< 0.02	5	0.017	0.001	3.818
	0.02 - 0.05	12	0.028	0.002	7.288
	> 0.05	8	0.143	0.004	2.960
	All data	25	0.063	0.003	4.472
		Al-ext (mg/L)			
Spring-1	< 0.025	14	0.007	0.005	67.036
	0.025 - 0.05	4	0.032	0.006	19.604
	> 0.05	10	0.099	0.040	40.327
	All data	28	0.043	0.024	55.775
Summer-1	< 0.025	3	-0.008	0.003	-37.293
	> 0.05	1	0.128	0.034	26.609
	All data	4	0.026	0.017	65.414
Summer-2	< 0.025	11	0.008	0.002	27.499
	All data	11	0.008	0.002	27.499
Summer-1+2	< 0.025	14	0.005	0.002	51.106
	0.05	1	0.128	0.034	26.609
	All data	15	0.013	0.009	71.075
Fall-2	< 0.025	16	0.007	0.002	31.820
	0.025 - 0.05	3	0.030	0.002	7.047
	> 0.05	7	0.096	0.006	6.374
	All data	26	0.034	0.004	11.031
		Al-tot (mg/L)			
Spring-1	< 0.05	9	0.033	0.004	12.785
	0.05 - 0.1	7	0.076	0.021	27.864
	> 0.1	12	0.212	0.013	6.145
	All data	28	0.121	0.014	11.465
Summer-1	< 0.05	1	0.039	0.015	39.000
	0.05 - 0.1	1	0.068	0.007	11.055
	> 0.1	2	0.260	0.082	31.539
	All data	4	0.157	0.059	37.407
Summer-2	< 0.05	9	0.025	0.012	48.428
	> 0.05 - 0.1	2	0.057	0.004	7.297
	All data	11	0.031	0.011	36.025
Summer-1+2	< 0.05	10	0.026	0.012	47.167
	0.05 - 0.1	3	0.060	0.005	9.084
	> 0.1	2	0.260	0.082	31.539
	All data	15	0.064	0.032	49.294
Fall-2	< 0.05	14	0.022	0.005	21.753
	0.05 - 0.1	5	0.082	0.041	49.207
	> 0.1	7	0.228	0.066	28.794
	All data	26	0.089	0.039	43.297

(Continued)

Table E-1. Continued

Subsurvey-Lab	Concentration ranges	Number of pairs	Grand mean	Pooled S_p	%RSD_p
		Al-org (mg/L)			
Spring-PL	< 0.02	5	0.015	0.001	8.854
	0.02 - 0.05	17	0.031	0.002	7.645
	> 0.05	6	0.078	0.004	5.322
	All data	28	0.038	0.003	7.127
Summer-PL	< 0.02	17	0.008	0.002	31.628
	All data	17	0.008	0.002	31.628
Fall-PL	< 0.02	18	0.011	0.001	9.726
	0.02 - 0.05	4	0.036	0.005	14.908
	> 0.05	3	0.075	0.003	3.384
	All data	25	0.022	0.002	11.080
		ANC (μeq/L)			
Spring-1	< 5	9	-3.128	3.389	-108.36
	5 - 25	5	17.220	4.557	26.461
	25 - 100	11	62.164	5.135	8.261
	> 100	4	193.687	5.422	2.799
	All data	29	52.293	4.605	8.805
Summer-1	< 5	3	-15.000	5.405	-36.031
	5 - 25	1	16.250	1.909	11.749
	25 - 100	2	59.700	0.500	0.838
	All data	6	15.108	3.911	25.886
Summer-2	5 - 25	1	7.150	0.071	0.989
	25 - 100	2	42.875	2.072	4.832
	> 100	8	257.162	8.275	3.218
	All data	11	195.473	7.112	3.638
Summer-1+2	< 5	3	-15.000	5.405	-36.031
	5 - 25	2	11.700	1.351	11.546
	25 - 100	4	51.287	1.507	2.938
	> 100	8	257.162	8.275	3.218
	All data	17	131.815	6.175	4.684
Fall-2	< 5	6	-13.708	5.650	-41.218
	5 - 25	8	10.675	1.037	9.713
	25 - 100	2	70.125	9.903	14.122
	> 100	9	245.078	5.334	2.177
	All data	25	93.964	5.108	5.437
		BNC (μeq/L)			
Spring-1	0 - 50	8	38.119	11.378	29.849
	> 50	21	66.529	16.231	24.397
	All data	29	58.691	15.049	25.641
Summer-1	0 - 50	4	36.700	5.656	15.412
	> 50	2	100.450	7.710	7.676
	All data	6	57.950	6.414	11.069
Summer-2	0 - 50	9	31.928	5.000	15.661
	> 50	2	58.450	11.904	20.366
	All data	11	36.750	6.799	18.499
Summer-1+2	0 - 50	13	33.396	5.211	15.603
	> 50	4	79.450	10.029	12.623
	All data	17	44.232	6.666	15.069
Fall-2	0 - 50	16	36.462	7.076	19.407
	> 50	10	84.955	19.678	23.163
	All data	26	55.113	13.407	24.326

(Continued)

Table E-1. Continued

Subsurvey-Lab	Concentration ranges	Number of pairs	Grand mean	Pooled S_p	$\%RSD_p$
		Ca (mg/L)			
Spring-1	< 2	14	1.351	0.063	4.650
	2 - 3	11	2.519	0.016	0.640
	3 - 5	1	3.035	0.064	2.097
	> 5	3	6.953	0.057	0.825
	All data	29	2.431	0.050	2.049
Summer-1	< 2	4	1.304	0.064	4.935
	2 - 3	2	2.339	0.012	0.510
	All data	6	1.649	0.053	3.213
Summer-2	< 2	1	0.711	0.004	0.626
	2 - 3	2	2.933	0.009	0.304
	3 - 5	4	3.418	0.093	2.718
	> 5	4	7.237	0.067	0.926
	All data	11	4.472	0.069	1.547
Summer-1+2	< 2	5	1.185	0.058	4.859
	2 - 3	4	2.636	0.011	0.400
	3 - 5	4	3.418	0.093	2.718
	> 5	4	7.237	0.067	0.926
	All data	17	3.476	0.064	1.839
Fall-2	< 2	13	1.167	0.015	1.327
	2 - 3	2	2.290	0.030	1.307
	3 - 5	6	3.855	0.027	0.710
	> 5	5	6.936	0.058	0.838
	All data	26	2.983	0.032	1.066
		Cl^- (mg/L)			
Spring-1	< 1	11	0.519	0.150	29.012
	1 - 7	8	2.551	0.102	3.982
	> 7	9	14.630	2.000	13.668
	All data	28	5.635	1.139	20.211
Summer-1	< 1	2	0.242	0.053	21.751
	1 - 7	1	4.121	4.777	115.892
	> 7	3	10.461	1.013	9.686
	All data	6	5.998	2.078	34.639
Summer-2	< 1	4	0.566	0.012	2.070
	1 - 7	4	2.765	0.022	0.788
	> 7	3	11.130	0.239	2.151
	All data	11	4.247	0.126	2.965
Summer-1+2	< 1	6	0.458	0.032	6.947
	1 - 7	5	3.036	2.136	70.356
	> 7	6	10.796	0.736	6.820
	All data	17	4.865	1.238	25.458
Fall-2	< 1	12	0.451	0.025	5.563
	1 - 7	6	1.768	0.039	2.224
	> 7	8	11.207	0.317	2.827
	All data	26	4.064	0.178	4.369
		Cond (µS/cm)			
Spring-1	< 25	11	21.181	0.507	2.396
	25 - 50	10	36.985	0.761	2.056
	> 50	8	77.612	1.340	1.727
	All data	29	42.198	0.890	2.110

(Continued)

Table E-1. Continued

Subsurvey-Lab	Concentration ranges	Number of pairs	Grand mean	Pooled S_p	$\%RSD_p$
		Cond (µS/cm)(continued)			
Summer-1	< 25	1	24.350	0.071	0.290
	25 - 50	3	39.100	8.921	22.816
	> 50	2	58.900	0.000	0.000
	All data	6	43.242	6.308	14.588
Summer-2	< 25	1	23.450	0.071	0.302
	25 - 50	6	35.750	0.365	1.021
	> 50	4	74.637	0.943	1.263
	All data	11	48.773	0.630	1.291
Summer-1+2	< 25	2	23.900	0.071	0.296
	25 - 50	9	36.867	5.159	13.994
	> 50	6	69.392	0.770	1.109
	All data	17	46.821	3.782	8.077
Fall-2	< 25	13	19.505	0.567	2.909
	25 - 50	5	38.780	0.265	0.682
	> 50	8	75.700	0.496	0.656
	All data	26	40.502	0.500	1.235
		DIC-closed (mg/L)			
Spring-PL	< 0.5	5	0.405	0.026	6.418
	0.5 - 1	5	0.725	0.065	8.898
	1 - 2	16	1.521	0.045	2.978
	> 2	3	3.085	0.058	1.873
	All data	29	1.353	0.048	3.554
Summer-PL	< 0.5	4	0.292	0.047	15.917
	0.5 - 1	4	0.682	0.012	1.696
	1 - 2	3	1.351	0.029	2.130
	> 2	6	3.562	0.176	4.932
	All data	17	1.725	0.108	6.239
Fall-PL	< 0.5	3	0.480	0.024	4.993
	0.5 - 1	9	0.712	0.024	3.344
	1 - 2	6	1.438	0.055	3.792
	> 2	8	3.525	0.062	1.759
	All data	26	1.718	0.046	2.687
		DIC-eq (mg/L)			
Spring-1	< 0.5	11	0.268	0.032	12.029
	0.5 - 1	10	0.704	0.201	28.509
	1 - 2	5	1.525	0.071	4.639
	> 2	3	3.301	0.104	3.140
	All data	29	0.949	0.127	13.434
Summer-1	< 0.5	3	0.290	0.107	36.936
	0.5 - 1	1	0.660	0.179	27.085
	1 - 2	2	1.347	0.141	10.433
	All data	6	0.704	0.133	18.867
Summer-2	< 0.5	2	0.210	0.020	9.695
	0.5 - 1	2	0.669	0.082	12.297
	1 - 2	1	1.410	0.006	0.451
	> 2	6	3.146	0.089	2.839
	All data	11	2.004	0.075	3.754
Summer-1+2	< 0.5	5	0.258	0.084	32.509
	0.5 - 1	3	0.666	0.123	18.498
	1 - 2	3	1.368	0.115	8.391
	> 2	6	3.146	0.089	2.839
	All data	17	1.545	0.099	6.435

(Continued)

Table E-1. Continued

Subsurvey-Lab	Concentration ranges	Number of pairs	Grand mean	Pooled S_p	%RSD_p
		DIC-eq (mg/L)(continued)			
Fall-2	< 0.5	14	0.112	0.021	18.616
	0.5 - 1	2	0.765	0.177	23.116
	1 - 2	3	1.417	0.024	1.700
	> 2	7	2.755	0.096	3.471
	All data	26	1.025	0.072	7.017
		DIC-initial (mg/L)			
Spring-1	< 0.5	1	0.290	0.014	4.877
	0.5 - 1	8	0.671	0.147	21.957
	1 - 2	16	1.446	0.174	12.063
	> 2	4	3.182	0.159	5.010
	All data	29	1.432	0.162	11.324
Summer-1	< 0.5	2	0.404	0.210	52.026
	0.5 - 1	2	0.568	0.062	10.919
	1 - 2	2	1.411	0.087	6.146
	All data	6	0.795	0.136	17.140
Summer-2	< 0.5	1	0.374	0.016	4.343
	0.5 - 1	2	0.643	0.011	1.775
	1 - 2	2	1.392	0.058	4.171
	> 2	6	3.397	0.100	2.938
	All data	11	2.257	0.078	3.459
Summer-1+2	< 0.5	3	0.394	0.172	43.621
	0.5 - 1	4	0.606	0.045	7.362
	1 - 2	4	1.402	0.074	5.266
	> 2	6	3.397	0.100	2.938
	All data	17	1.741	0.102	5.883
Fall-2	< 0.5	5	0.411	0.054	13.114
	0.5 - 1	8	0.668	0.042	6.299
	1 - 2	5	1.295	0.071	5.509
	> 2	8	3.230	0.075	2.333
	All data	26	1.528	0.062	4.051
		DOC (mg/L)			
Spring-1	< 3	12	1.820	0.075	4.115
	3 - 5	12	3.513	0.131	3.732
	> 5	5	7.051	0.843	11.953
	All data	29	3.423	0.363	10.611
Summer-1	< 3	3	1.284	0.603	46.975
	3 - 5	2	3.985	0.112	2.806
	> 5	1	5.800	1.152	19.858
	All data	6	2.937	0.638	21.725
Summer-2	< 3	2	2.605	0.139	5.347
	3 - 5	5	4.050	0.165	4.083
	> 5	4	7.236	0.233	3.222
	All data	11	4.946	0.189	3.821
Summer-1+2	< 3	5	1.812	0.475	26.229
	3 - 5	7	4.031	0.152	3.770
	> 5	5	6.949	0.556	7.997
	All data	17	4.237	0.408	9.640
Fall-2	< 3	8	2.036	0.051	2.504
	3 - 5	13	4.323	0.357	8.253
	> 5	5	9.282	0.276	2.975
	All data	26	4.573	0.281	6.150

(Continued)

Table E-1. Continued

Subsurvey-Lab	Concentration ranges	Number of pairs	Grand mean	Pooled S_p	$\%RSD_p$
		F^--total (mg/L)			
Spring-1	< 0.025	8	0.019	0.002	10.768
	0.025 - 0.05	13	0.041	0.001	3.298
	> 0.05	8	0.092	0.009	9.865
	All data	29	0.049	0.005	10.181
Summer-1	0.025 - 0.05	1	0.026	0.000	0.552
	> 0.05	5	0.074	0.003	3.933
	All data	6	0.066	0.003	4.031
Summer-2	< 0.025	2	0.022	0.001	2.864
	0.025 - 0.05	4	0.037	0.002	4.879
	> 0.05	5	0.064	0.002	3.187
	All data	11	0.047	0.002	3.811
Summer-1+2	< 0.025	2	0.022	0.001	2.864
	0.025 - 0.05	5	0.035	0.002	4.650
	> 0.05	10	0.069	0.003	3.639
	All data	17	0.053	0.002	3.986
Fall-2	< 0.025	4	0.020	0.003	13.871
	0.025 - 0.05	8	0.039	0.002	5.095
	> 0.05	14	0.096	0.004	3.722
	All data	26	0.067	0.003	4.558
		Fe (mg/L)			
Spring-1	< 0.025	9	0.013	0.004	29.186
	0.025 - 0.05	5	0.035	0.005	13.907
	0.05 - 0.1	7	0.061	0.004	6.854
	> 0.1	8	0.137	0.013	9.194
	All data	29	0.063	0.008	12.019
Summer-1	< 0.025	2	0.018	0.004	22.869
	0.025 - 0.05	1	0.031	0.001	2.245
	0.05 - 0.1	2	0.084	0.025	29.609
	> 0.1	1	0.127	0.006	4.991
	All data	6	0.061	0.015	24.503
Summer-2	< 0.025	7	0.012	0.005	42.347
	0.025 - 0.05	1	0.033	0.003	7.737
	0.05 - 0.1	2	0.075	0.007	9.567
	> 0.1	1	0.895	0.669	74.734
	All data	11	0.106	0.202	191.082
Summer-1+2	< 0.025	9	0.013	0.005	36.611
	0.025 - 0.05	2	0.032	0.002	5.802
	0.05 - 0.1	4	0.080	0.018	23.118
	> 0.1	2	0.511	0.473	92.520
	All data	17	0.090	0.163	181.120
Fall-2	< 0.025	8	0.009	0.002	26.081
	0.025 - 0.05	5	0.039	0.007	17.976
	0.05 - 0.1	4	0.065	0.006	8.611
	> 0.1	9	0.251	0.016	6.291
	All data	26	0.107	0.010	9.435
		K (mg/L)			
Spring-1	< 0.2	3	0.152	0.008	5.086
	0.2 - 0.5	17	0.311	0.005	1.674
	> 0.5	9	0.792	0.042	5.279
	All data	29	0.444	0.024	5.356

(Continued)

Table E-1. Continued

Subsurvey-Lab	Concentration ranges	Number of pairs	Grand mean	Pooled S_p	%RSD_p
		K (mg/L)(continued)			
Summer-1	< 0.2	1	0.157	0.000	0.000
	0.2 - 0.5	4	0.307	0.002	0.576
	> 0.5	1	0.534	0.004	0.661
	All data	6	0.320	0.002	0.638
Summer-2	0.2 - 0.5	7	0.324	0.006	1.821
	> 0.5	4	0.784	0.023	2.964
	All data	11	0.492	0.015	3.008
Summer-1+2	< 0.2	1	0.157	0.000	0.000
	0.2 - 0.5	11	0.318	0.005	1.519
	> 0.5	5	0.734	0.021	2.840
	All data	17	0.431	0.012	2.774
Fall-2	< 0.2	8	0.159	0.010	6.560
	0.2 - 0.5	10	0.274	0.056	20.306
	> 0.5	8	0.856	0.060	7.066
	All data	26	0.418	0.048	11.603
		Mg (mg/L)			
Spring-1	< 0.5	12	0.384	0.004	1.008
	0.5 - 1	11	0.657	0.004	0.652
	> 1	6	1.419	0.025	1.752
	All data	29	0.702	0.012	1.691
Summer-1	< 0.5	3	0.315	0.074	23.485
	0.5 - 1	2	0.557	0.006	1.124
	> 1	1	1.065	0.014	1.328
	All data	6	0.521	0.053	10.126
Summer-2	< 0.5	1	0.333	0.006	1.722
	0.5 - 1	4	0.586	0.004	0.644
	> 1	6	1.619	0.012	0.740
	All data	11	1.126	0.009	0.826
Summer-1+2	< 0.5	4	0.319	0.064	20.076
	0.5 - 1	6	0.576	0.005	0.824
	> 1	7	1.540	0.012	0.800
	All data	17	0.913	0.032	3.529
Fall-2	< 0.5	15	0.287	0.002	0.810
	0.5 - 1	6	0.711	0.004	0.629
	> 1	5	1.577	0.014	0.878
	All data	26	0.633	0.007	1.055
		Mn (mg/L)			
Spring-1	< 0.025	14	0.015	0.001	6.053
	0.025 - 0.05	10	0.032	0.001	4.231
	> 0.05	5	0.108	0.005	4.203
	All data	29	0.037	0.002	5.812
Summer-1	< 0.025	3	0.005	0.001	14.630
	0.025 - 0.05	2	0.032	0.001	1.550
	> 0.05	1	0.128	0.001	0.550
	All data	6	0.035	0.001	1.866
Summer-2	< 0.025	9	-0.002	0.001	-37.749
	0.025 - 0.05	1	0.029	0.001	2.896
	> 0.05	1	0.121	0.006	4.909
	All data	11	0.012	0.002	16.765

(Continued)

Table E-1. Continued

Subsurvey-Lab	Concentration ranges	Number of pairs	Grand mean	Pooled S_p	%RSD_p
		Mn (mg/L)(continued)			
Summer-1+2	< 0.025	12	-0.001	0.001	-158.89
	0.025 - 0.05	3	0.031	0.001	2.040
	> 0.05	2	0.125	0.004	3.391
	All data	17	0.020	0.002	8.239
Fall-2	< 0.025	11	0.009	0.001	9.000
	0.025 - 0.05	12	0.036	0.002	6.094
	> 0.05	3	0.105	0.001	0.908
	All data	26	0.033	0.002	4.966
		Na (mg/L)			
Spring-1	< 1	9	0.656	0.008	1.145
	1 - 2	6	1.295	0.022	1.718
	2 - 5	5	3.353	0.037	1.097
	> 5	9	7.688	0.171	2.220
	All data	29	3.435	0.097	2.822
Summer-1	< 1	2	0.563	0.004	0.710
	2 - 5	2	3.805	0.019	0.513
	> 5	2	6.802	0.019	0.279
	All data	6	3.723	0.016	0.427
Summer-1	< 1	3	0.805	0.010	1.224
	1 - 2	2	1.478	0.038	2.604
	2 - 5	3	2.735	0.063	2.314
	> 5	3	5.982	0.333	5.567
	All data	11	2.866	0.178	6.207
Summer-1+2	< 1	5	0.708	0.008	1.135
	1 - 2	2	1.478	0.038	2.604
	2 - 5	5	3.163	0.051	1.598
	> 5	5	6.310	0.258	4.093
	All data	17	3.168	0.143	4.526
Fall-2	< 1	9	0.465	0.005	1.178
	1 - 2	6	1.357	0.010	0.741
	2 - 5	3	2.285	0.044	1.915
	> 5	8	7.626	0.063	0.828
	All data	26	3.084	0.038	1.248
		NH_4^+ (mg/L)			
Spring-1	< 0.01	23	0.002	0.007	325.207
	0.01 - 0.05	3	0.025	0.034	133.162
	> 0.05	3	0.079	0.008	10.686
	All data	29	0.013	0.013	103.016
Summer-1	< 0.01	5	0.002	0.004	217.866
	0.01 - 0.05	1	0.023	0.026	111.332
	All data	6	0.005	0.011	209.210
Summer-2	< 0.01	7	-0.006	0.002	-38.030
	0.01 - 0.05	4	0.019	0.004	21.908
	All data	11	0.003	0.003	103.695
Summer-1+2	< 0.01	12	-0.003	0.003	-103.79
	0.01 - 0.05	5	0.020	0.012	60.633
	All data	17	0.004	0.007	183.639
Fall-2	< 0.01	12	0.001	0.007	893.560
	0.01 - 0.05	6	0.029	0.003	10.890
	> 0.05	8	0.143	0.010	7.078
	All data	26	0.051	0.008	14.794

(Continued)

Table E-1. Continued

Subsurvey-Lab	Concentration ranges	Number of pairs	Grand mean	Pooled S_p	$\%RSD_p$
		NO_3^- (mg/L)			
Spring-1	< 0.05	8	-0.018	0.001	-4.485
	0.1 - 0.5	10	0.222	0.045	20.415
	> 0.5	11	0.984	0.022	2.247
	All data	29	0.445	0.030	6.724
Summer-1	< 0.05	1	0.035	0.020	55.602
	0.05 - 0.1	4	0.064	0.034	52.542
	> 0.1	1	0.204	0.017	8.246
	All data	6	0.083	0.029	35.640
Summer-2	< 0.05	10	0.016	0.006	38.624
	0.1 - 0.5	1	0.461	0.000	0.015
	All data	11	0.056	0.006	10.273
Summer-1+2	< 0.05	11	0.017	0.008	47.287
	0.05 - 0.1	4	0.064	0.034	52.542
	> 0.1	2	0.332	0.012	3.580
	All data	17	0.065	0.018	27.639
Fall-2	< 0.05	11	0.015	0.016	106.990
	0.05 - 0.1	5	0.072	0.017	24.126
	0.1 - 0.5	8	0.227	0.008	3.339
	> 0.5	2	0.852	0.044	5.151
	All data	26	0.155	0.018	11.625
		P-total (mg/L)			
Spring-1	< 0.005	8	0.003	0.001	44.223
	0.005- 0.01	6	0.008	0.002	31.503
	> 0.01	15	0.017	0.009	50.787
	All data	29	0.011	0.006	56.567
Summer-1	< 0.005	1	0.004	0.000	10.879
	0.005- 0.01	4	0.008	0.004	46.735
	> 0.01	1	0.019	0.003	17.631
	All data	6	0.009	0.003	36.588
Summer-2	< 0.005	4	0.003	0.001	32.051
	0.005- 0.01	3	0.007	0.000	3.371
	> 0.01	4	0.021	0.002	8.686
	All data	11	0.011	0.001	11.731
Summer-1+2	< 0.005	5	0.003	0.001	27.940
	0.005- 0.01	7	0.008	0.003	36.716
	> 0.01	5	0.020	0.002	10.752
	All data	17	0.010	0.002	21.892
Fall-2	< 0.005	6	0.003	0.001	28.953
	0.005- 0.01	7	0.006	0.002	27.485
	> 0.01	13	0.016	0.004	23.516
	All data	26	0.010	0.003	27.287
		pH-closed (pH units)			
Spring-PL	< 6	17	5.459	0.028	NA
	6 - 7	10	6.493	0.027	NA
	> 7	2	7.132	0.027	NA
	All data	29	5.931	0.028	NA
Summer-PL	< 6	5	5.293	0.082	NA
	6 - 7	8	6.584	0.124	NA
	> 7	4	7.112	0.043	NA
	All data	17	6.329	0.098	NA

(Continued)

Table E-1. Continued

Subsurvey-Lab	Concentration ranges	Number of pairs	Grand mean	Pooled S_p	%RSD_p
		pH-closed (pH units)(continued)			
Fall-PL	< 6	14	5.312	0.024	NA
	6 - 7	9	6.698	0.019	NA
	> 7	3	7.255	0.018	NA
	All data	26	6.016	0.022	NA
		pH-BNC (pH units)			
Spring-1	< 6	12	5.423	0.071	NA
	6 - 7	15	6.485	0.083	NA
	> 7	2	7.075	0.061	NA
	All data	29	6.086	0.077	NA
Summer-1	< 6	4	5.160	0.023	NA
	6 - 7	2	6.565	0.035	NA
	All data	6	5.628	0.028	NA
Summer-2	< 6	1	5.840	0.113	NA
	6 - 7	3	6.558	0.036	NA
	> 7	7	7.228	0.107	NA
	All data	11	6.919	0.094	NA
Summer-1+2	< 6	5	5.296	0.055	NA
	6 - 7	5	6.561	0.036	NA
	> 7	7	7.228	0.107	NA
	All data	17	6.464	0.077	NA
Fall-2	< 6	11	5.254	0.059	NA
	6 - 7	9	6.535	0.224	NA
	> 7	6	7.199	0.029	NA
	All data	26	6.146	0.138	NA
		pH-ANC (pH units)			
Spring-1	< 6	12	5.392	0.065	NA
	6 - 7	15	6.454	0.072	NA
	> 7	2	7.072	0.036	NA
	All data	29	6.057	0.068	NA
Summer-1	< 6	4	5.157	0.042	NA
	6 - 7	2	6.587	0.045	NA
	All data	6	5.634	0.043	NA
Summer-2	< 6	1	5.815	0.092	NA
	6 - 7	5	6.699	0.040	NA
	> 7	5	7.235	0.122	NA
	All data	11	6.862	0.091	NA
Summer-1+2	< 6	5	5.289	0.056	NA
	6 - 7	7	6.667	0.041	NA
	> 7	5	7.235	0.122	NA
	All data	17	6.429	0.077	NA
Fall-2	< 6	12	5.255	0.042	NA
	6 - 7	9	6.591	0.225	NA
	> 7	5	7.195	0.030	NA
	All data	26	6.091	0.136	NA
		pH-eq (pH units)			
Spring-1	< 6	11	5.377	0.067	NA
	6 - 7	12	6.582	0.061	NA
	> 7	6	7.296	0.141	NA
	All data	29	6.273	0.086	NA

(Continued)

Table E-1. Continued

Subsurvey-Lab	Concentration ranges	Number of pairs	Grand mean	Pooled S_p	%RSD_p
		pH-eq (pH units)(continued)			
Summer-1	< 6	3	4.882	0.052	NA
	6 - 7	2	6.362	0.067	NA
	> 7	1	7.155	0.276	NA
	All data	6	5.754	0.125	NA
Summer-2	6 - 7	4	6.656	0.047	NA
	> 7	7	7.535	0.157	NA
	All data	11	7.215	0.128	NA
Summer-1+2	< 6	3	4.882	0.052	NA
	6 - 7	6	6.558	0.055	NA
	> 7	8	7.487	0.176	NA
	All data	17	6.700	0.127	NA
Fall-2	< 6	11	5.207	0.061	NA
	6 - 7	7	6.668	0.106	NA
	> 7	8	7.307	0.347	NA
	All data	26	6.247	0.204	NA
		SiO_2 (mg/L)			
Spring-1	< 0.5	4	0.032	0.035	108.786
	0.5 - 2	3	1.185	0.087	7.300
	2 - 5	15	3.516	0.251	7.137
	> 5	7	5.857	0.180	3.081
	All data	29	3.359	0.203	6.055
Summer-1	< 0.5	2	0.232	0.011	4.712
	0.5 - 2	3	1.713	1.212	70.751
	2 - 5	1	2.777	0.058	2.088
	All data	6	1.397	0.858	61.395
Summer-2	< 0.5	2	0.155	0.017	11.137
	0.5 - 2	4	1.212	0.040	3.267
	2 - 5	5	3.306	0.048	1.453
	All data	11	1.972	0.041	2.075
Summer-1+2	< 0.5	4	0.193	0.014	7.469
	0.5 - 2	7	1.427	0.794	55.653
	2 - 5	6	3.217	0.050	1.549
	All data	17	1.769	0.511	28.865
Fall-2	< 0.5	4	0.361	0.019	5.367
	0.5 - 2	9	0.835	0.012	1.422
	2 - 5	10	3.012	0.034	1.131
	> 5	3	6.134	0.119	1.933
	All data	26	2.211	0.047	2.110
		SO_4^{2-} (mg/L)			
Spring-1	< 5	9	3.441	0.197	5.721
	5 - 7	15	5.947	0.069	1.168
	> 7	5	10.270	0.320	3.115
	All data	29	5.915	0.179	3.033
Summer-1	< 5	2	4.767	0.162	3.388
	5 - 7	4	5.826	0.069	1.183
	All data	6	5.473	0.109	1.990
Summer-2	< 5	6	4.022	0.070	1.750
	5 - 7	2	6.447	0.067	1.043
	> 7	3	8.518	0.186	2.178
	All data	11	5.689	0.114	1.997

(Continued)

Table E-1. Continued

Subsurvey-Lab	Concentration ranges	Number of pairs	Grand mean	Pooled S_p	$\%RSD_p$
		SO_4^{2-} (mg/L)(continued)			
Summer-1+2	< 5	8	4.208	0.101	2.404
	5 - 7	6	6.033	0.068	1.133
	> 7	3	8.518	0.186	2.178
	All data	17	5.613	0.112	1.995
Fall-2	< 5	10	3.378	0.083	2.446
	5 - 7	13	5.760	0.136	2.370
	> 7	3	8.932	0.176	1.965
	All data	26	5.210	0.124	2.389
		True color (PCU)			
Spring-PL	< 15	11	8.409	1.846	21.957
	15 - 30	9	20.000	1.667	8.333
	> 30	9	40.833	1.841	4.508
	All data	29	22.069	1.791	8.114
Summer-PL	< 15	4	11.250	3.536	31.427
	15 - 30	4	18.125	3.062	16.893
	> 30	9	43.889	2.357	5.370
	All data	17	30.147	2.844	9.434
Fall-PL	< 15	6	7.917	1.443	18.232
	15 - 30	6	19.583	2.500	12.766
	> 30	14	53.571	1.890	3.528
	All data	26	35.192	1.961	5.573
		Turbidity (NTU)			
Spring-PL	< 1	24	0.569	0.038	6.693
	> 1	5	1.310	0.332	25.366
	All data	29	0.697	0.142	20.409
Summer-PL	< 1	12	0.350	0.029	8.248
	> 1	5	3.730	0.055	1.468
	All data	17	1.344	0.038	2.853
Fall-PL	< 1	16	0.531	0.035	6.655
	> 1	10	1.580	0.045	2.830
	All data	26	0.935	0.039	4.197

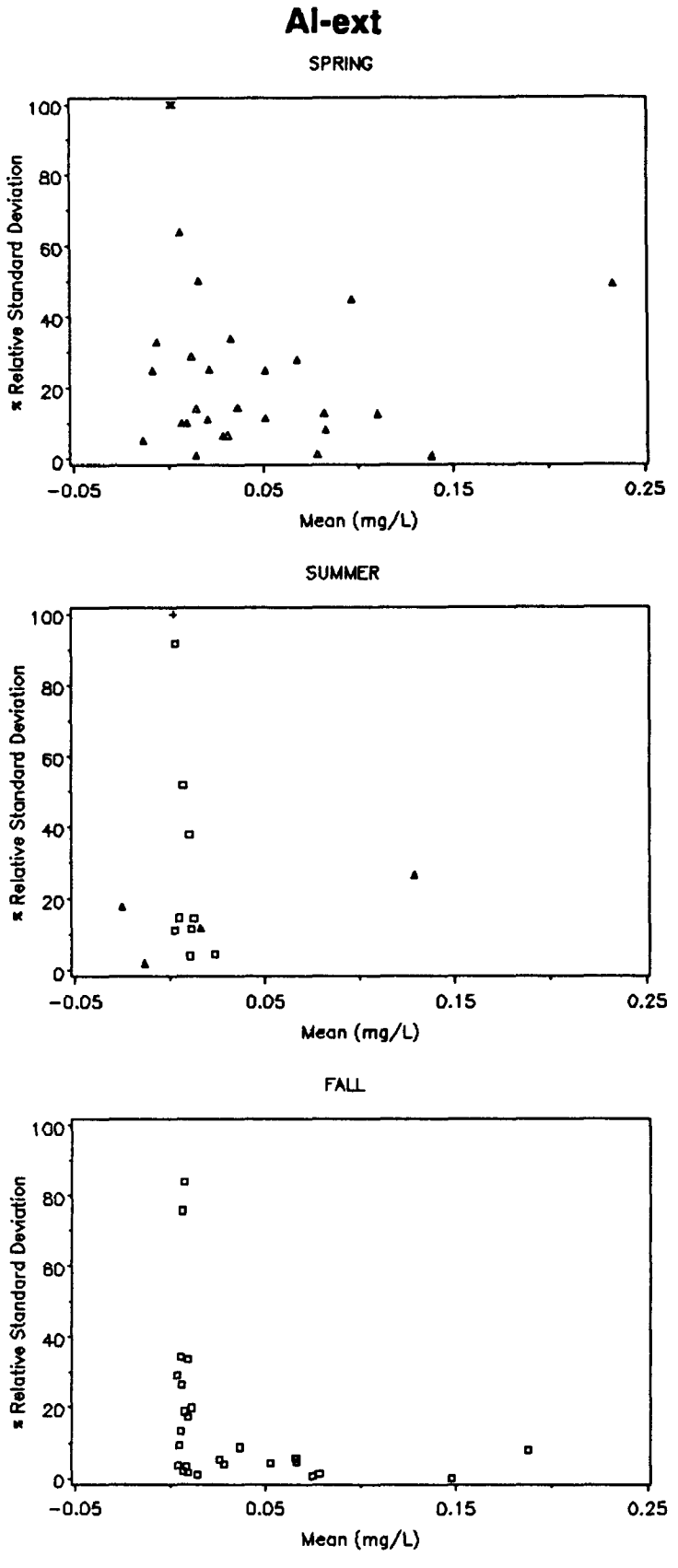

Figure E-1. Extractable aluminum (Al-ext) plot of routine-duplicate means and % RSD.

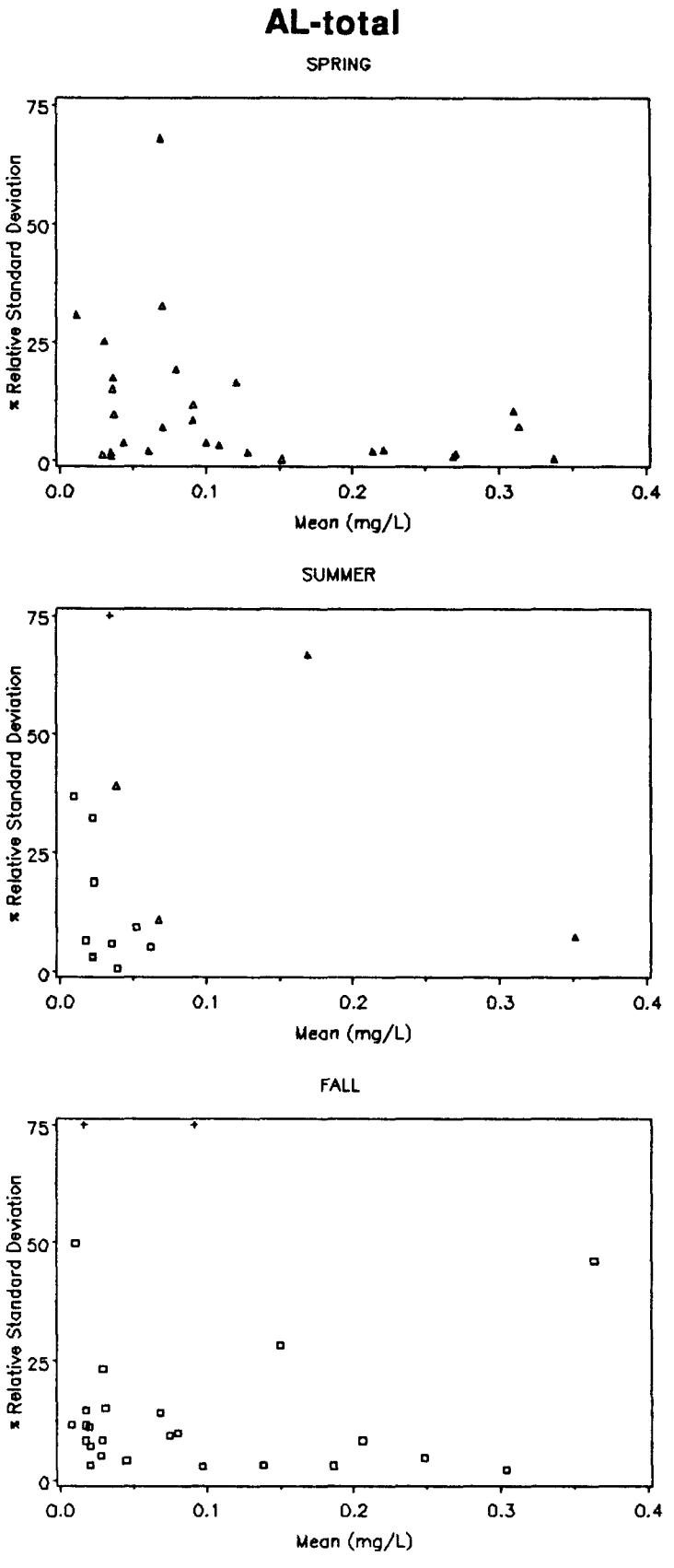

Figure E-2. Total aluminum (Al-total), plot of routine-duplicate means and % RSD.

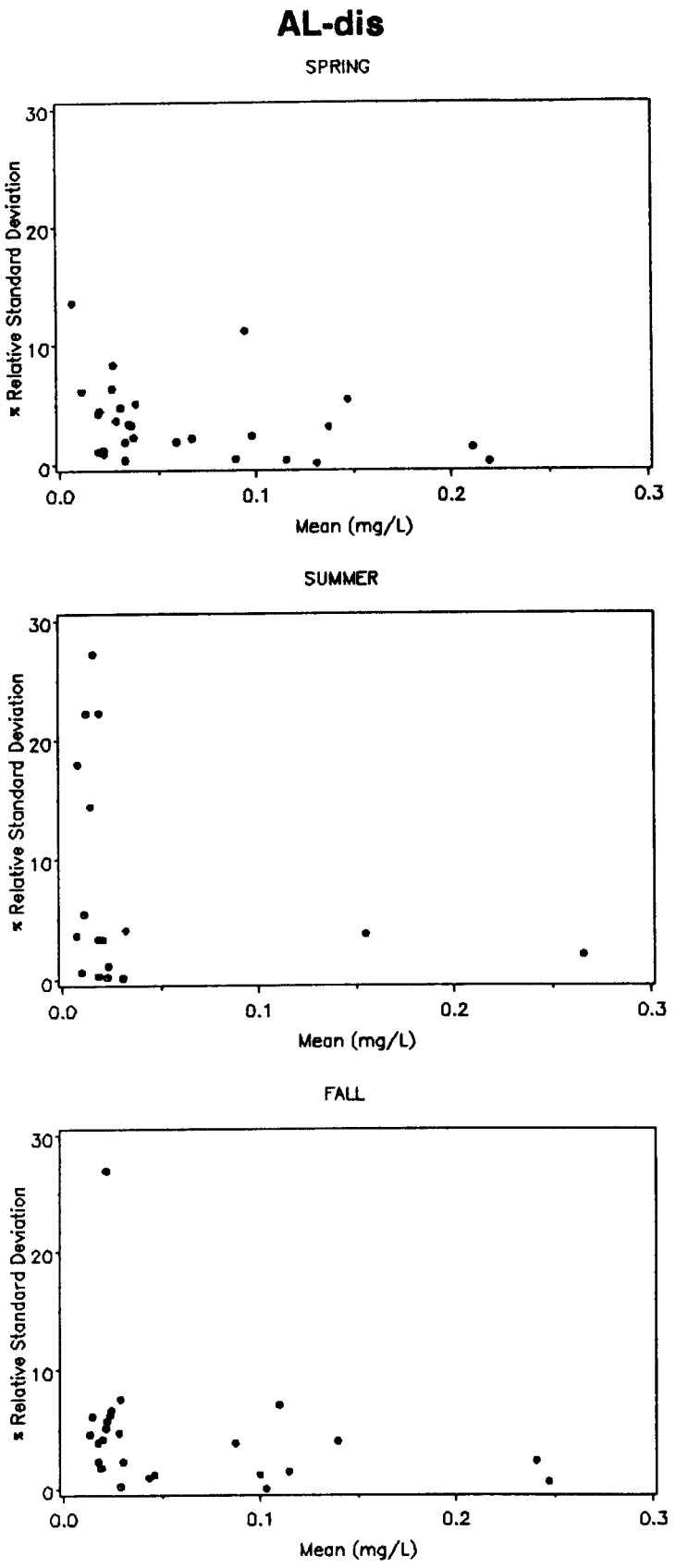

Figure E-3. Dissolved monomeric aluminum (Al-dis), plot of routine-duplicate means and % RSD.

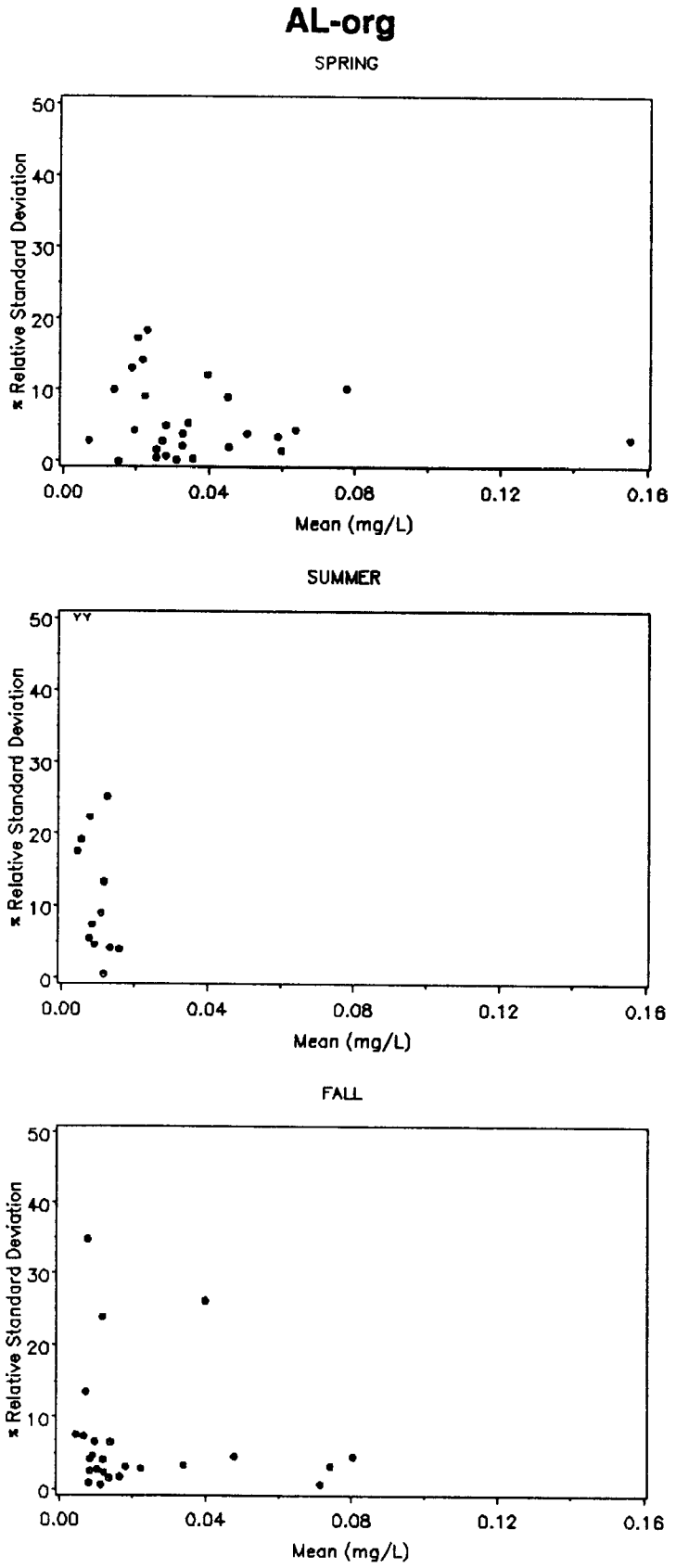

Figure E-4. Nonexchangeable monomeric aluminum (Al-org), plot of routine-duplicate means and % RSD.

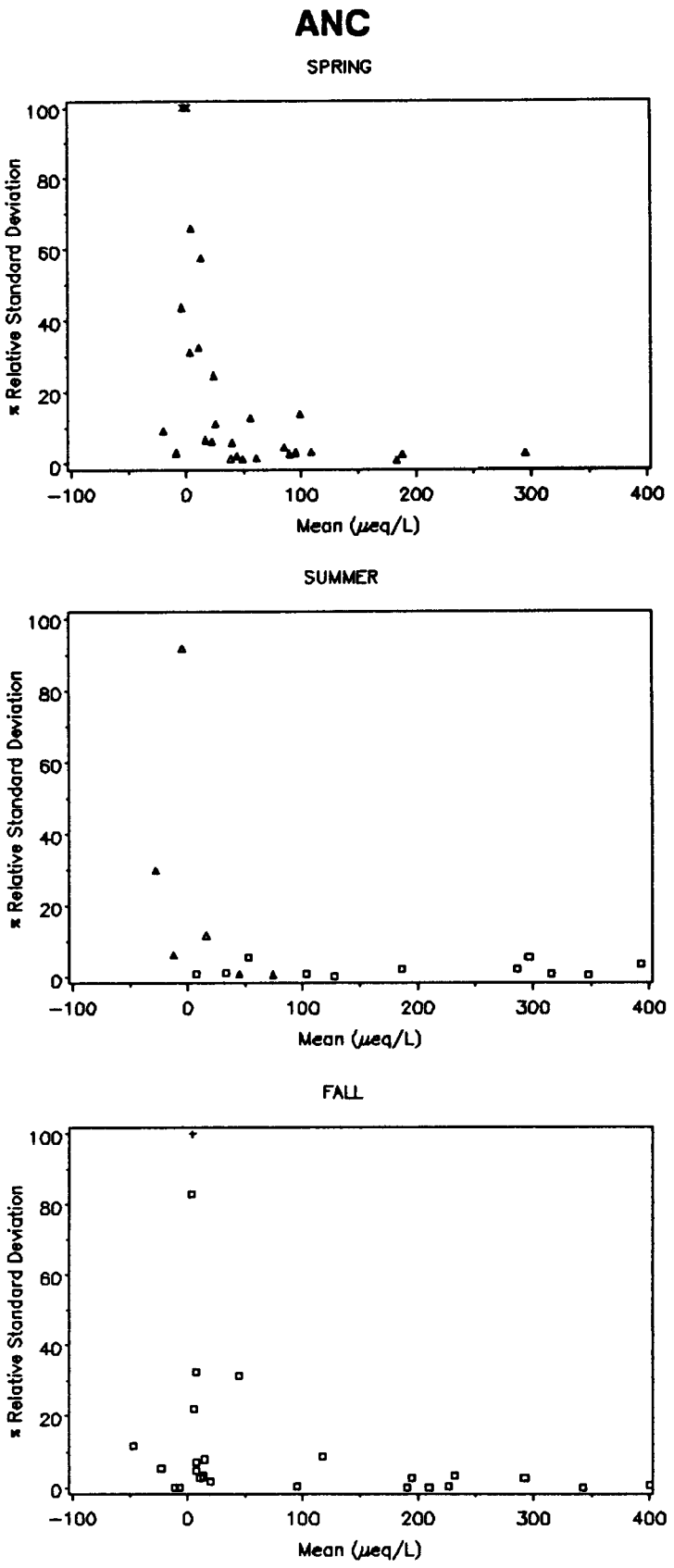

Figure E-5. Acid neutralizing capacity (ANC), plot of routine-duplicate means and % RSD.

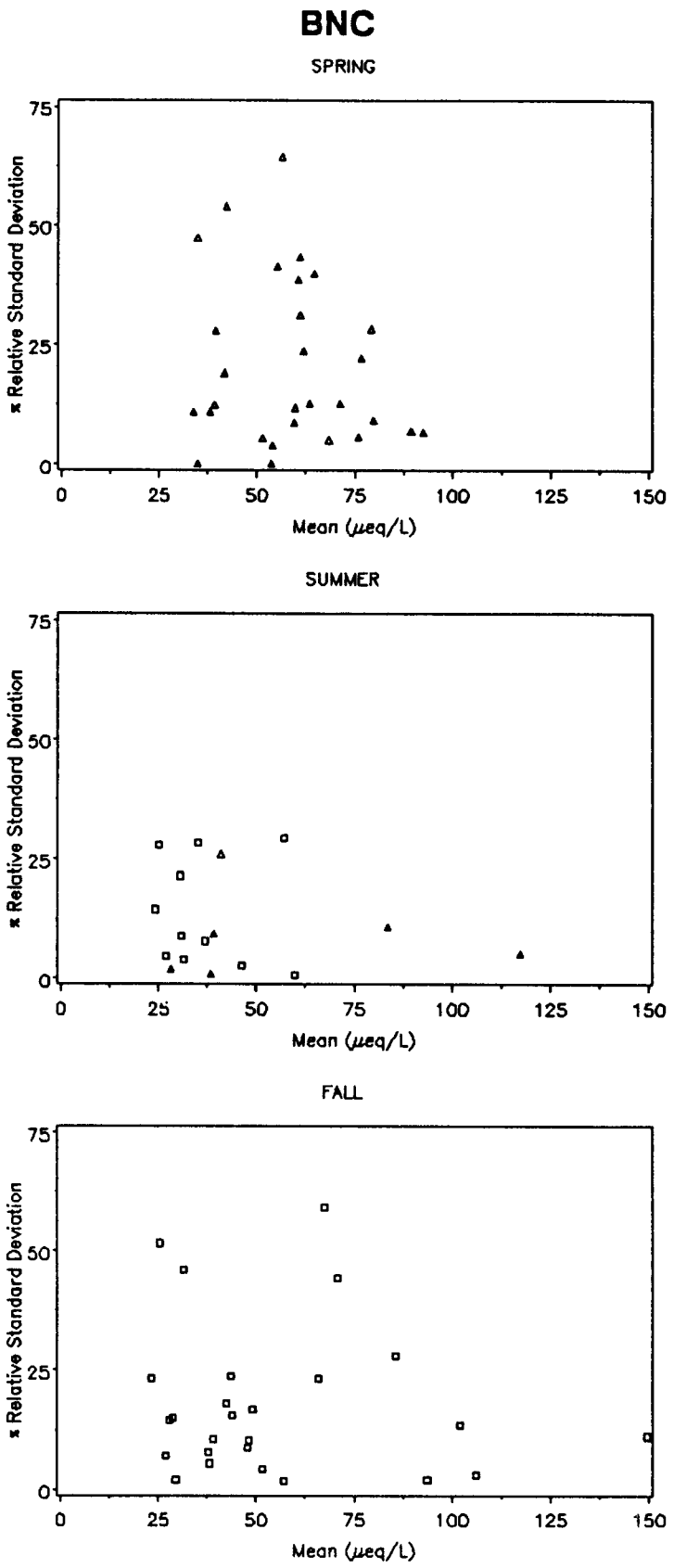

Figure E-6. Base neutralizing capacity (BNC), plot of routine-duplicate means and % RSD.

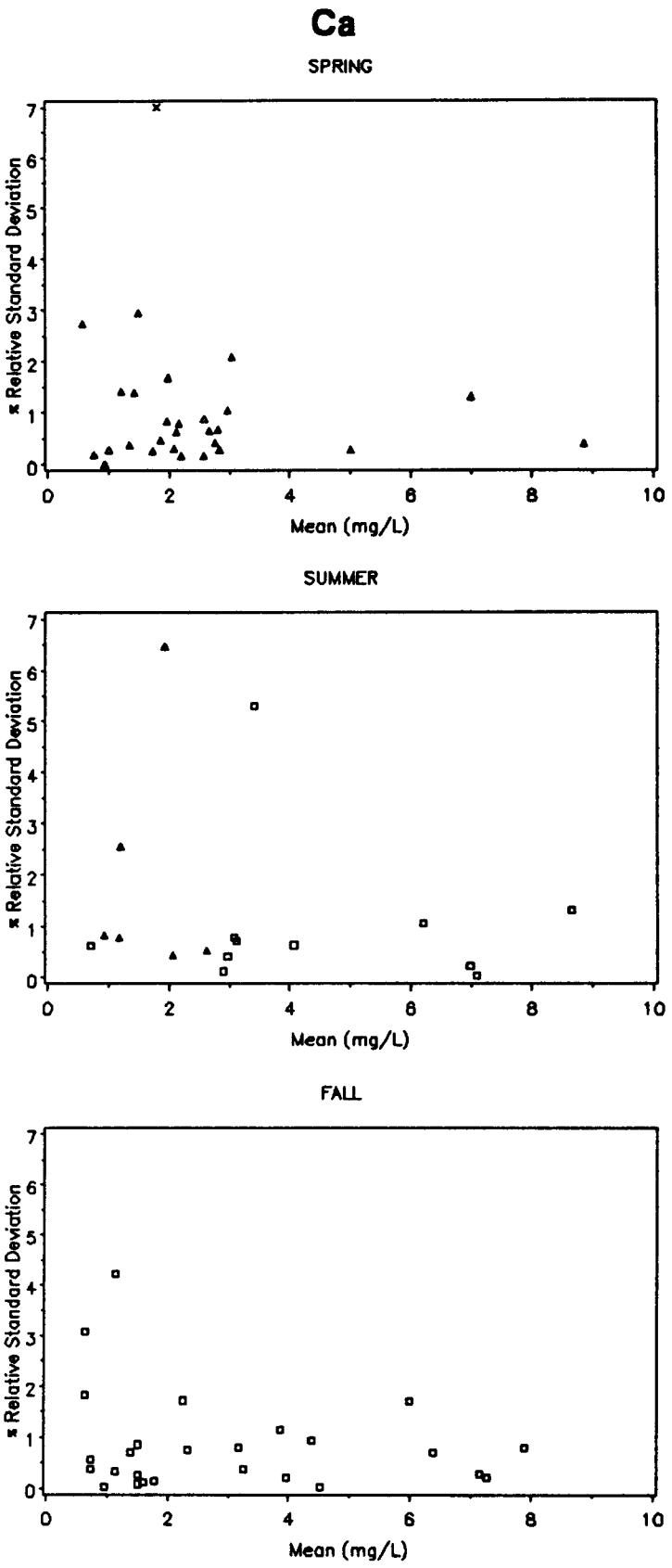

Figure E-7. Calcium (Ca), plot of routine-duplicate means and % RSD.

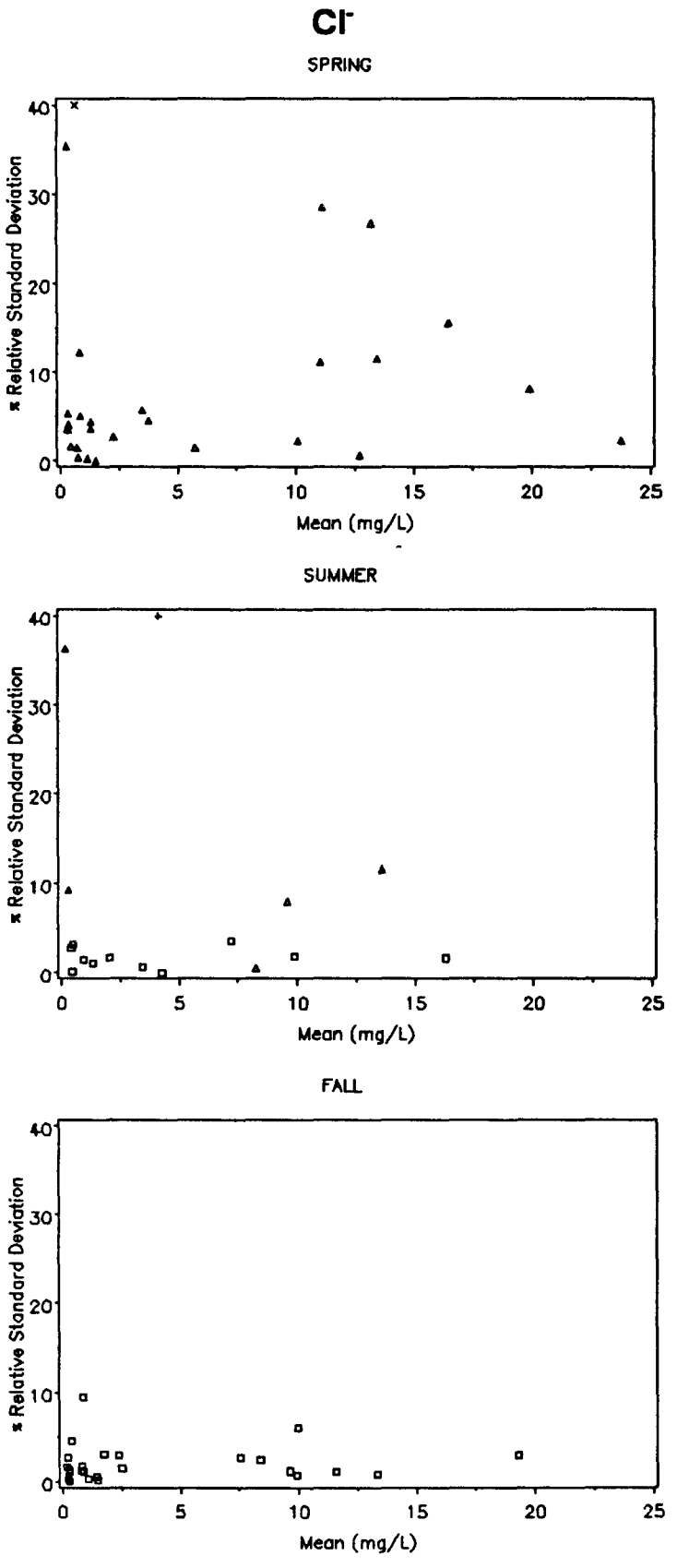

Figure E-8. Chloride (Cl^-), plot of routine-duplicate means and % RSD.

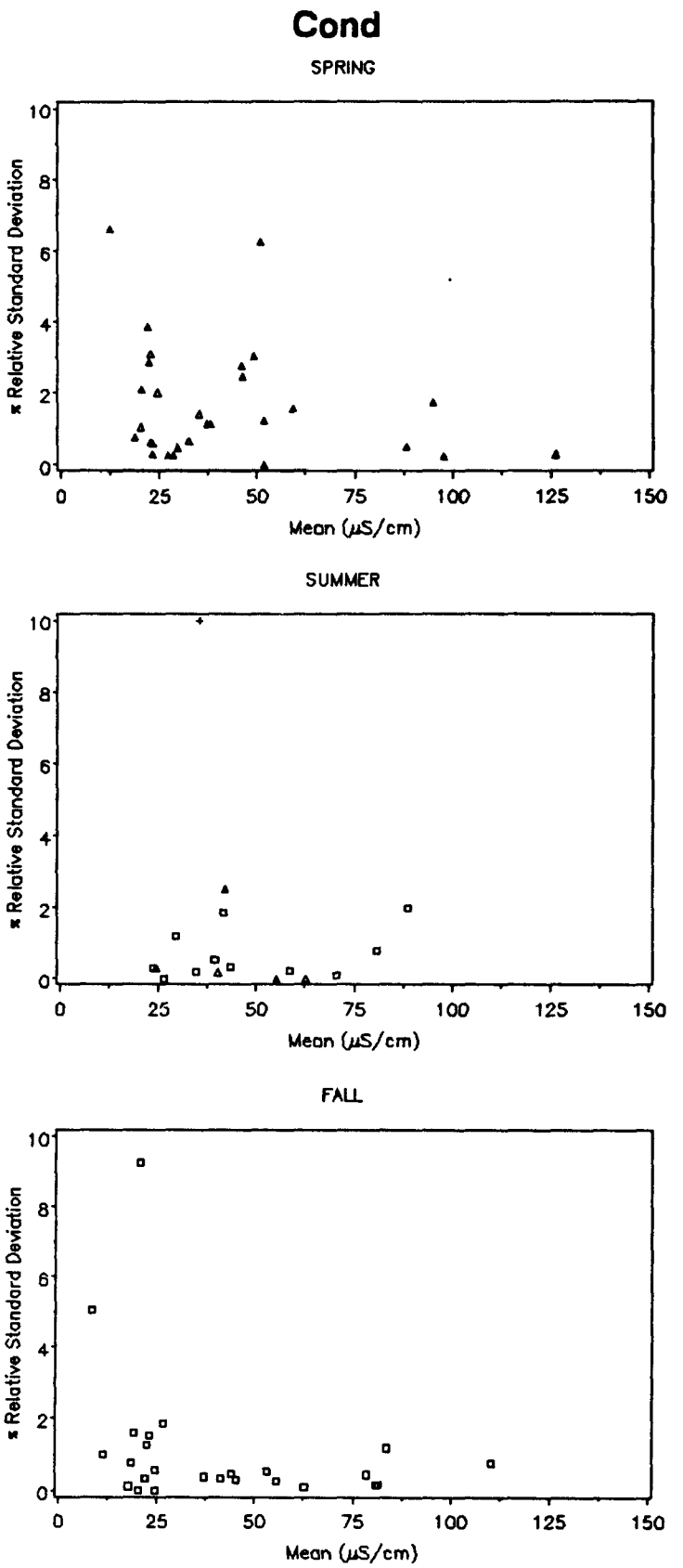

Figure E-9. Conductivity (Cond), plot of routine-duplicate means and % RSD.

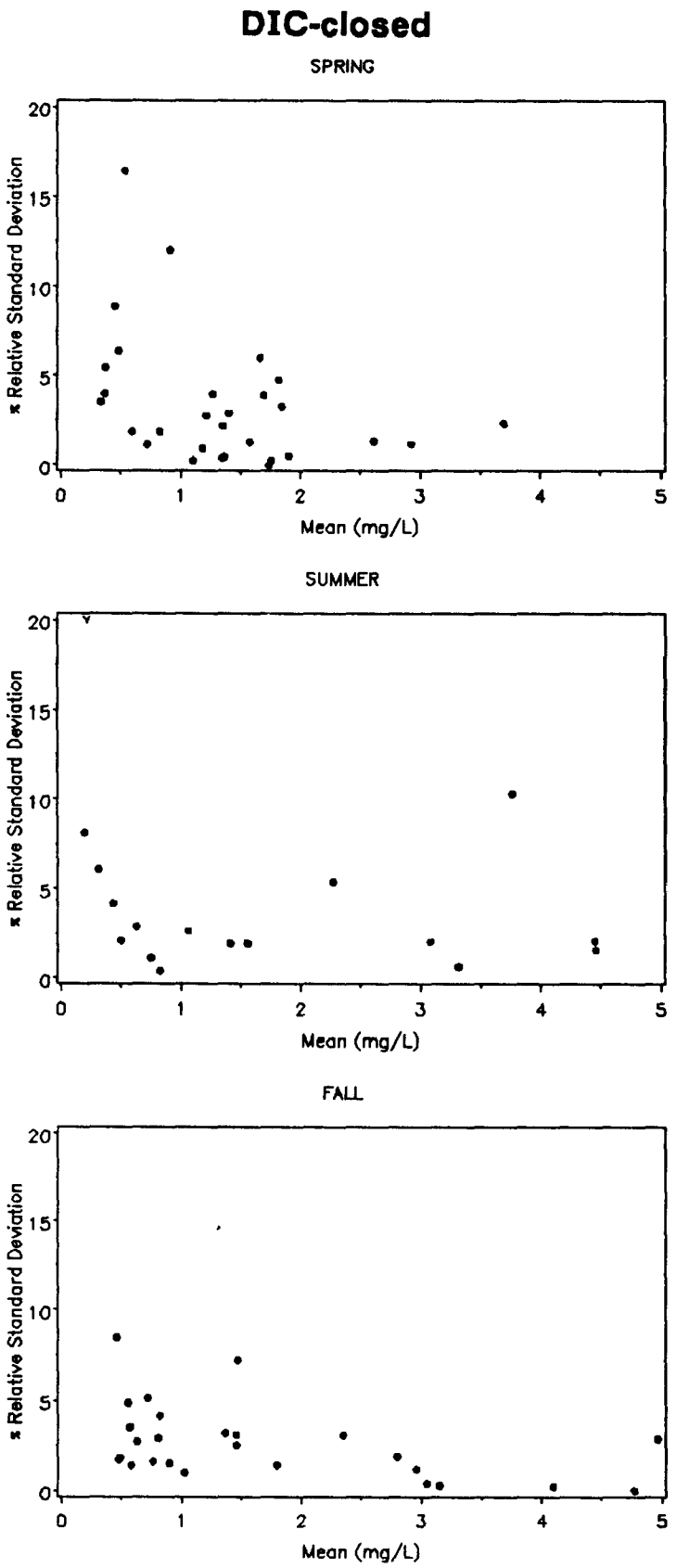

Figure E-10. Dissolved inorganic carbon-closed (DIC-closed), plot of routine-duplicate means and % RSD.

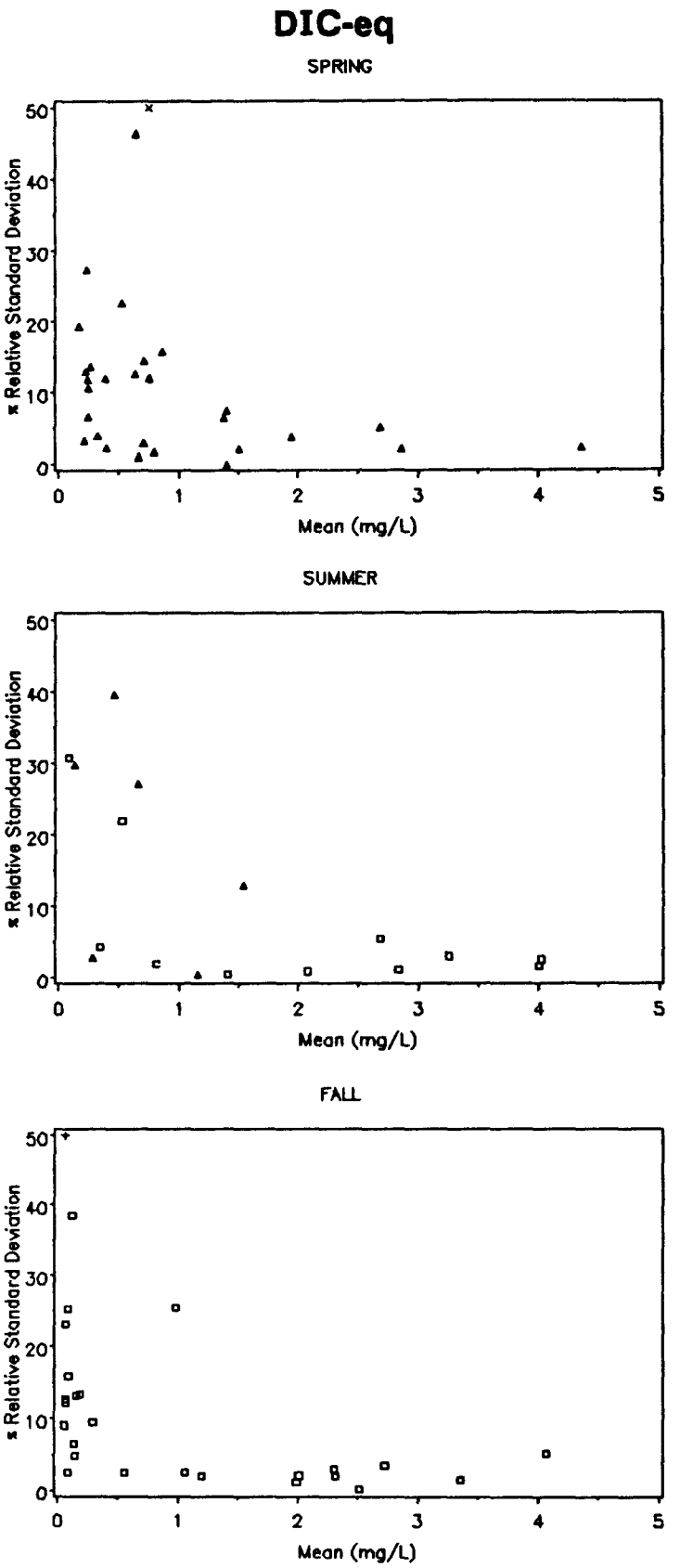

Figure E-11. Dissolved inorganic carbon-equilibrated (DIC-eq), plot of routine-duplicate means and % RSD.

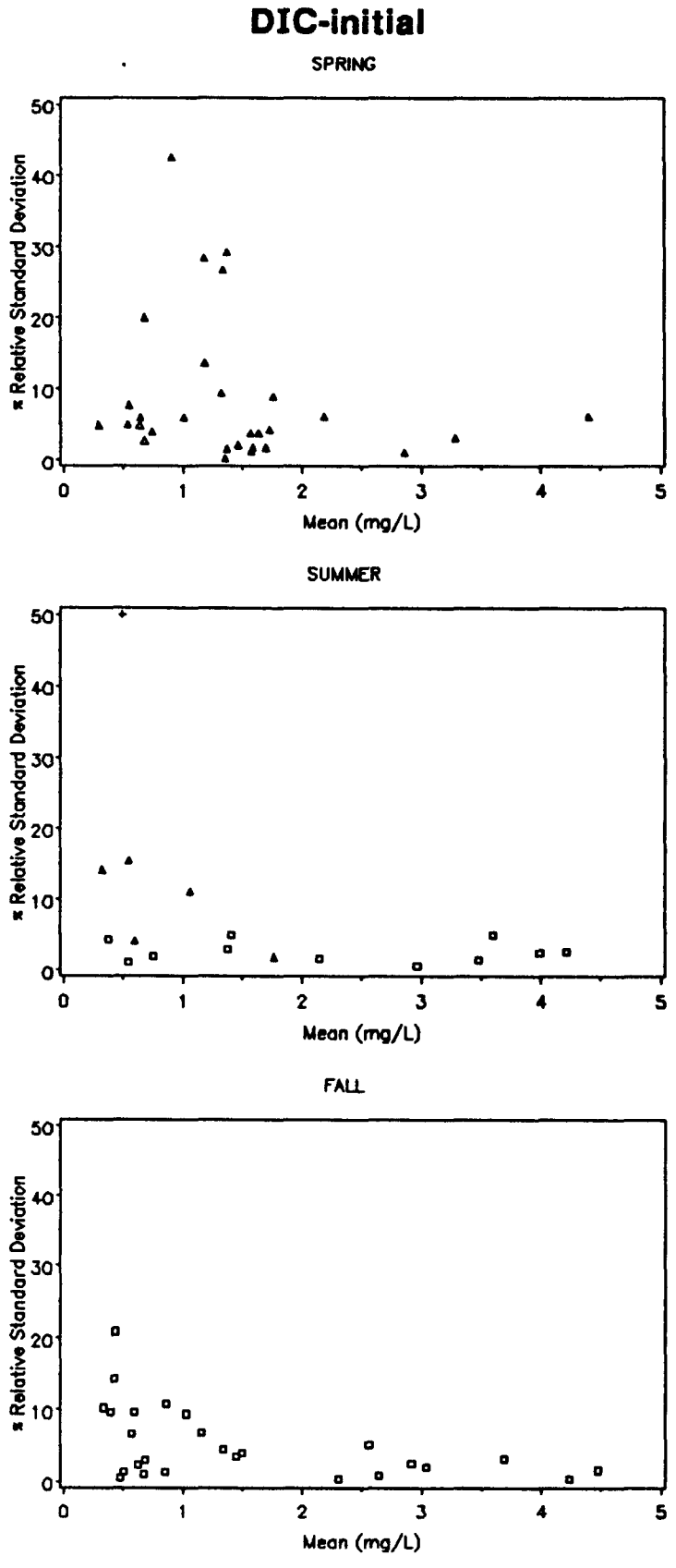

Figure E-12. Dissolved inorganic carbon-initial (DIC-initial), plot of routine-duplicate means and % RSD.

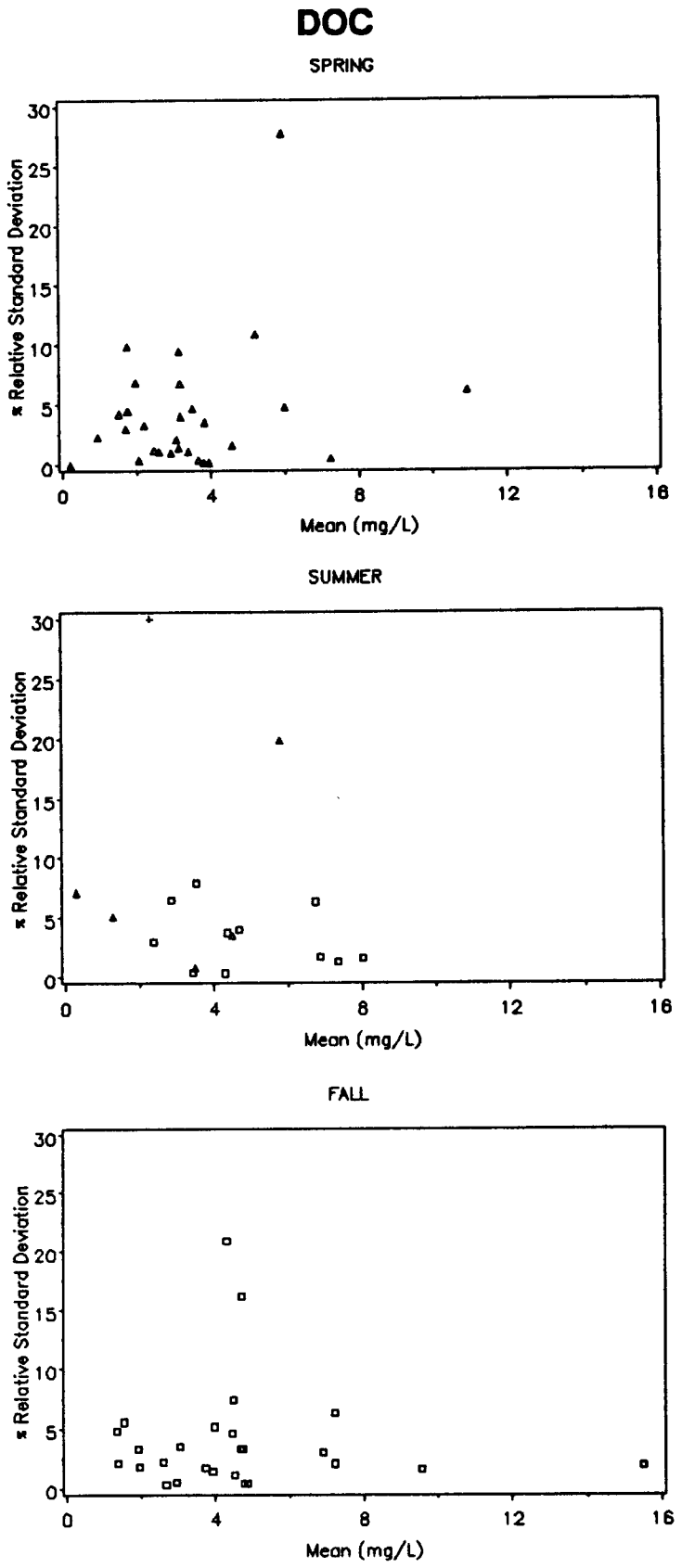

Figure E-13. Dissolved organic carbon (DOC), plot of routine-duplicate means and % RSD.

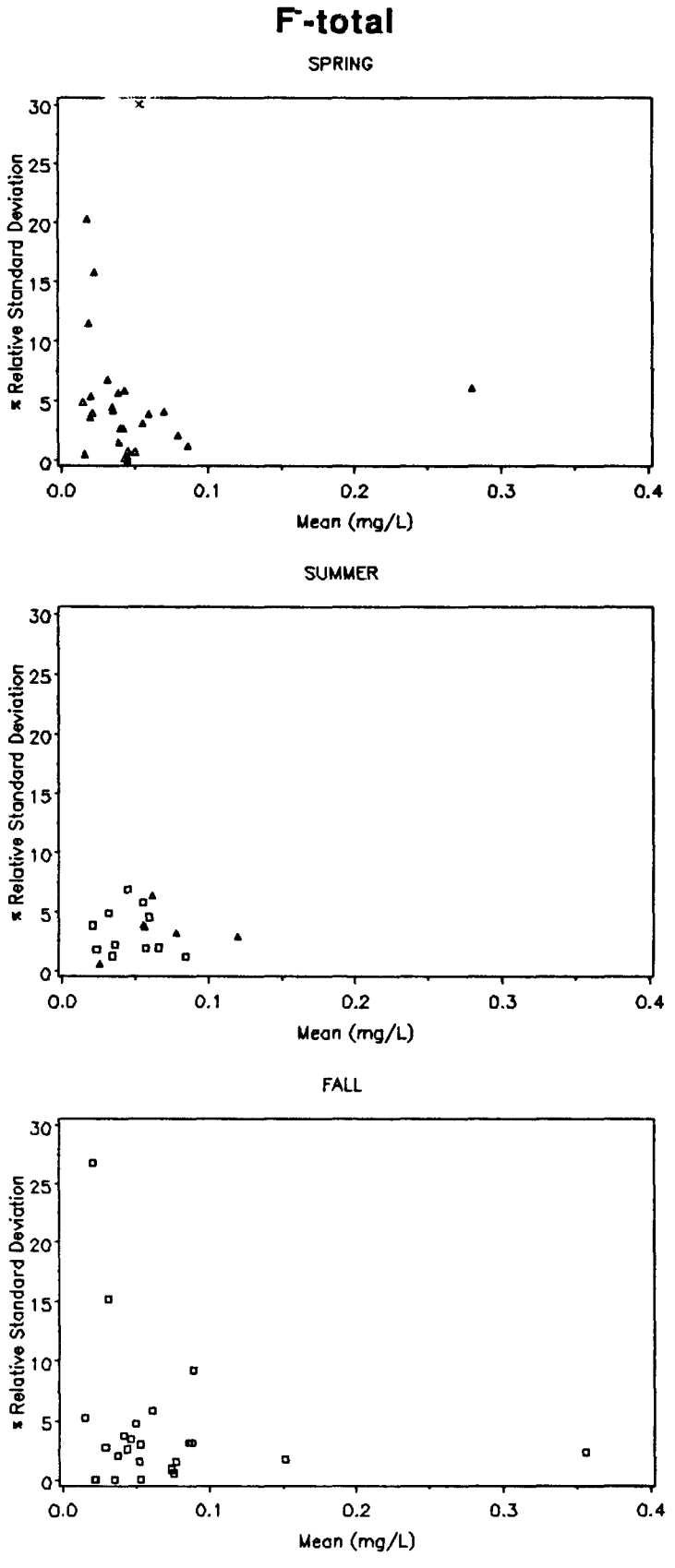

Figure E-14. Total fluoride (F⁻-total), plot of routine-duplicate means and % RSD.

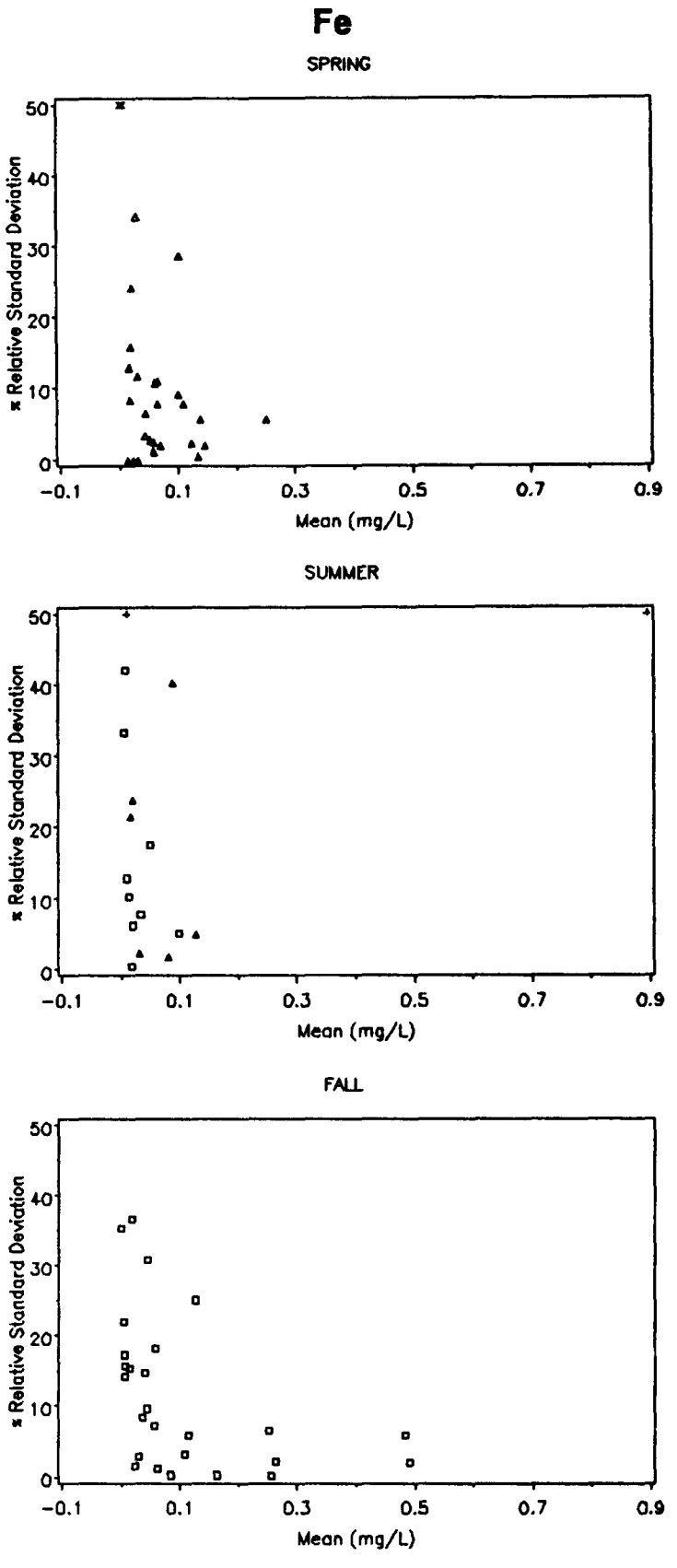

Figure E-15. Iron (Fe), plot of routine-duplicate means and % RSD.

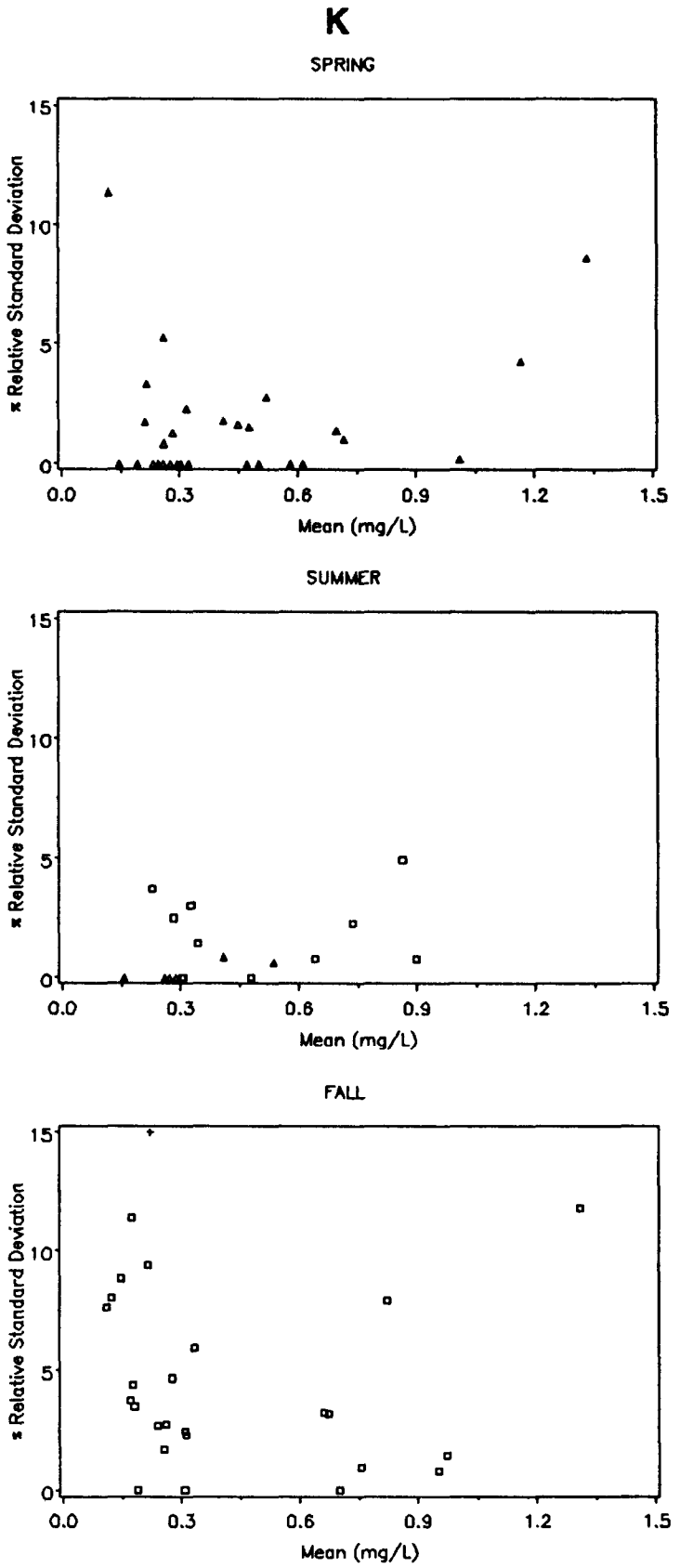

Figure E-16. Potassium (K), plot of routine-duplicate means and % RSD.

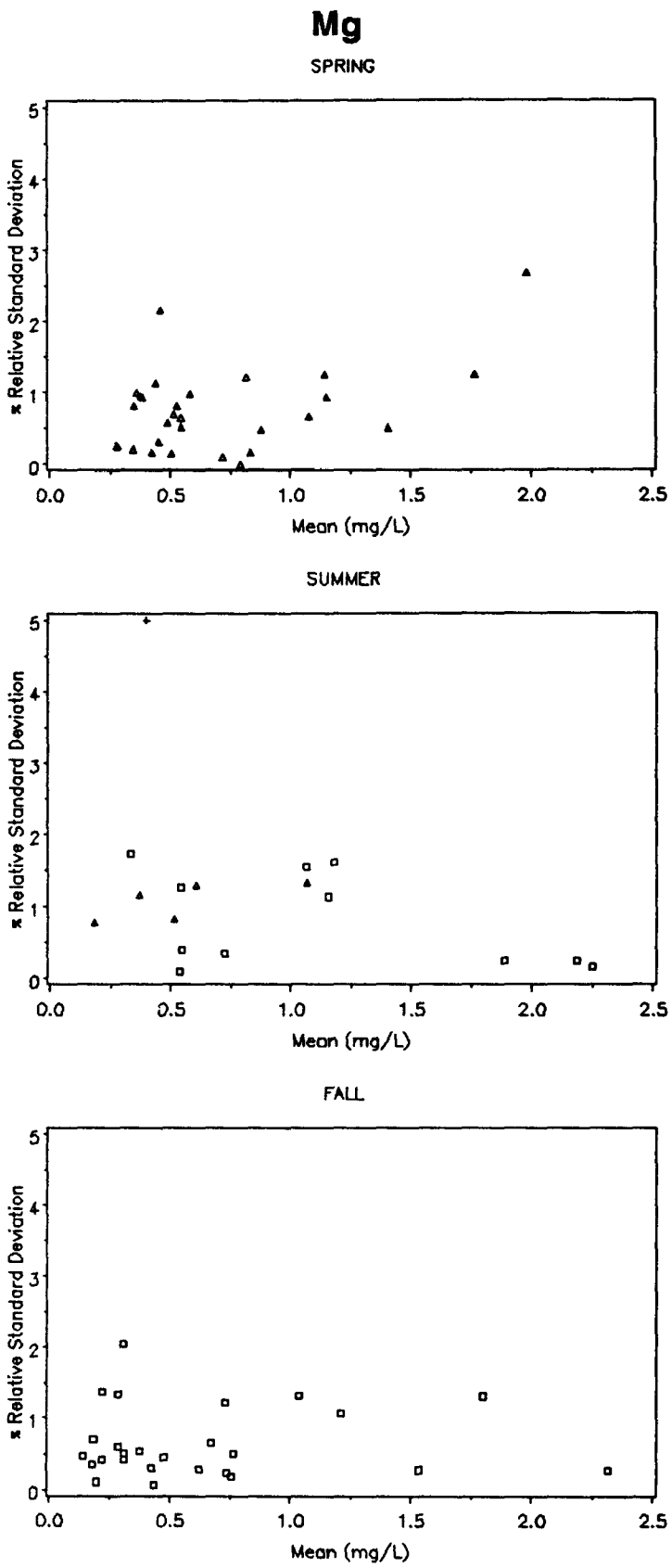

Figure E-17. Magnesium (Mg), plot of routine-duplicate means and % RSD.

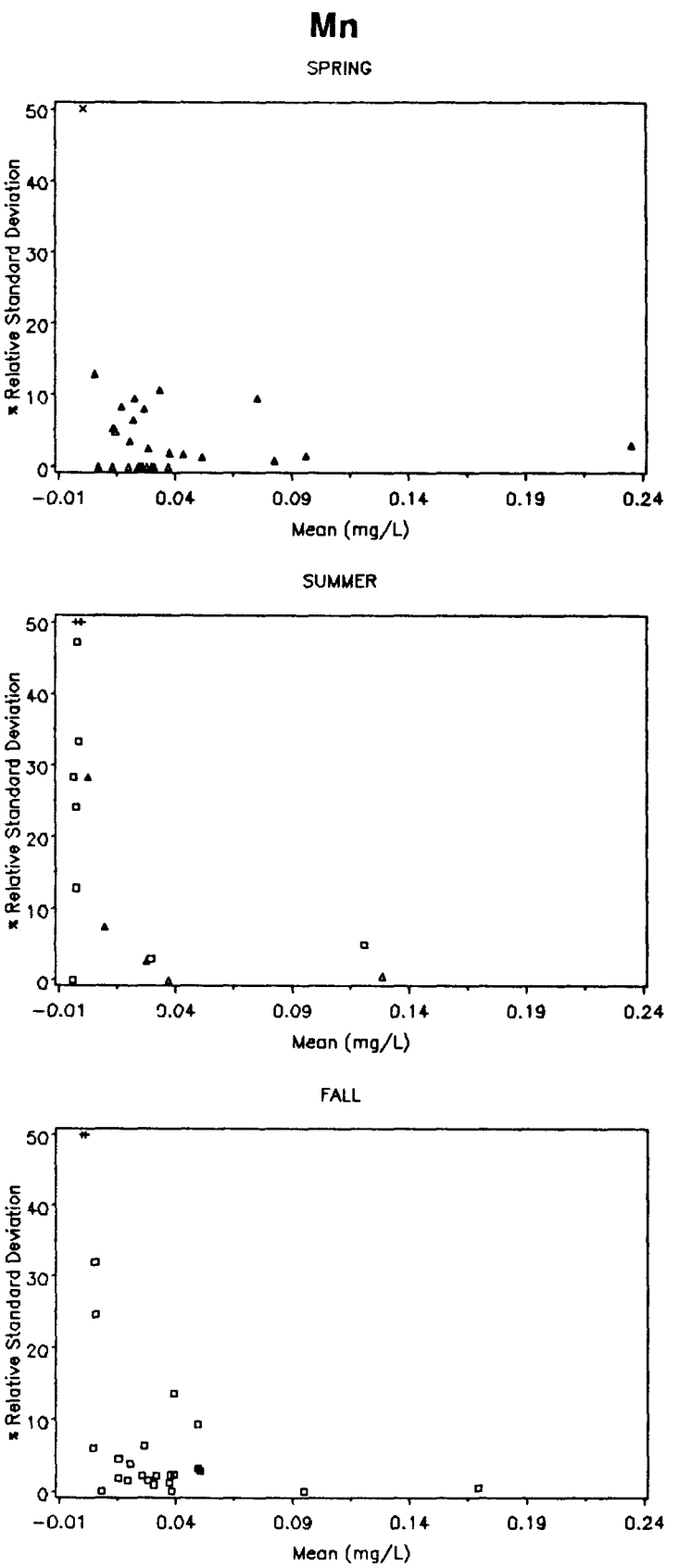

Figure E-18. Manganese (Mn), plot of routine-duplicate means and % RSD.

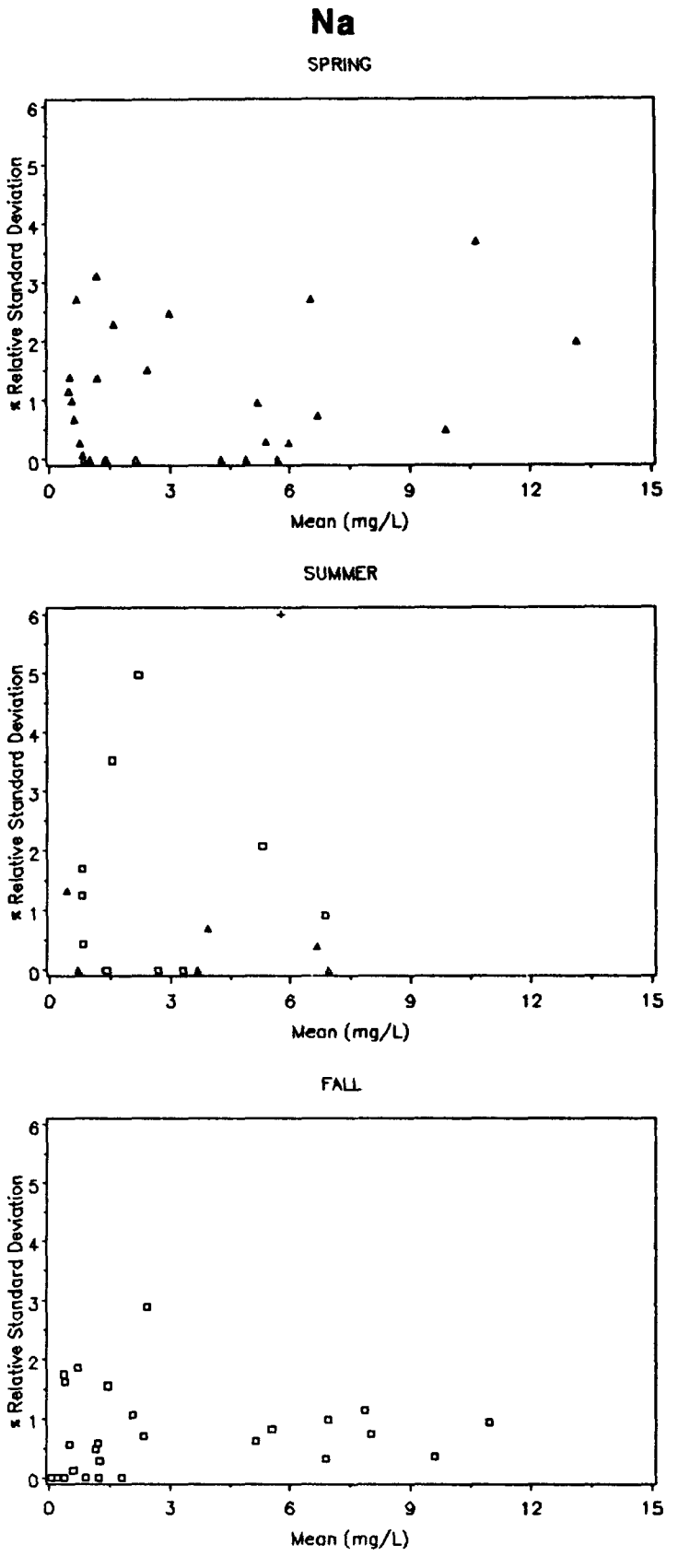

Figure E-19. Sodium (Na), plot of routine-duplicate means and % RSD.

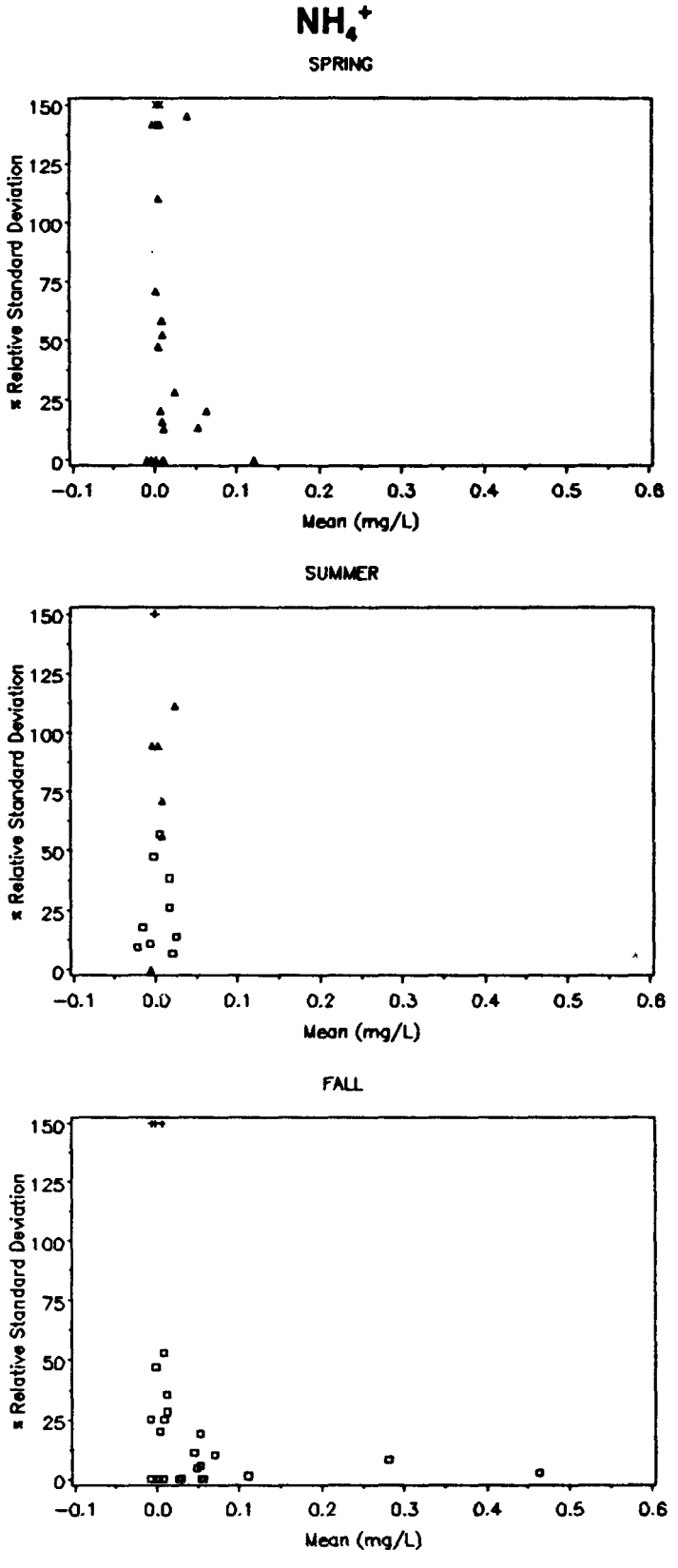

Figure E-20. Ammonium (NH_4^+), plot of routine-duplicate means and % RSD.

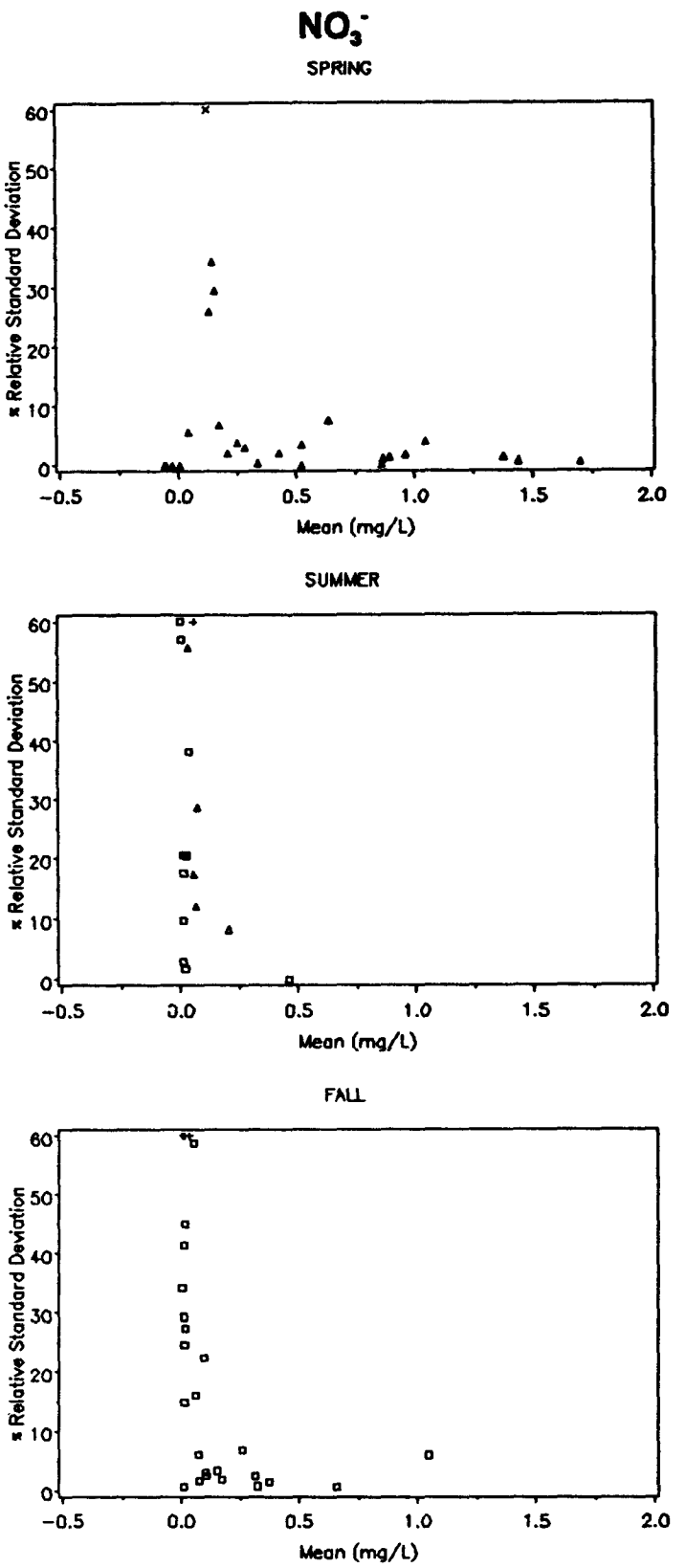

Figure E-21. Nitrate (NO_3^-), plot of routine-duplicate means and % RSD.

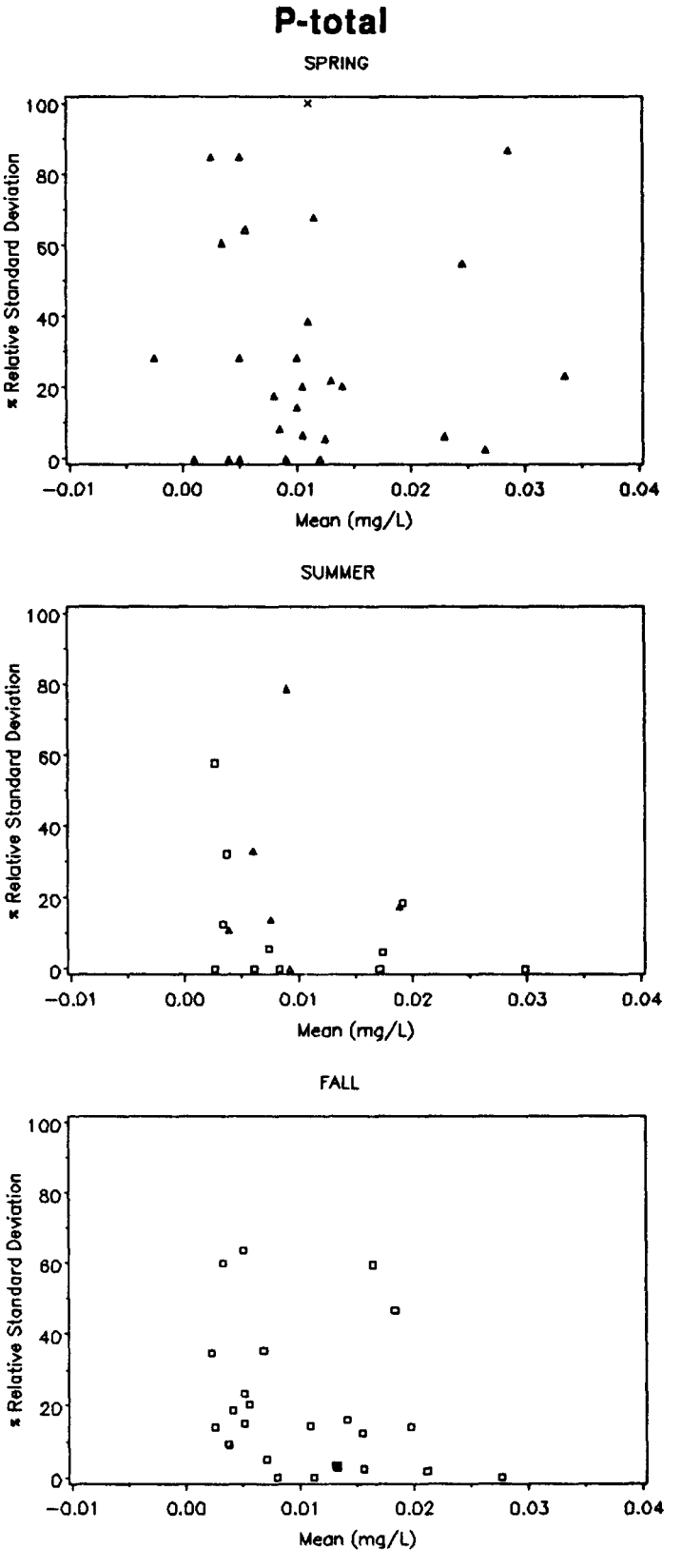

Figure E-22. Total dissolved phosphorus (P-total), plot of routine-duplicate means and % RSD.

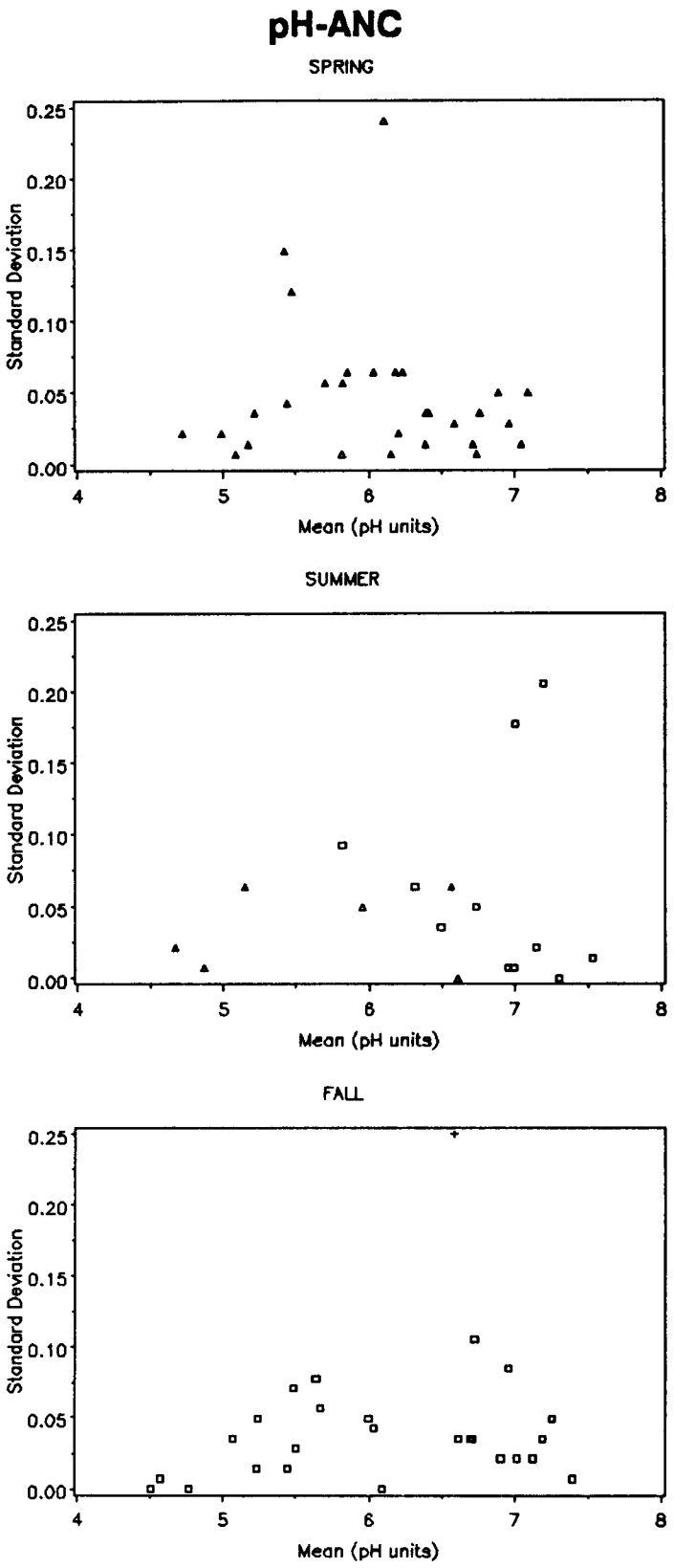

Figure E-23. pH, initial for acid titration for ANC (pH-ANC), plot of routine-duplicate means and std. dev.

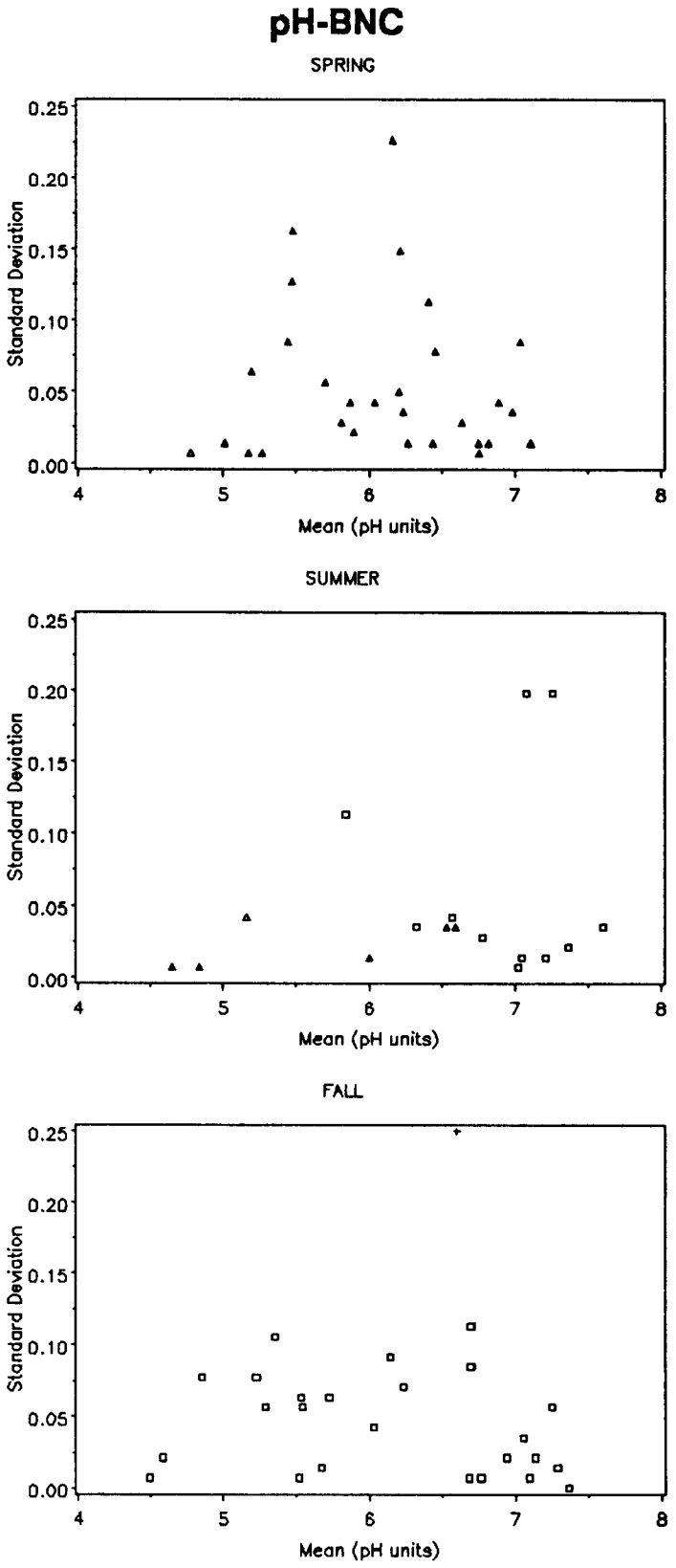

Figure E-24. pH, initial for acid titration for BNC (pH-BNC), plot of routine-duplicate means and std. dev.

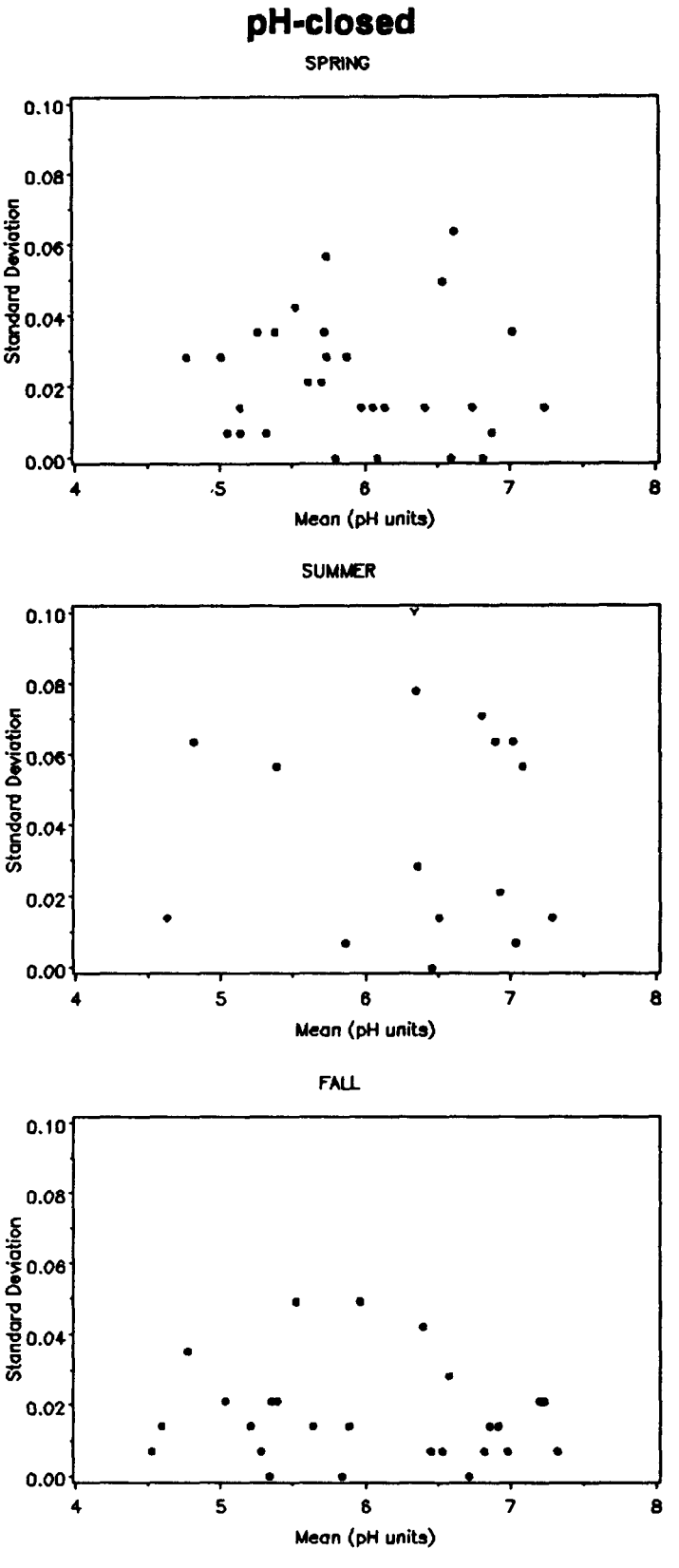

Figure E-25. pH-closed system (pH-closed), plot of routine-duplicate means and std. dev.

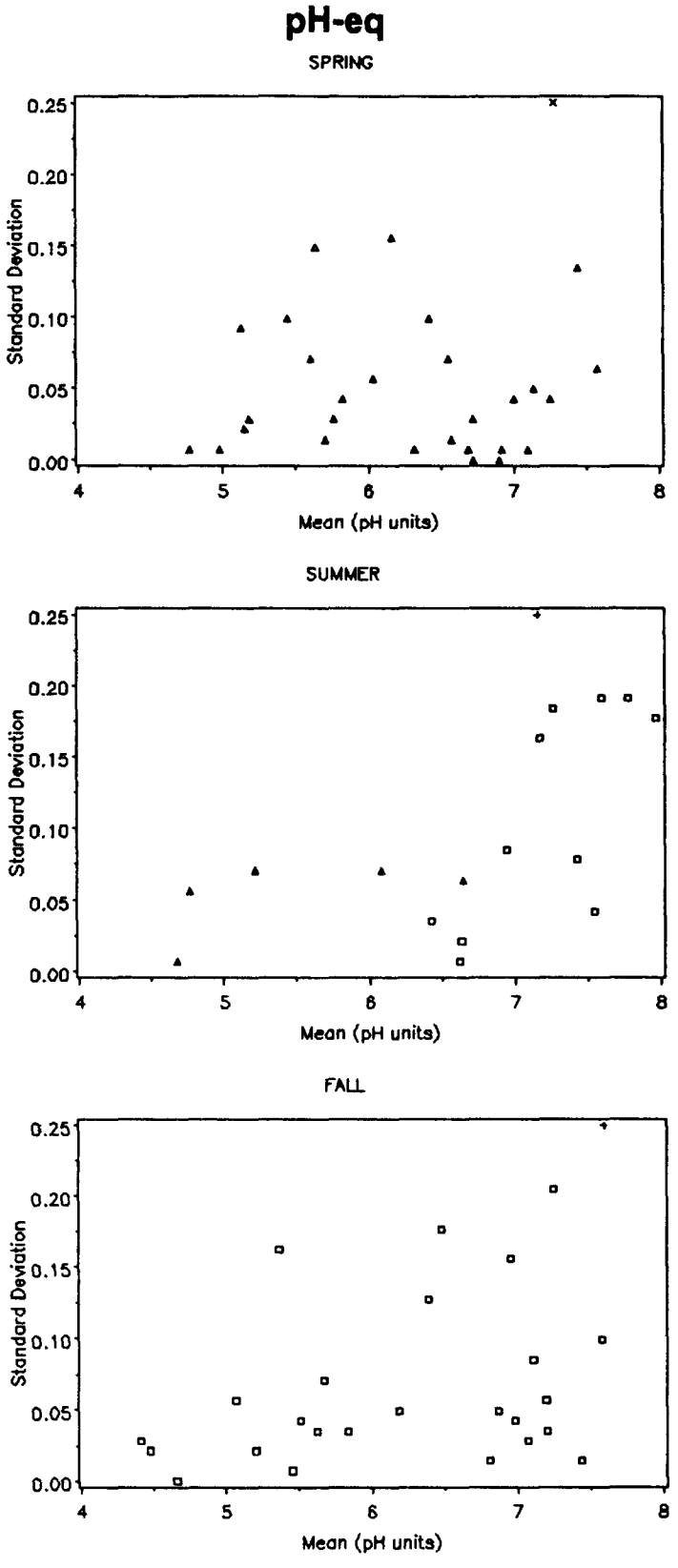

Figure E-26. pH-equilibrated (pH-eq), plot of routine-duplicate means and std. dev.

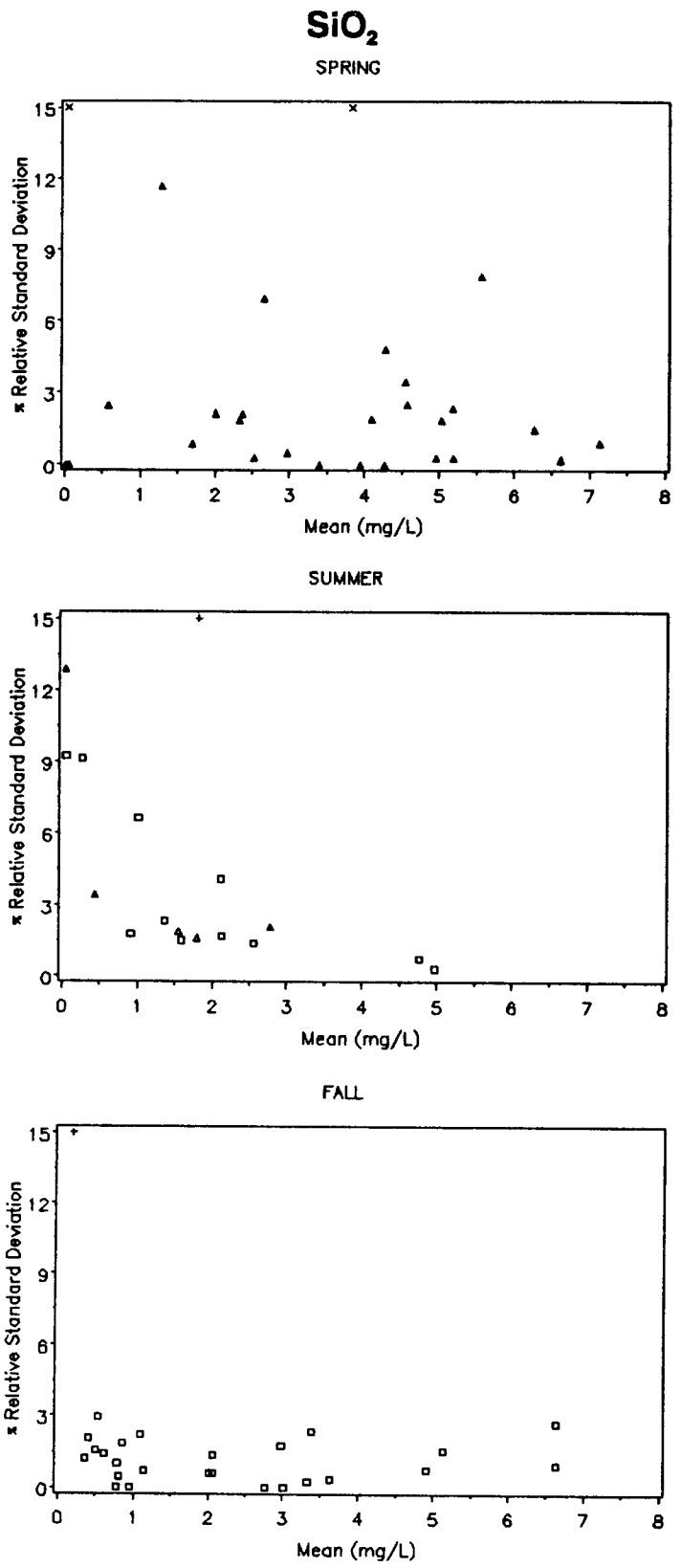

Figure E-27. Silica (SiO_2), plot of routine-duplicate means and % RSD.

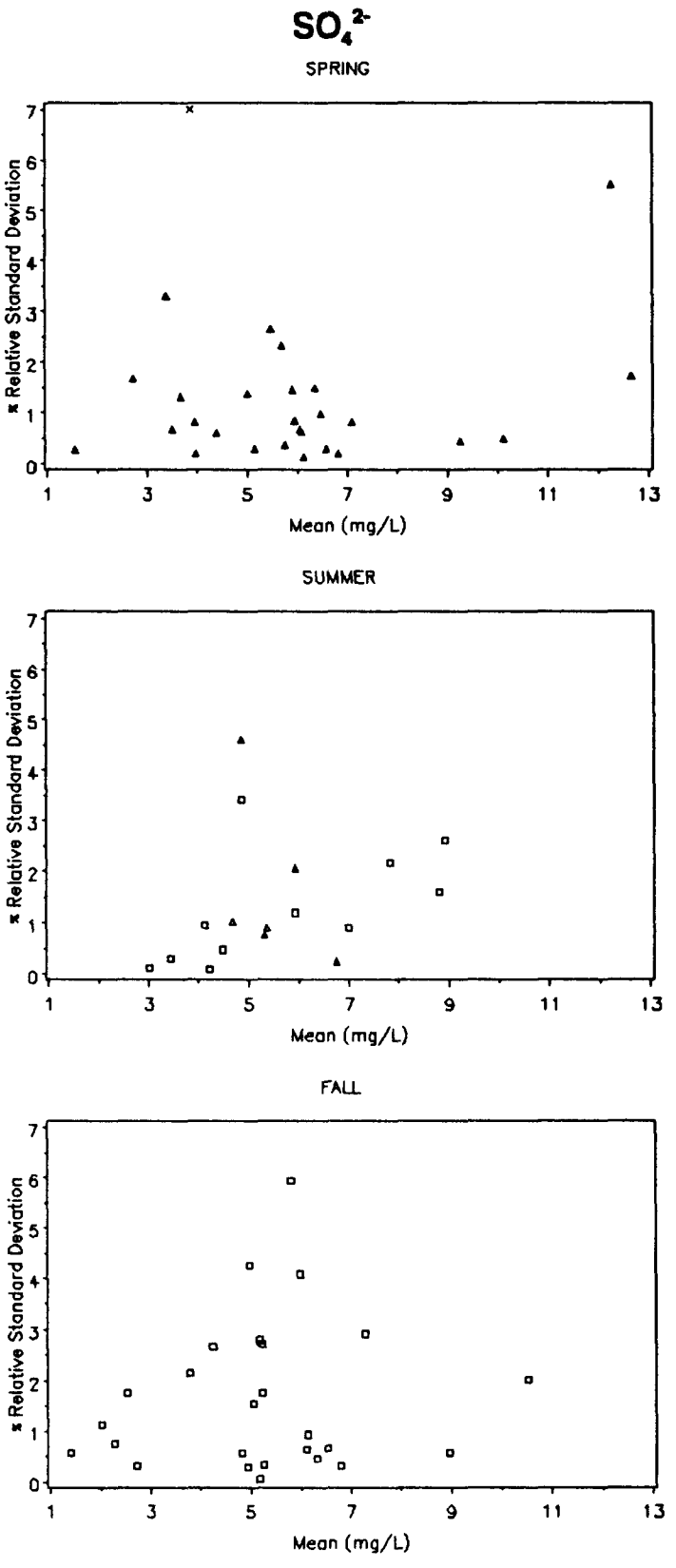

Figure E-28. Sulfate (SO_4^{2-}), plot of routine-duplicate means and % RSD.

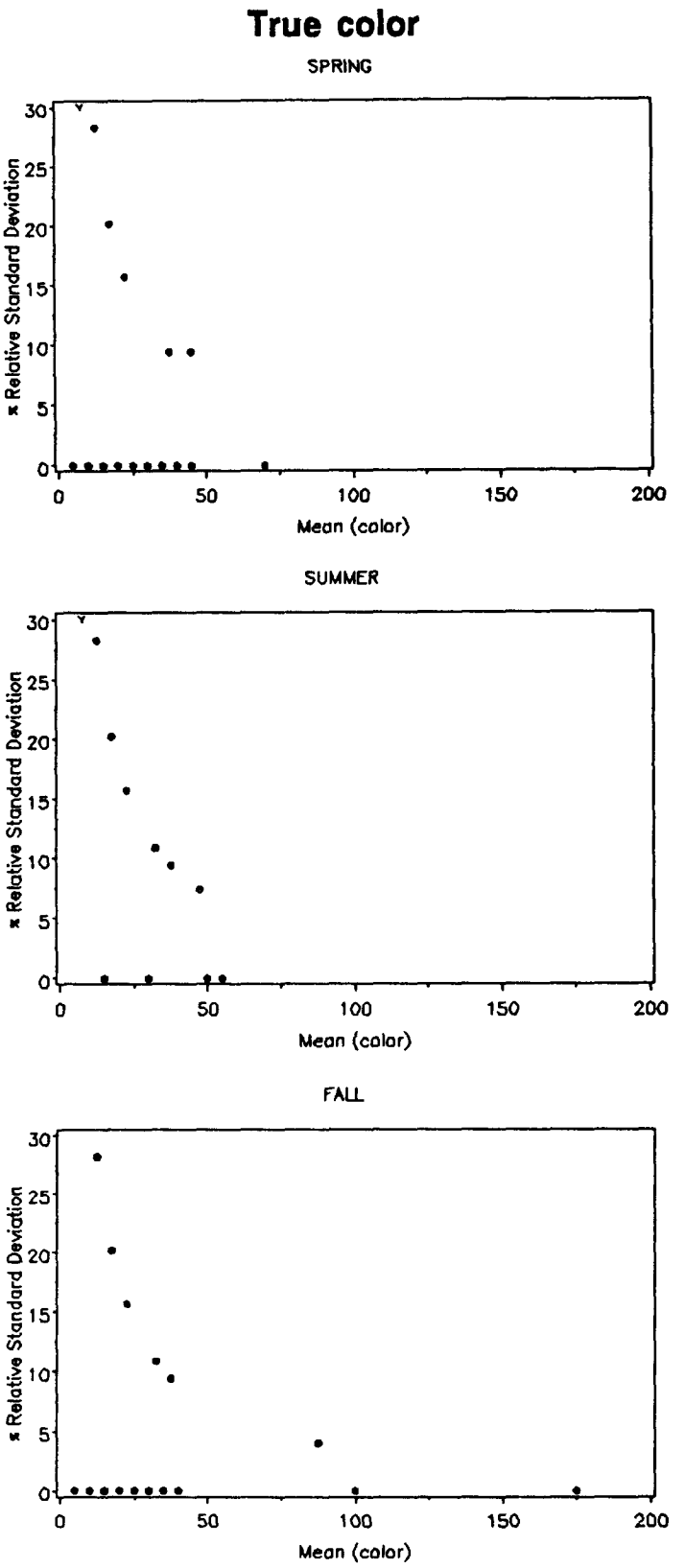

Figure E-29. True Color, plot of routine-duplicate means and % RSD.

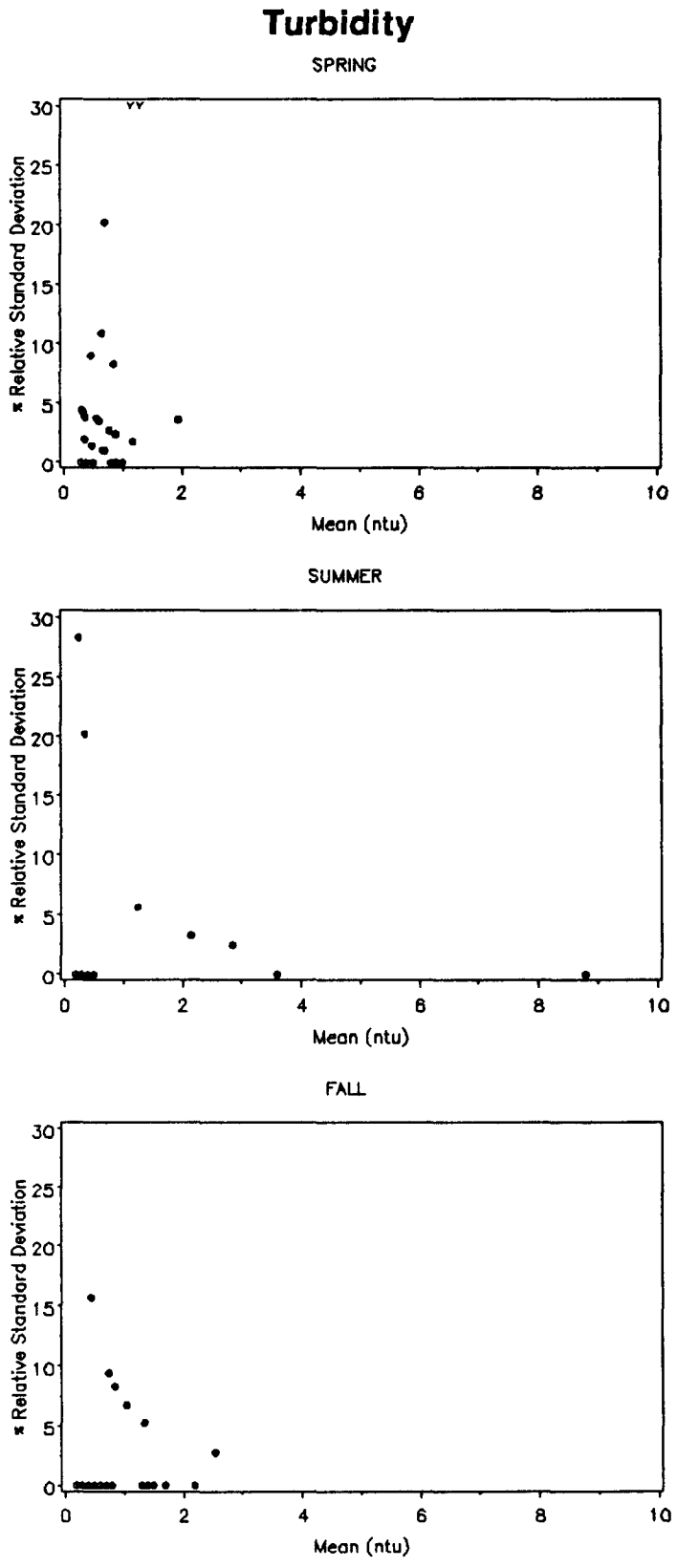

Figure E-30. Turbidity, plot of routine-duplicate means and % RSD.

Appendix F

Split Sample Plots for the Interlaboratory Bias Study

Data from the Interlaboratory Bias experiment conducted as part of the Summer Seasonal subsurvey are presented in figures E-1 through E-23. Analytical results from Laboratory 1 are plotted against analytical results from Laboratory 2. All analytes measured in the analytical laboratories were plotted except for Al-ext which was not included in the Interlaboratory Bias study. Twenty-six samples are represented in each plot.

The diagonal line in the plots represents a one-to-one relationship in which a Laboratory 1 result equals the Laboratory 2 result. Regression statistics are presented in the caption of each figure.

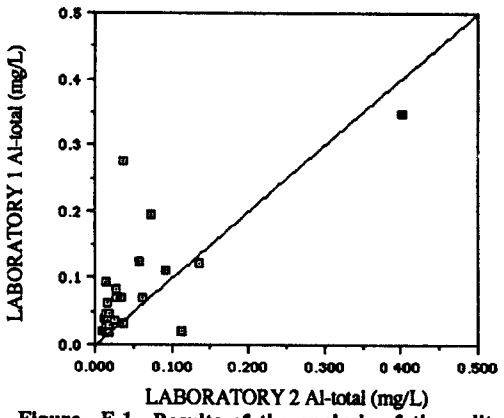

Figure F-1. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 0.04 + 0.75(Lab 2);
R2 = 0.53; 95% Confidence Interval for Slope = 0.453 - 1.047

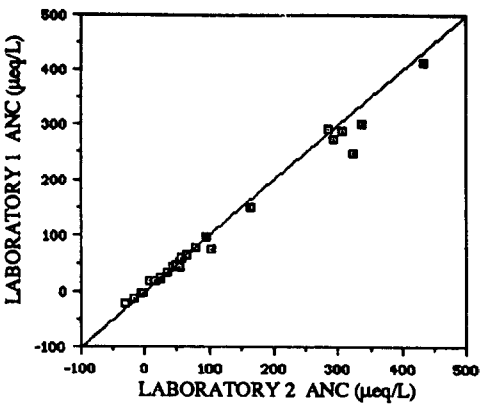

Figure F-2. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 2.455 + 0.903(Lab 2);
R2 = 0.988; 95% Confidence Interval for Slope = 0.859 - 0.947

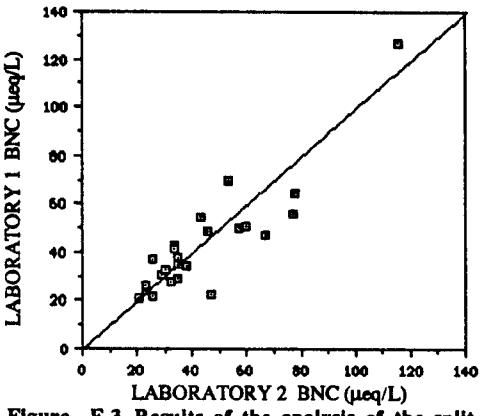

Figure F-3. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 3.433 + 0.893(Lab 2);
R2 = 0.793; 95% Confidence Interval for Slope = 0.696 - 1.09

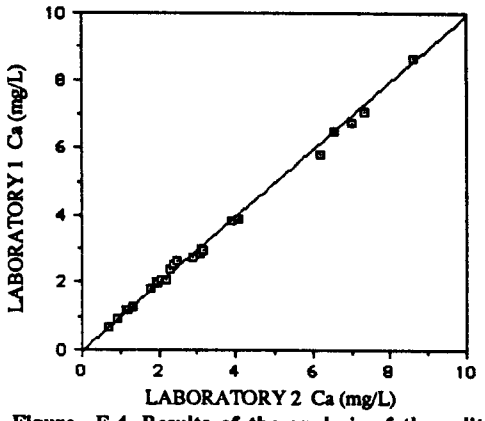

Figure F-4. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 0.047 + 0.964(Lab 2);
R2 = 0.997; 95% Confidence Interval for Slope = 0.942 - 0.987

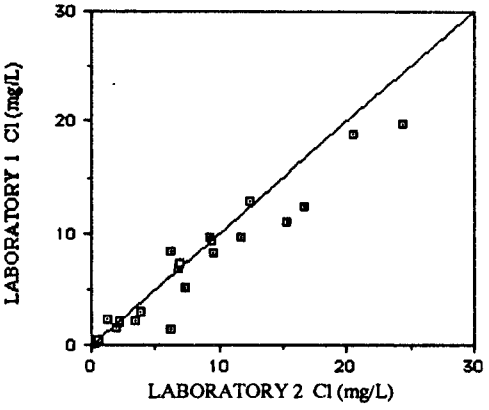

Figure F-5. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 0.243 + 0.836(Lab 2);
R2 = 0.938; 95% Confidence Interval for Slope = 0.745 - 0.927

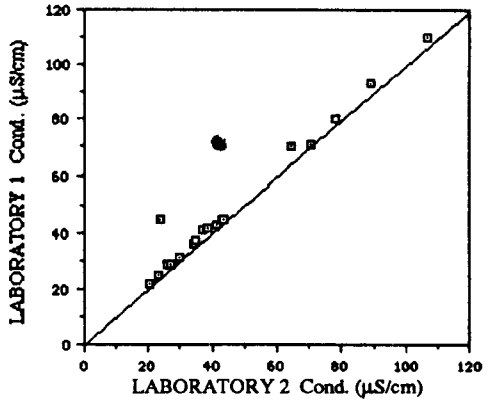

Figure F-6. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 4.496 + 0.976(Lab 2);
R2 = 0.965; 95% Confidence Interval for Slope = 0.877 - 1.075

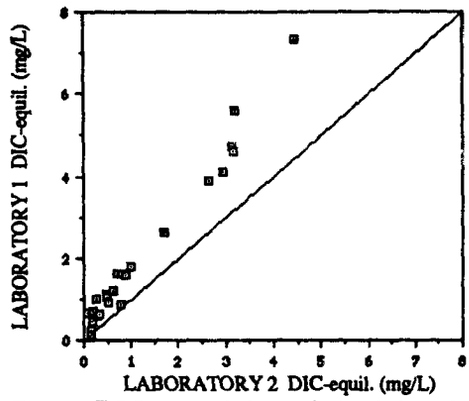

Figure F-7. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II: Lab 1= 0.227 + 1.499(Lab 2); R2 = 0.978; 95% Confidence Interval for Slope = 1.403 - 1.596

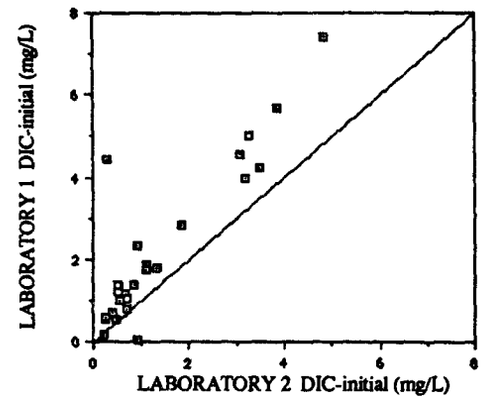

Figure F-8. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II: Lab 1= 0.421 + 1.301(Lab 2); R2 = 0.796; 95% Confidence Interval for Slope = 1.017 - 1.586

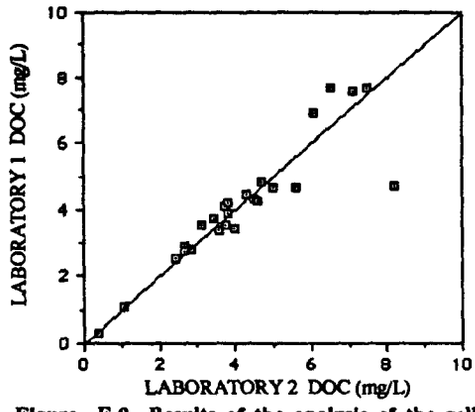

Figure F-9. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II: Lab 1= 0.474 + 0.874(Lab 2); R2 = 0.808; 95% Confidence Interval for Slope = 0.691 - 1.058

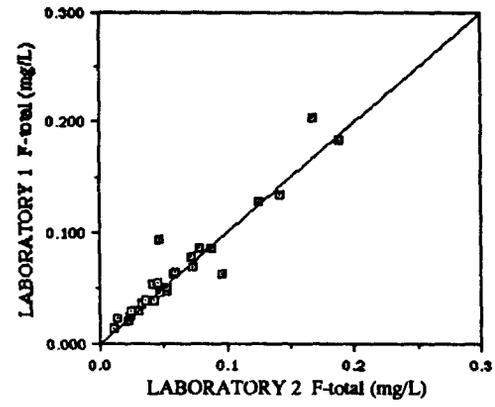

Figure F-10. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II: Lab 1= 0.004 + 0.99(Lab 2); R2 = 0.914; 95% Confidence Interval for Slope = 0.862 - 1.118

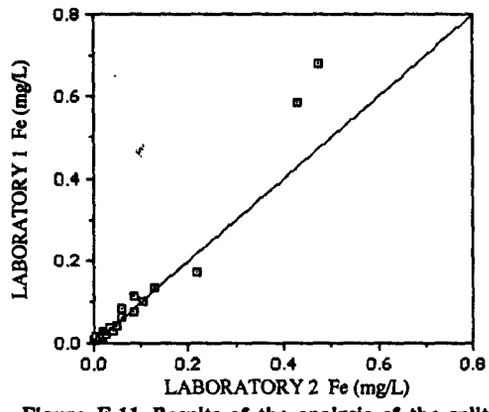

Figure F-11. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II: Lab 1= -0.013 + 1.355(Lab 2); R2 = 0.969; 95% Confidence Interval for Slope = 1.253 - 1.457

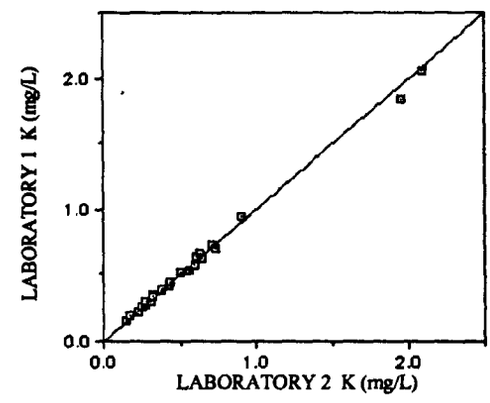

Figure F-12. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II: Lab 1= 0.019 + 0.962(Lab 2); R2 = 0.997; 95% Confidence Interval for Slope = 0.94 - 0.983

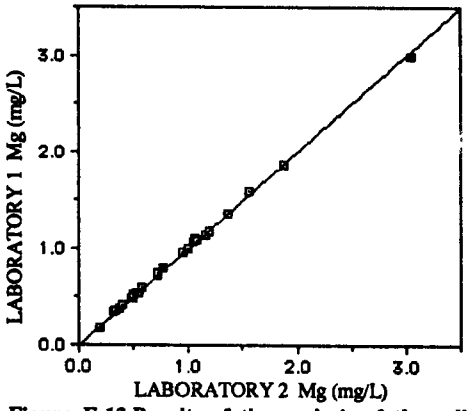

Figure F-13. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 0.025 + 0.981(Lab 2);
R2 = 0.999; 95% Confidence Interval for Slope = 0.97 - 0.992

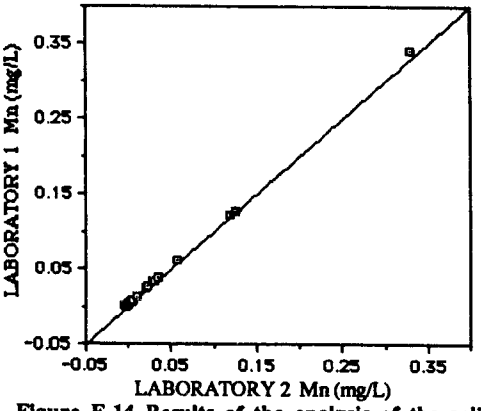

Figure F-14. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 0.004 + 1.017(Lab 2);
R2 = 0.999; 95% Confidence Interval for Slope = 1.01 - 1.023

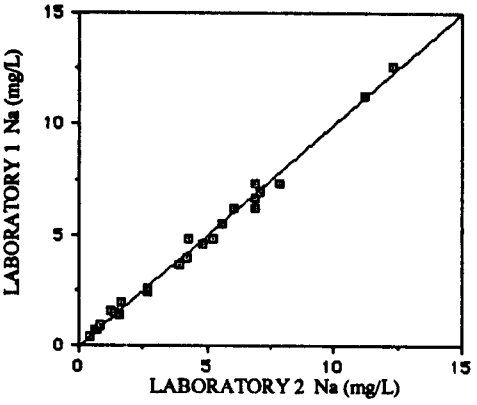

Figure F-15. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= -0.027 + 0.993(Lab 2);
R2 = 0.992; 95% Confidence Interval for Slope = 0.957 - 1.03

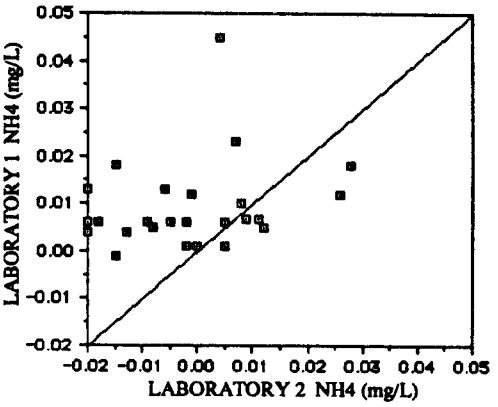

Figure F-16. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 0.01 + 0.171(Lab 2);
R2 = 0.059; 95% Confidence Interval for Slope = -0.124 - 0.467

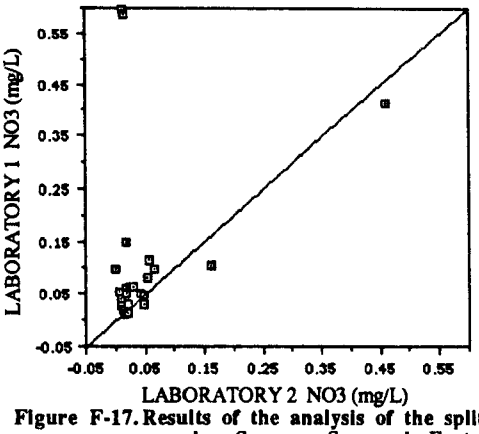

Figure F-17. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 0.081 + 0.62(Lab 2);
R2 = 0.12; 95% Confidence Interval for Slope = -0.089 - 1.328

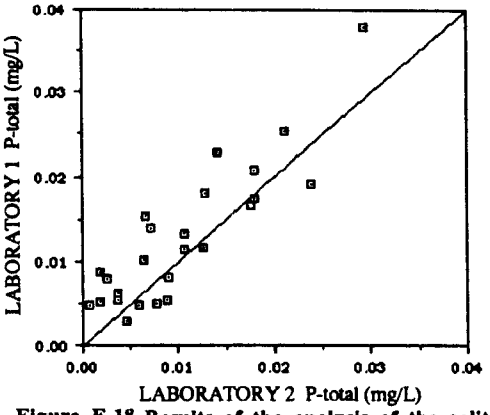

Figure F-18. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 0.003 + 0.977(Lab 2);
R2 = 0.777; 95% Confidence Interval for Slope = 0.751 - 1.202

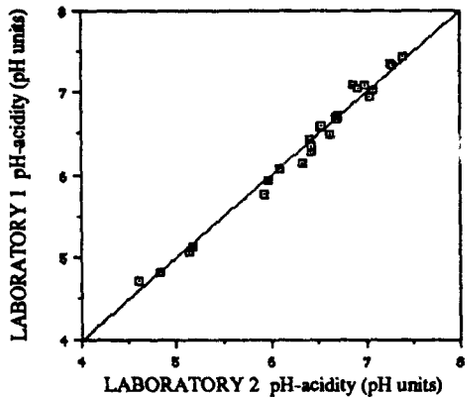

Figure F-19. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= -0.067 + 1.017(Lab 2);
R2 = 0.983; 95% Confidence Interval for Slope = 0.958 - 1.075

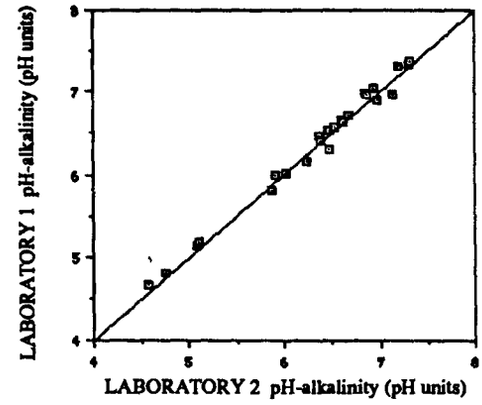

Figure F-20. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 0.112 + 0.987(Lab 2);
R2 = 0.988; 95% Confidence Interval for Slope = 0.941 - 1.033

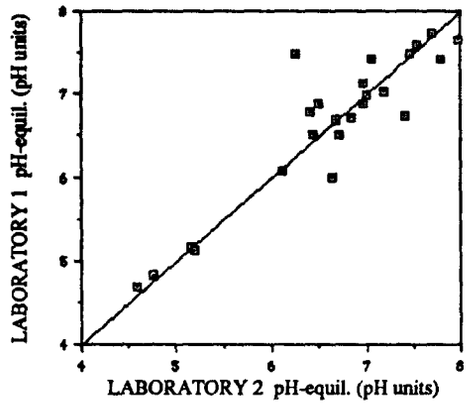

Figure F-21. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 0.722 + 0.892(Lab 2);
R2 = 0.839; 95% Confidence Interval for Slope = 0.723 - 1.06

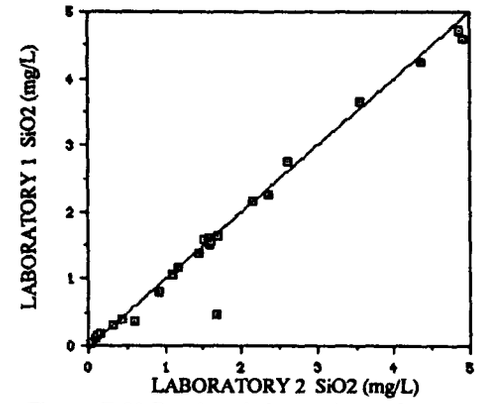

Figure F-22. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= -0.04 + 0.971(Lab 2);
R2 = 0.971; 95% Confidence Interval for Slope = 0.901 - 1.042

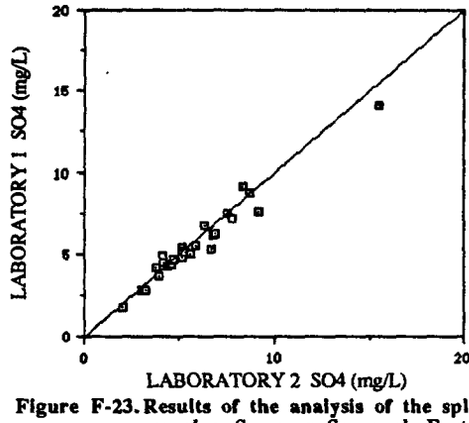

Figure F-23. Results of the analysis of the split samples, Summer Seasonal, Eastern Lake Survey-Phase II:
Lab 1= 0.358 + 0.896(Lab 2);
R2 = 0.955; 95% Confidence Interval for Slope = 0.815 - 0.978

Glossary

absolute bias	The difference between a measured value and the true value. (See "accuracy.")
accuracy	The closeness of a measured value to the true value of an analyte.
acid-neutralizing capacity (ANC)	Total acid-combining capacity of a water sample determined by titration with a strong acid. Acid-neutralizing capacity includes alkalinity (carbonate species) as well as other basic species (e.g., borates, dissociated organic acids, alumino-hydroxy complexes).
acid titrant	Standardized acidic reagent added to a water sample by titration for the purpose of determining the acid neutralizing capacity of the water.
air equilibration	The process of bringing a sample aliquot to equilibrium with standard air (300 ppm CO_2) before analysis; used with some pH and dissolved inorganic carbon measurements.
aliquot	Fraction of a sample prepared for the analysis of particular constituents; sent in a separate container to the analytical laboratory.
alkalinity balance checks	See protolyte analysis program.
analyte	A chemical species that is measured in a water sample.
analytical laboratory	In this report, a laboratory under contract with the U. S. Environmental Protection Agency to analyze water samples shipped from the processing laboratory.
anion	A negatively charged ion.
anion-cation balance	In an electrically neutral solution such as water, the total charge of positive ions (cations) equals the total charge of negative ions (anions). In this report, anion-cation balance is expressed as percent ion balance difference and is calculated as follows:

$$\frac{\Sigma \text{ anions} - \Sigma \text{ cations} + \text{ANC}}{\Sigma \text{ anions} + \Sigma \text{ cations} + \text{ANC} + 2[H^+]} \quad 100$$

where:

Σ anions $= [Cl^-] + [F^-] + [NO_3^-] + [SO_4^{2-}]$,
Σ cations $= [Na^+] + [K^+] + [Ca^{2+}] + [Mg^{2+}] + [NH_4^+]$,

ANC $\approx$ alkalinity (the ANC value is included in the calculation to account for the organic ions.

$[H^+] = (10^{-pH}) \times 10^6$ μeq/L.

Glossary (Continued)

ASTM Type I reagent-grade water	Deionized water that meets American Society for Testing and Materials (ASTM) specifications for Type I reagent-grade water (ASTM, 1984) and that has a measured conductance of less than 1 μS/cm at 25 °C. This water is used to prepare blank samples and reagents.
audit sample	In this survey, a standardized water sample submitted to an analytical laboratory for the purpose of checking overall performance in sample analysis. Natural audit samples in the ELS-II were lake water; synthetic audit samples were prepared by diluting concentrates of known chemical composition in ASTM Type I reagent grade water.
base site	A location providing support for sampling personnel during field sampling operations.
base-neutralizing capacity (BNC)	Total base-combining capacity of a water sample due to dissolved CO_2, hydronium, and hydroxide; determined by titration with a strong base.
batch	A group of samples processed and analyzed together. A batch consists of all samples (including quality assurance and quality control samples) that are assigned a unique batch identification number and that are processed and sent to one analytical laboratory in one day. In the ELS-II, a batch did not exceed 30 samples.
batch ID	The numeric identifier for each batch.
bias	The systematic difference between values or sets of values.
blank sample	A sample of ASTM Type I reagent-grade water analyzed as a quality assurance or quality control sample during the ELS-II (see calibration, reagent, processing laboratory, and field blanks).
CADAVERS	See Computer Aided Data Verification System.
calculated alkalinity	The estimate of alkalinity based on the protolyte analysis program.
calculated conductivity	The sum (as microsiemens per centimeter) of the theoretical specific conductances of all measured ions in a sample.
calculated carbonate alkalinity	See calculated alkalinity.
calibration blank sample	A sample of ASTM Type I reagent-grade water defined as a 0 mg/L standard used in standardizing or checking the calibration of analytical instruments; also used to determine instrument detection limits.
calibration curve	The linear regression of the analytical instrument response to a set of calibration standards (varying in concentrations) from which the linear dynamic range is determined.
cation	positively charged ion.
charge balance	See anion-cation balance.
closed system	Method of measurement in which a water sample is collected and analyzed for pH and dissolved inorganic carbon without exposure to the atmosphere. These samples were collected in syringes directly from the sampling apparatus and were analyzed in the processing laboratory.

Glossary (Continued)

comparability — A measure of data quality that allows the similarity within and among data sets to be established confidently.

completeness — A measure of data quality that is the quantity of acceptable data actually collected relative to the total quantity that was expected to be collected.

Computer Aided Verification System — A series of data checking programs used by the QA staff to assess data for reasonableness based upon preset criteria for precision, accuracy, detectability, internal consistency of the sample and other chemical relationships, holding times, etc. The system also provides a means for tracking changes made to the data base.

conductivity balance — A comparison of the measured conductance of a water sample (in microsiemens per centimeter) to the equivalent conductances (in microsiemens per centimeter) of each ion measured in that water sample at infinite dilution. In this report, conductance balance is expressed as percent conductance difference and is calculated as follows:

$$\frac{\text{calculated conductivity - measured conductivity}}{\text{measured conductivity}} \quad 100$$

The ions used to calculate conductance are Ca, Cl^-, CO_3^{2-}, H^+, HCO_3^-, K, Mg, Na, NO_3^-, OH^-, NH_4^+, and SO_4^{2-}.

confidence interval (95% and 99%) — The range of values, calculated from an estimate of the mean and deviation, between the confidence limits. This interval has a high probability (a 95 or 99 percent level of confidence) of containing the true population value.

confidence limits — Two statistically derived values or points, one below and one above a statistic, that provide a given degree of confidence that a population parameter falls between them.

contract-required detection limit — The data quality objective criterion for analytical laboratory detectability for specified analytes.

control limits — Two values between which the analytical measurement of a quality assurance or quality control sample is expected to be; measurements outside these limits are suspect.

Cubitainer — A 3.8-L container made of semirigid polyethylene used to transport field samples (routine, duplicate, blank) from the lake site to the processing laboratory.

data base — All computerized results of the survey, which include the raw, verified, validated, and enhanced data sets as well as back-up and historical data sets.

data package — A report, generated by an analytical laboratory for each batch of samples analyzed, that includes analytical results, acid-neutralizing capacity titration data, ion chromatography specifications, analysis dates, calibration and reagent blank data, quality control check sample results, and analytical laboratory duplicate results.

Glossary (Continued)

data qualifier	Annotation applied to a field or analytical measurement related to possible effects of the quality of the datum. (See definitions for "flag" and "tag.")
data quality objectives	Accuracy, detectability, and precision limits established before a sampling and analytical effort. Also includes comparability, completeness, and representativeness.
Data Base 1	Set of files containing raw data. (See definition for "raw data base.")
Data Base 2	Set of files containing verified data. (See definition for "verified data base.")
Data Base 3	Set of files containing validated data. (See definition for "validated data base.")
Data Base 4	Set of files containing final, enhanced lake data. (See definition for "enhanced data base.")
detectability	The capability of an instrument or method to determine a measured value for an analyte above either zero or background levels.
detection limit quality control check sample	A quality control check sample that has a specified theoretical concentration and that is designed to check instrument calibration at the low end of the linear dynamic range.
dissolved inorganic carbon (DIC)	A measure of the dissolved carbon dioxide, carbonic acid, bicarbonate and carbonate anions that constitute the major part of ANC in a lake.
dissolved organic carbon (DOC)	In a water sample, the organic fraction of carbon that is dissolved or unfilterable (for this report, the fraction that will pass a filter of 0.45-μm pore size).
dissolved oxygen (DO)	In a water sample, a measure of the dissolved oxygen. For this report, the measurement was taken in the lake water column (in situ)
double-blind	Term used for a QA sample for which the analyst does not know either the source (e.g., type) or the expected concentration.
enhanced data set	Data Base 4. Missing values or errors in the validated data set are replace by substitution values; duplicate values are averaged; negative values (except for ANC and BNC) are set to zero. Values for field blank, field duplicate, and performance audit samples are not included in this data set.
epilimnetic routine sample	A routine lake sample collected in the Summer Seasonal subsurvey at 1.5m from the surface at the Fall Index Site.
equivalent	Unit of ionic charge; the quantity of a substance that either gains or loses one mole of protons or electrons.
exception	An analytical result that does not meet the expected QA or QC criteria and for which a data flag is generated.
exception program	A computer program in CADAVERS that identifies or flags analytical results classified as exceptions.

Glossary (Continued)

extractable aluminum	Operationally defined aluminum fraction that is extracted by the procedure used during the ELS-II; this measurement is intended to provide an indication of the concentration of the aluminum species that may be available in a form toxic to fish.
Fall Seasonal	See seasonal subsurvey.
Fall Variability Study	A special study conducted in the fall Seasonal subsurvey designed to estimate the effect of sampling variability of the lake chemistry at the Fall Index Site.
field audit sample	A standardized water sample submitted to field laboratories to check overall performance in sample analysis by field laboratories and by analytical laboratories. Field natural audit samples were lake water; field synthetic audit samples were prepared by diluting concentrates of known chemical composition into ASTM Type I reagent-grade water.
field blank sample	A sample prepared at the processing laboratory consisting of ASTM Type I reagent-grade water and transported to the lake site by the field sampling crews. At the lake site, the blank was processed through the sampling apparatus. These samples were analyzed at the processing laboratory (except for pH and DIC) and analytical laboratories and were employed in the calculation of system decision and system detection limits and instrument detection limits.
field duplicate sample	The second sample of lake water collected by the sampling crew at the same location and depth at the lake site immediately after the routine sample, in accordance with standardized protocols.
field duplicate pair	A routine lake water sample and a second sample (field duplicate sample) collected from the same lake, by the same sampling crew, during the same visit, and according to the same procedure.
field natural audit sample	See field audit sample.
field synthetic audit sample	See field audit sample.
flag	Qualifier of a data point that did not meet established acceptance criteria or that was unusual. Flags were assigned during the verification and validation procedures.
Gran analysis	A mathematical procedure used to identify the equivalence point or points of the titration of a carbonate system and subsequently for ANC and BNC of that system.
history file	An electronic documentation program in CADAVERS that tracks all the numeric and character changes form the raw data set to the verified data set.
holding time	(1) In the processing laboratory, the elapsed time between sample collection and sample preservation. (2) In the analytical laboratory, the elapsed time between sample processing in the processing laboratory and final sample analysis or reanalysis.

Glossary (Continued)

in-situ	For this survey, any measurements made within the water column of a lake.
initial dissolved inorganic carbon (DIC)	A measurement of dissolved inorganic carbon made on an aliquot immediately before it is titrated for ANC.
instrument detection limit	For each chemical variable, a value calculated from laboratory calibration blank, reagent blank, or field blank samples that indicates the minimum concentration reliably detectable by the instrument(s) used; calculated as three times the standard deviation of 10 or more nonconsecutive (i.e., from different calibrations) blank sample analyses.
interlaboratory bias	Systematic differences in performance between laboratories estimated from analysis of the same type of samples.
ionic strength	A measure of the interionic effect resulting from the electrical attraction and repulsion between different ions. In very dilute solutions, ions behave independently, and the ionic strength can be recalculated from the measured concentrations of anions and cations present in the solution.
lake ID	An identification code, assigned to each lake in the survey, which indicates subregion, alkalinity characteristics, and map coordinates.
linear dynamic range	The range of analyte concentration for which the calibration curve is best fitted by a straight line.
matrix	The physical and chemical composition of a sample being analyzed.
matrix spike	A QC sample, analyzed at an analytical laboratory, that was prepared by adding a known concentration of analyte to a sample. Matrix spike samples can be used to determine possible chemical interferences within a sample that might affect the analytical result.
maximum required holding time	The date by which a sample was contractually to be analyzed by the analytical laboratory.
measured ANC	The ANC result determined in the analytical laboratory with an acid titration.
member M01	A member containing a merge of forms 1,2, and 11. Form 1 is all the lake data information collected by the sampling crew; Form 2 is all the analytical, QC, and sample batching data generated by the processing laboratory; and Form 11 is only the results of the field sample analysis performed by the analytical laboratory.
method blank	See calibration blank.
mobile processing laboratory	See processing laboratory.
modified verified data base	The data base created after the Special Data Assessment based upon changes to the official verified data base.
natural audit sample	See audit sample.

Glossary (Continued)

nephelometric turbidity unit	A measure of light scatter by a solution of suspended materials detected at an angle of 90 degrees to an incident light source.
official verified data base	The data base created as a result of data verification based upon changes to the official verified data base.
on-site evaluation	A formal on-site review of field sampling, field laboratory, or analytical laboratory activities to verify that standardized protocols are being followed.
open system	A measurement of pH or dissolved inorganic carbon obtained from a sample collected in a beaker and exposed to the atmosphere during collection, processing, and preparation before measurement.
outlier	Observation not typical of the population from which the sample is drawn.
outlier data base	A data set generated as result of the Special Data Assessment.
P_{95}	The 95th percentile of a distribution of blank sample measurements.
percent conductance difference calculation	A QA procedure used to check that the measured specific conductance does not differ significantly (outside the acceptance criteria) from the calculated specific conductance value.
percent ion balance difference calculation	QA procedure used to check that the sum of the anion equivalents equals the sum of the cation equivalents (see anion-cation balance).
percent relative standard deviation (%RSD)	The standard deviation divided by the mean, multiplied by 100, expressed as percent (sometimes referred to as the coefficient of variation).
performance audit sample	See audit sample.
pH	The negative logarithm of the hydrogen-ion activity. The pH scale runs from 1 (most acidic) to 14 (most alkaline); the difference of 1 pH unit indicates a tenfold change in hydrogen-ion activity.
pH-ANC	A measurement of pH made in the analytical laboratory immediately before the ANC titration procedure and before the potassium chloride spike has been added.
pH-BNC	A measurement of pH made in the analytical laboratory immediately before the BNC titration procedure and before the potassium chloride spike has been added.
platinum cobalt unit (PCU)	A measure of the color of a water sample defined by a potassium hexachloroplatinate and cobalt chloride standard color series.
population estimate	A statistical estimate of the number of lakes (target lakes) that have a particular set of chemical characteristics (i.e., alkalinity class within a subregion) extrapolated from the number of lakes sampled (probability sample).
precision	A measure of the capability of a method to provide reproducible measurements of a particular analyte.

Glossary (Continued)

processing laboratory	The laboratory that processed samples and measured selected variables. The ELS-II processing laboratory was located in Las Vegas, Nevada.
processing laboratory blank	An ASTM Type I reagent-grade water sample prepared and processed at the processing laboratory but analyzed at an analytical laboratory.
protolyte	That portion of a molecule that reacts with either H^+ or OH^- in solution.
protolyte analysis program	An exception-generating computer program of CADAVERS that evaluates in situ, processing laboratory, and analytical laboratory measurements of pH, DIC, ANC, BNC, and DOC in light of known characteristics of carbonate equilibria.
QC chart	A graphical plot of test results with respect to time or sequence of measurement, together with limits within which the results are expected to lie when the system is in a state of statistical control (Taylor, 1987).
quality assurance (QA)	Steps taken to ensure that a study is adequately planned and implemented to provide data of the highest quality and that adequate information is provided to determine the quality of the data base resulting from the study.
quality assurance sample	A sample (other than the routine lake sample) that is analyzed in the analytical laboratory and that has an origin and composition unknown to the analyst.
quality control (QC)	Steps taken during sample collection, processing, and analysis to ensure that the data quality meets the minimum standards established by the QA plan.
quality control check sample (QCCS)	A sample of known concentration used to verify continued calibration of an instrument.
quality control sample	Any sample used by the analyst to check immediate instrument calibration or response; the measurement obtained from a quality control sample is expected to fall within specific acceptance criteria or control limits.
rain water audit	Standard reference material composed of reverse osmosis water spiked with various chemical constitutes to simulate rain water.
raw data set	Data Set 1. The initial data set that received a cursory review to confirm that data are provided in proper format and are complete and legible.
reagent	A substance (because of its chemical reactivity) added to water to determine the concentration of a specific analyte.
reagent blank sample	A laboratory blank sample that contained all the reagents required to prepare a sample for analysis.
representativeness	The degree to which sample data accurately and precisely reflect the characteristics of a population.
required detection limit	For each chemical variable, the highest instrument detection limit based on analyses of laboratory blanks or detection limit check standards allowable in the analytical laboratory contract.

Glossary (Continued)

round robin	A method of determining relative laboratory performance with multiple laboratories measuring samples from the same audit lot.
routine sample	The first lake sample collected at a site in accordance with standardized protocols.
sample ID	The numeric identifier given to each lake sample and to each QA sample in each batch.
sampling crew	A team of lake sampling personnel who gained access to the lake site on foot or by vehicle.
SAS	Statistical Analysis System, Inc. A statistical data file manipulation package that has data management, statistical, and graphical analysis abilities. The ELS-II data base was developed and analyzed primarily using SAS software and is distributed in SAS format.
seasonal subsurvey	One of three (spring, summer, fall) major lake sampling and analytical components of ELS-II designed to assess the temporal variability of lake chemistry.
Special Data Assessment	An intensive evaluation of the ELS-II data base that took place after the creation of the official verified data set.
specific conductance	A measure of the electrical conductance (the reciprocal of the electrical resistance) or total ionic strength of a water sample expressed as microsiemens per centimeter at 25 °C.
spike	A known concentration of an analyte introduced into a sample or aliquot.
split sample	A replicate portion or subsample of a total sample obtained in such a manner that it is not believed to differ significantly from other portions of the same sample (Taylor, 1987).
Spring Seasonal	See seasonal subsurvey.
standard deviation	The square root of the variance of a given statistic, calculated by the equation: $$\text{standard deviation} = [\Sigma(x - \bar{x})^2/(n - 1)]^{1/2}$$
standard operating	A detailed method that is documented in a step-by-step fashion to ensure consistency in performance by any operating personnel.
statistical (significant) difference	A conclusion based on a stated probability that two sets of measurements did not come from the same population of measurements.
subregion	For this report, geographic portions of Region 1 (northeastern U.S.) denoted as subregions 1A (Adirondacks), 1B (Poconos/Catskills), 1C (Central New England), 1D (Southern New England), and 1E (Maine).
Summer Seasonal	See seasonal subsurvey.
synthetic audit	See audit sample.

Glossary (Continued)

synthetic audit sample	See audit sample.
system audit	See on-site evaluation.
system blank	See field blank sample.
system decision limit	For each chemical variable except pH, a value that reliably indicates a concentration above background, estimated as either the 95th percentile (P_{95}) or as 1.65 times the standard deviation of the field blank sample measurements.
systematic error	A consistent difference introduced in the measuring process. Such differences commonly result in biased estimations.
tag	Code on a data point that is added at the time of sample collection or analysis to qualify the datum.
target population	In this survey, the lake population of interest that was sampled. This population was defined by the sampling protocol.
target lake	A lake of interest in the target population.
titration data	Individual data points from the Gran analysis of ANC and BNC.
transaction files	Individual electronic numeric or character changes to the working data set.
true color	The color of water that has been filtered or centrifuged to remove particles that may impart an apparent color; true color ranges from clear blue to blackish-brown.
turbidity	A measure of light scattering by suspended particles in an unfiltered water sample.
validated data base	Data Base 3. Final product of the validation process in which sample data are examined in the context of a subregional set of samples, rather than at the batch and sample level. Outliers are identified and flagged. Data for field blank, field duplicate, and performance audit samples are included in this data set.
validation	Process by which data are evaluated for quality with reference to the intended data use; includes identification of outliers and evaluation of potential systematic error after data verification.
validation outliers	Data considered suspicious based on data validation.
verification	Process of ascertaining the quality of the data in accordance with the minimum standards established by the QA plan.
verified data base	Data Base 2. Final product of the verification process in which each sample batch and each sample value has been reviewed individually and all questionable values are corrected or identified with an appropriate flag.
windows	Statistically calculated limits based upon the distribution of a set of data.

Glossary (Continued)

within-batch precision	The estimate of precision expected in the analysis of samples in a batch by the same laboratory on any single day. In this report, overall within-batch precision includes the effects of sample collection, processing, and analysis; analytical within-batch precision includes the effects of sample analysis within the analytical laboratories.
working data set	The data set containing the most updated changes in the history file prior to the creation of the verified data set.
X flag	A special data qualifier alerting the data user that the value qualified has been verified but is most likely erroneous or has no documentation or whose integrity was otherwise violated.

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