Standard Operating Procedure for the Determination of Specific Conductance CCAL 11B.1

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1.0 Scope and Application

1.1 Specific Conductance is a numerical expression of the ability of a water sample to carry an electric current. This number depends on the total concentration of ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valence, and their actual and relative concentrations affect conductivity. The practical range of determination is 0 µS – 3 S.

2.0 Summary of Method

2.1 Specific Conductance is determined with a YSI 3200 with temperature-compensation if a low volume sample is submitted. The meter is calibrated with a single point calibration. The samples are measured using a glass probe with thermistor. A consistency standard is analyzed once each analysis batch to monitor instrument drift over time.

2.2 Specific Conductance is determined with a ManTech AutoTitrator System with temperature-compensation if more than 40mL of sample is submitted. The meter is calibrated with four points. A consistency standard is analyzed once each analysis batch to monitor instrument drift over time.

3.0 Definitions

3.1 DI water: Water that has been through a deionization system to produce water similar to ASTM Type I reagent with 16.7 Mohms resistivity (ASTM) (Reference 16.3).

3.2 Method Detection Limit (MDL): The minimum concentration of an analyte that can be measured and reported with 99% confidence, based on a one-sided 99% confidence interval (*t*-value at a significance level of 0.01 and *n-1* degrees of freedom) from at least seven repeated measurements of a low concentration standard measured within an analysis run.

MDL = ts

Where,
t = Student's t value at a significance level of 0.01 and $n-1$ degrees of freedom
s = standard deviation of at least seven repeated measurements of a low level standard

4.0 Interferences

4.1 Electrolytic conductivity (unlike metallic conductivity) increases with temperature at a rate approximately 2% per degree C. Significant errors can result from inaccurate temperature measurements. Although the YSI model 3200 meter compensates for variability in temperature, samples are still allowed to warm to at least 18º C to minimize temperature effect.

4.2 Sources of contamination include dust, carryover and salts from hands. The probe must be washed thoroughly between samples and gloves should be worn during the procedure.

4.3 Air bubbles trapped inside the probe will result in erratic measurements. Shake the probe to remove trapped bubbles before each measurement.

4.4 Build-up on the conductivity cell may contaminate solution and alter conductivity reading. The cell should be cleaned as a part of regular maintenance.

4.5 The platinum black on the electrodes is extremely important to cell operation. The cell should be cleaned and the electrodes replatinized if wear or flaking is observed.

5.0 Safety

5.1 The toxicity or carcinogenicity of each reagent has not been precisely determined; however, each chemical should be regarded as a potential health hazard. Exposure to these chemicals should be reduced to the lowest possible level. Cautions are included for known extremely hazardous materials.

6.0 Equipment and Supplies

Note: *Brand names, suppliers and part numbers are for illustrative purposes only. No endorsement is implied. Equivalent performance may be achieved using apparatus and materials* *other than those specified here, but demonstration of equivalent performance that meets the requirements of this method is the responsibility of the laboratory.*

6.1 YSI 3200 Conductivity Instrument

6.2 YSI 3256 Glass probe with thermistor

6.3 ManTech AutoTitrator System

6.3.1 Model 4510 Conductivity Meter
6.3.2 Instrument Controller
6.3.3 Data Collection Software (PC-Titrate)
6.3.4 Temperature Probe
6.3.5 Mixing Paddle with Motor

6.4 100 mL beakers

6.5 Nitrile gloves

7.0 Reagents and Standards

7.1 USGS Standard Reference samples from Round Robin Inter-laboratory comparison are used to monitor stability of standards.

7.2 Calibration Check Standards/Calibration Standards:
Standards are purchased from a vendor that provides traceability to NIST standards. 10, 100, 1000, and 10000 µS/cm standards are used to calibrate the instrument, and as a daily to check to confirm calibration of the instrument.

8.0 Sample Handling and Storage

8.1 Unfiltered samples are stored at 4°C in the dark. Samples are analyzed within 7 days to ensure sample integrity.

9.0 Quality Control

9.1 Blank: DI water run before the calibration.

9.2 Quality Control Check Sample (QCCS): Run once per analysis batch.

9.3 Accuracy of calibration is checked daily with 10, 100, 1000 and 10000 µS/cm standards (only standards within conductivity range of samples used). If results fall outside acceptable precision limits, the instrument is recalibrated.

9.4 Method Detection Limit (MDL): Established for each analyte. Based on a one-sided 99% confidence interval (t-value) from at least seven repeated measurements of a low concentration standard. The t-distribution value is multiplied by the standard deviation of the population (n-1) to obtain the MDL.

9.5 Analytical Duplicate: Separate analysis from the same sample aliquot. Run a minimum of once every analysis set.

10.0 Calibration and Standardization

10.1 Balances: calibrated yearly by external vendor.

11.0 Procedure

11.1 YSI Model 3200

11.1.1 Calibration

11.1.1.1 Refer to the YSI model 3200 Operations Manual to properly configure the instrument. This will include calculating and storing the cell constant. Temperature compensation should be set to "natural". The instrument will need to be reconfigured each time a new cell is necessary.

11.1.1.2 At least 1 hour before initiating conductivity analysis fill the glass electrode chamber in the conductivity probe with fresh DI water.

11.1.1.3 Press the power switch and allow the conductivity meter to warm up and equilibrate for at least 15 minutes.

11.1.1.4 Rinse the probe with DI water and shake-out any excess.

11.1.1.5 Fill the probe with fresh DI water.

11.1.1.6 Allow the instrument to equilibrate (generally 1 - 2 minutes) before recording the readout on the data sheet. The reading for DI water should be approximately 0.4 -0.7 µS/cm. Rinse probe and shake dry.

11.1.1.7 Analyze the QCCS solution. Rinse the electrode chamber with enough solution to completely rinse the electrodes and discard the rinse. Fill the electrode chamber with solution, allow the instrument to equilibrate (1 - 2 minutes) and record the measurement. Rinse probe with DIW and shake dry.

11.1.1.8 Analyze the 10 and 100 µS/cm standards following the same rinse-and-fill procedure as above. Record results. If results are outside precision limits (+/- 0.1 µS/cm for 10 µS/cm standard or 2% for 100 µS/cm standard), the instrument is recalibrated.

11.1.2 Sample Testing Procedure

11.1.2.1 Rinse the electrode chamber three times with DI water and shake-out any excess after the last rinse.

11.1.2.2 Rinse the electrode chamber with enough sample to completely rinse the electrodes and discard the rinse. Then fill the electrode chamber with sample, allow the instrument to equilibrate (1 - 2 minutes) and record the measurement.

11.1.2.3 Repeat steps 1 and 2 for all samples.

11.1.3 System Notes

11.1.3.1 Although the YSI model 3200 meter compensates for variability in temperature, blank, standard and samples are still allowed to warm to at least 18º C to minimize temperature effect.

11.1.3.2 If there is a shift in order of magnitude in response between two samples, the meter is allowed to stabilize with the new sample; the sample is discarded and poured fresh for determination.

11.1.3.3 The electrode should always be immersed with DI water when not in use. This keeps the electrode hydrated and provides for more stable response.

11.1.3.4 Care must be taken not to insert anything in the electrode chamber that would cause any of the black platinum coating from the electrode to chip-off.

11.1.3.5 The instrument automatically sets the range for the analysis. All analyses are performed in conductance mode. Be certain to correctly record the proper unit magnitude (µS/cm, mS/cm, S/cm). Readings should be recorded to the nearest tenth of a unit for the µS/cm scale, to the nearest unit for the mS/cm and S/cm scales.

11.1.3.6 Keep a record of analyzed values for the QCCS over time. Large deviations show that the meter is not functioning or the solution has deteriorated.

11.2 ManTech Model 4510 Conductivity Meter

11.2.1 Calibration

11.2.1.1 Refer to the ManTech Model 4510 Conductivity Meter manual to properly configure the instrument. This will include calculating and storing the cell constant. Temperature compensation should be set to "natural". The instrument will need to be reconfigured each time a new cell is necessary.

11.2.1.2 Connect a standard pre-calibrated cell to the unit.

11.2.1.3 Setup Conductivity template on ManTech Autotitrator.

11.2.1.4 Analyze DI water, 10, 100, 1000, 10000 and QCCS (only standards within conductivity range of samples used). If results are outside precision limits (+/- 0.1 µS/cm for 10 µS/cm standard or 2% for 100, 1000, and 10000 µS/cm standard), the instrument is recalibrated.

11.2.2 Sample Testing Procedure

11.2.2.1 Each cup is filled with a minimum of 40mL of sample.

11.2.3 System Notes

11.2.3.1 Although the ManTech Model 4510 Conductivity Meter compensates for variability in temperature, blank, standard and samples are still allowed to warm to at least 18º C to minimize temperature effect.

11.2.3.2 The electrode should always be immersed with DI water when not in use. This keeps the electrode hydrated and provides for more stable response.

12.0 Data Analysis and Calculations

12.1 YSI model 3200 and the ManTech 4510 Autotitrator data are direct reading and require no calculation.

13.0 Method Performance

13.1 This method was validated through inter-laboratory studies. The CCAL Water Analysis Laboratory participates in the USGS Standard Reference Water QA program.

14.0 Pollution Prevention

14.1 The chemicals used in this method pose little threat to the environment when properly managed.

14.2 All standards and reagents should be prepared in volumes consistent with laboratory use to minimize the volume of disposable waste.

14.3 For further information on pollution prevention consult *Less is better: Laboratory Chemical Management for Waste Reduction*, available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington D.C. 20036, (202) 872-4477.

15.0 Waste Management

15.1 It is the laboratory's responsibility to comply with all federal, state and local regulations governing waste management, and to protect the environment by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is required.

15.2 For further information on waste management, consult "The Waste Management Manual for Laboratory Personnel", and "Less is Better: Laboratory Chemical Management for Waste Reduction", both available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington DC, 20036.

16.0 References

16.1 Standard Methods For The Examination of Water and Wastewater, Method 2510-Conductivity. American Public Health Association. 21st Edition, 2005.

16.2 Code of Federal Regulations. Protection of Environment. Section 40, Appendix B to Part 136. Definition and procedure for the determination of the method detection limit. Revision 1.11. Revised July 1, 1990. Office of the Federal Register, National Archives and Records.

16.3 ASTM. American Society for Testing and Materials. Standard Specifications for Reagent Water. D1193-77 (Reapproved 1983). Annual Book of ASTM Standards, Vol. 11.01. ASTM: Philadelphia, PA, 1991.

16.4 YSI 3200 Conductivity Instrument Manual. YSI Environmental, YSI Incorporated.

16.5 ManTech Model 4510 Conductivity Meter Manual. ManTech Incorporated.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

17.1 YSI Conductivity Data Sheet

YSI Conductivity

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Project: __________________

Analyst: __________________ Date: ____________________

Remarks: ____

Sample Number	Final µS/cm	Sample Temp °C	Minutes in Progress							
			3	6	9	12	15	18	21	24
Cond Std 10										
Cond Std 100										
QS										

17.2 ManTech AutoTitrator Conductivity Data Sheet

Conductivity

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Project: __________________

Analyst: _______________ Date: ____________________

Remarks: ____

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Cup #	Sample #	Observations	Sampler #
	Blank		1
	Std 10		2
	Std 100		3
	Std 1000		4
	QS		5
			6
			7
			8
			9
			10
			11
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18.0 Document Revision History

Original Document: March 2006
Version: 11A.0
Title: Standard Operating Procedure for the Determination of Conductivity

Edit Date: February 2010
New Version: 11A.1
Address update
Change text from “Conductivity” to “Specific Conductance”
Section 13.1: add Environment Canada Proficiency Testing Program participation.

Edit Date: February 2015
New Version 11A.2
Section 7.1: revised standards
Section 8.0: changed holding time for analysis
Section 11: revised and reorganized for accuracy and clarity
Section 17.2: updated data sheet
General editing

Edit Date: July 2025
New Version 11B.1
Section 2.1: Low volume submitted
Section 2.2: Specific Conductance is determined with ManTech AutoTitrator System with temperature-compensation
Section 4.1: 18º
Section 6.0: added equipment and supplies
Section 7.0: updated standards
Section 9.3: updated standards
Section 11.0: YSI model 3200 Operations Manual Procedure
Section 12.0: added ManTech Model 4510 Conductivity Meter Procedure
Section 17.5: added Model 4510 manual reference
Section 18.1: updated YSI conductivity data sheet
Section 18.2: added ManTech AutoTitrator Conductivity Data Sheet
General Editing