

Appendix F: KTWQP Nutrient, Phytoplankton, Periphyton and Algal Toxin SAP

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QUALITY ASSURANCE/QUALITY CONTROL PLAN

REFERENCES:

METHODS FOR THE DETERMINATION OF ORGANIC COMPOUNDS IN DRINKING WATER
USEPA/EMSL
DOCUMENT NUMBER EPA/600/4-88/039

USEPA CONTRACT LABORATORY PROGRAM
STATEMENT OF WORK FOR INORGANICS ANALYSIS
DOCUMENT NUMBER ILM02.0

USEPA CONTRACT LABORATORY PROGRAM
STATEMENT OF WORK FOR ORGANICS ANALYSIS
DOCUMENT NUMBER OLM03.0

STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER
19TH EDITION

CODE OF FEDERAL REGULATIONS (CFR)
SECTION 40 - PROTECTION OF ENVIRONMENT
REVISED AS OF JULY 1, 1993

MICROBIOLOGICAL METHODS FOR MONITORING THE ENVIRONMENT - WATER AND WASTES
EPA 600/8-78-017

TEST METHODS FOR ESCHERICHIA COLI AND ENTEROCOCCI IN WATER BY THE MEMBRANE
FILTER PROCEDURE
EPA-600/4-85/076

INTERIM GUIDELINES AND SPECIFICATIONS FOR PREPARING
QUALITY ASSURANCE PROJECT PLANS
EPA 600/4-83-004

Approval: _____

Steven Lazoff, Laboratory Manager

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QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN

The QA/QC Program employed by Aquatic Research, Incorporated is based upon procedures developed for use in the Environmental Protection Agency's Contract Laboratory Program (CLP) for Organics and Inorganics. The program outlined here is essentially the same as that currently in use by CLP. While the focus of CLP is for the analysis of specific contaminants, the same practices and procedures apply to all analytical work conducted by Aquatic Research.

Quality Assurance (QA) can be defined as the set of all activities which ensure that reported laboratory results:

- accurately reflect actual sample concentrations;
- are of known acceptable quality; and
- are legally defensible.

Quality Control (QC) is used here to define those procedures used in the laboratory to define and hold in control those variables that will impact the reliability of the laboratory result.

The primary function of our QA/QC program is to provide a uniform basis for evaluation and documentation of the analytical methods and procedures for data reduction and reporting as used in our laboratory. Our goal is to provide the client with accurate results and a clearly traceable and unequivocal record of the procedures used to obtain the reported concentrations. A flow chart showing the components of the analytical scheme used by Aquatic Research is presented in Figure 1.

Generally, the QA Program of Aquatic Research includes the following:

- Development of, and strict adherence to, principles of good laboratory practice.
- Consistent usage of Standard Operating Procedures (SOP's).
- Use of reliable and well-maintained equipment.
- Employment of appropriate calibrations and standards.
- Maintenance and oversight of all operations by management and senior personnel.
- Training of all personnel in the procedures specified in analytical methods and SOP's (carried out by senior staff).
- Training of all personnel in specific QA/QC procedures (carried out by senior staff and the QA Manager).

OVERVIEW OF THE QA PROGRAM

Case File Assignment

Our QA program begins with the Agreement for Analytical Services (see figure 1) in which the sampling and analytical requirements for the requested parameters and matrices will be identified. This will include a definition of the Contract Required Detection Limits (CRDL) for each requested parameter. For purposes of sample tracking and document control, Aquatic Research will establish a Case File for each contracted project and/or for each batch of samples received for laboratory analysis. Each Case File will be given a unique alphanumeric address, which will identify the client and sequential job number for that client. Case File numbers will be assigned at the time of agreement for analytical services and cross referenced to a client project identifier. Hard copy of all correspondence and documentation related to the project or batch of samples will be including in the Case File. The Case File will be maintained by Aquatic Research and delivered to the client upon request or at the time of submission of the final analytical report. Components of the Case File are listed in Table 1. Current CLP detection limits are listed in Table 2.

Field Sampling

Aquatic Research may have little input regarding the sample collection process except to identify the required maximum holding times for the requested parameters and the required sample size (volumes/weights), containers and preservation techniques. While we may have little

control over sample collection, we will require certain basic information regarding all samples received for analysis. This information must be contained on a sample traffic report, chain-of-custody form, letter of transmittal or any similar document routinely used by the client for the transport and delivery of laboratory samples. The minimum required information will include: the client name and project identifier (or Case File Number); the date/time of sample collection, the date/time of sample shipment; a unique sample identification number, matrix identifier and requested parameters for each sample contained in the shipment (see example Chain-of-Custody form).

Guidelines for sample containers, preservation techniques and holding times for the various analyses conducted in our laboratory are presented in Table 3. In general, samples will be analyzed as soon as possible after collection and within the time specified in the aforementioned table. The client will be notified if the holding time for any parameter has been exceeded and the resulting data will be flagged "HTE" in the analytical report.

Samples shipped by Common Carrier or in the Mail must comply with Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). Relative to preservation techniques listed in Table 2, the Hazardous Materials Regulations do not apply to the following:

- Hydrochloric acid (Hal) in water solutions at concentrations < 0.04% by weight (pH >1.95);
- Nitric acid (HNO₃) in water solutions at concentrations < 0.15% by weight (pH >1.52);
- Sulfuric acid (H₂SO₄) in water solutions at concentrations < 0.35% by weight (pH >1.15);
- Sodium hydroxide (Noah) in water solutions at concentrations < 0.08% by weight (pH <12.3).

Sample Login Procedures

Upon receipt of a sample shipment, Aquatic Research will complete the sample login procedure. This will include: recording of the date/time of receipt; reconciliation of client project number with the Case File Number; reconciliation of samples received with samples listed on the transport delivery document; evaluation of sample container condition; verification that holding times for the requested parameters have not been exceeded; and verification that proper procedures for sample storage and preservation have been employed. Login data will be entered on standardized forms including the Sample Check-in List and the Chain-of-Custody Form (see example forms), signed by the individual receiving the samples and placed into the Case File along with the transport/delivery documents. Discrepancies or problems will be noted on the login forms, and on the Nonconformance Memo, and then the client will be immediately notified for resolution of the problem.

Analytical Parameters and methods used

Once samples have been logged in, the process of sample analysis may begin. The analytical methods and method numbers employed by Aquatic Research are shown in Table 4. The parameters listed in that table are analyzed in strict accordance to the protocols outlined in this QA manual and to the accompanying Standard Operating Procedures.

Analysis of QC Samples

In order to evaluate the quality of data, the end-user must be able to be assured that the lab was doing quality work at the time the data was generated. Aquatic Research uses a combination of Laboratory Control Samples (LCS), preparation and reagent blanks and calibration checks to monitor the laboratory's day-to day performance of routine analytical parameters.

An LCS consists of a standard control matrix, which is spiked with a group of target compounds representative of the method analyses. The LCS is analyzed with environmental samples to provide evidence that the laboratory is performing within accepted QC guidelines during the data collection event. The frequencies in which the LCS, prep. Blanks and other QC samples are analyzed for various regulatory requirements are listed in Table 5.

Lass's are analyzed in duplicate, and the recovery and the relative percent difference for each of the analyses are compared to established control limits. This data, in conjunction with reagent blank data, is used to monitor daily performance. If precision and accuracy are within acceptable limits, and blank values are acceptable, the laboratory is said to be "in control" during data generation. If the control samples are outside of acceptable limits, or blank values are unacceptable, then the laboratory is considered to be "out of control", and data generated with those control samples are considered suspect. This situation triggers an investigation and possible corrective action in the laboratory. This process is shown in Figure 2.

Reporting of QC Data and Analytical Data

Most monitoring programs do not specify that any QC data be reported with the analytical data. As a result, many times it is virtually impossible for the end-user to evaluate the quality of the data that one receives. One program that is notable for the "deliverables" required is EPA/CLP, which requires all QC plus all raw data, generated during the analytical process. While some information above and beyond a table of analytical results is needed to evaluate data quality, it is debatable that the average user of environmental data has the expertise to use and evaluate a data package, which includes all of the raw data.

As discussed above in the section on Case File Assignment and below in Table 1, Aquatic Research has instituted a policy of reporting the following information with each data package:

- Case narrative commenting on any anomalies encountered during sample preparation or analysis.
- Analytical results, reported with appropriate significant figures.
- Instrument or method detection limits.
- Method used.
- Dates of sample receipt, sample digestion or other preparation and analysis.
- Results of prep or reagent blanks.
- Results of LCS or other QC check samples.
- Results of matrix and analytical spikes.
- Results of digestion or analytical duplicate analyses.

The majority of the time, this data package gives the end-user enough information with which to evaluate data quality and usability. In addition, this information is supported by extensive documentation kept

on file in the laboratory, and is available to the end-user on request. This documentation includes:

- All sample receipt and tracking documentation.
- All bench sheets associated with sample preparation.
- All raw data from environmental and QC samples.
- All calibration data associated with the samples.
- Standard Operating Procedures, which define, each step of the analytical process.

Data Validation

Data Validation begins with the processing of the raw data to a reduced form and continues to the reporting of the analytical results. The following steps shall be used to validate all data:

1. Initial Data Reduction: Except for a few tests, including trace metals analyses, all raw data is reduced on a computer using a spreadsheet program (Excel or 1-2-3). The analyst is to follow the data reduction SOP explicitly for all data. The QA Manager is to check 10% of the data reduced by the laboratory employees.
2. Final Data Review: The Laboratory or QA Manager has the responsibility for reviewing all data for completeness and to insure that all associated QC data has been verified.
3. Review of Data Reporting: After a draft report is prepared, the reported results are to be checked against the reviewed processed data so that transcription errors do not occur. As the QA and Laboratory Manager have the responsibility of preparing data reports, it is these individuals' responsibility to follow the guidelines outlined in the Data Reporting SOP.
4. Final Approval: once the Laboratory Manager has checked the draft report, the QA Manager signs the report. A cover page is included, signed by the Laboratory Manager who authorizes the release of the data.

QC PROCEDURES

Quality Control activities begin with: laboratory personnel; standard laboratory practices for cleanliness with respect to distilled water, reagents and lab ware; and proper instrument operation, calibration and maintenance. QC culminates in those procedures employed during the analytical run to ensure that the reported values accurately reflect the actual sample values within constraints imposed by instrument detection limits and sample matrices.

The laboratory practices and analytical procedures used by Aquatic Research are summarized and documented in our manual of Standard Operating Procedures (SOP's). This manual provides step-by-step

instructions for all laboratory practices and is the basic working document for our analysts, thus insuring consistency between analysts and analytical runs. The SOP's are revised and updated, as necessary, by the laboratory director or QA manager.

Laboratory Personnel

Current laboratory personnel include the Laboratory Director, the Quality Assurance Manager, analytical chemists, and laboratory technicians. These individuals have been trained in all phases of the analytical work being conducted in our laboratory and are under the immediate supervision of the Laboratory Director. All laboratories supervisory personnel currently employed by Aquatic Research hold college degrees in Science and have a minimum of 5 years experience in Standard Laboratory Operations and Environmental Chemistry. The Laboratory Director oversees the daily analytical operations, provides training in new techniques and instrumentation and, in conjunction with the QA Manager, inspects all raw data and conducts all data reduction and reporting.

Aquatic Research recognizes that the role of the individual analyst is of utmost importance in fulfilling the goals of its QA/QC Plan. New personnel will satisfy basic requirements of at least a Bachelors Degree in Environmental Science-Chemistry and/or a minimum of 2 years experience/training in Analytical Chemistry. New analytical personnel will receive thorough instruction in the analytical and quality assurance procedures used by Aquatic Research before they are allowed to analyze client samples. The Laboratory Director and the Quality Assurance Manager will provide this instruction. Additionally, once trained, all laboratory personnel will have specific Standard Operating Procedures (SOP's) that are to be explicitly followed. These SOP's outline all details of laboratory operation from sample receipt to data reporting. Personnel are assigned additional duties only as the Laboratory or QA Manager feels that an individual can master the new tasks. Therefore, senior personnel continuously monitor the performance of individual analysts.

A list of employees and their job titles are provided in Table 6.

Standard Laboratory Practices

A requirement for trace level analysis is the provision of contaminant free distilled water, reagents and glassware. In recognition of the importance of this requirement, Aquatic Research has implemented the following procedures:

1. Our reagent water source consists of 2 de-ionization canisters, an activated charcoal canister, and a 0.2-micrometer filtration system. This water is used for the cleaning of glassware. Passing through 4 de-ionization cartridges before the final 0.2-micrometer filter further purifies the de-ionized water. This provides the laboratory with water equivalent to ASTM Type II Grade Water with an electrical resistance of 12-mega ohms/cm or more. This grade water is used as reagent water and as a final rinse of critical glassware. Resistivity is monitored daily by all laboratory personnel at time of use, and must pass minimum resistivity of 12 me ohms/cm.

2. Analytical Reagent (AR) Grade reagents and solvents are used exclusively for the analyses conducted in our laboratory. All reagents and standards are prepared with distilled/demonized water and are checked by calibration blanks. Individual methods generally specify which reagents require frequent standardization or close attention to holding time. The analyst conducting a particular analytical run is thoroughly familiar with these requirements and explicitly follows procedures. Commercially prepared reagents and standards are used when it is demonstrated that they meet the method requirements (verified by calibration blanks).
3. The various types of glass and plastic ware used in the laboratory serve three basic functions: sample and reagent storage, measurement and mixing of solution volumes, and confinement of reactions. The type of labware used is dependent upon the intended function. In general, Aquatic Research uses borosilicate glass (Pyrex, Kimax) containers for reagent and standard preparation and storage. Glass and polypropylene containers are used for sample storage. Borosilicate glass, ceramic or Teflon containers are used for digestion and reaction vessels. Lab ware with removable parts (e.g. burettes and separatory funnels) is equipped with Teflon stopcocks.
4. Glassware used in the laboratory is segregated on the basis of intended analytical use. This helps to prevent cross-contamination problems and facilitates cleaning operations.
 - Glassware reserved for nutrient analysis is cleaned with soap and hot water, then tap water, then rinsed with 1:1 hydrochloric acid and followed by five rinses with de-ionized water.
 - Glassware intended for metals analysis is washed as per nutrients glassware, except that the acid rinse is with 1:1 nitric acid.
 - Glassware reserved for semi-volatile organics is rinsed with the last solvent used, then rinsed with cold tap water. Cold water is essential so that the glassware washer is not overwhelmed by vaporized solvent from the previous step. The glassware is then washed with soap and hot water, rinsed 5 times with de-ionized water, and then allowed to drip dry. Non-volumetric glassware that has no ground glass may be muffled at 550°C. Glassware that is stored is sealed with aluminum foil. Immediately prior to next use, the analyst must rinse the glassware with the next solvent to be used.
 - Glassware reserved for volatile organics is washed with soap and water, then rinsed 5 times with de-ionized water. It is then rinsed with reagent water (de-ionized water that has been boiled and purged with nitrogen). Some non-volumetric glassware, such as the purging device, may be dried in an oven at 105°C. Sample vials should be muffled at 550°C. Glassware used in the preparation of standards or high concentration samples, including syringes and volumetric flasks/vials, should be rinsed with the same solvent used (usually methanol).
 - Glassware reserved for microbiology is washed as per nutrients glassware, except no acid rinse, then autoclaved.

Cleaned glassware is allowed to drip dry and then stored inverted in closed dust-free cabinets. Only phosphate-free detergents are used for glassware cleaning. This means, generally, that glassware will be cleaned with detergent solutions (Alconox or NoChromix) and then thoroughly rinsed with hot tap water, dilute acids and de-ionized water.

5. Lab ware used for sample collection and storage is cleaned immediately after use and periodically checked for presence of contamination by running blank determinations on randomly selected vessels from within a given lot. If evidence of contamination is indicated, the entire lot will be cleaned with the appropriate solutions and reevaluated.

Instrumentation and Maintenance

The analytical laboratory is heavily dependent upon advanced and sophisticated instrumentation. This instrumentation represents a significant capital cost. The quality of the analytical result and the smooth and efficient operation of the laboratory (avoidance of down time) depend upon its proper operation and maintenance. Our laboratory presently includes the following instruments:

Organics Department (GC,GC/MS)

Purge and Trap System

OI Analytical model 4560 Purge and Trap Sample Concentrator. This unit is equipped with a cryofocussing module (model CFM), infrared sample heater, and Cyclone water management system.

PATTI II software.

5 ml fritted purge vessels and 25 ml fritted purge vessels.

.53 mm ID DB-1 precolumn on CFM, OI Analytical, part# 226134.

Carrier gas inlet operated under electronic pressure control from the GC/MS system.

#9 Trap (Tenax / Silica Gel / Charcoal), OI Analytical, part# 219972

Trap is 11 3/4 inch long (29.8 cm), packed according to EPA specifications, having equal lengths of Tenax (0.24 g), Silica gel (0.47 g), and Charcoal (0.2 g). The outer diameter of the trap is 1/8" (0.125" = 3.2 mm), and the inner diameter of the trap is 0.106" (2.7 mm).

Semivolatile Injection System

Hewlett-Packard 7673A controller.

Hewlett-Packard 7673 GC/SFC injector.

Hewlett-Packard G1296A bar code reader.

GC system

Hewlett-Packard 5890 series II Gas Chromatograph with Electronic Pressure Control (EPC).

J+W DB-5MS column, 30 meters, .25mm ID, 1 micron film, catalog#122-5533 (volatiles by cryofocussing).

Hewlett-Packard HP-624 column, 25 meters, .20 mm ID, 1.12 micron film, catalog#19091V-402 (volatiles without cryofocussing).

Hewlett-Packard HP-5MS column, 30 meters, .25mm ID, .25 micron film, catalog#19091S-433 (Semivolatiles)

Hewlett-Packard 6890 series Gas Chromatograph with Electronic Pressure Control (EPC), FID detector.

MS system

Hewlett-Packard 5971 Mass Selective Detector.

Data system

PENTIUM COMPUTER

Hewlett-Packard G1034C Chemstation software.

NIST/EPA/NIH Mass Spectral Library containing 75,000 compounds.

EnviroQuant G1032C software.
Microsoft Windows 98
Microsoft Excel 97

Accessories

Hewlett-Packard 59822B ionization gauge controller
Humonics model 520 Digital Flowmeter

Helium Supply

Helium, high purity, 99.995%
Glass Indicating Moisture Trap, 100 cc, 1/8" fitting, Hewlett-Packard part# 3150-0532.
Oxygen Trap, 1/8" fitting, Hewlett-Packard part# 3150-0414.
1/8" solvent-rinsed copper tubing, Hewlett-Packard part# 5180-4196.

Extraction Equipment

Varian Filtration Manifold for Solid Phase Extraction
Separatory funnels
Sonicator (see Conventionals Department)
Horizon Technologies Solid Phase Extractors (SPE-DEX 4790)

Organics Department (TOC)

Shimadzu TOC-Vcph Total Organic Carbon Analyzer (computer controlled, autosampler)
Shimadzu TOC-5000 Solid Sample Module

Metals Department

Leeman Labs model PRODIGY ICP SIMULTANEOUS atomic emission spectrometer (Eschelle monochromator, computer controlled, autosampler)
Leeman Labs model PS1000 ICP atomic emission spectrometer (Eschelle monochromator, computer controlled, autosampler)
Hitachi model Z-9000 graphite furnace spectrometer (4 channel, Zeeman background corrected, computer controlled, autosampler)
Leeman Labs model PS200 automated mercury analyzer (computer controlled, autosampler and cold vapor/hydride generation attachment)
Aquatic Research model 1 TCLP extractor (using Dayton model 5K941A split phase gearmotor)
SCP SCIENCE BLOCK DIGESTOR

Hot Plates

Corning model PC-500 Hot Plate
Thermolyne model HP47135-60 Cimarec 3 Hot Plate

Nutrients Department

2 Alpkem autoanalyzer (2 channel, computer controlled, autosampler)
 model 301 Sampler
 model 302 Micro Pump
 model 303 Analytical Cartridge Module
 model 304 Power Module
 model 305 Photometer
 model 305 Photometer
Alpkem autoanalyzer (3 CHANNEL)
 model 501 XYZ Sampler
 model 502 Pump
 model 503 Cartridge Heater
 model 509 Power Distribution Module
 model 510 Monochromator Detector
 model 510 Monochromator Detector
 model 510 Monochromator Detector
 model 511 Dilutor
 model 512 Valve Module

Labconco model 60011, catalog#60300 micro-Kjeldahl digestors (2 of them)

Conventionals and General Department

Drying ovens and muffle furnace

Humboldt drying oven
GCA corp. model Precision Mechanical Convection Oven
Neytech model 85M muffle furnace

Incubators

GCA Corp. Precision Scientific model Thelco Incubator
Boekel Industries catalog#132000 Incubator
General Electric refrigerator, with Hach model 2597A Incutrol/2 (for BOD analysis)
Boekel Industries water bath.

Balances

A&D model FX-320 Electronic Balance
A&D model HA-180M Electronic Balance
A&D model EK-120A Electronic Balance
Mettler model H80 Balance

Spectrophotometers

2 Hitachi model U-2000 UV-VIS Spectrophotometer (computer controlled)
Hitachi model F-1200 Fluorescence Spectrophotometer
Buck Scientific model 404 Total Hydrocarbon Analyzer

Centrifuges

VWR Scientific Model Super-Minor
Fisher Scientific Model 228

Mixers

Sensaur catalog#V73052A Lab Mixer
Thermolyne model M37615 Maxi Mix II

Miscellaneous

Jenco model 6071 pH meter
Hach model 2100A Turbidimeter
Sonicor model UPP-400 Sonicator
Heat Systems sonicator.
Tuttnauer model 2340 autoclave
Amber Scientific model 604 Conductivity Meter
Gast model DOA-P104-AA Pumps for Filtration (2 of them)

In order to protect our investment in equipment and to ensure the quality of work, our analysts are trained to have an in depth understanding of the fundamental operating characteristics of these instruments and an awareness of how to detect equipment malfunction and when to call in more expert help. All instruments are routinely calibrated before and during use and are subject to scheduled maintenance and inspection. Maintenance and monitoring records are kept with each instrument as well as the Standard Operating Procedures and the manufacturers operating manual.

Standard Analytical Procedures

Standard Analytical Procedures are those techniques, which are used before and during a routine analytical run for instrument calibration and verification and an analysis of accuracy and precision with respect to the "true" sample values. All data acquired during an analytical run (instrument set-up, calibration and sample data) are recorded by the analyst on standardized worksheets for each type of analysis (see example forms). These forms are maintained in an analytical run file and

submitted to the Laboratory Director and QA Manager for review, data reduction and entry to the appropriate Case File. Overall tracking the results of verification standards analysis monitors analytical performance. These results are reviewed monthly by the QA Manager and control charts showing average percent deviations over time with respect to established control limits are plotted. These are reviewed with the laboratory director and analysts to identify consistent trends and rectify potential problem areas.

Quality Control is an integral part of the analytical sequence, not an "after-thought". Successful implementation is dependent upon the individual analyst. Our analysts are thoroughly trained in, and apply, the following procedures and protocol.

A flow chart for QC analysis during a routine analytical run is shown in Figure 2. The terminology and procedures follow those used for the CLP.

Instrument Detection Limit (IDL)

An IDL is determined for each parameter and is evaluated relative to the contract required detection limits (CRDL). The IDL is determined as 3 times the average of the standard deviations obtained from the analysis of a standard solution (verification standards) at a concentration of 3 to 5 times the IDL.

An analytical method may be used as long as the IDL meets the CRDL. Higher detection levels may be used if the sample concentration exceeds 5 X the IDL.

Method Detection Limit (MDL)

Method Detection Limits are determined according to the 40 CFR Part 136, Appendix B item 6A. It is requested that no fewer than seven replicates be used to determine the MDL.

Initial Calibration and Verification

The following is an example of initial calibration for metals. Please refer to the SOP's for further details on specific analyses including organics, nutrients, etc.

Instrument calibration is conducted daily or each time the instrument is set up for an analytical run. A 4 to 9-point calibration (a calibration blank and standards) using the same type of acid(s) and at the same concentrations used for the samples will be used. Standards will be selected to cover an appropriate linear range with one standard at the CRDL. Results for the standards must be within $\pm 5\%$ of the true value. If the values do not fall within this range, re-calibration is necessary.

Following initial calibration, calibration verification will be conducted. Calibration verification is conducted by analyzing an Initial Calibration Verification (ICV) standard (a standard obtained from a source other than that used for the calibration) at a concentration other than that used for the calibration curve but within the range of determination. ICV results are compared to EPA control limits of 90 to 110% of the "true" value. An out-of-control condition requires recalibration and reverification.

A calibration blank is run after the ICV and then again with each subsequent Continuing Calibration Verification (CCV) standard. If the absolute value of the calibration blank exceeds the CRDL, the analysis is stopped and the instrument recalibrated.

Continuing Calibration Verification consists of the analysis of a midrange standard and a calibration blank at a frequency of 10% (1 in 10) or every 2 hours during the run and then again after the completion of the run. CCV results are compared to EPA control limits of 90 to 110% of the "true" value. An out-of-control condition requires instrument recalibration and reanalysis of the preceding 10 samples.

Preparation Blank Analysis

The following is an example of preparation blank requirements for metals. Please refer to the SOP's for further details on specific analyses including organics, nutrients, bacteria, etc.

At least 1 Preparation Blank (PB) will be processed through each sample preparation procedure at a frequency of 5% (1 in 20) or with each batch of samples digested. The PB is used to evaluate possible contamination through the preparation/digestion process as follows:

- If the concentration of the PB is less than the CRDL, the analysis proceeds;
- If the concentration of the PB is greater than the CRDL then the concentration of the least concentrated sample in the batch associated with that blank must be 10X the PB concentration. All associated samples less than 10X the PB concentration will be redigested and reanalyzed.

Spiked Sample Analysis

The following is an example of matrix spiking requirements for metals. Please refer to the SOP's for further details on specific analyses including organics, nutrients, etc.

Spiked Sample Analysis is used to provide information about the effect of the sample matrix upon digestion and analytical method. The spike is added before digestion at a frequency of 5% (1 in 20) or for each matrix type contained within a sample batch. Levels for spike addition for a given parameter are derived from CLP procedures and are shown in Table 2.

Spike recoveries (% Recovery) are computed as:

$$\% \text{ Recovery} = [(SSR - SR) / SA] \times 100$$

Where: SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added

If spike recoveries are not within the range of 75 - 125 % the data on all samples associated with that spike and determined by the same analytical procedure will be flagged with the letter "N" to indicate possible matrix problems. If the sample concentration is > 4X the spike concentration, the data are not flagged.

For trace metals analysis by ICP and Flame AA, if the predigest spike recovery falls outside of the control limits of 75 - 125 % and the sample

concentration is $\leq 4X$ the spike concentration, then a post-digest spike will be conducted. Post-digest spikes are performed at a concentration of $2X$ the ambient level or CRDL, whichever is greater.

Duplicate Sample Analysis

Duplicate sample analyses are conducted in order to evaluate the precision of the analytical procedure. Duplicate samples are analyzed for each batch of samples at a frequency of 5% (1 in 20). Duplicates are not averaged for reporting purposes but are used solely to evaluate precision. Precision is expressed as the Relative Percent Difference (RPD) and is calculated as follows:

$$RPD = \frac{| D1 - D2 |}{(D1 + D2) / 2} \times 100$$

Where: D1 = original value
D2 = duplicate value

If the sample values are $\geq 5X$ the CRDL, an RPD control limit of $\pm 20\%$ is used for evaluation. If the sample values are $< 5X$ CRDL, a control limit of \pm CRDL is used.

If the duplicate samples are outside the control limits, all samples associated with that duplicate analysis (matrix type or batch) will be flagged with a "*" to indicate possible precision problems.

Specific Procedures for Graphite Furnace Analysis

The analysis of metals by Graphite Furnace Atomic Absorption Analysis (GFAA) requires special consideration related to matrix and analytical interferences. The basic consideration is the procedures by which the raw data will be quantitated: Standard Calibration Curve or Method of Standard Additions (MSA). A Flow Diagram for GFAA work is presented in Figure 3.

All furnace samples consist of duplicate injections for which our Hitachi four channel Zeeman background corrected system outputs the mean, the standard deviation and the relative standard deviation (RSD or coefficient of variation).

Analysis proceeds with standard calibration curve and calibration verification procedures (Figure 4). The Preparation Blank and Verification Standard are given analytical spikes (post-digest spikes), which are evaluated relative to a recovery range of 85 - 115 %. An out-of-control condition requires a rerun of the spikes and evaluation of the system.

Samples and analytical spikes (at $2X$ CRDL) are prepared and run. Duplicate injections must agree within 20% RSD (for samples quantitated above the detection limit) or the sample is rerun and flagged with "M" if the readings are still out. The analyses must fall within the calibration range or the sample will be diluted and rerun.

If spike recovery is less than 40 %, the sample will be diluted (factor of 5 to 10), respiked and rerun. If recovery is still less than 40% the data will be flagged with an "E" to indicate interference problems. If spike recovery is greater than 40% and the sample absorbance is less than 50% of the spike absorbance, the results are reported to the Instrument Detection Limit (IDL) and flagged with a "W" dependent upon level of spike recovery.

If the sample absorbance is greater than 50% of the spike absorbance and spike recovery is within the range of 85 to 115%, the calibration curve is used for quantitation of the data. If spike recovery is not within the range of 85 to 115%, the Method of Standard Additions (MSA) will be used for quantitation.

The MSA analysis requires the preparation of three standard addition spikes at levels of approximately 50, 100 and 150% of the sample absorbance. These additions must fall within the linear range of analysis for the calibration curve. Least squares regression is run on the results of the standard additions and the regression equation is used to compute the sample value. Dependent upon the correlation coefficient (r), the results will be flagged with either an "s" or "s+".

Other Laboratory Procedures

Please refer to the Standard Operating Procedures (SOP's) for all other inorganic and organic Procedures.

Performance Evaluation (PE) Analysis

Aquatic Research participates in the Washington State Department of Ecology Environmental Assessment Program. In conjunction with this program, we receive WS & WP Performance Evaluation (PE) samples from Analytical Products Group, Inc (APG, Inc., Belpre, Ohio). These samples are analyzed semi-annually and include, but are not limited to, the following trace metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, copper, antimony, beryllium, nickel, thallium, boron, aluminum, manganese, molybdenum, zinc. Also included are trihalomethanes, volatile organic compounds, residual free chlorine, turbidity, total filterable residue, calcium, pH, alkalinity, corrosivity, sodium, sulfate, total cyanide, nitrate, and fluoride.

Certified Reference Materials

In order to be certain that all analytical systems are "in-control", it is necessary that all reagents used for calibration verification and LCS's be of a known, verified source independent of reagents used for initial calibration purposes. It is the policy of Aquatic Research to use Standard Reference Materials and other Certified Reference Materials from reputable organizations for use as these critical QC samples. Some of these sources include:

NIST (source of solid LCS for trace metals analysis).

SPEX (source of calibration verification standards for ICP, GFAA, and CVAA spectroscopy).

APG (source of calibration verification standards for ICP, GFAA, and CVAA spectroscopy as well as nutrients and conventional parameters).

ERA (source of liquid LCS for trace metals analysis).

The SOP's for the organics department includes suggested sources for common standards. Additionally, there is an SOP entitled "Preparation of Organic Standards" which gives very detailed procedures for preparation, documentation, etc. of organic standards to give full traceability to the original source.

TABLE 1. DATA RETAINED BY THE LABORATORY

1. Analytical request/quotation and all correspondence related to sample analysis.
2. Transport/delivery document(s), sample login form.
3. Analytical raw data and laboratory worksheets.
 - 3.1. Information will include extraction logs, digestion logs and instrument readouts showing the following QC data:
 - 3.2. Instrument calibration (multiple point Standard Curve run at the beginning of sample run).
 - 3.3. Initial and continuing calibration verification (independent standards) to include calibration blanks processed at a frequency of 10 % or every two hours during the run (for metals) or as appropriate to the specific analysis.
 - 3.4. Preparation blanks (prepared with every 20 samples received or with each batch of samples digested or extracted).
 - 3.5. Spiked sample analysis (1 per sample lot/matrix or at a frequency of 5%).
 - 3.6. Duplicate sample analysis (1 per sample lot/matrix or at a frequency of 5%).
 - 3.7. Analysis by Method of Standard Additions (if applicable).
 - 3.8. Instrument Detection Limits (IDLs), summary of quarterly determinations.
4. Tabulated Analytical Results

- 4.1. Reported sample concentrations and associated QA data (Preparation Blanks, Sample Spikes and Sample Duplication) by client identification number (micrograms/liter or milligrams/liter for aqueous samples, milligrams/kilogram dry weight for solid samples).
- 4.2. Summary of Spiked and Duplicate sample analysis, analysis date and method, blank result, and result of independent calibration verification check standard.
- 4.3. **Case narrative indicating any problems with the receipt or analysis of the samples.**

TABLE 2.
EPA CONTRACT REQUIRED DETECTION LIMITS (CRDL) AND RECOMMENDED SPIKING LEVELS FOR SPIKED SAMPLE ANALYSIS OF METALS

Reference: ILM02.0 page C-1 for CRDL
 ILM02.0 page E-20 for spiking levels

ELEMENT	CRDL (ppb)	SPIKING LEVELS (ppb)				
		ICP		FURNACE AA		OTHER
		WATER	SEDIMENT	WATER	SEDIMENT	
Aluminum	200	2000	NR	-	-	
Antimony	60	500	500	100	100	
Arsenic	10	2000	2000	40	40	
Barium	200	2000	2000	-	-	
Beryllium	5	50	50	-	-	
Cadmium	5	50	50	5	5	
Calcium	5000	NR	NR			
Chromium	10	200	200	-	-	
Cobalt	50	500	500	-	-	
Copper	25	250	250	-	-	
Iron	100	1000	NR	-	-	
Lead	5	500	500	20	20	
Magnesium	5000	NR	NR			
Manganese	15	500	500	-	-	
Mercury	0.2					1
Molybdenum						
Nickel	40	500	500	-	-	
Potassium	5000	NR	NR			
Selenium	5	2000	2000	10	10	
Silicon						
Silver	10	50	50	-	-	
Sodium	5000	NR	NR			
Thallium	10	2000	2000	50	50	
Vanadium	50	500	500	-	-	
Zinc	20	500	500	-	-	

Elements without spike levels and not designated as **NR** (not required) must be spiked at appropriate levels.

The spike levels shown for sediments indicate concentrations in the final digestate of the spiked sample (100 ml for mercury and 200 ml for all other metals) when the wet weight of 1 gram (for ICP, Furnace, and Flame AA), or 0.2 grams (for mercury) of sample is taken for analysis. Adjustment must be made to maintain these spiking levels when the weight of sample taken deviates by more than 10% of these values.

TABLE 3.
RECOMMENDED SAMPLE CONTAINERS, PRESERVATION AND MAXIMUM HOLDING TIMES

Reference: ILM02.0 page D-4 for metals and cyanide
 40 CFR Part 136.3 Table II
 40 CFR Methods 624 & 625
 Methods 524.2 & 525.1
 SM 18th ed. Table 1060:I, page 1-22 for others

PARAMETER	CONTAINER	PRESERVATIVE		HOLDING TIME
		AQUEOUS	SOLID	
BACTERIA	P/G	cool, 4°C 0.008%Na ₂ S ₂ O**	N/A	6 hours
METALS	P/G	HNO ₃ , pH <2	cool, 4±2°C	6 mo (180 days)
Cyanide	P/G	NaOH, pH >12 cool, 4±2°C 0.6 g Ascorbic Acid**	cool, 4±2°C	14 days
Chromium +6	P	cool, 4°C	“	24 hrs
Mercury	P	HNO ₃ , pH <2	“	14 days
Turbidity	P/G	cool, 4°C		48 hrs
Conductivity	P/G	“		28 days
Alkalinity	P/G	“		14 days
Hardness	P/G	pH <2		6 mo
TSS	P/G	cool, 4°C		7 days
Nitrate	P/G	H ₂ SO ₄ , pH <2 cool, 4°C		28 days 48 hrs
Nitrite	P/G	H ₂ SO ₄ , pH <2 cool, 4°C		14 days 48 hrs
Ammonia	P/G	H ₂ SO ₄ , pH <2		28 days
TKN	P/G	H ₂ SO ₄ , pH <2		28 days
total Phosphate	P/G	cool, 4°C		28 days
ortho Phosphate	P/G	filter, cool, 4°C		48 hrs
Sulfate	P/G	cool, 4°C		28 days
Chloride	P/G	none		28 days
Fluoride	P/G	none		28 days
<u>ORGANICS</u>				
VOA (Method 624) (Method 8240)	G, 40 ml vial, teflon cap	cool, 4±2°C 2 drops 1:1 HCl 10 mg sodium-thiosulfate**	cool, 4±2°C	14 days
BNA (Method 625) extraction	G, 1 liter amber	cool, 4±2°C 80 mg sodium-thiosulfate**	cool, 4±2°C	7 days for extraction 40 days for analysis <u>after</u>
VOC (Method 524.2) (Method 8260)	G, 40 ml vial, teflon cap	cool, 4±2°C 2 drops 1:1 HCl 25 mg ascorbic acid**	cool, 4±2°C	14 days

FLUORIDE	Potentiometric with distillation	340.2	4500F-C
SULFUR			
Sulfate	Turbidimetric	375.4	4500SO4E
Sulfite	Iodometric	377.1	4500SO3B
Sulfide	Iodometric	376.1	4500S2-E
	Methylene Blue	376.2	4500S2-D

TABLE 4. (continued)
 ANALYTICAL PARAMETERS AND METHODS USED
 EPA SM SW846

Parameter	Description	Method	Number**
DISSOLVED OXYGEN	Winkler (field fixed)	360.2	4500O2C
BIOLOGICAL OXYGEN DEMAND (BOD 5)	5 day	405.1	5210B
CHEMICAL OXYGEN DEMAND (COD)		410.4	5220D
COLOR	Platinum Cobalt	110.2	2120B
NUTRIENTS			
NITROGEN			
Ammonia	Automated phenate with distillation	350.1	4500NH3H
TKN	Micro-kjeldahl	351.1	4500NORGC
NO ₂ +NO ₃	Automated Cd Reduction	353.2	4500NO3F
Nitrite (NO ₂)	Sulfanilamide/NED	353.2	4500NO2B
TPN (Total Persulfate)	Automated Korolev		
	Sample filtration as required		
PHOSPHOROUS			
Total	Automated Ascorbic Acid	365.1	4500PF
SRP(Soluble Reactive)	Automated Ascorbic Acid	365.1	4500PF
	Sample filtration as required		
MISCELLANEOUS			
CYANIDE			
Total	Spectrophotometric	335.2/9010	4500CN-E
Acid Dissociable			4500CN-I
Amenable		335.1/9010	4500CN-G
TOTAL PHENOLS	4AAP Colorimetric	420.1/9065	5540A,D
MBAS SURFACTANTS	Methylene Blue	425.1	5540C
OIL AND GREASE (FOG)	Gravimetric	1664	

TABLE 4. (continued)
 ANALYTICAL PARAMETERS AND METHODS USED

	EPA	SM	SW846
TOTAL PETROLEUM HYDROCARBONS (TPH)			
TPH	Freon/Infrared	418.1	
TPH low level screen	Fluorimetric		
TOTAL ORGANIC CARBON (TOC)			
TOC water	Automated Persulfate/UV	415.1	5310B
TOC sludge/soil	High temp furnace	415.1	5310B
Purgeable (POC)	High temp furnace	415.1	
METALS			
FILTRATION FOR DISSOLVED METALS			
DIGESTION	Nitric acid/Peroxide	3020/3050/CLP	
PERCENT SOLIDS	Gravimetric	160.3	
TCLP EXTRACTION		1311	
FLAME ATOMIC ABSORPTION		200/7000 METHODS	
INDUCTIVELY COUPLED PLASMA (ICP)		200.7/6010/CLP	
GRAPHITE FURNACE AA		200/7000 CLP methods	
MERCURY	Automatic cold vapor	245.2/7470/7471	
HEXAVALENT CHROMIUM	Colorimetric	7196	
PRIORITY POLLUTANT (13)			
	ICP/CVAA only (high IDL's)	6010/7471	
	ICP/GFAA/CVAA(low IDL)	6010/7471/7000 methods	
TCLP METALS (8) INCLUDING EXTRACTION			
	ICP/CVAA only	6010/7470	
	ICP/GFAA/CVAA	6010/7470/7000 methods	
as total metals	ICP/CVAA only	6010/7470/7471	
EPA TARGET METALS	ICP/GFAA/CVAA	CLP	
TISSUE ANALYSIS AVAILABLE			

CLP PACKAGES AVAILABLE

TABLE 4. (continued)
 ANALYTICAL PARAMETERS AND METHODS USED

	EPA	SM	SW846
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ORGANICS

VOA	Purge & Trap GC/MS	624/8240	
VOC	Drinking Water	524.2	
BNA	GC/MS	625/8270	
BNA DRINKING WATER	Solid Phase Extraction	525.1	
TPH/FOG	See Miscellaneous Section		

BIOLOGICAL

TOTAL COLIFORMS	Membrane Filter		9222B
FECAL COLIFORMS	Membrane Filter		9222D
TOTAL/FECAL CONFIRMED	MPN5		9221B,E
FECAL	MPN5		9222E
TISSUE MPN			
CHLOROPHYLL_a/PHAEOPHYTIN_a	Spectrophotometric		10200H

TABLE 5
FREQUENCY OF QUALITY CONTROL SAMPLES REQUIRED UNDER
RCRA, CERCLA, CWA, SDWA

Matrix	Lab	Method	BLANKS		DUPLICATES		
			Field	Field	Field	Dup	Spike
Spike	Control	Method	Blank	Blank	Dup	Samples	Dup
Analytes	Sample	Methods	Blank	Blank	Dup	Samples	Dup
CERCLA - Superfund (CLP)							
Water, Soil, Waste Samples							
Metals -	AA	200.0 CLP	5%, ESS	REC	-	5%	-
	5%, ESS						
	ICP	200.7 CLP	5%, ESS	REC	-	5%	-
	5%, ESS						
RCRA							
Soil, Waste Samples							
Metals -	Acid Digest	3000	ESS	NS	NS	20%	-
	ESS						
	AA	7000	ESS	NS	NS	5%	5%, 10%
	ESS						
	ICP	6010	ESS	NS	NS	5%	20%
	ESS						
Clean Water Act							
Water and Wastewater Samples							
Metals -	AA	200.0	ESS	-	NS	Opt, 10%	-
-	-						
	ICP	200.7	ESS	-	NS	-	-
	-						
Safe Drinking Water Act							
Finished Drinking and Raw Source Water							
Metals -	AA	200.0	ESS	-	NS	Opt, 10%	-
-	-						
	ICP	200.7	ESS	-	NS	-	-
	-						

ESS = Each Sample Set.
 CLP = CLP criteria are used.
 NS = Not Specified.
 OPT = Optional.

REC = Recommended.

TABLE 6
LIST OF KEY CURRENT EMPLOYEES AND JOB TITLES

<u>EMPLOYEE</u>	<u>JOB TITLES</u>
STEVEN LAZOFF	LABORATORY MANAGER
DAMIEN GADOMSKI, PhD	OPERATIONS MANAGER ENVIRONMENTAL ENGINEER
JOHN SCOLLARD, PhD	SENIOR SCIENTIST QA OFFICER
TOM MEADOWS	GC, GC/MS CHEMIST QUALITY ASSURANCE MANAGER
SHAUN NIELSON	CONVENTIONALS CHEMIST
OLGA ANALARYAN	CONVENTIONALS CHEMIST
KIOMARTH KHAZEPOUL	METALS CHEMIST
WAYNE FRANCIS	METALS CHEMIST
HYO-JUNG YOON, PhD	ANALYTICAL CHEMIST

ETHICS CODE AND NON-DISCRIMINATORY HIRING PRACTICES

Aquatic Research Inc. shall at all times conduct business in a manner which assures fair, equal, and non-discriminatory treatment of all persons without respect to race, color, religion, sex, national origin, age, handicap, or veteran status and will maintain open hiring and employment practices strictly complying with all requirements of applicable Federal, State, and Local laws.

Aquatic Research Inc. considers data integrity to be paramount. The company at no time will subject its employess to undue pressures to meet deadlines. Any data of dubious nature will not be released and will be thoroughly investigated. Sample re-analysis is required when QC criteria are not met and is encouraged when analysts do not feel substantially certain about their obtained results. Abusive or fraudulent practices are grounds for immediate termination.



CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
 ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM
 Accredited Fields of Testing



AQUATIC RESEARCH

Lab Phone (206) 632-2715

3927 AURORA AVENUE NORTH
 SEATTLE, WA 98103

Certificate No: 2625 Renew Date: 06/30/2009

Field of Testing: 102 - Inorganic Chemistry of Drinking Water

102.060	001	Nitrate calc.	EPA 353.2
102.070	001	Phosphate, Ortho	EPA 365.1
102.100	001	Alkalinity	SM2320B
102.121	001	Hardness	SM2340C
102.130	001	Conductivity	SM2510B
102.200	001	Fluoride	SM4500-F C
102.233	001	Nitrate calc.	SM4500-NO3 F
102.241	001	Phosphate, Ortho	SM4500-P F
102.251	001	Sulfate	SM4500-SO4 E
102.260	001	Total Organic Carbon	SM5310B
102.261	001	DOC	SM5310B
102.261	002	TOC/DOC	SM5310B

Field of Testing: 103 - Toxic Chemical Elements of Drinking Water

103.040	002	Antimony	SM3113B
103.040	003	Arsenic	SM3113B
103.040	008	Copper	SM3113B
103.040	013	Selenium	SM3113B

Field of Testing: 104 - Volatile Organic Chemistry of Drinking Water

104.040	000	Volatile Organic Compounds	EPA 524.2
104.040	000	Volatile Organic Compounds	EPA 524.2
104.045	005	Trihalomethanes	EPA 524.2
104.045	005	Trihalomethanes	EPA 524.2

Field of Testing: 105 - Semi-volatile Organic Chemistry of Drinking Water

105.090	001	Alachlor	EPA 525.2
105.090	003	Atrazine	EPA 525.2
105.090	004	Benz(a)pyrene	EPA 525.2
105.090	008	Di(2-ethylhexyl) Adipate	EPA 525.2
105.090	009	Di(2-ethylhexyl) Phthalate	EPA 525.2
105.090	016	Hexachlorobenzene	EPA 525.2
105.090	017	Hexachlorocyclopentadiene	EPA 525.2
105.090	022	Molinate	EPA 525.2
105.090	023	Pentachlorophenol	EPA 525.2
105.090	025	Simazine	EPA 525.2
105.090	028	Thiobencarb	EPA 525.2
105.090	029	Polynuclear Aromatic Hydrocarbons	EPA 525.2

AQUATIC RESEARCH

Certificate No: 2625
Renew Date: 06/30/2009

105.201	001	Halocetic Acids (HAA5)	EPA 552.3
Field of Testing: 108 - Inorganic Chemistry of Wastewater			
108.200	001	Ammonia	EPA 350.1
108.210	001	Kjeldahl Nitrogen	EPA 351.1
108.231	001	Nitrate calc.	EPA 353.2
108.380	001	Oil and Grease	EPA 1664
108.390	001	Turbidity	SM2130B
108.410	001	Alkalinity	SM2320B
108.451	001	Chloride	SM4500-Cl- C
108.464	001	Chlorine	SM4500-Cl F
108.496	001	Ammonia	SM4500-NH3 H (18h)
108.510	001	Nitrite	SM4500-NO2 B
108.542	001	Phosphate, Ortho	SM4500-P F
108.543	001	Phosphorus, Total	SM4500-P F
108.590	001	Biochemical Oxygen Demand	SM5210B
108.591	001	Carbonaceous BOD	SM5210B
108.602	001	Chemical Oxygen Demand	SM5220D
108.610	001	Total Organic Carbon	SM5310B
108.640	001	Surfactants	SM5540C
Field of Testing: 116 - Volatile Organic Chemistry of Hazardous Waste			
116.080	000	Volatile Organic Compounds	EPA 8260B
116.080	120	Oxygenates	EPA 8260B
Field of Testing: 117 - Semi-volatile Organic Chemistry of Hazardous Waste			
117.010	001	Diesel-range Total Petroleum Hydrocarbons	EPA 8015B
117.110	000	Extractable Organics	EPA 8270C

Scope of Accreditation

Aquatic Research, Inc.

Seattle, WA

is accredited by the State of Washington Department of Ecology to perform analyses for the parameters listed below using the analytical methods indicated. This Scope of Accreditation may apply to any of the following matrix types: non-potable water, drinking water, solid and chemical materials, and air and emissions. Accreditation for all parameters is final unless indicated otherwise in a note. Accreditation is for the latest version of a method unless otherwise specified in a note. EPA refers to the U.S. Environmental Protection Agency. SM refers to American Public Health Association's publication, Standard Methods for the Examination of Water and Wastewater, 18th, 19th or 20th Edition, unless otherwise noted. ASTM stands for the American Society for Testing and Materials. PSEP stands for Puget Sound Estuary Program. Other references are detailed in the notes section.

Matrix Type/Parameter Name	Reference	Method Number	Notes
Drinking Water			
Alkalinity, Total	SM	2320 B(4a)	
Chlorine Residual, Free	SM	4500-Cl F	
Color	SM	2120 B	
Cyanide, Total	SM	4500-CN E	
Fluoride	SM	4500-F C	
Hardness, Total (as CaCO ₃)	SM	2340 C	
Nitrate	SM	4500-NO ₃ F	
Nitrate + Nitrite	EPA	353.2	
Nitrite	SM	4500-NO ₃ F	
Orthophosphate	SM	4500-P F	
Orthophosphate	EPA	365.1	
pH	SM	4500-H	1
Solids, Total Dissolved	SM	2540 C	
Specific Conductance	SM	2510 B	
Sulfate	SM	4500-SO ₄ E	
Sulfate	ASTM	D516-02	
Total Organic Carbon	SM	5310 B	
Turbidity	EPA	180.1	
Aluminum	SM 18/19	3113 B	

Matrix Type/Parameter Name	Reference	Method Number	Notes
Aluminum	EPA	200.7	
Antimony	SM 18/19	3113 B	
Arsenic	SM 18/19	3113 B	
Barium	EPA	200.7	
Beryllium	EPA	200.7	1
Beryllium	SM 18/19	3113 B	
Cadmium	EPA	200.7	
Chromium	EPA	200.7	
Copper	EPA	200.7	
Copper	SM 18/19	3113 B	
Iron	EPA	200.7	
Lead	SM 18/19	3113 B	
Magnesium	EPA	200.7	
Manganese	EPA	200.7	
Mercury	EPA	245.2	
Nickel	EPA	200.7	
Selenium	SM 18/19	3113 B	
Silver	EPA	200.7	
Sodium	EPA	200.7	
Zinc	EPA	200.7	
Chlorinated Pesticides	EPA	508.1	
Haloacetic Acids	EPA	552.3	
PCBs	EPA	508.1	
Organic Compounds	EPA	525.2	
Purgeable Organic Compounds	EPA	524.2	
Trihalomethanes	EPA	524.2	
Vinyl Chloride	EPA	524.2	
Non-potable Water			
Acidity	SM	2310 B(4b)	
Alkalinity, Total	SM	2320 B(4b)	

Matrix Type/Parameter Name	Reference	Method Number	Notes
Ammonia	SM 18	4500-NH3 H	
Ammonia	EPA	350.1	
Anionic Surfactants	SM	5540 C	
Biochemical Oxygen Demand, BOD/CBOD	SM	5210 B	
Chemical Oxygen Demand (COD)	SM	5220 D	
Chloride	SM	4500-Cl- C	
Chlorine Residual, Total	SM	4500-Cl F	
Color	SM	2120 B	
Cyanide, Total	SM	4500-CN E	
Dissolved Oxygen	SM	4500-O C	
Fluoride	SM	4500-F C	
Hardness, Total (as CaCO3)	SM	2340 C	
Hexane Extractable Material	EPA	1664	
Nitrate	SM	4500-NO3 F	
Nitrate	EPA	353.2	
Nitrate + Nitrite	EPA	353.2	
Nitrite	SM	4500-NO2 B	
Nitrogen, Total	SM 20	4500-N C	
Nitrogen, Total Kjeldahl	EPA	351.1	
Nitrogen, Total Kjeldahl	SM	4500-Norg C	
Orthophosphate	EPA	365.1	
Orthophosphate	SM	4500-P F	
pH	SM	4500-H	
Phosphorus, Total	EPA	365.1	
Phosphorus, Total Persulfate	SM	4500-P F	
Solids, Total	SM	2540 B	
Solids, Total Dissolved	SM	2540 C	
Solids, Total Suspended	SM	2540 D	
Solids, Total Volatile	SM	2540 E	
Specific Conductance	SM	2510 B	

Matrix Type/Parameter Name	Reference	Method Number	Notes
Sulfate	ASTM	D516-02	
Sulfate	SM	4500-SO4 E	
Sulfide	SM	4500-S2 D	
Sulfide	SM	4500-S2 F	
Total Organic Carbon	SM	5310 B	
Turbidity	SM	2130 B	
Aluminum	EPA	200.7	
Aluminum	SM 18/19	3113 B	
Antimony	SM 18/19	3113 B	
Arsenic	SM 18/19	3113 B	
Barium	EPA	200.7	
Beryllium	EPA	200.7	
Beryllium	SM 18/19	3113 B	
Cadmium	SM 18/19	3113 B	
Cadmium	EPA	200.7	
Calcium	EPA	200.7	
Chromium	SM 18/19	3113 B	
Chromium	EPA	200.7	
Copper	SM 18/19	3113 B	
Copper	EPA	200.7	
Hardness, Total (as CaCO3)	EPA	200.7	
Iron	EPA	200.7	
Lead	EPA	200.7	
Lead	SM 18/19	3113 B	
Magnesium	EPA	200.7	
Manganese	EPA	200.7	
Mercury	EPA	1631	
Molybdenum	SM	3113 B	
Nickel	EPA	200.7	
Potassium	EPA	200.7	

Matrix Type/Parameter Name	Reference	Method Number	Notes
Selenium	SM 18/19	3113 B	
Silica	EPA	200.7	
Silver	EPA	200.7	
Silver	SM 18/18	3113 B	
Sodium	EPA	200.7	
Vanadium	EPA	200.7	
Zinc	EPA	200.7	
Organochlorine Pesticides	EPA	8081	
Organochlorine Pesticides	EPA	608	
Polychlorinated Biphenyls	EPA	8082	
Polychlorinated Biphenyls	EPA	608	
BNA Extr (Semivolatile) Organics	EPA	8270	
Volatile Organic Compounds	EPA	8260	
Fecal Coliform - count	SM	9222 D	2
Total & Fecal Coli - count	SM	9221 B1,2,C&E1	
Solid and Chemical Materials			
Aluminum	EPA	6010	1
Barium	EPA	6010	1
Beryllium	EPA	6010	1
Cadmium	EPA	6010	1
Calcium	EPA	6010	1
Chromium	EPA	6010	1
Cobalt	EPA	6010	1
Copper	EPA	6010	1
Iron	EPA	6010	1
Lead	EPA	6010	1
Manganese	EPA	6010	1
Molybdenum	EPA	6010	1
Nickel	EPA	6010	1
Silver	EPA	6010	1

Matrix Type/Parameter Name	Reference	Method Number	Notes
Sodium	EPA	6010	1
Strontium	EPA	6010	1
Titanium	EPA	6010	1
Vanadium	EPA	6010	1
Zinc	EPA	6010	1
Glycols	EPA	8015	
Total Pet Hydrocarbons - Diesel	WDOE	NWTPH-Dx	
BNA Extr (Semivolatile) Organics	EPA	8270	
Volatile Organic Compounds	EPA	8260	

Accredited Parameter Note Detail

(1) Provisional pending acceptable proficiency testing (PT) results (WAC 173-50-110). (2) Provisional pending receipt of evidence that requirements in the microbiology audit report have been met.



Authentication Signature

May 9, 2008

Date

Stewart M. Lombard, Lab Accreditation Unit Supervisor

