

# Quality Assurance Project Plan

FOR

## WACCAMAW RIVER WATER QUALITY MONITORING PROGRAM

Lead Organization: Coastal Carolina University  
Burroughs and Chapin Center for Marine and  
Wetland Studies  
Waccamaw Watershed Academy  
Environmental Quality Lab (Lab ID 26001)

Project Manager: John Michael Trapp, EQL Laboratory Director  
CCU, Environmental Quality Lab

Principal Investigators: John Michael Trapp, EQL Laboratory Director  
CCU, Environmental Quality Lab

Susan M. Libes, EQL Program Director  
CCU, Waccamaw Watershed Academy

October 2011

## WACCAMAW RIVER WATER QUALITY MONITORING PROGRAM

### Management Approvals:

Signature indicates that this QAPP is approved and will be implemented in conducting the research of this project.

John Michael Trapp, PhD  
Project Manager and Liaison  
Coastal Carolina University  
Burroughs and Chapin Center for Marine and Wetland Studies  
Environmental Quality Lab

  
\_\_\_\_\_  
Signature

3/29/12  
\_\_\_\_\_  
Date

Susan M. Libes, PhD  
EQL Program Director  
Coastal Carolina University  
Waccamaw Watershed Academy  
Burroughs and Chapin Center for Marine and Wetland Studies  
Environmental Quality Lab

  
\_\_\_\_\_  
Signature

3/29/12  
\_\_\_\_\_  
Date

### Quality Assurance:

Signature indicates that this QAPP meets the quality requirements of USEPA and SCDHEC.




**Bureau of Environmental Services  
Office of Quality Assurance**

**MEMO**

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**DATE:** March 28, 2012

**TO:** Dr. Michael Trapp,  
Coastal Carolina University

**FROM:** Nydia F. Burdick,  
Manager, Office of Quality Assurance 

**SUBJECT:** Waccamaw River Quality Monitoring Project QAPP

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This is to inform you that your QAPP entitled "Waccamaw River Quality Monitoring Project QAPP" is fully approved except for the following caveat:

Because SC DHEC analysis of nutrients is based on non-filtered waters, it is not possible to compare the data obtained from filtering samples. Therefore, SC DHEC will not use the data from filtered water for nutrient data to make regulatory decisions. This data will only be considered for informational purposes.

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## A. PROJECT MANAGEMENT

### A3 Distribution List:

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### A4 Project/Task Organization:

The tasks of the Environmental Quality Lab (EQL) in the Waccamaw River Water Quality Monitoring Program are to conduct sampling and analysis for regulatory-level, water-quality monitoring at six sites in the Waccamaw River and one site in the Pee Dee River. This sampling will be conducted in close proximity to existing U.S. Geological Survey (USGS) river gaging stations to take advantage of applicable continuous data collection at those sites.

The organization and lines of responsibility for EQL for this project are shown in **Figure 1**.

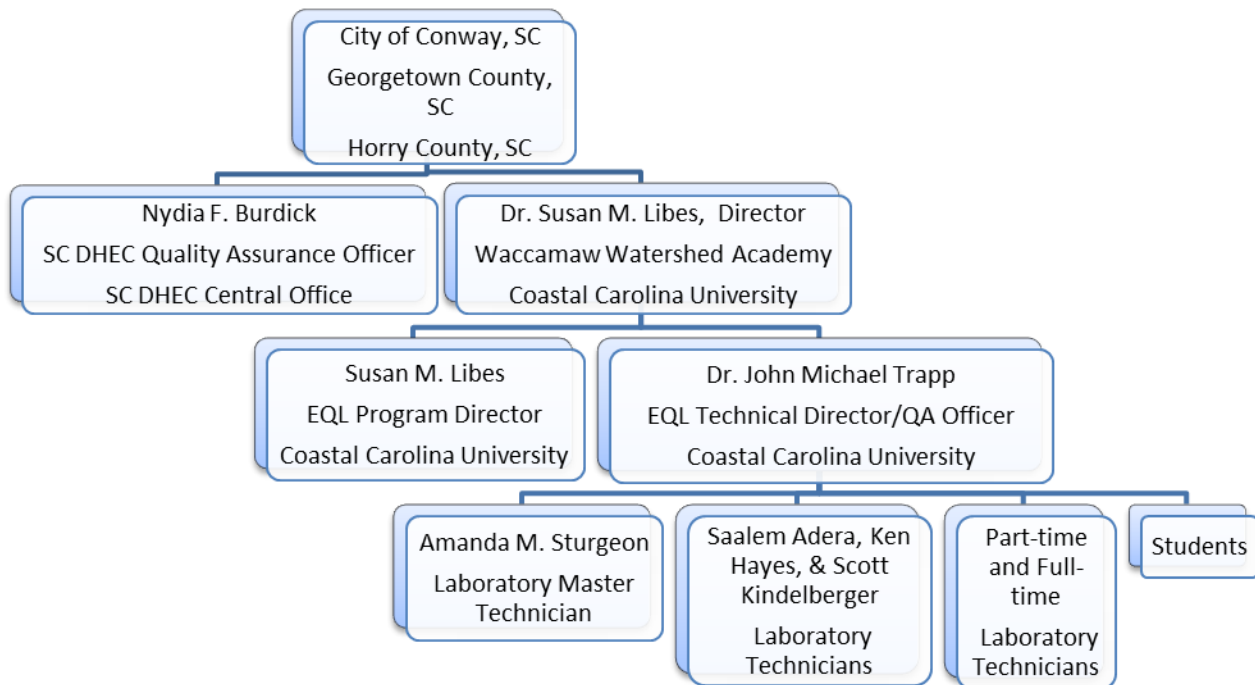
The responsibilities of the EQL participants are as follows:

#### *Laboratory Quality Assurance Officer-Dr. J. Michael Trapp*

The Laboratory Quality Assurance Officer (QAO) is responsible for the direction of all laboratory quality assurance (QA) activities, and reports directly to the Laboratory Director. QAO responsibilities include development, documentation, and evaluation of quality assurance/quality control (QA/QC) procedures and policy. The QAO is also responsible for writing and maintaining the QAPP. The QAO conducts internal audits, reviews data reports, compiles and evaluates method performance, trains staff in QA/QC requirements, tracks nonconformance and corrective actions, prepares quality documents and reports, and reviews standard operating procedures (SOPs). A primary responsibility of the QAO is to ensure that all personnel have a clear understanding of the QA program, know their roles relative to one another, and appreciate the importance of their roles to the overall success of the program.

Deputies to act in the Quality Assurance Officer’s absence include the Laboratory Program Director and Laboratory Master Technician (relative to their particular work areas). Since staffing of the laboratory is not sufficient at this time to assign both a QAO and a Laboratory Director; Dr. Trapp functions in both of these positions. The QAO, and any deputies performing in a QAO capacity, have the authority to stop any work where quality is deemed questionable.

**Figure 1. Project Organization**



*Laboratory Technical Director- Dr. J. Michael Trapp*

The Laboratory Technical Director, also referred to throughout this document and other laboratory documents as the Laboratory Director, oversees all functional aspects of the EQL. Duties may include, but are not limited to, overseeing personnel training, equipment and systems maintenance, laboratory safety, working with customers to identify project-specific requirements, monitoring scheduling and status of work, approval of EQL standard operating procedures, implementing preventive and corrective actions, and cost control. The Laboratory Director is ultimately responsible for the timely reporting of data and for ensuring that the data meet the client's specifications. Deputies to act in the Laboratory Director’s absence include the Laboratory Program Director and the Laboratory Master Technician, relative to their particular work areas.

### *Laboratory Program Director – Dr. Susan Libes*

The Laboratory Program Director is a senior faculty member of Coastal Carolina University. The Program Director develops applied and basic research projects appropriate for utilizing and expanding the capabilities of the laboratory. The Program Director coordinates the involvement of students in the EQL to facilitate the laboratory goal of training students for careers in environmental chemistry and marine analytical technology. The Program Director meets frequently with the Laboratory Director to discuss and plan business development activities.

### *Laboratory Master Technician*

The Laboratory Master Technician reports directly to the Laboratory Director. The Laboratory Master Technician is responsible for generating technically valid analytical results to be reported on environmental samples and for documenting all data in support of those results. It is the responsibility of the master technician to follow quality control procedures specified in laboratory standard operating procedures (SOPs), as well as the fulfillment of any special quality control (QC) procedures that are designated for an analysis, and to document any deviations from QC specifications, when conducting sample preparations, analyses, data entry, data reductions and validation.

The Laboratory Master Technician instructs and serves as a mentor for new laboratory staff and students in laboratory procedures for sampling, analysis, and record keeping. The master technician serves as the primary contact for the laboratory in the absence of the Laboratory Director. Throughout this document any listing or reference to technician is also meant to include master technician.

The Laboratory Master Technician also must perform, when applicable, instrument calibration, maintenance and troubleshooting. The Laboratory Master Technician also writes analytical SOPs at the direction of the QA Officer or Laboratory Director. The master technician is responsible for critically observing and evaluating all procedures performed by both herself/himself and any others working in the laboratory. The master technician is also responsible for bringing any practices or occurrences that might affect the reliability of analytical data to the attention of the individual involved and the Laboratory Director/QAO. The master technician is required to perform and document any necessary corrective action, enlisting the assistance of the Laboratory Director or QAO when needed.

### *Laboratory Technician*

The Laboratory Technician reports directly to the Laboratory Director. The Laboratory Technician is responsible for generating technically valid analytical results to be reported on environmental samples and for documenting all data in support of those results. It is the responsibility of the technician to follow quality control procedures specified in laboratory standard operating procedures (SOPs), as well as the fulfillment of any special



quality control (QC) procedures that are designated for an analysis, and to document any deviations from QC specifications, when conducting sample preparations, analyses, data entry, data reductions and validation.

The Laboratory Technician also must perform, when applicable, instrument calibration, maintenance and troubleshooting. The Laboratory Technician may be required to write analytical SOPs at the direction of the QA Officer or Laboratory Director. The technician is responsible for critically observing and evaluating all procedures they perform, and for bringing any practices or occurrences that might affect the reliability of analytical data to the attention of the Laboratory Director or QAO. The technician is required to perform and document any necessary corrective action, enlisting the assistance of the Laboratory Director or QAO when needed.

### *Student*

The students working in the EQL report directly to the Laboratory Director. Students perform activities required to support laboratory operations, conduct sample analyses, and/or participate in independent study projects. This work may include sample preparation, maintenance activities on equipment (such as ovens, balances, and glassware), data archiving, research, and other duties, as needed. Each student is required to follow quality control procedures specified in laboratory standard operating procedures (SOPs), as well as the fulfillment of any special quality control (QC) procedures that are designated for an activity, and to document any deviations from QC specifications. He/she is also responsible for critically observing and evaluating all procedures they perform and for bringing any practices or occurrences that might affect the reliability of analytical data the attention of the Laboratory Director or QAO.

## **A5 Background and Project Objectives:**

The goal of this project is to provide water quality data to the SMS4s (Horry County, Georgetown County and the City of Conway) that lie in HUC 03040206. These data are designed to support the NPDES Phase II Stormwater programs undertaken by Small Municipal Separate Storm Sewer Systems (SMS4s) as covered by SC DHEC Permit #SCR030000. The data will be used to assess: (1) site-specific “normal” conditions for the Waccamaw and Pee Dee Rivers, (2) long-term trends, (3) the occurrence of illicit discharges, and (4) for the development of TMDLs for water bodies with specific impairments.

The data have been collected twice per month at the sites listed in **Table 1** since January 2008. Thus, this is an ongoing project. Measurements of temperature, conductivity, dissolved oxygen and pH are made in situ. Grab samples are returned to the lab for analysis of: (1) nutrients (filtered TN (not certified) and TP), (2) chlorophyll (and phaeophytin), (3) bacteria (Fecal Coliform), (4) 5-Day Biochemical Oxygen Demand (BOD5), (5) turbidity, and (6) water toxicity (not a certified parameter). Validated results, updates on finding and specific regulatory information about each site are provided to the SMS4s at the public at a website maintained by the Burroughs & Chapin Center for Marine and Wetland Studies ([https://bcmw.coastal.edu/river\\_gauge/](https://bcmw.coastal.edu/river_gauge/)). **Table 1** lists other

data collected concurrently, including water quality, height, velocity and discharge by the USGS. The former are collected at 15-min intervals. Monthly samples collected by SC DHEC personnel as noted in Table 1, with some sites being active only during basin study years, the last of which was 2008. Grab sampling is staggered with the SC DHEC schedule such that the pooled data represent two to three samplings per month.

Other project deliverables include: (1) an annual report containing a data summary, statistical analyses of temporal trends, exceedances of known water quality standards, a narrative interpretation (2) emergency notification if sample results exceed SC DHEC's water quality standards or the US EPA's recommended water quality criteria, and (3) submission to DHEC for consideration in developing future regulatory plans.

**Table 1:** Sampling Sites showing data collected by USGS and SC DHEC plus 303(d) and TMDL status

Site #	Municipality	Lat/Long, NAD	USGS		2008 303 (d) & TMDL Status**	SC DHEC			
	HUC	Drainage Area	# / Name	Parameters*		DHEC	Type	Status	Bi-Monthly Measurements
1	Horry, HUC 03040206	Latitude 33°57'12", Longitude 78°43'12" NAD27. 49.4 sq. mi.	02110400 Buck Creek near Longs	ALL + Precip	AL: Copper and Nickel; Dissolved oxygen, standard attained in 2006 and 2008	PD-362	Integrator	Inactive	Temp,DO,pH, Turb, BOD5, DIN, TKN, DP, FC,Alk
2	Horry, HUC 03040206	Latitude 33°54'45", Longitude 78°42'55" NAD27. 1,110 sq. mi.	02110500 Waccamaw River near Longs	ALL	AL: Copper (since 2002); Dissolved Oxygen, standard attained 2004 FISH: Mercury	MD-124	Integrator	Inactive	Temp,DO,pH, Turb, BOD5, DIN, TKN, DP, FC,Alk
3	Conway. HUC 03040206	Latitude 33°49'47", Longitude 79°02'38" NAD27. 1,440 sq. mi.	02110704 Waccamaw River at Conway Marina	ALL	TMDL: Dissolved Oxygen, Standard not attained	MD-110	Pee Dee Basin Site	Inactive	
4	Conway, HUC 03040206	Latitude 33°51'39", Longitude 79°02'29" NAD27. 17.8 sq. mi.	02110701 Crabtree Swamp	ALL- Q (tidal) + Precip	AL: Dissolved Oxygen REC: Fecal Coliform standard attained in 2008	MD-158	Pee Dee Basin Site	Inactive	
5	Georgetown, HUC 03040206	Latitude 33°38'56", Longitude 79°05'40" NAD27. ??? sq. mi.	02110802 Waccamaw River At Bucksport	Ht, T, DO	TMDL: Dissolved Oxygen, Standard attained	MD-146	Pee Dee Basin Site	Inactive	
6	Georgetown, HUC 03040206	Latitude 33°30'23", Longitude 79°07'38" NAD27. ??? sq. mi.	021108125 Waccamaw River near Pawleys Isl.	Ht, T, DO, Cond	None	MD-142	Integrator	Active	Temp,DO,pH, Turb, BOD5, DIN, TKN, DP, FC,Alk
7	Horry, HUC 03040206	Latitude 33°58'24", Longitude 79°14'27" NAD27. 24.6 sq. mi.	02135060 Chinners Swamp near Aynor	ALL	REC: Fecal Coliform standard attained in 2006 and 2008	PD-352	Integrator	Active	Temp,DO,pH, Turb, BOD5, DIN, TKN, DP, FC,Alk
8	Horry, HUC 03040206	Latitude 33°51'02", Longitude 78°53'52" NAD27. ????? sq. mi.	Reeves Ferry	ALL	REC: Fecal Coliform (2010)	PD-369	Pee Dee Basin Site	Inactive	
9	Horry, HUC 03040206	Latitude 34°03'24", Longitude 79°14'53" NAD27. ?????? sq. mi.	Galivants Ferry	ALL	None				

\*ALL = Temperature, DO, Turbidity, pH, Conductivity, Ht, Q,velocity ; Q = Discharge; Ht = Water height; T = temperature; DO = dissolved oxygen, Cond = conductivity, Precip = rainfall

\*\*AL = Aquatic life criteria; REC = Recreational criteria; FISH = Fish consumption criteria; TMDL = Total Maximum Daily Load.

The 303(d) listing and TMDL status of the sampling sites are also shown in Table 1. Sites are listed for dissolved oxygen, fecal coliform, and metals. Most of these listings have been continuous since the 1990s suggesting chronic issues with eutrophication, hypoxia, bacterial contamination, and toxics. These problems are somewhat interlinked with conditions of low dissolved oxygen (hypoxia) arising from the introduction of sewage and septage that also carry bacteria into natural waters. Introduction of nutrients from runoff of fertilizers and the breakdown of organics, such as sewage and septage, stimulate plant growth. Overgrowth of algae produces organic matter which eventually decays, thereby reducing dissolved oxygen levels and leads to hypoxia.

The relationship between the parameters measured and existing water quality standards is presented in **Table 2**. The frequency which sites contravene the water quality standards is used to identify hot spots. This provides guidance for illicit discharge inspections and restoration activities. In some cases, site-specific standards need to be developed. This is another planned use of the data once a significant time period has been sampled.

**Table 2.** Status of Water Quality Standards for the Waccamaw River and Coastal Waters

<i>Parameter</i>	<i>Waccamaw River</i>	<i>Pollutant Problem</i>
Temperature	Narrative WQS (Class FW, SC DHEC)	Thermal pollution, contributes to low DO by lowering gas solubility
Dissolved Oxygen (DO)	Site Specific Quantitative WQS (Class FW, SC DHEC)	Hypoxia and anoxia that lead to fish and benthic animal mortality
Turbidity	Quantitative WQS (Class FW, SC DHEC) EPA recommendation*	Indicator of excessive soil erosion or introduction of other particles. Particles carry absorbed pollutants such as toxics and bacteria.
Fecal Coliform	Quantitative WQS (Class FW, SC DHEC)	Presence of pathogens from septage, sewage or animals
Conductivity	None	Accepted tracer of polluted stormwater runoff.
BOD5	None	Indicator of oxygen-demanding substances such as septage, sewage, eroded soils, decaying vegetation.
Chlorophyll	EPA recommendation*	Indicator of algal overgrowth.
Nutrients	EPA recommendation*	Stimulates algal overgrowth. Caused by fertilizer runoff and breakdown of organics such as sewage, septage and eroded soils.
Toxicity	None	Broad screen of water toxicity reflecting high levels of metals, herbicides, pesticides, etc.

S.C. Regulation 61-68, *Water Classifications and Standards* and S.C. Regulation 61-69, *Classified Waters*

\*US EPA (2000) Ambient Water Quality Criteria Recommendations Information Supporting the Development Of State And Tribal Nutrient Criteria For Rivers And Streams In Nutrient Ecoregion XIV, EPA 822-B-00-022

\*\*US EPA (2008) National Coastal Condition Report III, EPA/842-R-08-002

Due to the high cost of measuring individual toxic compounds, a broad screen of water toxicity is being performed. Samples that have high toxicity should be further analyzed to identify the specific toxics. High levels of toxicity are indicative of the presence of toxics, such as heavy metals, pesticides, herbicides, etc. The IQ Toxicity Test™ by Kingwood Diagnostics (<http://www.kingwooddiagnostics.com/>) is being used to perform this screen as it has been verified by the USEPA under their Environmental Technology Verification Program. The verification report for this test is located at: [http://www.battelle.org/environment/pdfs/verifications/water/verifications/01\\_vr\\_aqua\\_survey.pdf](http://www.battelle.org/environment/pdfs/verifications/water/verifications/01_vr_aqua_survey.pdf). The IQ Toxicity Test™ characterizes the toxicity of a water sample by measuring short-term stressor-related suppression of enzyme activity in *Daphnia magna*, a freshwater aquatic invertebrate that reacts rapidly when exposed to toxins.

#### **A6 Project/Task Description and Schedule:**

The tasks of the EQL in the Waccamaw River Water Quality Monitoring Program are to conduct sampling and analysis for regulatory-level, water-quality monitoring at six sites in the Waccamaw River and one site in the Pee Dee River. Laboratory staff will conduct field measurements and collect samples at the seven study sites shown in **Figure 2**. Collected samples will be analyzed for the following:

1. nutrients, filtered total nitrogen and filtered total phosphorus
2. chlorophyll *a* and pheophytin *a*
3. fecal coliform bacteria
4. 5-day biochemical oxygen demand (BOD<sub>5</sub>)
5. water toxicity
6. turbidity

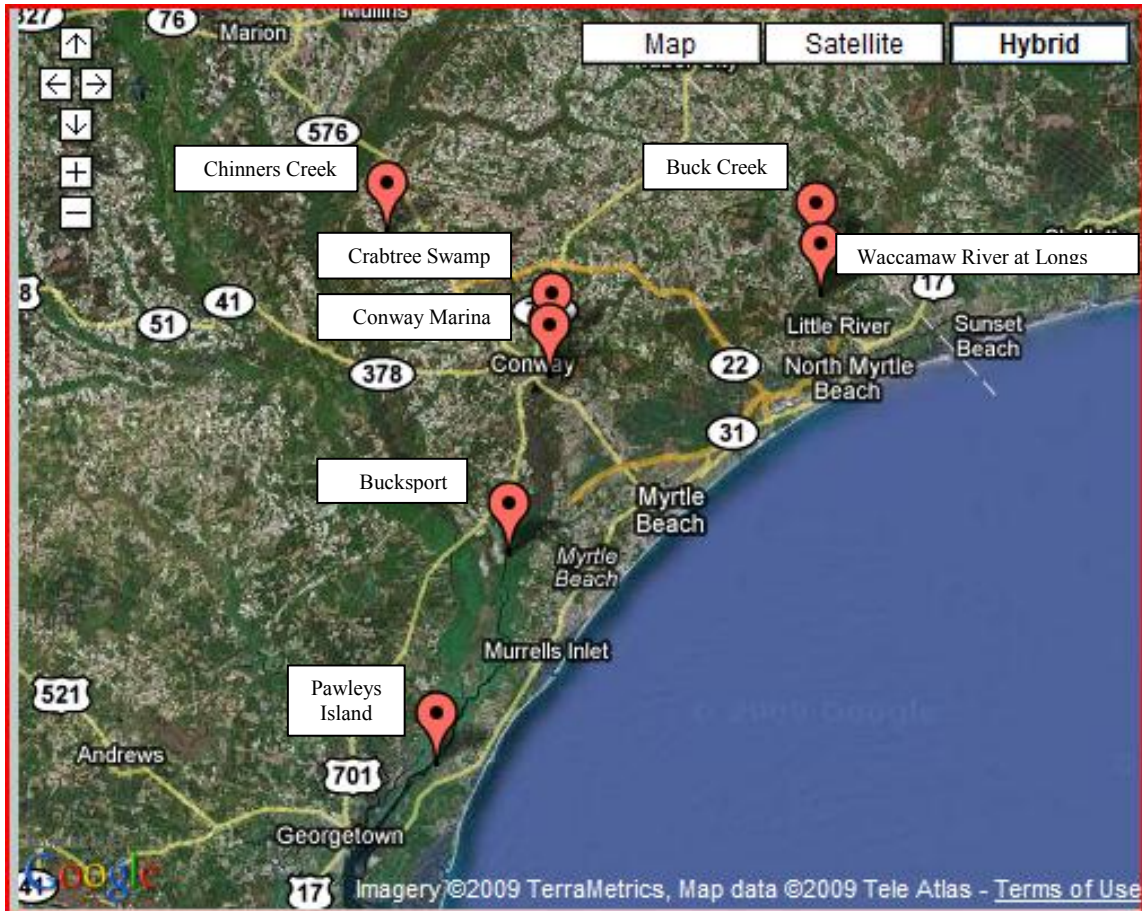
The seven sampling sites are all USGS river gauging sites where some or all field measurements for temperature, conductivity, dissolved oxygen, pH, and turbidity are continuously performed. Typically samples are collected on first and third Wednesday or Thursday of the month. Weather does not impact this schedule unless it is severe.

While there are no time constraints, there are personnel and certification issues. It is hoped that Dr. Trapp will be able to hire a lab manager in order to relinquish one of the several roles he has. Another constraint is that of the Total Nitrogen (TN) parameter. Dr. Trapp is in the process of asking for an Alternative Test Procedure allowance by EPA. Until that is obtained, TN data will be for informational purposes only. It should be noted that these filtered results will not be directly comparable to DHEC results.

As previously discussed, sampling has been conducted by EQL staff twice each month beginning in January 2008. In addition to EQL sampling and analyses at these river gage sites, South Carolina Department of Health and Environmental Control (SCDHEC) also samples once every other month. EQL and SCDHEC communicate regularly to ensure they do not sample during the same week. The purpose of this QAPP is to describe a

project that has already begun, but previous data will be used for historical purposes. The Project is open-ended and will continue indefinitely and on the same schedule as described above. It is possible that the sampling sites and/or parameters will be augmented and a QAPP Addendum or revision will be published if that occurs.

**Figure 2. Project Monitoring Sites.**



#### **A7 Data Quality Objectives and Criteria for Data Measurement:**

The DQO Process:

- 1.State the Problem:** The municipalities want to know when and where illicit discharges occur as well as provide data for regulatory purposes.
- 2.Identify the Decision-** This is an investigative study. The only decisions that will be made will be whether an illicit discharge exists.
- 3.Inputs to the Decision-** The lab data obtained and field observations of the water conditions.

4. **Define the Study Boundaries-** The sites shown in Figure 2 and sampling at a depth of 0.3 meters.
5. **Develop an analytical approach and a decision rule-** The first priority is to determine water quality, other priorities include obtaining data for regulatory purposes, and possibly determining illicit point source discharges. The only decision rule would be if a point source discharge is identified. If a point source discharge is discovered then the SMS4 involved would determine the course of action which may include additional sampling sites and sampling.
6. **Specify Limits on Decision Error-** This is mostly non-applicable. However, in terms of the decision rule stated above, additional sampling would be performed to limit decision error.
7. **Optimize the design for obtaining the data-** This is an ongoing study with multiple years and multiple sampling sites and with 2 samples per month, this is enough to ensure that DQIs of representativeness are met. Comparability is assured because the same methodology is used to collect and analyze the samples. Accuracy is established through quality control limits for each parameter measured and for each analytical technique, per matrix where applicable. Precision is established through quality control limits for each parameter measured and for each analytical technique, per matrix where applicable. Detectability is established by reporting limits (RLs) which are the minimum concentrations to be reported without qualification for routine laboratory conditions for each parameter measured and for each analytical technique. Enough samples have been collected in the past and will be in the future that the loss of a sample is not critical and while completeness is important, this is not a critical DQI.

Two types of decision points are required by this project: (1) Detection of significant temporal and spatial trends for the seven sampling sites and (2) identification of single samples that contravene numeric water quality standards. The former will be detected with a seasonal Mann-Kendall trend analysis test after collection of three years of data (Gilbert 1987; Gibbons and Colman 2001) and the later with the protocols laid out in Gibbons and Colman (2001) for comparison of a single measurement to a regulatory standard. Development of site specific standards will follow the protocols laid out in US EPA (2000). Confirmations of 303(d) listing status and standards attainment will also be made using SC DHEC parameter thresholds (SC DHEC 2008).

Because this is an open-ended monitoring program, statistical analysis will be conducted on an ongoing basis.

As previously stated, EQL's tasks in the Waccamaw River Water Quality Monitoring Program are to conduct sampling and analysis for regulatory-level, water-quality monitoring at six sites in the Waccamaw River and one site in the Pee Dee River. EQL provides copies of all measurement results for those sampling and analysis activities to the SMS4 contacts for evaluation and use in actions designed to eliminate illicit discharges and reduce pollutants in stormwater runoff. EQL is a certified laboratory in the SC DHEC's Environmental Laboratory Certification Program (Appendix B) and established DQIs and

associated action criteria to ensure collected and generated data satisfy the project's and data users' needs.

The quality of measurements made for the project by this laboratory is determined by the following DQIs, or characteristics: representativeness, accuracy, precision, detectability, completeness, and comparability. Specific criteria for each characteristic were established to assist in the selection of appropriate sampling and analytical protocols and to identify applicable documentation, sample handling procedures, and measurement system procedures. These DQI criteria were established based on site conditions, requirements of the project, and knowledge of available measurement systems, and were addressed whenever appropriate for the data generated.

### *Representativeness*

Representativeness is a qualitative measure of the extent to which a sample acquired from a matrix describes the chemical or physical characteristics of that matrix. Sample collection, handling (e.g., splitting, preservation, storage), and measurements are all conducted according to protocols allowing for the highest degree of representativeness possible for the sample media (air, soil, water, etc.). Recording procedures are utilized which document adherence to proper protocols and maintain sample identification and integrity.

### *Accuracy*

Accuracy describes the degree of agreement between an observed value and an accepted reference (true) value. It includes a combination of random error (precision) and systematic error (bias) components which are introduced in sampling and analytical operations. DQI criteria for accuracy are established through quality control limits for each parameter measured and for each analytical technique, per matrix where applicable. These objectives are assessed through the analysis of sterility checks, positive and negative culture checks, blanks, matrix spike (MS)/matrix spike duplicates (MSDs), and laboratory control samples (LCSs), as specified by the analytical method, required by the project, or generated and updated from data acquired through required quality control measurements. Nominal quality control limits for each parameter and analytical technique are specified in the analytical methods.

### *Precision*

Precision is a measure of the reproducibility of an analysis under a given set of conditions, regardless of the true value of the target analyte in a sample. The overall precision of a sampling event has both a sampling and an analytical component. DQI criteria for precision are established through quality control limits for each parameter measured and for each analytical technique, per matrix where applicable. These objectives are assessed through the analysis of MSDs (if practical), LCS duplicates (if available), field duplicates, laboratory replicates, and split laboratory samples, as specified by the analytical method, required by the project, or generated and updated from data acquired through required quality control measurements. Nominal quality control limits are specified for each parameter and analytical technique in the analytical methods.



### *Detectability*

Method detectability objectives define the lowest concentration or quantities required of the measurement system for each analyte or parameter. The laboratory has established reporting limits (RLs) which are the minimum concentrations to be reported without qualification for routine laboratory conditions. Data quality indicator criteria for detectability (i.e., RLs) are established for each parameter measured and for each analytical technique. These criteria are specified by the analytical method, required by the project, or determined and updated from data acquired through required quality control measurements (e.g., the replicate analyses of samples or standards containing low concentrations of the analyte of concern).

The RL for an analyte is a function of the specific analytical procedures and can vary substantially as a result of dilutions and similar procedure modifications. In all cases, the RL necessary to fulfill data quality objectives is confirmed by laboratory measurements. Nominal RLs for each parameter and analytical technique are listed in the analytical methods and on the report of analysis.

### *Completeness*

The characteristic of completeness is a measure of the amount of valid data obtained compared to the amount that was expected to be obtained under normal conditions. The amount of valid data expected is based on the measurements required to accomplish project objectives.

### *Comparability*

The characteristic of comparability reflects both internal consistency of measurements and expression of results in units consistent with other organizations reporting similar data. The generation of comparable data requires operating within the calibrated range of an instrument and utilizing analytical methodologies which produce comparable results. Appropriate standard units for measurement values are utilized for each measurement system, which yields internally and externally comparable results assuming other comparability criteria are met.

### *Project DQIs*

Because of the intended data uses, the general philosophy for determining the project's DQI criteria was that data quality should meet current industry standards for such measurement data. In general, measurement DQI criteria are based on the following:

- Temperature by thermometer or thermistor, based on Method 2550 B. of *Standard Methods*
- Conductivity by electrical conductivity, based on Method 2510 B. of *Standard Methods*

- Dissolved oxygen by membrane electrode method, based on Method 4500-O G. of *Standard Methods*
- pH (hydrogen ion concentration) by electrometric method, based on Method 4500-H+ B. of *Standard Methods*
- Turbidity by nephelometry, based on Method 2130 B. of *Standard Methods*
- Total nitrogen by alkaline persulfate oxidation of filtered or unfiltered samples followed by cadmium reduction and colorimetric measurement, based on Methods 4500-N C., 4500-NO<sub>3</sub><sup>-</sup> E., and 4500-N<sub>org</sub> D. of *Standard Methods*
- Total phosphorus by alkaline persulfate oxidation of filtered or unfiltered samples followed by colorimetric measurement, based on Methods 4500-P B., 4500-P E., and 4500-P H. of *Standard Methods*
- Chlorophyll *a* and pheophytin *a* by fluorometric technique, based on Method 10200 H. of *Standard Methods*
- Fecal coliform bacteria by fecal coliform direct test (A-1 medium), based on Methods 9221 C. and 9221 E. of *Standard Methods*
- 5-day biochemical oxygen demand (BOD<sub>5</sub>) by measurement oxygen consumed in incubated samples in a 5-day period, based on Method 5210 B. of *Standard Methods*
- Water toxicity by Kingwood Diagnostics IQ Toxicity Test™, <http://www.kingwooddiagnostics.com/> verified by the USEPA under their Environmental Technology Verification Program (For information purposes only)

Specific criteria for measurement DQIs for the analyses to be performed are summarized in **Table 3**.

**Table 3. Specific criteria for measurement DQIs.**

Parameter	Units	Accuracy <sup>a</sup> (LCS)	Accuracy <sup>a</sup> (Matrix Spike)	Precision <sup>a</sup> (RSD or RPD)	MDL <sup>b</sup>	RL <sup>c</sup>	Completeness (%)
Air Temperature	°C	± 1.0°C	NA	± 1.0°C	NA	NA	95
Water Temperature	°C	± 0.5°C	NA	± 0.5°C	NA	NA	95
Conductivity <200 µS/cm	µS/cm	90-110%	NA	≤25%	<50	<50	95
Conductivity ≥200 µS/cm	µS/cm	95-105%	NA	≤20%	NA	NA	95
Dissolved Oxygen	mg/L	90-110%	NA	≤25%	<0.3	<0.3	95
pH	Standard Units (S.U.)	±0.1 S.U.	NA	±0.1 pH	NA	NA	95
Turbidity	NTU	90-110%	NA	≤25%	<0.5	<0.5	95
Total Nitrogen	mg/L	90-110%	75-125%	≤25%	<0.05	<0.05	95
Total Phosphorus	mg/L	90-110%	65-135%	≤35%	<0.003	<0.003	95
Chlorophyll A	µg/L	90-110%	NA	≤25%	<1.0	<1.0	95
Phaeophytin	µg/L	90-110%	NA	≤35%	<1.0	<1.0	95
Fecal Coliform <150 MPN/100 mL	MPN/100 mL	Each media lot must pass sterility, negative, and positive QC checks	NA	≤200%	<2	<2	95
Fecal Coliform ≥150 MPN/100 mL	MPN/100 mL	Each media lot must pass sterility, negative, and positive QC checks	NA	≤100%	NA	NA	95
5-Day Biochemical Oxygen Demand	mg/L	85-115%	85-115%	≤25%	<2.0	<2.0 <sup>d</sup>	95

LCS = laboratory control sample  
 MDL = method detection limit  
 MS = matrix spike  
 NA = not applicable

% R = percent recovery  
 RL = reporting limit  
 RPD = relative percent difference  
 % RSD = percent relative standard deviation

<sup>a</sup> Criteria apply to concentrations ≥ RL.

<sup>b</sup> For undiluted samples.

<sup>c</sup> For undiluted samples. If sample is diluted, RL is proportionally higher.

<sup>d</sup> Method constraint for valid measurement. Many river samples are below this method constraint, which was designed primarily for waste water discharges, so measured values for river samples will be reported.

## **A8 Special Training Requirements and Certifications**

The Certificate issued by the SC DHEC Office of Environmental Laboratory Certification is 26001002.

The generation of reliable data by a laboratory requires that all operations are conducted by knowledgeable and trained personnel. The laboratory requires the accomplishment of a prescribed sequence of training objectives by a staff member before that individual is designated as qualified and permitted to independently conduct any assignment or analyses. The indoctrination and qualification process includes as a minimum:

- Reading and understanding applicable laboratory SOP,
- Reading and understanding applicable reference documents,
- Hands-on training under the supervision of an experienced and qualified individual, and
- For analytical methods used for measurements, a successful initial demonstration of analytical capability (i.e., IDC) by performing four replicate measurements which satisfy precision and accuracy criteria for the method (IDC Form 1020, Appendix A) as well as a MDL Study.

Training records for staff are maintained by the Laboratory Director, and training files are kept for each staff member in the training and qualification files. Lab analysts also collect samples and perform field parameters. A summary of training accomplishments is recorded on a Personnel Qualification Record, Form 110 (Appendix A).

## **A9 Documentation and Records:**

Personnel on the distribution list will receive the QAPP Electronic.

An email report will be sent out for each sampling event. The report will include:

1. A narrative including sample collection and analysis results
2. A Summary of findings and observations
3. The actual data in spreadsheet format

All records and documents generated by EQL specifically for this project are described and listed in **Table 17** in the “Data Management” element of this QAPP. The formats of the records are illustrated in the copies of all applicable forms provided in Appendix A. The server is backed up weekly to an external hard drive. Annually, electronic records are backed up onto disk and kept for a minimum of 10 years. Hardcopies are bound and stored for a minimum of 10 years. All records are kept onsite.

EQL document control procedures are described in the “Analysis: Document Control” element of this QAPP, and controlled copies of this QAPP are provided to the addressees

listed in the “Distribution List” element.

### *Data Reporting*

After completion of analyses, analysts enter results for both samples and QC measurements into the laboratory's computer-based report templates (i.e., spreadsheets). After peer review of the data is completed and the results are acceptable, the Laboratory Director reviews the preliminary report and works with necessary laboratory personnel to make any needed corrections. A final report is then produced and submitted to the customer, either electronically or by mail depending on the contract. For this project excerpts from laboratory's results database (Microsoft Excel) containing completed, reviewed, and approved project results are periodically sent to the EQL Program Director for distribution to all project customers.

If a hard copy report is requested, the procedures for preparation and distribution of a report are as follows: (1) assemble, (2) paginate, (3) final review, (4) approval and signature by Laboratory Director, (5) copy, (6) mail to customer. The copy of the data package provided to the client and all associated raw data are typically kept for period of at least 10 years. The retention period may be different if requested by the client and regulatory acceptable as determined by the uses and recipients of the data. These records are stored in the laboratory for approximately two years, and then transferred to locked university storage room for secure, long term storage.

For electronic data deliverables (EDDs) in Microsoft Excel or similar formats, files are maintained on the laboratory's desk top computers and the university's intranet, with access restricted to the Laboratory Director, Laboratory Master Technician, and Laboratory Technicians. Backup copies of the electronic files are prepared at least annually and stored in a secure area off-site.

## **B. MEASUREMENT/DATA ACQUISITION**

### **B1 Sampling Process Design (Experimental Design):**

The selection and rationale for the type of samples, sampling locations, and frequency of sampling for the Waccamaw River Water Quality Monitoring Program are described in Coastal Carolina University's scopes of work for the program for the city of Conway, Georgetown County, and Horry County (Appendix C).

In short the sampling sites were chosen because:

1. They already were SC DHEC sites with a long analytical history
2. The sites are in the municipalities that have contracted this work with Coastal Carolina.
3. These sites are also monitored by USGS which will provide water parameters in 15 minute intervals.

Only water samples will be collected. The sampling will be twice a month for an indefinite period. Samples will be collected according SOP 302 located in Appendix D

Sampling sites' names will be the same as those used by SC DHEC. Samples will be identified by the site name and the date. It is not expected that access to the sampling sites will ever be impeded except in the case of extreme weather events. When this happens the sampling event will be rescheduled or eliminated. No specific sample is critical because of the number of samples that will be pulled year around. The only variability for this project is the weather. However, samples will be collected rain or shine. Weather conditions are documented so it is expected that a correlation of rainfall and analytical results will be seen.

In summary, field measurements and samples are collected at six sites in the Waccamaw River and one site in the Pee Dee River, samples are river water grab samples, and samples are collected twice each month. To estimate variability introduced by sampling, on each sampling date EQL collects duplicate samples (i.e., field duplicates) at one of the sites. The site where duplicate samples are collected changes each sampling date, so eventually duplicates are collected several times at each site.

## **B2 Sampling Methods**

### *Sampling Points and Frequencies*

Beginning in January 2008, sampling has been conducted by EQL staff twice each month at the seven sites shown in **Figure 2**. In addition to EQL sampling and analyses at these river monitoring sites, South Carolina Department of Health and Environmental Control (SCDHEC) also samples once each month. EQL and SCDHEC communicate regularly to ensure they do not sample during the same week.

Sampling will be conducted as per SOP 302. Water samples will be collected at a depth of 0.3 M.

The seven sampling sites are all USGS river gauging sites where some or all field measurements for temperature, conductivity, dissolved oxygen, pH, and turbidity are continuously performed. Field Analysis SOPs are attached in SOP 410 in Appendix D. How sampling equipment and samplers should be cleaned is given in SOP 301 in Appendix D.

Field measurement procedures and sample collection, handling, receiving, storage, and associated record keeping procedures are integral parts of the EQL's QA program. The policies are designed to ensure that each measurement result and each sample are accounted for at all times. The primary objectives of EQL measurement and sample control procedures are as follows:

- Each field measurement is recorded and uniquely identified at the time of measurement,
- Each sample received for analysis is uniquely identified,
- The correct samples are analyzed and are traceable to the applicable data records,
- Important and necessary sample characteristics are preserved,

- Samples are protected from loss, damage, or tampering,
- Any alteration of samples during collection or transport (e.g., filtration, preservation, breakage) is documented,
- Records of field measurements and sample custody (i.e., chain of custody) and integrity are established which will satisfy legal scrutiny, and
- A record of ultimate sample disposition (i.e., disposal or release from laboratory) is established.

### *Sample Collection*

A summary of sample collection, handling, and preservation activities is provided in **Table 4**.

Samples collected by EQL personnel are placed in appropriate containers, having the required preservatives or additives, and labeled with site-specific information to uniquely identify each container at the time of collection. Conditions of sampling sites, sample IDs, number of samples, dates/times of collection, equipment calibrations, etc., are recorded on site in field logbooks or on EQL chain of custody forms as appropriate. Unless otherwise specified, samples are stored on ice in coolers at 1-6 °C until their receipt at the laboratory. EQL samplers may be the Laboratory Director, Laboratory Master Technician, Laboratory Technicians, or CCU students trained in sampling. In general, samples collected are grab samples (i.e., sample collected at a specific time and place) and collected manually. For bacteria analysis, samples are collected using sterile glass or sterile plastic sample bottles and collected carefully at 0.3M as to not contaminate by touching the inside of either the bottle or its lid. The bottle is filled with sample to approximately one-inch from the top, and then the lid is replaced. The bottle is then placed in a snap and seal plastic bag and a cooler with ice for storage and transport to laboratory. For analyses other than bacteria, samples are collected in plastic bottles. Bottles are rinsed with river water at the site three times, carefully filled with river, capped, and then placed in a cooler for storage and transport to the laboratory. For nutrient (TN & TP) samples are filtered over a GFF glass fiber filter and acidified before being put into the cooler. Specific procedures for sample container preparation and sample collection are provided in EQL SOP 301, “Sample Container Preparation” and EQL SOP 302, “Sample Collection” (Appendix D).

If issues occur in the field, the sample collector will handle these and record the issue and the corrective action on the Field Measurement Page. If the sample collector cannot fix the situation, then the Project Manager, Dr. Trapp, is contacted.

**Table 4. Sample collection, handling and preservation activities.**

Sample Type	Parameter Measured	Sample Container	Minimum Sample Size	Preservation Method/ Storage
river water grab	fecal coliform bacteria	sterile glass or sterile plastic	100 mL	Field: store in cooler at 1-6 °C Lab: analyze within six hours of collection
river water grab	chlorophyll	plastic	500 mL	Field: store in cooler at 1-6 °C Lab: store in refrigerator at 1-6 °C, filter within 48 hours, analyze filter for chlorophyll with 21 days,
river water grab	dissolved total nitrogen, dissolved total phosphorus	plastic	500 mL	Field: Syringe filter through GFF glass fiber acidify (<2 pH with sulfuric acid) store in cooler at 1-6 °C Lab: store in refrigerator at 1-6 °C, analyze within 21 days
river water grab	5-day biochemical oxygen demand	plastic	1,000 mL	Field: store in cooler at 1-6 °C or at ambient temperature if to be analyzed immediately at lab Lab: store at room temperature and start analysis within six hours of collection or store in refrigerator at 1-6 °C and start analysis within 24 hours

**B3 Sampling Handling and Custody Requirements:**

For EQL samplers at the time of sampling, a chain of custody (COC) Form 218 (Appendix A) must be filled out. The following information must be recorded by samplers:

- Date sample was collected
- Time sample was collected
- Location of sample: city, general location, and specific location.
- Example for a river sample: Buck Creek – USGS Station 02110400, Bridge over creek



on Hwy 905 near Longs.

- Name of sampler
- ID of sampling bottle is the site name and the date collected.
- Analysis (e.g., bacteria) to be conducted, which must also be written in indelible ink on the sample bottle
- Environmental conditions (e.g., waves, currents, tide, wind, sky, rain, runoff)
- Describe in comments section any problems encountered during sampling and corrective actions taken

The sample collector is considered to have custody of the sample until relinquishing the sample. This sample is properly in the custody of the sampler as long as the sample is in possession of the sampler, within sight of the sampler, or locked in a secure place. When the sampler relinquishes custody he/she should sign, date, and write the time the sample was relinquished on the COC form. The person receiving the sample should then sign, date, and write the time the sample was received on the same line. The sample can be relinquished to other qualified individuals in the same manner. Sample receipt in the laboratory is indicated by the Laboratory Director, Laboratory Master Technician, or a Laboratory Technician accepting the sample and documenting it on the COC form. If the same individual transports the sample to the lab and processes that sample in the laboratory, then that person will record both accepting and relinquishing the sample on the COC form. In addition to the COC the sample collector also has a Field Measurement Form (2000F RG). This form is attached in Appendix A.

### *Sample Receiving and Storage*

Samples must be delivered to the laboratory in coolers packed in ice less than six hours after sample collection. Analysis of the samples must begin within the stated hold times for each parameter from the time of sample collection. At the beginning of sampling, a sample bottle containing water should be placed in the cooler with ice, and then upon delivery of the cooler to the laboratory, the water in this bottle is measured to determine the sample receipt temperature.

Prior to accepting custody and signing for the samples, the laboratory representative verifies that all samples submitted are listed on the COC and that the COC documentation is complete. Received samples and corresponding documentation are carefully reviewed for compliance with regard to condition of containers, sample preservation and temperature (i.e., reading temperature of water blank in cooler), holding times (collection date/time), and accurate identification on the COC.

Once the COC has been verified against the delivered samples, sample information is entered into the laboratory receipt log. The receipt log for samples is kept as a Microsoft Excel spreadsheet. The file is password protected.

Samples received by the laboratory are identified by unique laboratory identification numbers. The first character is an "E" which identifies it as an EQL sample. The next two characters identify the year in which the sample was received (i.e., 08 represents the year

2008). The final four characters are numbers assigned sequentially to identify the sample relative to the order that the sample was received. The sample number E11-0023 therefore is the 23<sup>rd</sup> sample received in 2011 by EQL for analysis.

The sample's EQL laboratory number is transcribed to each container associated with that sample using an indelible marker. Numbered samples are stored in secured areas according to aliquot preservation requirements.

At the end of the day or as soon as practical, the receipt log for all samples received on a day is printed, Form 220, and placed in a logbook in chronological order. The printed sheet(s) must be reviewed for correctness and then initialed at the bottom of the sheet where it states:

“Printed (date of printing) by \_\_\_\_\_” and “Approved (date of printing) by \_\_\_\_\_”

These hard copy pages of the receipt log are numbered sequentially. In the event an error is later found in the receipt log, the change must be made in the spreadsheet and then corrected on the appropriate hard copy page. The hard copy corrections must be made by drawing a single line through the error, writing the correct data above or to the side, and initialing and dating the entry.

#### *Sample Distribution and Handling*

Samples retrieved from their designated storage areas must be documented in an internal COC record, Form 217. Personnel removing samples from the storage areas are required to record the sample numbers removed, date, time, and their initials on the form. Staff must also document on that form the date and time samples are returned to storage. Several coolers and a refrigerator in the laboratory are for temporary storage of samples requiring refrigeration and awaiting preparation or analysis.

Notification of samples with parameters with critically short hold times (i.e., less than 48 hours) is provided verbally or in writing to the laboratory analytical staff on the day of receipt of such samples. Once notified, it is the responsibility of the analyst to perform the requested analysis within the appropriate hold time.

#### *Sample Disposal*

In general, samples are disposed of 24 hours after results have been reported to the client. Arrangements for shorter or longer storage times are made with client approval based on specific project requirements. All sample container labels are removed or obliterated prior to disposal. Destruction of samples are noted on internal COC forms.

All samples suspected to be bacterially hazardous, incubated samples, used media, and bacteria control samples are sterilized by autoclaving for 30 minutes at 121 °C. In general, other samples found to be hazardous, or RCRA “D” listed, are returned to the client for disposal. Other hazardous wastes are disposed of by the science building staff by sending

directly to an in-state permitted landfill.

Sterilized and non-hazardous aqueous samples are disposed of by pouring the sterilized, neutralized, or non-hazardous sample into a conventional drain to the municipal sewage treatment system. Non-hazardous solid wastes (including emptied disposable containers from aqueous samples) are disposed of by placing in a dumpster for municipal landfill disposal. The date of sample disposal is recorded on the internal COC form, Form 217, and autoclave sterilization log, Form 1070ASL.

#### **B4 Analytical Methods**

##### *Control of Analytical Processes*

All aspects of laboratory operations are controlled by the key documents, the QA manual (QAM) and SOPs. The SOPs detail and document the procedures which implement the activities and requirements specified in the QAM.

To perform the tasks described in this QAPP, the EQL uses five field analysis procedures and six laboratory analysis techniques:

- Temperature by thermometer or thermistor, based on Method 2550 B. of *Standard Methods*
- Conductivity by electrical conductivity, based on Method 2510 B. of *Standard Methods*
- Dissolved oxygen by membrane electrode method, based on Method 4500-O G. of *Standard Methods*
- pH (hydrogen ion concentration) by electrometric method, based on Method 4500-H+ B. of *Standard Methods*
- Turbidity by nephelometry, based on Method 2130 B. of *Standard Methods*
- Total nitrogen by alkaline persulfate oxidation of filtered or unfiltered samples followed by cadmium reduction and colorimetric measurement, based on Methods 4500-N C., 4500-NO<sub>3</sub><sup>-</sup> E., and 4500-N<sub>org</sub> D. of *Standard Methods*
- Total phosphorus by alkaline persulfate oxidation of filtered or unfiltered samples followed by colorimetric measurement, based on Methods 4500-P F. of *Standard Methods*
- Chlorophyll *a* and pheophytin *a* by fluorometric technique, based on Method 10200 H. of *Standard Methods*
- Fecal coliform bacteria by fecal coliform direct test (A-1 medium), based on Methods 9221 C. and 9221 E. of *Standard Methods*
- 5-day biochemical oxygen demand (BOD<sub>5</sub>) by measurement oxygen consumed in incubated samples in a 5-day period, based on Method 5210 B. of *Standard Methods*
- Water toxicity Kingwood Diagnostics IQ Toxicity Test™. See (<http://www.kingwooddiagnostics.com/>)

The step-by-step procedures of these techniques are provided in EQL SOPs 420 (field measurement of pH, DO, temperature, and conductivity), 440 (TN-TP digestion), 443 (TN analysis), 444 (TP analysis), 406 (turbidity), 430 (BOD<sub>5</sub>), 502 (Fecal coliform), 601 (IQ Toxicity Test), respectively. All EQL SOPs referenced in this QAPP are provided in Appendix D.

When issues occur in the laboratory they handled by the analyst. Appropriate corrective actions are given in SOP 201.

When samples are completely used or destroyed a notation is made on the internal chain of custody.

Laboratory turnaround time is generally associated with meeting holding times for samples.

Total Nitrogen and Kingswood Toxicity Testing are not approved methods. The laboratory has performed QC to ensure that the testing is accurate. However, at this time no ATP has been obtained for either and the data will be for informational purposes only.

## **B5 Quality Control (QC)**

### *Dissemination of Quality Requirements*

The laboratory uses several means of communication to ensure staff is informed of all quality requirements. Routine operational requirements are communicated to applicable staff through distribution of the QAPP and laboratory SOPs. All these documents are controlled internally and are issued to selected laboratory staff on an individual basis, depending on staff assignment, task responsibilities, and work location. The QAPP and all SOPs are available to all laboratory staff on the laboratory's computer network. Changes in requirements are communicated to laboratory staff by distribution of revisions to this QAPP and applicable SOPs.

Any laboratory staff member observing any occurrence (e.g., equipment failure) that impacts laboratory capabilities or schedule of deliverables (i.e., analysis results are to be reported to SC DHEC and clients within 24 hours of completion of analysis) must immediately bring that observation to the attention of the Laboratory Director. The Laboratory Director shall immediately communicate the situation to the affected customer. These communications shall be recorded in the Laboratory Director's telephone logbook, and a copy shall be placed in the project files. The Laboratory Director determines necessary corrective actions for such occurrences.

Quality control procedures for EQL measurements for this project are summarized in **Tables 5 through 12**. For recording results of QC measurements on samples (e.g., duplicate analysis), an acronym suffix is added to the sample number; the suffixes are as follows:

duplicate = D or DUP

matrix spike = MS

Acronyms for recording other QC measurements are as follows:

blank = B or BLK

replicates = R# or REP#

matrix spike duplicate = MSD

method blank = MB

calibration standard = CAL or CALIB  
initial calibration verification standard = ICV  
working standard = WS

calibration verification standard = CV  
primary standard = PS  
laboratory control sample = LCS

**Table 5. Summary of QC requirements for Measurements with Hach Ruggedized Probes.**

QC Sample or Activity	Minimum Frequency	Acceptance Criteria	Corrective Action
Capability demonstration	Four (4) prepared samples analyzed prior to any customer sample analyses	LDO 97-104% of theoretical DO pH $\pm$ 0.1 of expected Others RPD $\leq$ 25%	Repeat until acceptable.
Calibration stability monitoring	Immediately before calibration measure standards	Not applicable.	Not applicable. Results are used to monitor stability of probes and evaluate need for maintenance.
Calibration	Daily prior to sample analysis and after every 8 hours	After calibration, measure calibration standards (conductivity, pH, DO % saturation of water saturated air) as sample pH $\pm$ 0.1 of expected, others 99-101% R	Investigate and fix any obvious problems. Repeat until acceptable.
Calibration check	Immediately following calibration	Measurement of calibration standards or LCS (conductivity, pH, DO % saturation of LCS or of water saturated air) Cond. 90-110% R, pH $\pm$ 0.1 of expected, DO 97-104% sat <b>**LDO method requires LCS to be read in duplicate with each calib. event**</b>	Investigate and fix any obvious problems. Recalibrate and repeat until acceptable.
Field duplicate (duplicate sample collected at one of sampling sites)	One (1) per sampling event	RPD $\leq$ 25%	Investigate problem. If system precision is in control, qualify results. If system precision is out of control, reanalyze all sampling sites if possible.
Internal PE sample	Samples and frequency determined by Lab QA Officer	75-125% R RPD $\leq$ 25%	Investigate all unacceptable results.
Blind PE sample	Samples and frequency determined by accrediting agencies and projects	Determined by PE provider	Investigate all unacceptable results.

**Table 6. Summary of QC requirements for turbidity analysis by Hach meter.**

QC Sample or Activity	Minimum Frequency	Acceptance Criteria	Corrective Action
Capability demonstration	Four (4) prepared samples analyzed prior to any customer sample analyses	Criteria for duplicate precision RPD $\leq$ 25%	Repeat until acceptable
4-Point calibration plus deionized water blank	At least quarterly	90-110% R (measured value of primary standards when analyzed as samples within 10% of expected values)	Investigate problem. Correct any obvious problems. Repeat calibration until acceptable.
Assign values to permanent transfer standards using formazin primary standards	At least quarterly	Measurement after acceptable 4-point calibration and values within 10% of previous established values	Investigate problem. Correct any obvious problems including replacing transfer standards if necessary. Repeat until acceptable.
Daily calibration check	Immediately prior to and after sample analysis	GELEX Secondary Turbidity Standards should read within 10% of assigned values	Investigate problem. Correct any obvious problems. If necessary reassignment of GELEX values and reanalyze samples. Repeat calibration check until acceptable.
Method blank	Daily prior to sample analysis	<1.0 NTU (i.e., < RL)	Clean analytical system and repeat MB analysis. Identify and eliminate source of contamination.
Sample analysis	For all sample analyses	Direct sample reading within acceptable measurement range (i.e., 1.00 NTU to 4000 NTU)	If reading below range report result as < RL. If result above range dilute sample.
Sample duplicate	One (1) per preparation batch	RPD $\leq$ 25%	Investigate problem. If system precision is in control, qualify results. If system precision is out of control, reanalyze entire batch.
Internal PE sample	Samples and frequency determined by Lab QA Officer	75-125% R RPD $\leq$ 25%	Investigate all unacceptable results.
Blind PE sample	Samples and frequency determined by accrediting agencies and projects	Determined by PE provider	Investigate all unacceptable results.
LCS = laboratory control sample MB = method blank MDL = method detection limit MS = matrix spike PE = performance evaluation QC = quality control %R = percent recovery RL = reporting limit RPD = relative percent difference			

**Table 7. Summary of QC requirements for dissolved total nitrogen analysis by alkaline persulfate oxidation.**

QC Sample or Activity	Minimum Frequency	Acceptance Criteria	Corrective Action
Capability demonstration	Four (4) prepared samples analyzed prior to any sample analyses	Criteria for LCS recovery and duplicate precision	Repeat until acceptable
Initial calibration with digested standards (at least 5-point calibration plus blank)	Daily prior to sample analysis	Calibration standards approximately evenly spaced over calibration range. Standards digested like samples with 90-110% R (measured value of each standard within 10% of expected value)	Investigate problem. Correct any obvious problems. Repeat calibration until acceptable.
Digested deionized water blank (i.e., contains oxidizing reagent)	Daily with sample digestions. At least two (2) per preparation batch	Total Nitrogen <0.050 mg/L	Identify and eliminate source of contamination. Run blanks to confirm problem is solved. If significant adverse impact on results, reanalyze batch.
Digested method blank	Daily with sample digestions	Total Nitrogen <0.100 mg/L	Clean analytical system and repeat MB analysis. Identify and eliminate source of contamination. If significant adverse impact on results, reanalyze batch.
Digestion check standard / Laboratory control sample	At least one (1) per preparation batch	80-120% R	Investigate and identify the problem. If system accuracy is in control, no corrective action needed. If system is out of control, reanalyze batch.
Matrix Spike	At least one (1) per preparation batch When suspect matrix interference	Total Nitrogen 75-125%	Investigate problem. If system accuracy is in control, qualify results. If system accuracy is out of control, reanalyze batch.
		NA	
Sample analysis	For all sample analyses	Direct sample reading within calibration range (i.e., above lowest standard and below highest standard)	If reading below range report result as < RL. If result above range, dilute sample.
Sample duplicate or matrix spike duplicate	At least one (1) per preparation batch	Total Nitrogen RPD ≤ 25%	Investigate problem. If system precision is in control, qualify results. If system precision is out of control, reanalyze batch.
		NA	
Internal PE sample	Samples and frequency determined by Lab QA Officer	Criteria for LCS recovery and duplicate precision	Investigate all unacceptable results.
Blind PE sample	Samples and frequency determined by accrediting agencies and projects	Determined by PE provider	Investigate all unacceptable results.
<p>LCS = laboratory control sample            MB = method blank            MDL = method detection limit            MS = matrix spike            PE = performance evaluation</p> <p>QC = quality control            %R = percent recovery            RL = reporting limit (i.e., conc. of lowest cal. std adjusted for dilutions)            RPD = relative percent difference</p>			



**Table 8. Summary of QC requirements for dissolved total phosphorus analysis by alkaline persulfate oxidation**

QC Sample or Activity	Minimum Frequency	Acceptance Criteria	Corrective Action
Capability demonstration	Four (4) prepared samples analyzed prior to any sample analyses	Criteria for LCS recovery and duplicate precision	Repeat until acceptable
Initial calibration with digested standards (at least 5-point calibration plus blank)	Daily prior to sample analysis	Calibration standards approximately evenly spaced over calibration range. Standards digested like samples with 90-110% R (measured value of each standard within 10% of expected value)	Investigate problem. Correct any obvious problems. Repeat calibration until acceptable.
Digested deionized water blank (i.e., contains oxidizing reagent)	Daily with sample digestions. At least two (2) per preparation batch	Total Phosphorus <0.005 mg/L	Identify and eliminate source of contamination. Run blanks to confirm problem is solved. If significant adverse impact on results, reanalyze batch.
Digested method blank	Daily with sample digestions	Total Phosphorus <0.005 mg/L	Clean analytical system and repeat MB analysis. Identify and eliminate source of contamination. If significant adverse impact on results, reanalyze batch.
Digestion check standard / Laboratory control sample	At least one (1) per preparation batch	80-120% R	Investigate and identify the problem. If system accuracy is in control, no corrective action needed. If system is out of control, reanalyze batch.
Matrix Spike	At least one (1) per preparation batch When suspect matrix interference	Total Phosphorus 65-135%	Investigate problem. If system accuracy is in control, qualify results. If system accuracy is out of control, reanalyze batch.
Sample analysis	For all sample analyses	Direct sample reading within calibration range (i.e., above lowest standard and below highest standard)	If reading below range report result as < RL. If result above range, dilute sample.
Sample duplicate or matrix spike duplicate	At least one (1) per preparation batch	Total Phosphorus RPD ≤ 35%	Investigate problem. If system precision is in control, qualify results. If system precision is out of control, reanalyze batch.
Internal PE sample	Samples and frequency determined by Lab QA Officer	Criteria for LCS recovery and duplicate precision	Investigate all unacceptable results.
Blind PE sample	Samples and frequency determined by accrediting agencies and projects	Determined by PE provider	Investigate all unacceptable results.
<p>LCS = laboratory control sample                      QC = quality control            MB = method blank                                      %R = percent recovery            MDL = method detection limit                      RL = reporting limit            MS = matrix spike                                        RPD = relative percent difference            PE = performance evaluation</p>			

**Table 9. Summary of QC requirements for chlorophyll a and pheophytin an analysis by fluorometric technique.**

QC Sample or Activity	Minimum Frequency	Acceptance Criteria	Corrective Action
Capability demonstration	Four (4) prepared samples analyzed prior to any customer sample analyses	Criteria for duplicate precision	Repeat until acceptable
5-Point calibration	Quarterly	90-110% R (measured value of all standards when analyzed as samples within 10% of expected value)	Investigate problem. Correct any obvious problems. Repeat calibration until acceptable.
Solid secondary standard value establishment	Quarterly	Measurement after acceptable 5-point calibration and value within 10% of previous established value	Investigate problem. Correct any obvious problems including obtain new solid secondary standards if necessary
Calibration check with solid secondary standards	Daily prior to sample analysis	90-110% R	Investigate problem. Correct any obvious problems including new 5-point calibration if necessary. Repeat calibration check until acceptable.
Method blank	Daily prior to sample analysis	< RL	Clean analytical system and repeat MB analysis. Identify and eliminate source of contamination.
Sample analysis	For all sample analyses	Direct sample reading within calibration range (i.e., lowest and highest calibration standard concentrations)	If reading below range report result as < RL. If result above range dilute sample.
Sample duplicate	One (1) per preparation batch	RPD $\leq$ 25%	Investigate problem. If system precision is in control, qualify results. If system precision is out of control, reanalyze entire batch.
Internal PE sample	Samples and frequency determined by Lab QA Officer	75-125% R RPD $\leq$ 25%	Investigate all unacceptable results.
LCS = laboratory control sample MB = method blank MDL = method detection limit MS = matrix spike PE = performance evaluation QC = quality control %R = percent recovery RL = reporting limit RPD = relative percent difference			

**Table 10. Summary of QC requirements for fecal coliform analysis by direct test (A-1 medium).**

QC Sample or Activity	Minimum Frequency	Acceptance Criteria	Corrective Action
Capability demonstration	Four (4) prepared samples analyzed prior to any customer sample analyses	Criteria for LCS recovery and duplicate precision	Repeat until acceptable
Media sterility check	Prior to use of new lot of media and with every batch prepared for sample analysis	No growth	Investigate problem. Eliminate contaminations. Obtain new lot of A-1 medium if necessary. Repeat until successful before using A-1 medium.
Media positive check with control culture	Prior to use of new lot of media and with every batch prepared for sample analysis	Growth and gas produced	Investigate problem. Obtain new lot of A-1 medium if necessary. Repeat until successful before using A-1 medium.
Media negative checks with control culture	Prior to use of new lot of media and with every batch prepared for sample analysis	Growth allowed but no gas produced	Investigate problem. Obtain new lot of A-1 medium if necessary. Repeat until successful before using A-1 medium.
Method blank (media sterility check serves purpose for this analysis)	At least weekly, prior to sample analysis	No growth	Investigate problem. Eliminate contaminations. Obtain new lot of A-1 medium if necessary. Repeat until successful before using A-1 medium.
Sample duplicate or matrix spike duplicate	At least one (1) weekly, and one with all large sample batches (~20 samples)	RPD $\leq$ 200% for <150 MPN/100 mL RPD $\leq$ 100% for $\geq$ 150 MPN/100 mL	Investigate problem. If system precision is in control, qualify results. If system precision is out of control, reanalyze entire batch.
Internal PE sample	Samples and frequency determined by Lab QA Officer	Criteria for LCS recovery and duplicate precision	Investigate all unacceptable results.
Blind PE sample	Samples and frequency determined by accrediting agencies and projects	Determined by PE provider	Investigate all unacceptable results.
<p>LCS = laboratory control sample            MB = method blank            MDL = method detection limit            PE = performance evaluation</p> <p>QC = quality control            %R = percent recovery            RL = reporting limit            RPD = relative percent difference</p>			

**Table 11. Summary of QC requirements for 5-day BOD analysis.**

QC Sample or Activity	Minimum Frequency	Acceptance Criteria	Corrective Action
Capability demonstration	Four (4) prepared samples analyzed prior to any customer sample analyses	Criteria for LCS recovery and duplicate precision	Repeat until acceptable
Dilution water blank	Daily prior to sample analysis	< 0.2 mg/L DO depletion	Clean analytical system and repeat MB analysis. Identify and eliminate source of contamination.
Minimum residual DO and minimum DO depletion	For all measurements	Minimum DO depletion 2.0 mg/L Residual DO in bottle $\geq$ 1.0 mg/L	Results not considered to be valid
Seed control	For every preparation batch	DO uptake attributable to seed added to each bottle generally 0.6 to 1.0 mg/L but seed amount must provide acceptable GGA recovery	Investigate and identify the problem. If system is out of control, reanalyze entire batch.
Glucose-glutamic acid (GGA) check standard	One (1) per preparation batch	198 $\pm$ 30.5 mg/L	Investigate and identify the problem. If system is out of control, reanalyze entire batch.
Matrix spike (GGA)	When suspect matrix interference	75-125% R	Investigate problem. If system accuracy is in control, qualify results. If system accuracy is out of control, reanalyze entire batch.
Sample duplicate or matrix spike duplicate (GGA)	One (1) per preparation batch	RPD $\leq$ 25%	Investigate problem. If system precision is in control, qualify results. If system precision is out of control, reanalyze entire batch.
Internal PE sample	Samples and frequency determined by Lab QA Officer	Criteria for LCS recovery and duplicate precision	Investigate all unacceptable results.
Blind PE sample	Samples and frequency determined by accrediting agencies and projects. Once a year a successful analysis.	Determined by PE provider	Investigate all unacceptable results.
<p>LCS = laboratory control sample            MB = method blank            MDL = method detection limit            MS = matrix spike            PE = performance evaluation</p> <p>QC = quality control            %R = percent recovery            RL = reporting limit            RPD = relative percent difference</p>			

**Table 12. Summary of QC requirements for water toxicity analysis.**

<b>QC Sample or Activity</b>	<b>Minimum Frequency</b>	<b>Acceptance Criteria</b>	<b>Corrective Action</b>
Initial Demonstration of Capability	All technician performing test must perform once at end of training prior to actual sample analysis	The RPD of four (4) samples utilizing the same matrix must be within 90-110% of the results obtained by a trained technician reading an independently setup sample	Investigate issue. Observe technician-in-training for proper technique. Retrain as indicated. Repeat IDC's until results within acceptable criteria.
Negative Method Control	One (1) sets of triplicate per each batch analysis	≥15 fluorescing organisms for each set of three (3) Method Blank cells	Investigate issue. Re-run Method Blanks in a known "virgin" testing cell. Repeat until results are within acceptable limits.
Positive Method Control	One (1) sets of triplicate per each batch analysis	≥4 non-fluorescing organisms for each set of three (3) Method Blank cells	Investigate issue. Re-run Method Blanks in a known "virgin" testing cell. Repeat until results are within acceptable limits.
Sample Analysis	For each sample analyzed	Three (3) test chambers filled with six (6) Daphnia magna per each sample analyzed	Qualify any results that fail to meet criteria due to sample or testing reagent issues.
Laboratory Duplicate	One (1) per ten (10) samples analyzed	RPD ≤ 25%	Investigate issue. If system precision is in control, qualify results. If system precision is out of control, reanalyze entire batch associated with specific QC duplicate.
Field Duplicate	One (1) per ten (10) samples analyzed	RPD ≤ 25%	Investigate issue. If system precision is in control, qualify results. If system precision is out of control, reanalyze entire batch associated with specific QC duplicate.

### *Verification Methods and Calculations*

During the data review process, standardized methods and calculations are used to examine the measurement process against the specified QC requirements. These general methods and calculations, organized by DQI characteristics outlined in Section A, are described in the remainder of this section.

#### *Representativeness*

The appearance and records for samples should, at a minimum, be checked against project requirements for the following:

- Sampling protocols
- Sample types
- Sample containers
- Sample sizes
- Sample numbers
- Sample preservation
- Sample storage
- Sample analysis hold time
- Maintenance of sample chain-of-custody

#### *Accuracy*

Accuracy (bias) is a measurement of the extent to which a measured value of a quantity (parameter or analyte) agrees with the accepted value of that quantity. It is assessed by the analysis of samples of known concentration for the analytes of concern.

For LCSs, calibration standards, field reference standards, or additional QC samples of known concentration, accuracy is quantified by calculating the *percent recovery* (%R) of analyte from a known quantity of analyte as follows:

$$\%R = \frac{V_m}{V_t} \times 100$$

where:

$V_m$  = measured value (concentration determined by analysis)

$V_t$  = true value (concentration or quantity as calculated or certified by the manufacturer)

A matrix spike (MS) sample or a matrix spike duplicate (MSD) sample is designed to provide information about the effect of the sample matrix on the digestion and measurement methodology. A known amount of the analyte of interest is added to a sample prior to

sample preparation and instrumental analysis. To assess the effect of sample matrix on accuracy, the %R for the analyte of interest in the spiked sample is calculated as follows:

$$\%R = \frac{(SSR - SR)}{SA} \times 100$$

where:

SSR = spiked sample result

SR = sample result

SA = spike added

### *Precision*

Precision is a measurement of the random error in an analytical measurement process. It reflects the degree of agreement between independent measurements determined by the analysis of replicate samples. When calculated for duplicate sample analyses, precision is expressed as the *relative percent difference* (RPD), which is calculated as:

$$RPD(\%) = \frac{(S - D)}{\frac{S + D}{2}} \times 100$$

where:

S = first sample value (original result)

D = second sample value (duplicate result)

When precision is calculated for three or more replicate determinations, the *relative standard deviation* (RSD), also known as the coefficient of variation, expressed in units of percentage, is used. This is an expression of the spread of the data relative to the mean value of the determinations. The specific formulas used for calculating the RSD are:

$$\bar{x} = \frac{\sum_{i=0}^n (x_i)}{n}$$

$$s = \sqrt{\frac{\sum_{i=0}^n (x_i - \bar{x})}{n - 1}}$$

$$RSD(\%) = \frac{s}{\bar{x}} \times 100$$

where:

$\bar{x}$  = mean of n measurements

$x_i$  = result value for the  $i^{\text{th}}$  measurement

n = total number of measurements

s = standard deviation

### *Method Detection Limits*

Method detection limits (MDLs) are determined for each analyte for each method used. These MDLs are determined by (a) conducting replicate analyses of standards at quantities approximately one to five times the estimated MDL, (b) determining the standard deviation, s, of the replicate measurements, and then (c) calculating the MDL from:

$$\text{MDL} = t_{(n-1, 1-\alpha=0.99)} \times s$$

where:

n = number of replicate analyses

$t_{(n-1, 1-\alpha=0.99)}$  = t distribution value appropriate to a 99% confidence level (one-tailed) and standard deviation estimate with n - 1 degrees of freedom

s = standard deviation of the data set

The MDL calculated in this manner represents the minimum amount of a substance that can be measured and reported, with 99% confidence that the analyte quantity is greater than zero.

The MDL does *not* represent the analyte quantity for which there is a 99% probability that the analyte will be detected; there is a 50% probability of detection and reporting of the analyte whose actual amount is at the MDL. The analyte quantity at which there is a 99% probability that the analyte will be detected and reported is twice the MDL.

Because MDLs are usually determined using standards in a clean matrix, they represent optimum obtainable performance. MDLs for actual sample matrices are likely to be higher than those determined using clean matrices.

### *Quantitation/Reporting Limits*

Because of significant uncertainty (about 33% RSD) associated with MDLs determined in a "clean" matrix, plus possible additional variability due to actual sample matrix, EQL



uses higher levels, referred to as "limits of quantitation" or "reporting limits", down to which it routinely reports measured values.

The *limit of quantitation* (LOQ) is defined as 10 times the standard deviation (s) from the MDL determination. Therefore, the LOQ is roughly 3.33 times the MDL, since the MDL is usually about three times s.

The *reporting limit* (RL) is not as rigidly, and usually not as conservatively, defined as the LOQ. It is usually chosen at a level two to 10 times higher than the MDL. As much as possible, it is also chosen at a level which is below applicable regulatory action levels and which simplifies data review and reporting (e.g., RL of 1.0 µg/L for numerous parameters of similar chemical behavior, MDLs, and regulatory action levels).

### *Completeness*

The characteristic of completeness is a measure of the amount of valid analytical data obtained compared to the total number of analyses performed. Valid analytical data are those for which all QC specifications are met. Completeness of the reported data (expressed as a percentage) is calculated as:

$$\%C = \frac{M_v}{M_t} \times 100$$

where:

$M_v$  = number of measurements judged to be valid (meets all QC specifications)

$M_t$  = total number of measurements performed (based upon number of samples submitted)

### *Comparability*

Comparability of analysis results is evaluated by at a minimum checking the following against project requirements:

- Analysis method utilized
- Analysis QC measurement results
- Units utilized for reporting measurement values

### *Rejection of Data*

Rejection of an analytical result for a sample may be required if established quality control acceptance criteria are not satisfied at any point during the course of analysis. Nominal quality control decision criteria are provided in analytical method SOPs and the corresponding data review checklists.

Additionally, the EQL uses a statistical outlier test (*Standard Methods*, 1010 B. Statistics, 17<sup>th</sup> through 21<sup>st</sup> Editions) for evaluation of a questionable value from a group of replicate readings, measurements, results, etc., for an individual sample or standard. Briefly, the test involves dividing the difference between the questionable value and the replicates' mean value by the standard deviation for all replicate values, to calculate a quotient, T. The questionable value is rejected if the calculated T is greater than an established rejection T. The outlier test is conducted at the 99% confidence level, which means if the calculated T exceeds the rejection  $T_{0.99}$ , then the questionable value may be rejected with 99% probability that it is significantly different from the other values (Table 13).

**Table 13. Outlier Test for evaluation of a questionable value from a group of replicate values**

Questionable Value <sup>a</sup>	Formula for Calculating T <sup>b</sup>	Rejection	
		Number of Values	Quotient $T_{0.99}$
Smallest value ( $X_1$ )	$T = \frac{X_{ave} - X_1}{s}$	3	1.15
		4	1.49
		5	1.75
Largest value ( $X_n$ )	$T = \frac{X_n - X_{ave}}{s}$	6	1.94
		7	2.10
		8	2.22
		9	2.32
		10	2.41
		12	2.55
		14	2.66
		16	2.75

<sup>a</sup> Arrange values in order of increasing magnitude.

<sup>b</sup> If  $T > T_{0.99}$  reject questionable value.

$X_{ave}$  = average value for all replicates.

s = standard deviation for all replicates, where  $s = [\sum(X_n - X_{ave})^2 / (n - 1)]^{1/2}$

**B6 Instrument/Equipment Testing, Inspection, Maintenance Requirements:**

The term “equipment”, as used in this manual, includes equipment or instrumentation used in the areas of sample collection, preparation, or analysis. This includes laboratory glassware, as appropriate. The laboratory utilizes all equipment (**Table 14**) as appropriate and necessary for a given technique, as specified in a referenced method, or as required by regulatory programs. The equipment investment and subsequent capabilities are sufficient for the laboratory’s field and laboratory tasks for this project. Except for the autoclave, there is a backup instrument for every critical instrument. There is a rapid response maintenance contract for the autoclave.

**Table 14. Equipment list.**

<b>Instrument</b>	<b>Number of Units</b>
Analytical Balance	3
Autoclave	1
Conductivity/Dissolved Oxygen/pH Field Meter	2
Fluorometer	2
Incubator	3
pH Meter	2
Refrigerator/Freezer	5
Spectrophotometer	2
Turbidity Meter	2
Water Bath	2

*Preventive Maintenance:*

Manufacturer recommended preventative maintenance schedules are performed internally for all equipment, in all lab areas. Additionally, some equipment, such as autoclave and analytical balances, require service checks by the commercial vendor. Service calls of this nature are scheduled by the Quality Assurance Officer or science building staff according to the maintenance schedule.

Maintenance logs are used to document any procedures performed either internally, or by vendor service technicians. These logs also document maintenance or repair which may be necessary as a part of corrective action resulting from QC failures. Documentation in the logs is the responsibility of the analyst or technician operating the instrument or equipment.

A summary of preventive maintenance activities for equipment utilized for this project is provided in **Table 15**.

**Table 15. Instrument and equipment preventive maintenance and testing**

<b>Instrument</b>	<b>Frequency</b>	<b>Preventive Maintenance</b>
Autoclave	Each use	Clean drain screen, measure maximum temperature
	Monthly	Check timer, test sterility
	Quarterly	Quarterly maintenance service
Balance	Each use	Check level and adjust if needed, clean after use, calibration verification
	Monthly	Clean, level, calibration verification
	Annual	Annual maintenance service, check electrical cord
Conductivity/Dissolved Oxygen/pH field meter	Each use	Insert batteries and turn on; after use rinse probes, clean meter, replace pH probe storage solution, and remove batteries.
Controlled temperature equipment	Daily	Check temperature and adjust if needed
	Annual	Check temperature distribution, check electrical cord, clean instrument
Fluorometer	Each use	Plug in, turn on, allow 30 min. to warm up, check performance with secondary standards; after use turn off, unplug, and clean cuvettes
	Annual	Check lenses and clean if needed, check electrical cord
pH meter	Each use	Rinse probe, check probe electrolyte level, change electrode storage solution
	As needed and annual	Clean probe, replace probe electrolyte, check electrical cord
Spectrophotometer	Each use	Plug in, turn on, allow 30 min. to warm up, check performance with blank and standards; after use turn off, unplug, and clean cuvettes
	Annual	Check electrical cord
Thermometers	Annual	One-point or two-point calibration
Turbidity meter	Monthly	Turn on, allow 30 min. to warm up, check performance with secondary standards; after use turn off and clean cuvettes
	Annual	Check electrical cord
Water deionizing system	Each use	Check water resistance
	Semi-annual	Sterilize, change final filter
	Annual	Check connections and electrical cord, change exchange cartridges if needed

### **B7 Instrument Calibration and Frequency:**

Equipment requiring calibration must be calibrated according to manufacturer's instructions or the analytical method. General guidelines for analytical instrument calibrations are covered in the corresponding analytical SOPs. A summary of instrument calibration procedures for this task's measurements is provided in **Table 16**.

For equipment where documentation of the calibration can be obtained in the form of hardcopy printouts, the calibration data must be filed with the analytical run data. Where printouts are not possible, the following minimum information must be recorded in a calibration log or on the raw data sheet: equipment identification, calibration date, analyst initials, standard(s) used, certified concentration(s), equipment reading(s) per standard, calibration verification standard(s) results, due date for next calibration (if not "per use").

It is the responsibility of the analyst performing calibration to record this information in the calibration log. Further, when persons who are not EQL staff perform calibration on any equipment, it is also the responsibility of the analyst to record the details of this work performed, and obtain any applicable certificates from the vendor.

### **B8 Inspection/Acceptance Requirements for Supplies and Consumables:**

To maintain efficient, safe, and high quality operations in a laboratory, it is essential that standardized and clearly understood procedures are used for ordering and receipt of materials and services. Consequently, the EQL requires its staff to follow CCU's specific procurement procedures. These procedures include practices for source verification, ordering, receiving, inspection and testing, recordkeeping, and, if necessary, return to source.

The objectives of the laboratory's procurement procedures are as follows:

- Procurement procedures, including associated documentation, satisfy university and customer requirements
- Timely receipt of requested materials and services
- Received materials and services fulfill intended purposes
- Minimization of costs

Specifically for this project, ordering information for critical equipment and supplies is listed in each SOP (Appendix D) for the applicable activity or analysis. Typically the Laboratory Director orders needed supplies using a CCU credit card or a purchase order. Supplies are received at the laboratory by the Laboratory Director or the Laboratory Master Technician or Laboratory Technician. They inspect the received supplies and log the supplies into the laboratory equipment and supplies inventory list. If received supplies do not fulfill advertised specifications or are damaged, the Laboratory Director contacts the supplier to discuss replacement.

**Table 16. Instrument calibration procedures.**

<b>Instrument</b>	<b>Calibration Procedure</b>	<b>Frequency</b>	<b>Acceptance Criteria</b>	<b>Corrective Action if Unacceptable</b>
Incubators and Water Bath	One-point or two-point calibration of thermometer with NIST traceable thermometer	Annual	$\pm 0.5\text{ }^{\circ}\text{C}$	Replace thermometer
Refrigerators and pH Meters	One-point or two-point calibration of thermometer with NIST traceable thermometer	Annual	$\pm 2.0\text{ }^{\circ}\text{C}$	Replace thermometer
Freezers and Ovens	One-point or two-point calibration of thermometer with NIST traceable thermometer	Annual	$\pm 2.0\text{ }^{\circ}\text{C}$	Replace thermometer
Analytical Balance	Calibration verification using NIST traceable weights	Daily	$\pm 0.1\%$	Clean and autocal or repair
Analytical Balance	Calibrated by service technician during annual maintenance	Annual	Professional service	Repair balance
Fluorometer	Two-point calibration check with solid secondary standards	Every session	$\pm 10\%$ of established values	Investigate and correct problem. Perform new 5-pt calib. if necessary.
Fluorometer	Prepare series of liquid standards and perform five-point calibration, reestablish values of solid secondary standards	Quarterly	Acceptable 5-pt calibration and $\pm 10\%$ of expected primary standard values	Investigate and correct problem. If necessary prepare new liquid stds or repair instrum.
pH meter	Two-point calibration with standard buffers	Every session	Slope 90-102% $\text{pH} \pm 0.1$	Clean probe, replace electrolyte, or replace probe as needed. Repeat calibration until acceptable.
Turbidity meter	Calibration check with gel secondary standards	Every session	$\pm 10\%$ of established values	Investigate and correct problem. Perform new 5-pt calib. if necessary.
Turbidity meter	Five-point calibration with liquid primary standards, reestablish values of gel secondary standards	Quarterly	$\pm 10\%$ of expected primary standard values	Investigate and correct problem. If necessary prepare new liquid stds or repair instrum.
Conductivity / Dissolved Oxygen / pH field meter	One-point conductivity calib., one-point dissolved oxygen calib. with water saturated air, two-point or three-point pH calib.	Weekly	Conductivity or salinity $\pm 10\%$ , dissolved oxygen $\pm 5\%$ , $\text{pH} \pm 0.1$	Investigate and correct problem. Repeat calibration until acceptable, if cannot recalibrate repair meter.
Conductivity / Dissolved Oxygen / pH field meter	Repair by manufacturer or service technician	As needed	Per manufacturer	Repair meter

**B9 Non-direct Measurements**

This is Not Applicable. .

## **B10 Data Management:**

The data management scheme is as follows:

A lab staff member collects the sample and preserves it according to the SOPs. The samples are brought to the laboratory. If they are performing the analysis they relinquish them to themselves. If not, they relinquish them to sample custodian who logs and disseminates the samples. The samples are analyzed. The analyst verifies the sample calculations and then they make a hard copy of the data and submit it to Dr. Trapp. Dr. Trapp performs a second verification. Then Dr. Trapp gives it to the Master Technician who also reviews the QC and then enters the data into a Data Archive Spreadsheet. A preliminary report is submitted to Dr. Libes. Dr. Libes validates the data. If issues occur, Dr. Trapp will act as an assistant validator and will review any anomalies found to determine if the anomaly is valid. Once validation is complete, the data are released to SC DHEC.

Data integrity is ensured by the amount of verification that is performed. Hardware and software issues are also avoided by verification at several levels.

### *Document Review and Approval*

All of the laboratory's key quality documents and SOPs receive initial and annual review by applicable laboratory staff and are approved by the Laboratory Director. Review and approval of each document are recorded by signatures in a review and approval section in each document.

### *Document Control*

All of the laboratory's key quality documents, namely the microbiology QAM and SOPs, are controlled documents. A controlled document has been through the preparation, review, and approval cycle and may not be changed after release and issue without going through a formal review and change authorization process. Each controlled document contains a document assignment page that assigns the document to a named individual, office, or lab area, indicates the controlled document copy number, and instructs the document assignee on how to maintain the document and enter changes.

Revisions of controlled documents are identified by a consecutive revision number and the date of the revision on the document title page and page headers within the document. Within one month of final change approval, changes are distributed to those assigned a controlled copy of the applicable document. Each change transmittal is assigned a sequential issue number, which indicates the number of revisions the document has undergone. A record of revisions will accompany each change transmittal to indicate the number and type of changes to the document. Any document designated as an "Uncontrolled Copy" is not subject to updated revisions.

### *Analysis Methods*

Analytical method SOPs are the key guidance documents for analysis activities in the

laboratory. The analytical method SOPs use the following general format:

- SOP Title Number, Revision Number, Date and Page Number header
- Review and Approval Signature Block
- Scope/Application
- References
- Definitions
- Safety
- Method (Apparatus/Materials, Reagents, Procedures, Quality Control, Corrective Action)
- Calculations

Data and associated records from analysis of samples and from support activities in the EQL for this project are identified in **Table 17**.

All laboratory paper records are stored in file cabinets within the secure laboratory facility for a period of one to three years. After that period the records are placed in labeled boxes and transferred to a locked room in a nearby university storage room. Electronic data are stored in the laboratory's desktop computers and on a restricted access (i.e., access restricted to Laboratory Director, Laboratory Master Technician, and Laboratory Technicians) intra-university network. Backup copies of electronic media are prepared at least annually and stored in a secure area off-site.

#### *Disposition of Records*

Records are stored for a nominal period of at least ten years. Records are stored for longer periods if requested or required by the customer or regulatory authority.

#### *Requests for Records*

Access to recent (i.e., within the previous year) laboratory records is restricted to laboratory personnel. Access to archived laboratory records is restricted to the Laboratory Director, Laboratory Master Technician, and Laboratory Technicians. All requests for laboratory records should be directed to one of those individuals. Original documents shall not be taken from the file storage area without permission from one of the listed individuals, and copying and distribution of such documents must also have their authorization.



**Table 17. Data and records generated by field measurements, sample collection, and laboratory sample analysis.**

Activity	Data Generator	Data Type	Data Format	Forms <sup>a</sup>	Reference <sup>b</sup>
Field measurements	Field measurer	Field measurement results	Written field log sheets	Form 2000F, Hach_rug_calib	SOP 420
Sample collection	Sampler	Field information	Written Chain-of-Custody	COC Form 1060	SOP 302
Sample receipt	Laboratory Director, Laboratory Technician	Receipt custody and temperature	Written Chain-of-Custody	COC Form 1060	QAM 4.2
			Receipt Log Spreadsheet	Receipt Log, Form 220	QAM 4.3
Internal custody	Laboratory Director, Laboratory Technician, Student	Time and location of storage	Written Chain-of-Custody	Form 217	QAM 4.4
Analysis	Laboratory Director, Laboratory Technician, Student	5-day BOD, chlorophyll, fecal coliform, total nitrogen, total phosphorus, toxicity, turbidity measurements	Written log sheets and calculation spreadsheet printouts	Forms 5210 & 5220 (BOD), 2230 (FC), 2130 (Turb), 8711 (Tox), 10200H (Chl), 4500N (TN/TP), 2120 (Color)	SOPs, 406, 408, 430, 440, 443, 444, 502, 601
Data review, verification and validation	Laboratory Director, Laboratory Technician	Analysis results	Written log sheets, calculation spreadsheet printouts, and runlog spreadsheet	Run Log	QAM 7.1
Report	Laboratory Director, Laboratory Technician	Analysis results	Electronic template	Excerpt from Run Log Spreadsheet	QAM 7.4
<sup>a</sup> All forms are provided in Appendix A <sup>b</sup> Referenced SOPs are provided in Appendix D and QAM = EQL QA Manual					

**C. ASSESSMENT / OVERSIGHT**

**C1 Assessments and Response Actions:**

Assessment	Frequency	Description	Information reported to
Initial demonstration of capability (IDC)	Initially, prior to reporting client data independently	The analyst must prepare four aliquots of a known level of the analyte of interest, analyze them according to the appropriate method, and demonstrate the ability to recover the analyte within established acceptance criteria.	Analyst, Laboratory Director, Program Director, SCDHEC, EPA Region 4
Data generator review	Every time data is generated	Conduct real-time review and verification of 100% of the data resulting from their activities.	Laboratory Director
Peer review	Every time data is generated	The peer reviewer(s) must be a qualified individual other than the data generator and must meet the minimum training and qualifications requirements for analysts. Data is reviewed for technical correctness for a minimum of the method, proper units/significant digits, calculation verifications, variations documented, transcription errors, complete data package, QC measurements within limits or qualified, and hold times were met or exceptions documented.	Laboratory Director
Analysis of internal and/or external performance evaluation (PE) samples	Once per year or as required by specific client contract requirements.	Analysis of a blind sample for the analyte(s) of interest. Results are evaluated for accuracy by a third party.	Laboratory Director, PE provider, clients, Program Director, SCDHEC, EPA Region 4
Internal audits	Quarterly	Review of SOPs for referenced method, review of procedure, review of data files, review of logbooks, review of compliance with QA policies	Analysts, Lab Director, Program Director
External audits	Per request	Review of entire scope of accreditation and project tasks by state, agency, or affiliations through whom EQL holds some form of certification or contract.	Lab Director, Program Director,
Lab Certification Evaluations	Minimum of three years	Review of entire scope of accreditation and project tasks by SCDHEC's Office of Laboratory Certification	Laboratory Director, Program Director, SCDHEC, EPA Region 4

*Assessments*

Assessments are tools used to examine laboratory systems as they normally operate and to determine if quality assurance needs of the project are being met by current policies. The laboratory is evaluated through surveillance (e.g., an analyst's initial demonstration of capability (IDC) exercise), data generator review, peer review, analysis of internal and/or external performance evaluation (PE) samples, and both internal and external audits.

Surveillance results may be evaluated as part of an audit. Lab Certification Evaluations occur a minimum of every three years which Review of entire scope of accreditation and project tasks by SCDHEC's Office of Laboratory Certification.

#### *Demonstration of Capability*

An analyst training on a given method must perform an initial demonstration of capability (IDC) exercise prior to reporting client data independently (i.e., without the supervision of a qualified analyst). The analyst must prepare four aliquots of a known level of the analyte of interest, analyze them according to the appropriate method, and demonstrate the ability to recover the analyte within established acceptance criteria. Acceptance criteria for IDCs, depend on analytical technique and are listed on the IDC form, Form 1020B. Calculation of IDC results is done through a standard spreadsheet and may be performed by either the analyst or the QAO. Results are filed in the employee's technical training file and the IDC file in the QA records.

#### *Data Generator Review and Verification*

Data generators (i.e., the analyst or personnel conducting analyses) are responsible for conducting real-time review and verification of 100% of the data resulting from their activities. This review must be documented by the data generator's signature and review date on the raw data and on a worksheet or data review checklist. Data generators are accountable for ensuring that all data they generate are complete, accurate, and compliant with applicable requirements (QAM, SOP, method, or client-specified criteria). Data generators are responsible for performing all data reduction required prior to independent technical review, reporting and for notifying the Laboratory Director and/or QAO of any problems encountered during analysis and data review that may potentially impact data quality. The Laboratory Director and/or the QAO then determine and assign necessary corrective actions (see "Corrective Actions" element of this QAPP).

#### *Peer Review*

All laboratory data must also receive peer review (i.e., independent technical review and verification). The independent technical reviewer(s) must be a qualified individual other than the data generator (e.g., peer analyst or Laboratory Director). He/she must meet the minimum training and qualifications requirements for analysts. Individuals not qualified to perform data interpretation cannot perform independent technical review. The independent reviewer(s) must ensure that:

- Data generation and reduction were conducted in a technically correct manner in accordance with the methods used.
- Data are reported in the proper units and with the correct number of significant figures.
- Calculations were performed with a valid calculation program and are correct. Calculations are checked by a spot check of verified calculation programs or 100% check of all hand calculations.
- All variances from an accepted method and the rationale for the variations were

- documented and approved.
- Data were reviewed for transcription errors.
  - Analytical data documentation file or data package is complete, including sample preparation/extraction records, analysis sequence list, raw data, calculations or calculation records, calibration data or records, QC measurement results, test results summary, and completed worksheet or data validation checklist.
  - QC measurement results are within established program specification limits, or if not, the data are appropriately qualified.
  - Analytical sample holding times were met, or exceptions are documented.

Independent technical review is required before any data are approved for release and submitted to the data reporting process. The independent technical review process is documented with a signed and dated worksheet or data review checklist. The worksheet or checklist is archived in the associated data package. The peer reviewer must notify the data generator and the Laboratory Director and/or QAO of any problems identified during peer review that may potentially impact data quality. The Laboratory Director and/or the QAO then evaluate and assign, if necessary, corrective actions (see “Corrective Actions” element of this QAPP).

### *Performance Evaluations*

Performance evaluation (PE) studies, also referred to as proficiency test (PT) sample analyses, involve the analysis of a blind sample (i.e., a sample whose true analyte concentrations and/or analyte identities are not known by the laboratory) for the analyte(s) of interest. The analysis results of the study are evaluated for accuracy by a third party. The majority of PEs are performed by the lab in order to maintain state or agency certifications. PE sample analysis may also be required by specific client contract requirements. PE samples may either be provided by the state, agency, or client independently, or ordered by the lab from approved vendors having established PE programs. In-house blind samples may be prepared or purchased and submitted to the lab by the QAO at any time.

For this project the EQL obtains and analyzes PE samples from an approved vendor at least annually as one of the requirements for maintaining its certification in the SC DHEC Laboratory Certification Program.

PEs are often received in the form of concentrates, which must be prepared according to the vendor’s instructions in order to obtain an aliquot that is ready for routine sample preparation and analysis. Preparation and analysis of PE samples are recorded in the PE preparation log. The reconstituted aliquot must be prepared and analyzed according to the applicable method in the same manner as routine samples. The PE sample results must be subjected to the same QC requirements as used for validating a routine sample result.

All PE raw data and results must be reviewed and approved (initialed and dated) by the Laboratory Director. Copies of raw data and final worksheets, showing the approval with results to be reported, are forwarded to a QAO for submittal to the evaluator. Scoring is

performed by the provider, and the issued report is retained in the QAO files. These reports are available to all staff, auditing agents, and clients upon request. Any PE measurement result that is not within the acceptance range established for the measurement is reviewed by the Laboratory Director and/or the QAO, who then determine and assign necessary corrective actions (see “Corrective Actions” element of this QAPP).

### *Internal Audits*

Internal audits are conducted by the EQL Quality Assurance Officer (QAO). An audit may be performed by another designated staff member who is knowledgeable of the process. Activities of an internal audit include, but are not limited to the following:

- Review of the SOP against the referenced method(s)
- Review of the procedure with a staff member who routinely performs the process
- Review of data files for complete and proper documentation, calculations, and quality control frequency (examination may include all testing records showing standardization, spikes, duplicates, and QC samples from one or more analytical runs)
- Review of logbooks for accuracy and completeness
- Review of the process for compliance with laboratory QA policies including error corrections, corrective action, reagent labeling policies, etc.

EQL internal audits occur at minimum of one laboratory area per quarter. Areas are defined by method or technique for analytical audits and by section for operational activities audits. Auditing in this manner allows for a comprehensive, on-going review of several areas throughout the year. The scheduling of the quarterly audits is at the discretion of the QAO and Laboratory Director.

Any deficiency identified by an audit is reviewed by the Laboratory Director then assigned to appropriate individual(s) for corrective action. The Laboratory Director establishes a corrective action completion date and monitors the corrective action until completed.

### *External Audits*

External audits are initiated primarily by states, agencies, or affiliations through whom EQL holds some form of certification or contract. For this project, external audits of EQL will be conducted by SC DHEC’s Office of Laboratory Certification and possibly the City of Conway, Georgetown County, and Horry County Stormwater Managers. Audits of this nature cover the entire scope of the accreditation and project tasks, including sample handling, preparation, analysis, and reporting for all parameters. Clients may also employ a qualified third-party assessor on their behalf to perform an external audit. The level of detail of an external audit is at the discretion of the auditor as related to the lab’s responsibilities and activities described in the project QAPP.

Any deficiency identified by an audit is reviewed by the Laboratory Director then assigned to appropriate individual(s) for corrective action. The Laboratory Director establishes a corrective action completion date and monitors the corrective action until completed.

### **Corrective Actions:**

Any condition that adversely affects compliance with established QC requirements must be identified and corrected as soon as practical. Action taken to correct or preclude the recurrence of that condition is called “corrective action”. Some examples of corrective actions include repairs to equipment, revision of an SOP to eliminate a repetitive problem, or obtaining an approved variance to a procedure.

If severe issues are found then both Dr. Trapp and Dr. Libes have the authority to stop work.

### *Nonconformances*

Nonconformances are items or conditions of a process which do not meet established QAM, SOP, method, or project requirements. As described in EQL SOP 201, "Nonconformance Identification and Corrective Action", all nonconformances, and the corrective actions taken, must be documented on a Non-Conformance/Corrective Action Report (NCR). Completion of a NCR should include not only a description of the problem and corrective actions but also copies of any documentation to support the same. NCRs must be routed through the QAO and Laboratory Director for approvals and closure.

Should a nonconformance affect the reportability of a client’s data or the ability to analyze a sample, it is the responsibility of the staff member documenting the nonconformance to notify the Laboratory Director immediately. The Laboratory Director must in turn contact the client, describe the details of the problem, act on any further instructions received, and follow up with written notice to the client of the problem and its resolution. A copy of the NCR may be used for this purpose.

Client inquiries concerning quality assurance are handled in a similar manner. When a client has a concern regarding laboratory results or procedures, it is the responsibility of the Laboratory Director to initiate a NCR. The Laboratory Director will review testing records for the sample (if applicable) and any circumstances surrounding the complaint. This review may include examination of bench sheets, compiled results, or applicable log books to check for errors. A copy of the NCR, detailing all findings and corrective actions, will be kept with the file copy of the formal result report for the sample in question. Review and approval of the NCR by the Laboratory Director and a QAO is required. Again, a written follow-up to the client is required. All NCRs are logged, and originals are retained in QAO files.

### *Variations*

A variance is a type of corrective action involving an approved change to a process or procedure. A variance describes a deviation from a method, which affects the operation of the method, but not the method’s ability to achieve the performance standards or quality assurance objectives required. Variations must be requested in writing and receive approvals from the Laboratory Director and QAO.

### *Emergency Alternatives Policy*

Under extreme or unavoidable circumstances (such as equipment failure, or irreconcilable matrix difficulties) samples may not be able to be analyzed by methods specified by the client or program. Alternative procedures may be acceptable. However, use of these procedures must be approved by the client. Laboratory staff identifying the problem must notify the Laboratory Director. The Laboratory Director is responsible for communicating the situation to the client. This communication must take place prior to reporting the results of the test by the alternate method and must be documented. The Laboratory Director may also inform the client if an option exists to sub-contract the samples to an appropriately certified laboratory. Sub-contracting options are also subject to client approval. Only labs that are certified for the parameters needed will be used.

### **Quality Improvement:**

The EQL Laboratory Director, Laboratory Master Technician, and Laboratory Technicians meet periodically (as needed) as a quality improvement team to continually assess project work processes and laboratory operations, identify needed improvements, assign responsibilities for making improvements, and monitor progress on improvement actions.

The EQL quality improvement processes are summarized as follows:

- Nonconformance reporting
- Corrective actions
- Internal audits
- Management assessments
- Trend analysis
- Control charting

### *Trend Analysis*

As described in EQL SOP 201, "Nonconformance Identification and Corrective Action", the laboratory uses trend analysis to monitor its analytical systems and associated activities. The goals of the trend analysis are as follows:

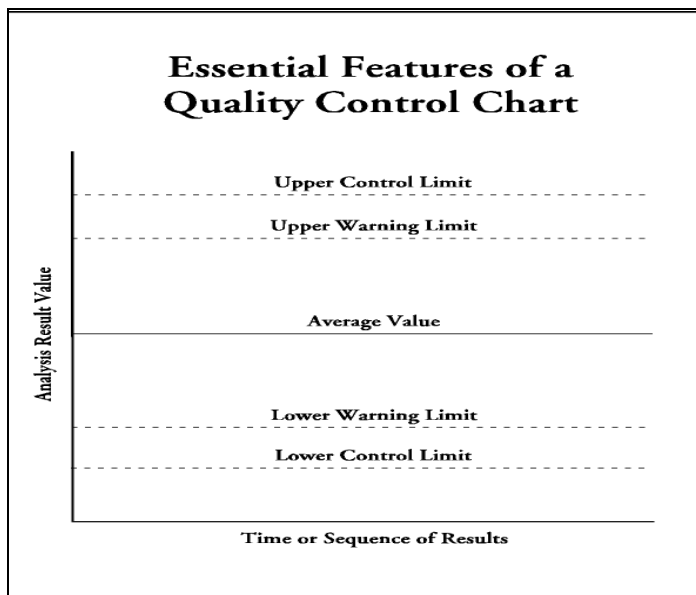
- To detect quality problems before they become significantly adverse to the quality of the products.
- To allow timely initiation of corrective actions to prevent development of significant quality problems.
- To ensure continuous quality improvement.

Control charting and frequency histograms are the main techniques EQL uses to conduct trend analysis; the parameters charted are nonconformance characteristics and QC measurement results.

### Control Charts

Control charts are used by the EQL laboratory to monitor trends in analytical performance. As illustrated in **Figure 3** a control chart consists of a graph with the vertical axis labeled in units of the analysis or parameter of interest and the horizontal axis labeled in units of time or sequence of results. The upper and lower warning and control limits, which are statistically determined or specified by the method, may be used as criteria for instituting corrective actions. When the parameter being plotted is the relative percent difference (RPD) the lower limits do not apply (i.e., the minimum value of the RPD plotted is always zero and the limits plotted are upper limits).

**Figure 3. Example of quality control charting.**



A basic principle in a QA program is the establishment of control limits. Such limits are utilized as decision criteria during analytical processes to reduce errors to acceptable levels and statistically characterize the results. Control limits are finite values which are comparable to the measurement values and can be used to statistically assess the acceptability of analytical measurements. There are two goals in establishing control limits. They should yield a narrow enough acceptance range so measurements that lie outside the upper or lower control limit indicate problems within the analytical system (i.e., the system is out of control). The limits, however, should not provide a range so narrow as to cause unnecessary adjustments of the analytical system and rejection of acceptably accurate and reliable results.

EQL's general policy is to utilize control limits where specified by the analytical method or where a sufficient data base exists (i.e., at least 20 data points) to establish control limits of  $\pm 3\sigma$  from the mean value of replicate measurements, where "s" is the estimated standard deviation for replicate measurements for the system of concern. Measurements exceeding the control limits (either blank or control sample recovery measurements or precision measurements) usually require halting the analytical process, institution of



corrective action measures necessary to obtain acceptable measurements, and documenting the corrective measures taken. This occurrence also normally requires rejection of any results generated between the last acceptable measurement and the unacceptable measurement or reporting those results with the notation that the analytical system was out of control. Warning limits of  $\pm 2\sigma$  are utilized. Measurements inside the control limits but exceeding the warning limits require close examination of the measurement system by the analyst. Measurements in this category do not normally require halting the analytical process and rejection of data unless a significant problem is discovered.

## **C2 Reports to Management:**

### *Annual Report*

By mid-June of each year, the Laboratory Director prepares an annual activity report summarizing the following:

- Goals
- Financial summary and projections
- Measures and comparisons
- Major activities and accomplishments for year
- Needs

An important objective of the report is to address any unresolved quality issues pertinent to each area of lab operation, including any deficiencies identified by internal or external audits concerning equipment, systems, training, and/or staffing levels required to maintain or improve product quality. The report is submitted to EQL Program Director/Watershed Academy Director, B&C CMWS Director, Marine Science Department Chairman, and College of Natural and Applied Sciences Dean.

### *Monthly Meeting/Report*

Laboratory staff meets early each month to discuss and plan that month's activities. The meeting agenda, which also serves as the meeting report for the previous month, lists accomplishments since the last meeting, the activities planned for the current month, review quality control issues, and important activities planned or expected in the near future. The meeting is always attended by the Laboratory Director and all Laboratory Technicians and is frequently attended by the Laboratory Program Director. The main purpose of the meeting is to finalize the assignments and scheduling of tasks for the upcoming month. Any issues that could adversely impact completeness, quality, or schedules of projects are thoroughly discussed and actions taken to ensure problems are avoided or reduced as much as possible.

### *Bi-Weekly Leadership Meeting*

The Program and Technical Director meet every other week to discuss laboratory operations. This includes discussions of data QA/QC and data validation concerns and non-conformances. Additionally, overall programmatic goals, data reporting, and communications with funding and data reporting partners are discussed.

**D. DATA VALIDATION AND USABILITY**

**D1 Data Review, Validation, and Verification Requirements:**

**Table 18.** Criteria for accepting, rejecting or flagging data.

<b>Item</b>	<b>Criteria</b>	<b>If not met sample is accepted, flagged or rejected?</b>	<b>Flag</b>	<b>Comments</b>
Sample not analyzed within hold time	Sample received in the lab within 6 hours of collection and analyzed within 2 hours of receipt appropriate hold time	Rejected	HT	
Lost sample	Proper COC documentation not followed and sample is misplaced	(Unable to analyze)	LS	
Unable to Collect Sample	Various circumstances (i.e., weather, lost sampling container) cause sample to not be collected	(Unable to analyze)	NS	
Sample not held within required temperature range	Temperature blank within cooler indicates temperature above 6° C or proper storage equipment failed to read within range (refrigerator/freezer)	Rejected	T	
Temperature blank not placed within cooler during sample transport	Unknown receipt temperature	Flagged	UT	
Incorrect sampling container used for sample collection	Incorrect sampling container used for sample collection	Flagged	SC	
Improper preservation	Improper preservation (i.e., acidification, filtering)	Flagged	IP	

## **D2: Validation and Verification Methods**

All processes at EQL (sample receiving and handling, sample analysis, data reduction, data reporting, data review, etc.) are subject to examination to evaluate adherence to project specifications. This examination consists of several layers of technical and QA review. These reviews ensure that all data released by EQL were scrutinized by qualified independent reviewers and are scientifically sound, appropriate to the method, completely documented, and legally defensible.

All data receive analyst review and independent analyst (i.e., qualified peer) review. The Laboratory Director and QAO also review the data to varying degrees at different points in the review process. These review processes are appropriately documented before data are released from the laboratory.

*Data review* ensures that raw data are properly collected, reduced, and reported. *Data verification* confirms by examination of the measurement process and provision of evidence, that specified method, procedural, or contractual requirements have been met. For example, QC measurements must indicate that deviations between measured values and known values are smaller than the maximum allowable error (i.e., DQIs). *Data validation* is the process of substantiating that specified performance criteria were achieved for an entire data set or data reporting group, including comparisons between analytes and samples to see if relationships are scientifically reasonable.

At EQL, a worksheet or data review checklist (DRC) for each analytical process outlines the performance criteria for the process. The worksheet or checklist is completed and signed for each analysis batch by both the analyst and a qualified peer to document the process as described earlier in the “Data Generator Review and Verification” and “Peer Review” subsections of the “Assessments and Response Actions” element of this QAPP.

The EQL review process must examine as a minimum the following data recording requirements for analyses:

- All original data must be recorded, signed, and dated in black waterproof ink.
- All data must be recorded clearly and accurately in laboratory records, bench sheets, or logbooks, and include applicable sample identification numbers.
- All changes and additions to original data must be made with a single-line drawn through the error with the correction entered above or next to the line-out. **White-out, correction tape, or similar correction techniques must not be used for changing laboratory data.** The change must be initialed and dated by the individual making the change (an explanation of the change or addition must be included if the change or addition deals with rejecting data).
- All data used from logbooks and laboratory records must be transferred and reduced completely and accurately.
- All laboratory records shall be maintained in permanent files.
- Data shall be organized into standard formats.
- All electronic data shall be stored appropriately to ensure that sample and QC data are

protected and readily retrievable. Corrections made to hardcopy data must also be made in electronic data files whenever possible.

The data review is documented by the Laboratory Director's signature and date on the final reports and is done before the reports are released to the client.

#### *Project Management / Data Validation*

The final step in the data validation and usability determination in the EQL analysis and reporting process is data validation or the project management review by the Laboratory Program Director, Dr, Susan Libes.

One hundred percent (100%) of the data reports must receive a relational technical review before being released to the client. The project management relational review occurs after the data have been entered and all analytical peer review has taken place.

This review must ensure that:

- Data are technically reasonable based on the technique used.
- Reported analytical data documentation or data package meets the clients' data quality objectives (DQOs).
- Relationships between related parameters are scientifically reasonable. Anomalies in the data will be investigated.
- Notation of contravention of water quality standards.
- Site specific statistical rankings of data based on the entire project data set
- Entry of data in to the online data base

### **D3. Reconciliation with User Requirements**

Reconciliation of data with DQI criteria to determine data usability is performed primarily by the Laboratory Program Director working in direct communication with the clients. Data reports following each sampling event are emailed to clients with a summary of water quality standards and reporting limits for each analysis. Reports include notation of parameters contravening the water quality standards. Additionally, data is assigned statistical rankings (<10%, <25%, normal, >75%, and >90%) based on the site specific historical records to give context to results for end users. Following validation data are uploaded to a public website [http://bccmws.coastal.edu/river\\_gauge/](http://bccmws.coastal.edu/river_gauge/). The website includes graphical tools to plot time series for individual sites, geographical comparisons for the study area, and comparisons to mean values.

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