Generic Quality Assurance Project Plan
For South Waterfront Brownfields Assessment, Knoxville, Tennessee
Conducted Under EPA Brownfields Cooperative Agreement No. BF-95443509-0
S&ME Project No. 1434-09-382, Revision 1
Date Prepared: March 11, 2011

Prepared for:

City of Knoxville, South Waterfront Department
400 Main Street, Suite 503, Knoxville, Tennessee 37902

Prepared by:

S&ME
1413 Topside Road
Louisville, Tennessee 37777

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A.1 APPROVALS:

Brownfields Grantee Project Manager:
City of Knoxville

Mr. Dave Hill — 3/24/2011
Printed Name — Date

S&ME Project Manager:

Mr. James R. Bruce — 3-11-11
Printed Name — Date

S&ME QA/QC Officer:

Mr. Eric Solt — 3-11-11
Printed Name — Date

USEPA Designated Approving Official:

BARBARA J. CAPUTA — 3-25-11
Printed Name — Date

EPA Brownfields Project Officer/Manager:

Mr. Serdar Ertep — 3/29/11
Printed Name — Date

TDEC Project Manager:

Mr. Andy Shivas — 3-11-2011
Printed Name — Date

NOTICE

This QAPP is valid only for this specific project as described herein. It is not to be used for other projects or subsequent phases of this project without the written approval of the Project Manager. The City of Knoxville is required to obtain advance approval from the Environmental Protection Agency (EPA) of this Generic Quality Assurance Project Plan (QAPP) prior to performance of any site work using federal grant funds under its EPA Brownfields Assessment Grant. The QAPP is a formal document describing quality assurance (QA) and quality control (QC) procedures to be implemented in order to achieve the stated performance criteria. Upon EPA's approval, this Generic QAPP will be valid for five years, subject to annual review and updates. In addition to this Generic QAPP, a Site-Specific QAPP (SSQAPP) Addendum will be required for each individual Phase II Environmental Assessment Project prior to beginning any Phase II assessment activities.

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A.3 DISTRIBUTION LIST
Generic Quality Assurance Project Plan
Revision 1
EPA Brownfields Cooperative Agreement No. BF-95443509-0
South Waterfront Brownfields Assessment
Knoxville, Tennessee

Copy No.

1. James R. Bruce, P.G., CHMM, Project Manager
S&ME, Inc.
1413 Topside Road
Louisville, Tennessee 37777
rbruce@smeinc.com
865-970-0003

2. Nathan Peterson, R.G., Field Team Leader
S&ME, Inc.
1413 Topside Road
Louisville, Tennessee 37777
npeterson@smeinc.com
865-970-0003

3. Eric Solt, P.G., S&ME Designated Approving Official
S&ME, Inc.
1413 Topside Road
Louisville, Tennessee 37777
esolt@smeinc.com
865-970-0003

4. Debbie Thomas, Health and Safety Officer
S&ME, Inc.
1413 Topside Road
Louisville, Tennessee 37777
dthomas@smeinc.com
865-970-0003

5. Leira Douthat, Risk Assessor
S&ME, Inc.
1413 Topside Road
Louisville, Tennessee 37777
ldouthat@smeinc.com
865-970-0003

6. Jane Wasilewski, Quality Assurance Manager
S&ME, Inc.
9759 Southern Pine Blvd.
Charlotte, North Carolina
jwasilewski@smeinc.com
704-523-4726

7. Tom Mellette, Quality Assurance Manager
Environmental Science Corporation
12065 Lebanon Road

Mt. Juliet, Tennessee 379122
tmellette@esclabsciences.com
615-758-5858

8. Jim Whetsel, Quality Assurance Manager
W. L. Gore & Associates, Inc.
100 Chesapeake Blvd.
Elkton, Maryland 21922
jwhetsel@wlgore.com
410-392-7600

9. Irma Faszewski, Quality Assurance Manager
Environmental Hazards Services, LLC
7469 Whitepine Road.
Richmond, Virginia 23237
managerqaqc@leadlab.com
800-347-4010

10. David Hill, AICP, ASLA, Sr. Director of South Waterfront Development
City of Knoxville
City-County Building, Suite 503, 400 Main Street
Knoxville, TN 37902
DHill@cityofknoxville.org
865- 215-3764

11. Serdar Ertep, EPA Brownfields Project Officer/Manager
U.S. EPA, Region IV
61 Forsyth Street, SW
Atlanta, Georgia 30303-3104
ertep.serdar@epamail.epa.gov
404-562-9683

12. Andrew Shivas
Tennessee Department of Environment and Conservation
4th Floor, L&C Annex
401 Church Street
Nashville, TN 37243-1538
Andy.Shivas@ tn.gov
615-532-0912

13. Erin Sutton
Tennessee Department of Environment and Conservation
3711 Middlebrook Pike
Knoxville, TN 37921
Erin.F.Sutton@tn.gov
865-594-5498

Note: Copy No. 1 is the Master Copy

All personnel will receive and follow applicable sections of this Generic QAPP and subsequent revisions.

A.4 PROJECT / TASK ORGANIZATION

This Quality Assurance Project Plan (QAPP) presents the organization, objectives, functional activities, and generic quality assurance (QA) and quality control (QC) activities associated with the Brownfields site assessment activities to be conducted under the South Waterfront Brownfields Assessment Grant in Knoxville, Tennessee. A site vicinity map is included as Figure 1 (Appendix A). This QAPP has been prepared in general accordance with US Environmental Protection Agency (EPA) guidance including EPA's *Brownfields Quality Assurance Project Plans Interim Instructions, Generic QAPP and Site Specific QAPP Addendum For Brownfields Site Assessments and/or Cleanups* (February 25, 2010), *Guidance for Quality Assurance Project Plans, QA/G-5* (EPA/240/R-02/009, May 2006), *EPA Requirements for Quality Assurance Project Plans, QA/R-5* (EPA/240/B-01/003, December 2002). A QAPP distribution list is presented in Section A.3.

The purpose of this QAPP is to outline generic procedures that will be implemented to assure and control the quality and integrity of sample collection and analysis during the course of the assessment. This QAPP describes the specific protocols to be followed for sampling, sample handling and storage, chain-of-custody, and laboratory analysis. Laboratory QA/QC procedures will be in accordance with applicable professional technical standards, EPA requirements, and specific project goals and requirements.

A site-specific QAPP Addendum, Field Sampling and Analysis Plan (FSAP) and Site Specific Health and Safety Plan (SSHSP) will also be developed for each selected assessment site and will be submitted under separate cover. The FSAP will describe the specific sampling and data gathering methods, which will be compatible with the Data Quality Objectives (DQOs) identified in this QAPP. The SSHSP will also describe procedures to be followed to minimize risks to health and safety during performance of the field activities.

The purpose of the Brownfields Assessments will be to understand the nature and extent of potential contamination in the areas assessed, which may include potential off-site impacts, as these factors may influence redevelopment opportunities. The results of proposed assessment activities may be used in negotiating Brownfields Agreements with the Tennessee Department of Environment and Conservation (TDEC). The results may also be used to evaluate if identified constituents of concern pose a potential environmental risk for planned future use. The results may also be evaluated to determine if additional assessment or remedial activities are warranted.

In general, the Phase II assessment activities to be conducted by S&ME Inc. (S&ME) at any selected project site may include the assessment of soil, groundwater, passive soil vapors, soil gas, sediment and surface water. Additional assessment may also include lead-based paint and asbestos in on-site structures. Assessments will generally be followed with a written report documenting all field activities and summarizing the analytical results. The report will include photographs, boring logs, figures, and all analytical data from sampling efforts. Even in cases where prior site characterization activities have been performed, additional assessment may be performed to confirm results derived from previous investigations or to provide additional data for those areas where existing information is limited or absent.

Personnel involved in the investigation and generation of data become a part of the overall project quality assurance program. Within that program, the following individuals have specific

responsibilities: Project Manager, Field Team Leader, Field Sampling Technicians, Laboratory Quality Assurance Officers, Laboratory Sample Custodians, Site Safety and Health Officer, and Senior Reviewer. The typical responsibilities of each are outlined below. Refer to Appendix B for resumes of key site personnel and Appendix C for a copy of the Project Organization Chart.

A.4.1 Project Manager

Mr. James R. Bruce, P.G., CHMM will serve as Project Manager. Mr. Bruce is a Geologist and Project Manager with S&ME in Knoxville, Tennessee. He will be responsible for direction of the work to be conducted and will oversee scheduling and budgeting. Mr. Bruce will also direct the preparation of each Site Specific QAPP (SSQAPP) Addendum and supporting documentation, and will coordinate the project activities including the following:

1. Approve the QAPP and subsequent revisions to meet Brownfields specific requirements and criteria;
2. Distribute the QAPP document to the Field Team Leader and other members of the project team and guide personnel in achieving a thorough understanding of the QAPP;
3. Assume overall responsibility of each investigation;
4. Coordinate field and laboratory activities;
5. Validate field data;
6. Ensure project activities are conducted in accordance with the QAPP;
7. Report to City of Knoxville Brownfields Grantee Project Manager and TDECs Brownfields Project Manager regarding the project status;
8. Prepare interim and final reports to TDEC and the City of Knoxville;
9. Make final project decisions with the authority to commit the necessary resources to conduct the project;
10. Institute corrective actions for problems encountered in the field sampling activities;
11. Communicate corrective actions to the Field Team Leader to remedy problems encountered in the field and coordinate with the respective Laboratory QA Managers to correct any corresponding problems encountered in the laboratory analyses; and
12. Compile documentation detailing any corrective actions and provide them to the QA/QC Officer and TDEC.

A.4.2 Field Team Leader

Mr. Nathan Peterson (S&ME personnel), or an equally qualified substitute, will be the Field Team Leader (FTL) for the assessments and report to the Project Manager. Mr. Peterson will be responsible for seeing that site activities are carried out in accordance with the project planning documents. Mr. Peterson will be responsible for providing quality assurance of field generated data, assist in the coordination of field activities conducted by subcontractors and provide daily on-site quality control for field work. He will also be responsible for maintaining clear communication between laboratory and assessment personnel.

Mr. Peterson will also assist with the coordination of the field project activities and his specific responsibilities include the following:

1. Select personnel that will comprise the field sampling team;

2. Conduct the field activities in accordance with the approved QAPP and supervise the field sampling team;
3. Following receipt from the Project Manager, Distribute the approved QAPP and subsequent revisions to the field sampling team members;
4. Provide project status updates to Project Manager;
5. Implement corrective actions in the field as directed by the Project Manager; and
6. Document corrective actions in field logs and provide to the Project Manager.

A.4.3 Field Sampling Technicians

The Field Sampling Technicians will be responsible for on-site sampling and sample handling activities. This includes proper labeling and security, chain-of-custody, analysis request forms, packaging, and shipping. The field sampling technicians will be qualified S&ME technicians and will assist Mr. Peterson in the field.

A.4.4 Laboratory Quality Assurance Officers

The Laboratory Quality Assurance Officer will be responsible for maintenance of laboratory quality assurance activities associated with the project. The Laboratory Quality Assurance Officer will also be responsible for coordinating the analysis of the samples and laboratory validation of the data. Other responsibilities will include sample receipt at the laboratory, selection of the analytical team, assurance that internal laboratory audits are conducted per the Laboratory's Quality Assurance Manual, and distributing applicable portions of the QAPP and subsequent revisions to the applicable members of the analytical team. Responsibilities also include instituting corrective actions for problems encountered in the laboratory analysis and reporting laboratory problems affecting the project data to the Project Manager.

Soil, sediment, soil gas and surface and groundwater samples will be submitted to Environmental Science Corporation (ESC), located in Mt. Juliet, Tennessee. The Laboratory Quality Assurance Officer for all ESC samples will be Mr. Tom Mellette, Laboratory Operations Manager. If passive soil vapor samples are collected, the Laboratory Quality Assurance Officer will be Mr. Jim Whetzel, Quality Assurance Manager with W.L. Gore & Associates, Inc. in Elkton, Maryland. If Asbestos samples are collected, the Laboratory Quality Assurance Officer will be Ms. Jane Wasilewski, QA/QC Director with S&ME, Inc. in Charlotte, North Carolina. If lead-based paint samples are collected, the Laboratory Quality Assurance Officer will be Ms. Irma Faszewski, Quality Manager with Environmental Hazards Services, LLC in Richmond, Virginia.

A.4.5 Risk Assessor

Ms. Leira Douthat of S&ME will serve as the project Risk Assessor. The Risk Assessor will be responsible for evaluating the results of field and laboratory QA samples and determining the usefulness of the analytical data. The Risk Assessor will review the analytical data packages and document variations from the analytical protocol and actions taken by the laboratory. The Risk Assessor will also validate the analytical data.

A.4.6 Site Safety and Health Officer

The Site Safety and Health Officer will advise the field team members on health and safety issues at the site and ensure compliance with the SSHSP. The Site Safety and Health Officer for each specific assessment project will be identified in the SSQAPP. Ms. Debbie Thomas with S&ME's Knoxville office will serve as the overall project Site Health and Safety Officer.

A.4.7 Project Quality Assurance Officer

Mr. Eric Solt, P.G. will serve as the Quality Assurance (QA) Officer and Senior Reviewer for the Brownfields assessment documents and deliverables. He will review documents for completeness, accuracy, and adherence to the required scope of work. In addition, Mr. Solt may conduct field audits as needed. Mr. Solt will also serve as S&ME's Designated Approving Official (DAO).

A.4.8 Regulatory Agencies

A.4.8.1 EPA Project Officer/Project Manager

Mr. Serdar Ertep will serve as the EPA Region 4 Brownfields Project Officer/Manager, with the responsibility to oversee and monitor the grant. As part of that responsibility he/she must ensure the process described in the work plan is followed and the terms and conditions of the grant are met.

A.4.8.2 EPA QA Manager's Designated Approving Official

The Brownfields Region 4 Quality Assurance Manager's DAO provides a technical assistance role to Region 4 Project Officer/Manager working on Brownfields sites. The DAO role is to provide technical reviews of the Generic QAPPs and SSQAPP Addenda that are generated. This includes the approval of the Generic QAPP and SSQAPP Addenda, respectively, and any revisions.

A.4.8.3 TDEC Project Managers

The TDEC, Division of Remediation is the lead regulatory review agency for this project. Mr. Andrew Shivas will be the lead TDEC Project Manager. He will act as EPA liaison and will provide oversight for all activities proposed at each Brownfields assessment site under this grant. Ms. Erin Sutton will serve as the TDEC Technical Project Manager and will provide technical oversight for all activities proposed at each Brownfields assessment site under this grant.

A.4.9 Analytical Laboratory

ESC will be used as the primary analytical laboratory for this project. The Laboratory Quality Assurance Officer for all ESC samples will be Mr. Tom Mellette, Laboratory Operations Manager. ESC is certified by the State of Tennessee to perform the requested laboratory analyses for the projects. Appendix D includes the qualifications and QA/QC Manual (on CD-ROM) for ESC.

W. L. Gore & Associates will be used as the analytical laboratory in the event that soil vapor samples are collected for this project. The Laboratory Quality Assurance Officer will be Mr. Jim Whetzel, Quality Assurance Manager with W.L. Gore & Associates, Inc. in Elkton, Maryland. Appendix D also includes the QA/QC Manual (on CD-ROM) for W. L. Gore & Associates, Inc.

Environmental Hazards Services, LLC (EHS) will be used as the analytical laboratory in the event that lead-based paint samples are collected for this project. The Laboratory Quality Assurance Officer will be Ms. Irma Faszewski, Quality Manager with Environmental Hazards Services, LLC in Richmond, Virginia. Appendix D also includes the QA/QC Manual (on CD-ROM) for EHS.

S&ME will be used as the analytical laboratory in the event that asbestos samples are collected for this project. The Laboratory Quality Assurance Officer will be Ms. Jane Wasilewski, QA/QC Director with S&ME, Inc. in Charlotte, North Carolina. Appendix D also includes the QA/QC Manual (on CD-ROM) for S&ME.

A.5 PROBLEM DEFINITION / BACKGROUND (IN SITE-SPECIFIC QAPP)

Site-Specific QAPP Addenda will be prepared upon selection of approved candidate sites and will include discussions of the specific site problem definitions and background information.

A.6 PROJECT / TASK DESCRIPTION (IN SITE-SPECIFIC QAPP)

Following selection of each approved candidate site, a SSQAPP Addendum will be prepared for the site and include a discussion of the project, the tasks to be performed, the data that will be collected, reports that will be generated, and the projected schedule.

Upon completion of each assessment, a determination will be made relative to whether environmental impacts in environmental media were identified, the concentrations exceed applicable regulatory screening criteria, and if site remediation is warranted based on those exceedances.

A.7 SPECIAL TRAINING / CERTIFICATION

The South Waterfront area includes a variety of properties that may have subsurface contamination resulting from historical property uses that may be selected for assessment. In general, due to the unknown nature and extent of surface and subsurface contamination, all on-site field personnel must have completed the OSHA 40-hour Hazardous Waste and Operations Training and annual 8-hour refreshers. Each SSQAPP and SSHSP will contain additional details on health and safety related requirements, tailored to the specific site requirements. All onsite S&ME personnel will also have completed the 10-hour Occupational Safety and Health Training Course in Construction Safety and Health as well.

S&ME personnel receive ongoing internal safety training under the direction of the S&ME Health and Safety Officer. Outside training is obtained on an as-needed basis for other specific

assigned tasks. Any determinations for new training are identified during personnel evaluations by S&ME Management.

It is the Project Manager's responsibility to communicate with the field personnel regarding field related training requirements, if necessary, or renewal of certifications or other project related training requirements. The Project Manager is responsible for ensuring that any training that is required for the project is documented and retained in the project file.

A Tennessee Certified Asbestos Inspector accredited by the TDEC, Division of Solid and Hazardous Waste Management, Toxic Substance Program will perform the asbestos and lead sampling. This individual will also be required to provide proof of their 40-hour and 8-hour HAZWOPER certifications.

Tennessee licensed drillers and environmental excavation subcontractors will perform the drilling services and test pits as appropriate for investigative purposes. Licensure of the driller or subcontractors will be confirmed during solicitation of services. All drillers and subcontractors will be required to provide proof of their 40-hour and 8-hour HAZWOPER certifications.

S&ME's corporate Health and Safety Officer maintains certifications for all 40-hour trained and 8-hour refresher trained personnel. The training certifications are retained in personnel files in S&ME's local office in Louisville, Tennessee as well as the corporate office in Raleigh, North Carolina. The officer also maintains an electronic spreadsheet with updates for renewing certifications and notifies employees annually regarding renewal requirements.

The Project Manager will conduct a kickoff meeting to communicate the SSQAPP and SSFSAP requirements, to ensure that the project team understands the project objective and QA/QC requirements. The project team is responsible for referring to the Generic QAPP and SSAPP and SSFSAP throughout the project to ensure the established data quality objectives are met.

It is the Field Team Leader's responsibility for seeing that site field activities are carried out in accordance with the project planning documents and verifying that field personnel and subcontractor's maintain their respective field relating training documents for the duration of all site investigation activities. The Field Team Leader will have current 40-Hour and 8-Hour Supervisor HAZWOPER training certifications.

In general, field activities will be overseen by a Tennessee Professional Geologist or Engineer who has been trained in site assessment field work and has demonstrated experience including soil, soil gas, groundwater, surface water and sediment sampling. All personnel involved in sampling procedures on this project will be experienced and will have demonstrated proficiency in the specific sampling procedures outlined in the SSQAPPs that are forthcoming for selected candidate sites. Each SSQAPP will be maintained at the project assessment site for the duration of field sampling activities.

The laboratories performing the analysis will analyze environmental and building materials samples for this project in compliance with all application regulations and standards. The analytical laboratory, methods of analysis, and applicable accreditation will be defined in the Site-Specific QAPP. It is anticipated that the following laboratories will be utilized for

assessments under this program; ESC, Environmental Hazards, Inc., W.L. Gore & Associates, and S&ME. The Laboratory QAM/LQM are included in Appendix D in electronic format.

A.8 DOCUMENTS AND RECORDS

S&ME understands the importance of producing deliverables that provide an accurate representation of existing site conditions, without typographic and data errors. For this reason, S&ME documents, including proposals, letters and reports undergo an internal Senior Review process before they are finalized. The S&ME Senior Reviewer Program has been in place for over fifteen years, and the Knoxville office has five approved Senior Reviewers, with three specializing in environmental services. In addition to quality control expected from each S&ME Project Manager, the Senior Reviewer Program ensures that all documents are reviewed by a second senior professional for technical accuracy, grammar and formatting. S&ME has fully integrated Geographic Information System (GIS) and Global Positioning System (GPS) technologies into our service lines. The use of our GPS capabilities during field efforts enables S&ME to more accurately locate sample collection points and other features of interest on a given site, and to share this information with other parties involved in the project. Within the Knoxville South Waterfront Development Area, GPS data will enable S&ME to accurately record points of interest throughout the study area, over an extended sampling period. GPS data will provide a mechanism for revisiting sample locations as needed, and for accurately displaying the data on all deliverables. S&ME's GIS analysts typically use the ESRI suite of products including ArcView with applicable extensions.

S&ME utilizes Trimble GeoXT and GeoXH Differential GPS for field mapping applications, and for use in a post-processing environment. For real time differential corrections, these instruments use Wide Area Augmentation System (WAAS) to achieve sub-meter accuracy. We also utilize ESRI ArcGIS 9.3.1 for office automation and interpolation of cartographic tasks. S&ME maintains multiple seats of this software program for GIS analysts and field staff. Trimble GPS Pathfinder Office is also utilized for the transfer of GPS data to ArcGIS and AutoCAD applications, and post-processing. Trimble TerraSync is used on the Trimble data-loggers for capturing GPS data and enforcing data quality standards.

A.8.1 Field Documents

S&ME field personnel will maintain a field logbook during all activities conducted on-site. Field documents will include sketch maps, field reports, sample details, chain of custody, boring logs, field measurements, calibration records, and monitoring well construction forms. Specific forms proposed for field use are provided in Appendix G.

S&ME's Field Team Leader will be responsible for ensuring field logbooks are properly maintained. Specific details for completing field logbooks will be provided in the SSFSAP. Field record documentation procedures relating to format and technique will include specific instructions relating to page format, terminology, time entries, neatness, photo descriptions, instruction for additions, clarifications and corrections.
Field note information will be recorded during all site visits and will typically include:

- Date, time and observed weather conditions. Changes in weather conditions will be noted as they occur;

- Names of personnel, subcontractors and all others on site;
- Field measurements including air and soil monitoring data, water quality parameters, purge and sample times, and analyses to be performed on all samples collected;
- Sketches or maps to identify photo and/or sample locations. Landmarks and direction of north will be included;
- Photographed locations will be referenced to a site sketch or map. Photograph information will include date, time, location, photographer, sample number and a complete description or identification of the subject in the photograph;
- Description of on-site health and safety equipment used;
- As part of the chain-of-custody procedure, in-situ sampling information will include sample number, date, time, sampling personnel, sample type, designation of sample as a grab or composite, and any preservative used. Sample locations will be referenced to sample numbers on a site sketch or map;
- Information for in-situ field measurements including sample identification, date, time, and personnel taking measurements. If in-field calculations are necessary, they will be checked in the field and signed by a second team member, whenever possible;
- Field decontamination procedures;
- Results of QC checks;
- If on-site interviews occur, relevant information obtained will be recorded. Names of persons interviewed, the interest group represented (if applicable), address, and phone number will be recorded; and
- Any other relevant information, which would be difficult to acquire at a later date, will be recorded.

A.8.2 Data Records

Related documents to be archived will include, at a minimum, records of key telephone conversations, meeting minutes/notes, field notes, data sheets, progress reports, photographs, laboratory data, document transmittals, and correspondence. Field information regarding sample number, location, date and time of sampling, and field results will be entered into a database for future merging with analytical results. Laboratory data deliverables are expected to be provided to S&ME within fourteen to twenty-one working days of sample submittal to the laboratory. All laboratory correspondence will go through the S&ME Project Manager. Hard copies of QA/QC data, raw laboratory data, field notes, and reports will be archived in hard copy format at S&ME's Louisville, Tennessee office for a minimum of seven years. In addition, electronic versions of reports, figures, tables, and project correspondence will be stored in electronic format (i.e., Portable Document Format or similar) on S&ME's Louisville, Tennessee office secure server for a minimum of seven years.

The laboratory report packages will include results for field samples, as well as QC sample results for blanks and duplicates, a description of data qualifiers that the laboratory applies to the sample results, a narrative describing any issues or problems and resolution during analysis, and chain of custody records.

Documentation will not include audit forms, since formal audits are not anticipated during the project. However, the Project Manager will document in the report whether the specific projects

were performed with respect to the performance goals specified in the QAPP and whether the data were accumulated, transferred, reduced, calculated, summarized, and reported correctly.

SECTION B: MEASUREMENT DATA ACQUISITION

B.1 SAMPLING DESIGN AND SITE FIGURES (IN SITE SPECIFIC QAPP)

The sampling design process and site figures will be provided in the Site Specific QAPP Addendum following selection of each selected assessment site.

B.2 SAMPLING AND ANALYTICAL PROCEDURES (IN SITE SPECIFIC QAPP)

A Site Vicinity Map and inventory database identifying potential assessment candidate properties in the South Waterfront Project Area is provided for reference in Appendix A. The property-specific sampling design procedures and site figures will be incorporated in each SSQAPP Addendum following selection of each candidate assessment site.

Based upon previous records review, samples may be collected to confirm the concentration of surface water or groundwater COCs within the specific property or corridor boundaries. If so, water quality characteristics will be collected to support the critical measurements of COCs in surface water and groundwater. Appropriate surface water and groundwater sampling methods will be used and associated guidance adhered to in completing sampling activities associated with this project (sampling methods referenced are provided in CD format in Appendix E).

Samples may be collected in order to determine the concentrations of COCs in soils or sediments within the specific property or corridor boundaries. Sample collection locations will be selected using a judgmental approach based on site observations and measurements, and identified using Global Positioning Satellite (GPS) technology and site observations. Appropriate soil or sediment sampling methods will be used and associated guidance adhered to in completing sampling activities associated with this project (sampling methods referenced are provided in CD format in Appendix E).

Table 1 below summarizes sampling containers, methods of analysis, numbers of samples for each analytical analysis and quality assurance sampling requirements. Detection limits typically reported by these methods are expected to be adequate to meet project data quality objectives. General information on holding times and other method-specific sample requirements are also provided. Additional methods of analysis not included below may be deemed appropriate to achieve project specific goals. These additional methods will be described in each SSQAPP Addendum as necessary following selection of each candidate assessment site.

Table 1 – Summary of Analytical Methods, Holding Times, Preservation, Container Types

Sample Analysis	Holding Time		Preservation Procedures		Container Type		
	Water	Soil/Sediment	Water	Soil/Sediment	Water	Soil	Other
Volatile Organic Compounds (Method 8260B)/includes TPH GRO (TN Method)	14 days	14 days	4°C; HCl to pH <2	4°C;Sodium Bisulfate or Methanol	(3) 40 mL VOA glass; Teflon lined septum	(2) 40 mL VOA glass; Teflon lined septum	NA
Semi-Volatile Organic Compounds (Method 8270C), EPH (TN Method)	7 days until extraction, 40 days after extraction	7 days until extraction, 40 days after extraction	4°C	4°C	1000 mL glass	4 oz. glass	NA
RCRA Metals (except Mercury) (Method 6010B/6020)	180 days	180 days	pH<2 with HNO3, 4°C	4°C	1 liter plastic	4 oz. glass	NA
Mercury (Method 7471)	28 days	28 days	pH<2 with HNO3, 4°C	4°C	1 liter plastic	4 oz. glass	NA
PCBs (Method 8082)	7 days until extraction, 40 days after extraction	14 days until extraction, 40 days after extraction	4°C	4°C	1000 mL glass	4 oz. glass	NA
Herbicides (Method 8051A)	7 days until extraction, 40 days after extraction	14 days until extraction, 40 days after extraction	4°C	4°C	1000 mL glass	4 oz. glass	NA
Pesticides (Method 8081A)	7 days until extraction, 40 days after extraction	14 days until extraction, 40 days after extraction	4°C	4°C	1000 mL glass	4 oz. glass	NA
Lead (Paint) (Method 7420)	NA	NA	NA	NA	NA	NA	Resealable plastic bag
Asbestos (Methods 600/M4-82-020 or 600/R-93/116)	NA	NA	NA	NA	NA	NA	Resealable plastic bag

Analyses conducted for soil, sediment, groundwater, surface water, and soil gas will be performed by Environmental Science Corporation located in Mt. Juliet, Tennessee. Any analyses conducted for lead based paint will be conducted by Environmental Hazards Services, LLC. located in Richmond, Virginia. Passive soil vapor sample analyses will be performed by W. L. Gore and Associates, in Elkton, Maryland. Asbestos sample analyses will be performed by S&ME, Inc. in Charlotte, North Carolina. Should additional laboratory needs or specialized analyses be necessary, these elements will be identified in each SSQAPP Addendum. Appropriate additional laboratory QC documents will also be included in each SSQAPP Addendum, if necessary.

B.2.1 Field Equipment and Testing

S&ME vehicles equipped for sampling will store the equipment listed in Table 2 and will serve as the on-site support facilities for this project. Field Technicians also maintain accounts with environmental equipment and supply vendors throughout the southeastern United States to provide additional support. All field personnel are equipped with cellular telephones and have direct access to alternative sampling and monitoring equipment when necessary.

Non-dedicated equipment as provided in Table 2 below will require decontamination between collections of each sample.

Table 2 – List of Instruments and Equipment

YSI Water Quality Meter (pH/cond./Temp) & Calibration buffers	Analytical Sample Containers	Stainless Steel Spoon (Non-Dedicated)	Tubing for Peristaltic Pump (Dedicated)
Hach Turbidity Meter & Calibration Buffer	Hammer Drill for Installing Gore Sorber Modules	Stainless Steel Bowl (Non-Dedicated)	Geoprobe®
MiniRAE 3000 Photo-ionization Detector*	Gore-Sorber® Modules	Backhoe for Test Pits	Post-Run Tubing System (Dedicated)
YSI DO 600 XL Meter	Sub-meter Differential Global Positioning System	Bailers (Dedicated)	Expandable Tip (Dedicated)
VRAE PGM 7800 4-Gas Meter*	Peristaltic Pump (Non-Dedicated)	Water Level Indicator (Non-Dedicated)	6-liter summa canisters (Dedicated)

Any single use (dedicated/consumable) items (equipment) provided in Table 3 below do not require decontamination procedures as they are not reused and are disposed of.

Table 3 – Project Supplies and Consumables

Supplies and Consumables	Construction Details/Acceptance Criteria	QA/QC Requirements
Well Bailing String	New nylon string, no visible contamination	Secure in a zip-lock bag and change string between potential well locations
Sample Gloves	New disposable nitrile, no visible tears or contamination	Change between samples and potential well locations
Aluminum Foil	Unopened package, no visible contamination	Change between samples
pH Buffer	New solution, no visible contamination	Change between samples
Conductivity Buffer	New solution, no visible contamination	Change between samples
Paper Towels	Unopened package, no visible contamination	Change between samples
Liquinox	New solution, no visible contamination	Change between decontamination
Isopropyl Alcohol	New solution, no visible contamination	Change between decontamination
Deionized Water	New solution, no visible contamination	Change between decontamination

B.3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

The Field Sampling Technicians performing environmental sample collection activities and the Certified Asbestos Inspector performing asbestos and lead sample collection activities will be responsible for sample custody in the field, and for sample shipment. General sample handling and custody procedures are summarized below:
Prior to sample collection, a self-adhesive sample label will be affixed to each sample container. At a minimum, the sample label will contain the following:

- Client - Job Name/Project Number;
- Sample Identification Code;
- Date and Time Collected (except for duplicate samples); and
- Preservatives Added.

Prior to collecting samples in the field, the Field Team Leader and Field Sampling Technicians will obtain the sample bottles necessary for the field operation. Field samplers will label each

sample collected, filling in the appropriate information in waterproof ink. The field sampler will be responsible for collecting the samples and for logging the samples into assigned field notebooks. Chain-of-Custody forms will accompany sample containers to document the transfer of the containers from field collection through shipping to the laboratory and receipt by the laboratory. A sample container is under custody in the field if one of the following conditions exists:

- It is in the field investigator's actual possession;
- It is in the field investigator's view after being in his/her physical possession;
- It was in the field investigator's physical possession and then he/she secured it to prevent tampering; or
- It is in a secure area restricted to authorized personnel only.

The Field Team Leader will complete and verify the Chain-of-Custody for accuracy. A copy of the Chain-of-Custody will be placed in the project files and the original will accompany the shipped samples. If used, overnight carrier shipping label numbers will be included on the Chain-of-Custody form at the bottom along with the company name of the carrier. The identity of field duplicate samples will not be disclosed to the analytical laboratory.

Shipping containers will be sealed and accompanied by the Chain-of-Custody record, with appropriate signatures. The transfer of custody is the responsibility of the Field Team Leader or Field Sampling Technicians and the laboratory.

In the laboratory, a sample custodian will be assigned to receive the samples. Upon receipt of a sample, the custodian will inspect the condition of the samples, reconcile the sample(s) received against the Chain-of-Custody record, log in the sample(s) in the laboratory log book, and store the sample(s) in a secured sample storage room or cabinet until assigned to an analyst for analysis.

The sample custodian will inspect the sample for leakage from the container. A leaky multiphase sample will not be accepted for analysis as this sample would no longer be a representative sample. The custodian will examine whether the sample bottle seal is intact or broken, since a broken seal may mean sample tampering and may make analytical results inadmissible in court as evidence. The Laboratory Coordinator will be promptly notified of broken seals so that appropriate action may be taken (e.g., collect another sample).

Discrepancies observed between the samples received, the information that is on the Chain-of-Custody record, and the sample analysis request sheet will be resolved before the sample is assigned for analysis. The Project Manager and/or On-Site Coordinator will be informed of any such discrepancy as well as its resolution. Results of the inspection will be documented in the laboratory sample log book. Discrepancies will be documented in the analytical case narrative, as appropriate.

Environmental samples will be transported as follows:

- Collect the sample in appropriate containers;

- Wrap glass sample containers in bubble wrap to protect from breakage. Small (less than 500 ml) glass containers will also be placed in plastic (e.g., Zip-Lock) bags;
- Place the sample containers in a strong outside container such as a picnic cooler. Place ice around sample containers;
- Place the signed Chain-of-Custody forms inside the cooler. Retain one copy of the signed Chain-of-Custody and store it in the project files;
- Each sample shipping container will be sealed with tape prior to shipping;
- Place Custody Seal over cooler lid;
- Clearly label each container's exterior with its destination; and
- Ship via air freight or other overnight carrier or hand-deliver directly to the laboratory.

For samples to be analyzed by ESC, it is likely that a lab courier will be utilized to transport the samples to the laboratory. For asbestos samples, S&ME will utilize Federal Express to transfer the samples to our accredited facility in Charlotte, North Carolina. Passive soil vapor module samples will be transported by Federal Express to W.L. Gore & Associates, Inc. in Elkton, Maryland. Lead-based paint samples will be transported by Federal Express to Environmental Hazards Services, LLC. in Richmond, Virginia. The Laboratory Sample Custodian and analysts will be responsible for custody of the sample at the laboratory.

B.4 ANALYTICAL METHODS AND REQUIREMENTS

The analytical procedures utilized in performing future assessment activities will primarily conform to the protocols described below as applicable. The Project Manager will provide a list of regulatory screening levels to the analytical laboratory to ensure the detection limits are below the applicable screening levels.

- US EPA Method 8260B will be utilized for analysis of volatile organic compounds (VOCs) in soil, sediment, surface water and groundwater samples. The field preparation method for soil samples for VOC analysis will be EPA Method 5035A. Detection limits for individual compounds are provided in the ESC analytical laboratory QA manual provided in Appendix D;

- US EPA Method 8270 will be utilized for analysis of semivolatile organic compounds (SVOCs) in soil, sediment, surface water and groundwater samples. Detection limits for individual compounds are provided in the ESC analytical laboratory QA manual provided in Appendix D;

- US EPA Method 8270 or 8310 will be utilized for analysis of Polynuclear Aromatic Hydrocarbons (PAHs) in soil, sediment, surface water and groundwater samples. The detection limits for these compounds are provided in the ESC analytical laboratory QA manual provided in Appendix D;

- US EPA Method 6010 and 7471 will be utilized for analysis of the eight RCRA metals in soil, sediment, surface water and groundwater samples. Detection limits for individual metals are provided in the ESC analytical laboratory QA manual provided in Appendix D;

- TN EPH Method will be utilized for analysis of Extractable Petroleum Hydrocarbons (EPH) in soil, sediment, surface water and groundwater samples. Detection limits for individual compounds are provided in the ESC analytical laboratory QA manual provided in Appendix D;

- TN GRO Method will be utilized for analysis of Gasoline Range Organics (GRO) in soil, sediment, surface water and groundwater samples. Detection limits are provided in the ESC analytical laboratory QA manual provided in Appendix D;

- US EPA SW 846 Method 8082 will be utilized for analysis of PCBs in soil, sediment, surface water and groundwater samples. Detection limits for individual compounds are provided in the ESC analytical laboratory QA manual provided in Appendix D;

- US EPA SW 846 Method 8051A will be utilized for analysis of Herbicides in soil, sediment, surface water and groundwater samples. Detection limits for individual compounds are provided in the ESC analytical laboratory QA manual provided in Appendix D;

- US EPA SW 846 Method 8081A will be utilized for analysis of Pesticides in soil, sediment, surface water and groundwater samples. Detection limits for individual compounds are provided in the ESC analytical laboratory QA manual provided in Appendix D;

- US EPA Method TO-15 will be utilized for analysis of volatile organic compounds (VOCs) in soil gas. Detection limits for individual compounds are provided in the ESC analytical laboratory QA manual provided in Appendix D; and

- US EPA Method 7420 will be utilized for lead analysis in paint chip samples. Detection limits are provided in the EHS analytical laboratory QA manual provided in Appendix D.

- US EPA Method 600/M4-82-020 will be utilized for determination of asbestos in bulk insulation samples and EPA-Method 600/R-93/116 for determination of asbestos in bulk building material samples. Detection limits are provided in the S&ME analytical laboratory QA manual provided in Appendix D.

B.5 FIELD QUALITY CONTROL REQUIREMENTS

Field quality control will be implemented through the collection and analysis of QA/QC samples for environmental sampling conducted for each Phase II ESA. Field quality control for building materials samples, including asbestos and lead based paint are not applicable. The following QA sample types will be collected for environmental samples collected during future Phase II ESAs. The number of QA samples will be determined based on the site-specific sampling program, and will be detailed in the SSQAPP Addendum for each selected assessment site. A summary of types of QA samples that may be used include the following:

- **Trip Blanks** –Trip blanks will be included for QA purposes should field observations or assessment findings warrant VOC groundwater sampling. These blanks consist of ultra-

pure water supplied by the laboratory contained in volatile organic compound (VOC) sample containers and preserved similar to VOC samples. These samples serve as a QC check on potential external contamination and/or cross-contamination between VOC groundwater samples during shipping and storage. A trip blank will accompany the sampling team during sample collection and the samples during shipment for each cooler of VOC samples sent to the laboratory. One trip blank may accompany the VOC samples collected during each sampling event.

- **Rinseate Blanks** - These are samples of ultra-pure water supplied by the laboratory which have been in contact with decontaminated sampling and/or drilling equipment. These samples serve as a QC check on the decontamination procedure. Rinseate blanks serve as a QC check on the decontamination procedure. With regard to soil sampling equipment, there is a potential that compounds could be transferred between samples if the proper decontamination procedures are not followed. Therefore, rinseate samples for select sample locations will be collected.

- **Field Duplicate Samples** - Duplicate samples are collected to allow determination of analytical repeatability. Differences in analytical reproducibility are a concern with respect to sample homogeneity. Therefore, a duplicate sample may be collected on sites where soil, groundwater, asbestos and lead-based paint sampling occurs.

- **Matrix Spike Sample** – Matrix spike/matrix spike duplicate (MS/MSD) samples will be submitted as a further QA/QC check. Sufficient sample must be collected in the field in order to perform these analyses. These samples are spiked through the addition of known concentrations of compounds at the laboratory and the amount of recovery of the spiked compounds is measured to evaluate the effects of the sample matrix on the laboratory analysis. The spiked compounds and the level of constituent added are defined in the analytical protocols or are consistent with appropriate analytical protocol. The matrix spike samples will be collected from areas of suspected low compound concentrations.

Duplicate and matrix spike samples will be acquired by collecting grab samples concurrent with the collection of the actual sample. For groundwater samples, each VOC container will be filled until full and capped sequentially. For other parameters, aliquots of the samples will be sequentially placed in each of the laboratory bottles until they are full.
For soil duplicate and matrix spike samples, the samples for analyses other than VOCs will be homogenized prior to placement into sample containers. Homogenization will be performed by mixing the soil sample in a decontaminated stainless steel or glass bowl and then sequentially placing aliquots of the mixed sample into the containers until full. Samples collected for VOC analysis will not be homogenized because of potential loss of analytes due to volatilization during the homogenization process and instead will be placed directly into sample bottles.

The table below lists the general types of QC samples that may be utilized for the selected assessment sites and provides the acceptance criteria (control limits) and corrective actions should the acceptance criteria be exceeded.

Table 4 – Summary of Field and Laboratory Quality Control

QC Sample	Frequency	Acceptance Criteria	Corrective Action
VOA Trip Blank	1 per cooler/event	No contaminants are detected	Flag in data report
Equipment Rinseate Blank	1 per day per matrix per equipment type per decontamination event	No contaminants are detected	Rerun sample Flag in data report
Field Duplicate (Soil, Groundwater and Lead Paint)	1 per every 20 samples	Duplicate concentrations are within ±50% of original sample	Rerun sample Flag in data report
Field Duplicate (Asbestos)	All samples	Duplicate analysis based upon positive-stop criteria.	Rerun sample Flag in data report
Matrix Spike Sample	1 per parameter per matrix	Mean 3 times standard deviation	Spiking technique is assessed to ascertain correct protocol, sample respiked and reanalyzed, flag data in report

Tables will be provided in the SSQAPP Addendum that will specify QC samples proposed for each Phase II assessment site.

B.6 LABORATORY QUALITY CONTROL REQUIREMENTS

As part of its QA/QC program, a routine preventive maintenance program will be conducted by each applicable contract laboratory to minimize the occurrence of instrument failure and other system malfunctions. The program will include an internal group to perform routine scheduled maintenance, repair, or to coordinate with the vendor for the repair of all instruments. Laboratory instruments are maintained in accordance with manufacturer's specifications under service contracts.

Specific routine maintenance procedures, preventive maintenance procedures, and maintenance logs for the GC-MS, TOC, GC-FID, ICP, GCF-AA, cold vapor AA, and other analytical instruments used to analyze samples for this project will be documented/maintained by the laboratory. This documentation will be available for review if requested.
Laboratory quality control checks include the following:

- Laboratory Control Standard
- Laboratory Control Standard Duplicates
- Matrix Spikes
- Matrix Spike Duplicates
- Method Reagent Blanks

The laboratory generates precision and accuracy targets from the matrix spikes and matrix spike duplicates to assess precision and accuracy. Pre-cleaned equipment blanks and duplicate samples will be collected. Trip Blanks will also be prepared by the laboratory and included in each sample cooler.

B.7 FIELD EQUIPMENT MAINTENANCE AND CALIBRATION

The information discussed in the following subsections will be performed to maximize efficiency in the laboratory and while working on the site. Note that no field instruments are applicable to asbestos sampling. Routine field instrumentation that may be used as a part of Phase II assessment activities may include:

- Mini Rae Photovac Photoionization Detector
- VRAE Plus 7800 Multi Gas Monitor
- Hach Turbidimeter 2100P
- YSI DO Meter
- YSI Water Quality Meter (pH, Specific Conductivity, Temperature)
- Trimble Global Positioning System
- X-Ray Flourescence (XRF) Analyzer

Specific preventive maintenance procedures to be followed for field equipment are those recommended by the manufacturer. Routine daily maintenance procedures conducted in the field will include the following:

- Removal of surface dirt and debris from exposed surfaces of the sampling equipment measurement systems;
- Storage of equipment away from the elements;
- Daily inspections of sampling equipment and measurement systems for possible problems (e.g., cracked or clogged lines or tubing; weak batteries); and
- Calibrations will also be conducted as appropriate in accordance with manufacturer's specifications to identify possible problems with the meters.

Field instrument maintenance, inspection, and testing procedures will be further addressed in the FSAP portion of future SSQAPP Addenda. Each Field Team Leader and Field Sampling Technician is responsible for inspection, testing, and maintenance of all field equipment. Sampling equipment and spare parts are maintained by S&ME or the equipment vendor as applicable. During implementation of field activities, spare parts for all field equipment and instrumentation will be stored in compartments of each instrumentation carrier for use if instrument repair is required. Any preventative or corrective maintenance completed will be documented in the field notes.

Additional notes on our X-Ray Fluorescence Analyzer and Nuclear Density Gauge:

All operators of the XRF Analyzer and Nuclear Density Gauge receive training on Radiation Safety and equipment- specific training before they are allowed to operate or transport the equipment. The designated Radiation Safety Officer for S&ME is Mr. John Coffee. S&ME does not require that S&ME equipment operators be monitored for exposure to radiation. This determination is based on limited frequency of use of the device by any one operator, the level of training required to operate the device safely, inherent safety of a sealed source device along with the low amount of radioactive isotope contained in the sealed source and its redundant safety mechanisms, and the exposure data history the manufacturer has documented over the years for these instruments, However, S&ME will monitor any device operator that wishes to

have exposure monitoring. S&ME currently uses the XRF for screening soil locations in order to direct samples acquired for laboratory analysis. S&ME does not use the XRF for Certified Analysis.

B.7.1 Field Calibration

An inspection checklist and initial calibration check will be performed by the Field Team Leader prior to mobilizing to assessment sites. The frequency of field calibration procedures are summarized in Table 5 below and will, at a minimum, include the following:

- Equipment for monitoring ambient air volatile organic compounds (e.g., PID) will be calibrated prior to use each day against an isobutylene or methane standard.

- The specific conductance meter (YSI multiparameter or similar) will be standardized a minimum of twice daily or after every 10 samples and documented in the site field book.

- The pH meter will be calibrated using specific techniques according to the manufacturer's instructions and two standard buffer solutions (either 4.0, 7.0, or 10.0). The pH values of these buffers will be compensated for temperature according to the values supplied on the manufacturer's bottle label. The temperature (measured as below) at which the sample pH was measured will then be used to compensate for temperature on the meter.

- Temperature measurements will be performed using the thermometer function on the conductivity meter, which will be calibrated to an NBS specification thermometer. Measurements will be recorded to the nearest 0.1 degree Celsius. This level of accuracy is sufficient for the temperature measurements required by this project.

- The dissolved oxygen meter should be calibrated prior to and at the end of each sampling day. The instrument will be calibrated in saturated conditions. More frequent calibrations may be performed as necessary to maintain analytical integrity.

- The turbidity meter (Hach or similar) is calibrated against a 0.02 NTU Reference Standard included with the meter. The turbidity meter should be calibrated at least twice per day unless field conditions dictate that more frequent calibrations should be conducted. The calibrations should be conducted at the beginning of the day and the middle of the day.

Field personnel may judge that increasing the frequency of calibrations and use of post-calibrations may be appropriate based on the nature of the measurements, change in service, environmental conditions, etc. Refer to Table 5 for a summary of field measurement QA/QC requirements, which include calibration methods and frequency. Field personnel will refer to the equipment operation manuals for details on calibration.

Table 5 – Summary of Field Instrument Calibration Requirements

Typical Instrument	Calibration Method	Minimum Calibration Frequency
YSI Meter (pH/cond./Temp) & Calibration buffers	Reference standards	2 times daily or after every 10 samples
Hach Turbidity Meter & Calibration Buffer	Reference standard	2 times daily (beginning of day and middle of day)
MiniRAE 3000 Photo-ionization Detector	Isobutylene (100 ppm)	Prior to use each day
YSI DO 600 XL Meter	Saturation (refer to manual)	2 times daily (prior to and at end of each sampling day) or after every 10 samples

B.8 LABORATORY EQUIPMENT CALIBRATION AND CORRECTIVE ACTION

Calibration procedures for this project may include those items summarized below and will follow the analytical protocols to be utilized as noted in the Laboratory QAMs provided in Appendix D. Table 6 summarizes continuing instrument calibration and corresponding corrective action related information for analytical methods proposed. For initial and independent calibration standard protocol, reference Appendix D, ESC QAM, Section 5.0.

The W.L. Gore & Associates laboratory individual responsible for equipment calibration is their Laboratory Manager, Don D'Apolito. The EHS laboratory individuals responsible for equipment calibration are their metals laboratory analysts. ESC laboratory personnel responsible for calibration include Laboratory Managers Jim Burns (Metals), JD Gentry (VOCs) and Chris Johnson (SVOCs).

Table 6 – Summary of Laboratory Instrument Calibration and QC

Typical Instrument	Calibration Method/Type	Acceptance/Rejection Criteria	Corrective Action	Minimum Calibration Frequency
GC/MS VOC 8260	Daily/Continuous; Tune & CCV every 12 hours, refer to ESC QAM for standards	Must pass established method tuning criteria; 8260-CCV must be < 20% difference for CCC compounds; RF criteria for SPCC compounds must meet method criteria. Targets must meet ESC% drift criteria.	Instrument will undergo evaluation to determine cause. All samples between last in control standard and first out of control check will be reanalyzed.	Every 12 Hours
ICP and ICPMS and Mercury	Continuing- 1Matrix Spike (MS), 1 Matrix Spike Duplicate (MSD) , refer to ESC QAM for standards	Spike must be within + 25 (ICP/ICPMS) and + 30% and MS and MSD must have and PPD < 20%	Instrument will undergo evaluation to determine cause. All samples between last in control standard and first out of control check will be reanalyzed.	1 of each per batch
GC/PCBs	Daily Continuing, refer to ESC QAM for standards	Must be within 15% of the initial calibration curve	Instrument will undergo evaluation to determine cause. All samples between last in control standard and first out of control check will be reanalyzed.	Beginning, every 10 and ending

Pesticides/Herbicides 8151A/8181A	Daily Continuing, refer to ESC QAM for standards	Must be within 15% of the initial calibration curve	Instrument will undergo evaluation to determine cause. All samples between last in control standard and first out of control check will be reanalyzed.	Beginning every 10 and ending
GC/MS Semi-volatiles 8270C/D	Daily Continuing, refer to ESC QAM for standards	Must pass established method criteria	Instrument will undergo evaluation to determine cause. All samples between last in control standard and first out of control check will be reanalyzed.	Every 12 Hours per method

Note: For initial and independent calibration standard protocol, reference Appendix D, ESC QAM, Section 5.0.

B.8.1 Instrument Performance and Tune

Prior to analysis of each set of samples and on a daily basis during the analysis (or as otherwise required), it will be demonstrated that the instrument meets the operating performance standards established in the appropriate analytical protocol. If an instrument does not meet the performance standards, it will be tuned until the performance criteria are achieved.

B.8.2 Calibration Curve

Instruments will be calibrated prior to the analysis of each batch of samples by analyzing known mixtures of the group of compounds metals, anion analytes, or other appropriate calibration material as required by the applicable protocols. Instrument calibration will be verified daily, or as required in each analytical protocol. A new calibration curve will be established if the response observed in the analysis of the continuing calibration check standard varies outside of prescribed protocol limits.

Specific calibration logs and equipment repair records for the GC-MS, TOC, GC-FID, ICP, GCF-AA, cold vapor AA, and other analytical instruments used to analyze samples for this project will be documented/maintained by the laboratory. This documentation will be available for review if requested.

The laboratory-specific QAM addresses the testing, inspection, and maintenance for the analytical instruments and is included in Attachment E. Procedures include reviewing the instrument log for any notations regarding problems experienced during previous use and verifying that scheduled preventative maintenance has been conducted in accordance with the manufacturer's recommendations and SOPs. The lab will document any preventive or corrective maintenance conducted on laboratory equipment/instrumentation.

B.9 ANALYTICAL SENSITIVITY AND PROJECT CRITERIA

Table 7 summarizes analytical sensitivity and project criteria for analytical methods that may be routinely performed for the project. This information will be included in site specific QAPP Addenda prepared for future Phase II ESA candidate sites. The information provided in this table will be utilized for project planning and evaluating the resulting data. The information presented in this table will be utilized as a reference in the data evaluation process.

Table 7 – Laboratory Analytical Sensitivity and Project Criteria

Class	Analyte	Method	Matrix	Accuracy %	Prec. (RPD)	RL	Unit
VOCs	Varies[1]	8260B	Soil	Varies[1]	34	.01	mg/kg
VOCs	Varies[1]	8260B	GW	Varies[1]	20	.001	mg/l
VOCs	Varies[1]	TO-15	Air	70-130	25	.2	ppbv
SVOCs	Varies[1]	8270C	Soil	Varies[1]	Varies[1]	.33	mg/kg
SVOCs	Varies[1]	8270C	GW	Varies[1]	Varies[1]	Varies*	mg/l
Metals	Varies[1]	6010B	Soil	Varies[1]	<20	Varies*	mg/kg
Metals	Varies[1]	6010B	GW	85-115	<20	Varies*	mg/l
PCBs	Varies[1]	8082A	Soil	46-126	34	.017	mg/kg
PCBs	Varies[1]	8082A	GW	62-131	22	.0005	mg/l
Pesticides	Varies[1]	8081A/B	Soil	Varies[1]	Varies[1]	Varies*	mg/kg
Pesticides	Varies[1]	8081A/B	GW	Varies[1]	Varies[1]	Varies*	mg/l
Herbicides	Varies[1]	8051A	Soil	Varies[1]	Varies[1]	Varies*	mg/kg
Herbicides	Varies[1]	8051A	GW	Varies[1]	Varies[1]	Varies*	mg/l
Asbestos	Asbestos	600[5]	ACM[4]	Varies[1]	Varies[2]	1%	%
Lead	Lead	7420	Paint Chip	Varies[1]	Varies[3]	10 ug	ug/g

[1]See ESC QAM, Table 12.3 for specific analyte RLs and other accuracy information
[2]See S&ME QAM for accuracy information
[3]See S&ME QAM for accuracy information
[4]Asbestos Containing Materials
[5]USEPA Method 600/M4-82-020 utilized for bulk insulation samples and Method 600/R-93/116 utilized for bulk material samples.

B.10 DATA MANAGEMENT AND DOCUMENTATION

Data for this project will be produced in two locations: onsite and at the laboratory. Data collected onsite will be recorded on field forms (included in Appendix F) and in field logbooks, which will become a part of the project file. The Project Manager will submit copies of the field forms and logbooks with the field activity report when field activities are complete. The Laboratory Director will submit laboratory data to the Project Manager within 10 calendar days of the laboratory's receipt of the samples. The Project Manager will be responsible for ensuring the analytical report meets requirements and for forwarding it to the TDEC Brownfields Project Manager when applicable.
A computer compatible with MS Office Suite will be used to help process, compile, and manage the data. Laboratory records will be managed according to the following as applicable:

- ESC QAM Section 12 "Data Reduction, Validation, and Reporting."
- EHS LQM Sections 4.4 and 4.5 "Data Reduction, Validation, and Data Recordkeeping."

- W. L. Gore & Associates LQM Section 15.1 "Records Management and Storage."
- S&ME LQM Section 7 "Data Validation, and Retention."

Adherence to these SOPs will assure that applicable information resource management requirements are satisfied. The laboratory will manage the original raw data from this project (both hard copy and electronic). The Laboratory Director retains and maintains laboratory records.

S&ME maintains the records of the field staff in the project folder, all electronic records including final reports are maintained in-house on the S&ME network in the project folder. The S&ME IT- department maintains the security of the network with up to date software and virus protection. The S&ME network maintains restricted access to S&ME staff. Sample results are provided from the laboratory both in hard-copy and electronic form (PDF) to ensure results remain in their original content. Additionally, files are maintained in a storage room.

The listing below summarizes types of reports, records, and other documents that may be generated for this project:

- Field Logs (checklists and standard forms- see Attachment F)
- Quality Assurance Project Plans
- Historical Phase I Environmental Assessments
- Phase II Environmental Assessments Limited Site Assessment Report
- Interim Source Removal Proposal
- Interim Source Removal Report
- Site Rehabilitation Plan
- Site Assessment Report
- Risk Assessment Report
- No Further Action Proposal
- Natural Attenuation with Monitoring Proposal
- Remedial Action Plan
- Remedial Action Status Report
- Post-Active Remedial Monitoring Report
- Site Rehabilitation Completion Report
- No Further Action Proposal with Monitoring Proposal
- No Further Action Proposal with Monitoring Report
- Combined Document

All records and reports, including any review comments and checklist from the USEPA Region 4 Designated Approving Official can be found in the physical project file located at S&ME's Louisville, Tennessee office located at 1413 Topside Road, Louisville, Tennessee 37777. The project file will be eventually archived for a period up to seven years. Any deviations from these procedures will be documented in the project file and approved by the S&ME QA/QC Officer before implementation.

Upon receipt of laboratory data, the data is reviewed for its useability. Upon this determination, data is then formatted into tables and compared to regulatory limits to determine if

contamination is present at the subject property. Most laboratories (defined in the Site-Specific QAPP) provide their data in formatted tables directly from their Laboratory Information Management System (LIMS); this lessens the required manipulation of data and therefore provides a more accurate presentation of data. Upon completion of formatting the Analytical Data Table; data is reviewed for accuracy by the QA/QC officer.

C.1 ASSESSMENTS AND CORRECTIVE ACTIONS

The Project Manager is responsible for overseeing that all field activities are performed following standard protocols as outlined under this QAPP. As in all fieldwork, problems arise and are generally handled by the Field Team Leader in conjunction with Project Manager. These problems and their resolutions are properly documented in records and discussed upon return from the field. If possible, improvements are implemented to prevent similar issues in the future.

C.1.1 Field Data Quality Assessment

To assist in collecting field data accurately and correctly, specific instructions will be issued by the Project Manager to personnel involved in field data acquisition. At the end of each field event, the Project Manager will review the field books used by project personnel to check that tasks were performed as specified in the instructions and the Work Plans. Forms utilized in the field may be found in Appendix F. Specific items to be reviewed may include:

- Samples collected in proper locations;
- Field equipment calibration procedures documented in field book and in accordance with acceptance criteria;
- Proper sampling techniques used;
- Field QA/QC requirements followed; and
- Samples analyzed for correct parameters.

Raw data and reduced data will be submitted by project personnel to the Project Manager for review. Equations, calculations, data transfers, consistent units, and significant figures will be subject to the quality assurance review.

C.1.2 Assessment and Oversight

The Project QA Officer may conduct audits. Because the Project QA Officer is in a review role and not part of field team, he will provide some level of independence from the sampling team. The Project QA Officer is not affiliated with the analytical laboratory.
These audits may include site visits during field activities. The Project QA Officer will determine the frequency of audits but given the short duration of the proposed work it is unlikely that more than one audit per site will be conducted. The role and responsibility of the QA Officer during these audits is to determine whether the work is being performed in accordance with the site specific work plans. Potential types of problems and examples of corrective actions are presented below.

Potential Audit Concerns	Examples of Corrective Action
• Improper use of field equipment	Instruct on proper methods
• Poor sample collection techniques	Collect additional samples properly
• Improper decontamination procedures	Consider cross contamination potential and resample if deemed necessary
• Wrong sample locations	Contact TDEC and determine if additional samples will be required
• Improper use of PPE	Consider cross contamination potential and resample if deemed necessary; instruct on potential health concerns associated with improper use.
• Poorly written field notes	Advise on proper techniques per the FSAP requirements and rewrite if necessary

In the event discrepancies are identified during an audit, the QA/QC Officer will discuss the findings with the Project Manager and Field Team Leader. The Field Team Leader, in consultation with the Project Manager, will be responsible for corrective actions related to field activities. Audit findings would be included in the Final Reports along with descriptions as warranted; this information is provided to project staff, state, and EPA project personnel.

C.1.3 Laboratory Corrective Action

Corrective actions are required when an out-of-control event or potential out-of-control event is noted. The corrective action taken is somewhat dependent on the analysis and the event. Laboratory personnel are alerted that corrective actions may be necessary if the following:

- QC data are outside the warning or acceptable windows for precision and accuracy;
- Blanks contain target analytes above acceptable levels;
- There are unusual changes in detection limits;
- Deficiencies are detected by the QA Department during internal or external audits or from the results of performance evaluation samples; or
- Inquiries concerning data quality are received.

Corrective action procedures are often handled at the bench level by the analyst who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike calibration mixes, instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor, manager and/or QA Department for further investigation. Once resolved, full documentation of the corrective action procedure is then filed with the QA Department. The laboratory will provide documentation as to what, if any, corrective actions were initiated concerning this study and report them to the Project Manager.

C.1.4 Contamination

For each matrix analyzed, the Laboratory Quality Assurance Officer will review the data from the analysis of field, trip, and method blanks. If excessive contamination (*e.g.,* concentrations above allowable limits set within an analytical protocol) is found in the blanks, corrective action will be taken, including requesting that the analytical laboratory do the following:

- check raw data and calculations; and
- if the contaminating analyte is also present at high levels in field samples, repeat the analysis of the laboratory stored sample or sample extract.

If contamination does not appear to originate at the laboratory, the Field Team Leader, in conjunction with the Project Manager, will review field sampling procedures to determine if a change in field protocol is necessary.

C.1.5 Missing or Lost Samples or Data

The objective for completeness is 95 percent. If samples or data are lost during sampling and analysis activities, corrective actions will be taken, including:

- requesting that the analytical laboratory re-analyze stored samples or extracts, if available; and
- repeating collection and analysis of samples.

C.1.6 Non-Compliant Data

In the event that field or laboratory data is determined to be non-compliant by the laboratory or upon data review, the criticality of the data point will be evaluated. If the necessary decisions identified in the DQO process can be made without the subject data point, then the necessary evaluations and decision-making process will proceed. In this case, the non-compliant data will be identified in the report and the rationale for the non-criticality of the data will be discussed.

If the subject data is determined to be critical to making the necessary decisions, then the subject sample location will require re-sampling and analysis. If this is the case, the Project Manager will contact the Brownfields Grantee Project Manager to discuss potential re-sampling. If re-sampling is authorized, then the reason for the re-sampling, and the initial and subsequent results of the re-sampling will be included in the final project report. In some cases, the data may not be rejected but may be qualified based upon review. In this case, this data limitation or qualification will be identified in the QA/QC section of the final report along with a discussion of the data qualification or limitation.

C.1.7 Corrective Action Reporting

Reporting of corrective actions will be accomplished as follows:

- Audit findings will be reported by the Project QA Officer via letter or memo to the S&ME Project Manager who will forward to the Brownfields Grantee Project Manager.

- The results of the data validation process will be reported via letter to the S&ME Project Manager.
- Corrective actions implemented during the field operations will be documented in daily field reports.

This documentation will be forwarded to the Brownfields Grantee Project Manager and will be included in an appendix to the final report for the site assessment activities.

C.2 PROJECT REPORTS

The Project Manager will prepare the final report, which will be reviewed for technical accuracy and data quality by the project QA/QC officer or similar senior technical staff (as appropriate). The final report will include a summary description of project activities, a summary of all data, the field activity report, a discussion on any problems encountered during the project and the corrective actions taken, a discussion of the conclusions drawn from the results and the rationale for those conclusions, and the results of the data quality assessment. The final report will be distributed to the project team. The report will then be reviewed for conformance with internal document standards. Final reports will be forwarded to the EPA project officer/manager as required. Laboratory analytical reports will be generated by the Laboratory Director and submitted to the Project Manager ten calendar days after receipt of the samples. The Project Manager will then forward the analytical information to the TDEC Brownfields Project Manager in conjunction with the field notes when applicable.

Execution of proposed field activities will commence with approval of the Generic QAPP and the Site-Specific QAPP Addendum.

D.1 FIELD DATA EVALUATION

The Project Manager and Risk Assessor will validate the field data and discuss any problems identified during the project with the Field Team Leader. Data will be reviewed for integrity by checking all field entries for errors and consistency. Data validation will be accomplished through a series of checks and reviews intended to assure that the reported results are of a verifiable, reproducible, and acceptable quality. The validation process will include:

- Quality control blanks meet criteria
- Quality control data (spikes, duplicates) are acceptable
- Surrogate spike recoveries are acceptable

A data usability review that includes an assessment of field procedures (including field notes, boring logs, field screening results, and field analytical data), completeness, comparability, representativeness, precision, and bias (accuracy) of the data will be performed by the Project Manager. The findings of this review will be documented and presented in the final report.

If verification or validation indicates that samples have been collected and/or analyzed out of compliance with the QAPP (for instance deviations from the acceptance criteria for quality control defined in this QAPP and its addendums), resampling may be required. The Project Manager must contact the Brownfields Coordinator and EPA Project Manager in the event that there are any deviations from the QAPP and the Brownfields Coordinator and EPA Project

Manager will determine if the data is acceptable or if resampling is required. If data that deviates from the QAPP is accepted, the data will be used for screening purposes only and the data will be annotated as such.

D.2 LABORATORY DATA EVALUATION

The Laboratory Director (ESC, EHS, S&ME or W.L. Gore & Associates) will review and verify the laboratory data generated under their corrective action system for accuracy according to the laboratory's QAM/LQM. Quality control checks are performed on field data by reviewing the chain of custody forms and results from the lab for each sampling event. All sample results will be reviewed and correlated to field measurements and observations. The validation process will include:

- Unacceptable data are identified and corrective actions are initiated
- Data qualifiers are assigned (by lab)if necessary

In addition to evaluating data qualifiers associated with laboratory analyses, a comparison of the sample duplicate(s) and the corresponding sample result(s) will be made to evaluate the reproducibility of the sample results based on the laboratory analysis and sample collection and transportation procedures. For this comparison, if the duplicate or sample result is less than 5 times the reporting limit then the comparison is made by the absolute difference between the results (S-D). For water samples, if this difference is less than the magnitude of the (higher) reporting limit, precision is considered "acceptable". For soil samples, if the difference is less than twice the magnitude of the (higher) reporting limit, precision is considered "acceptable". If these differences are within 2X the "acceptable" limits, they are considered "slightly high"; anything beyond that would be considered "high". If both sample and duplicate results are greater than five times (5X) the reporting limit (the higher of the two RLs, if they're not the same), then precision is assessed by the %RPD (difference in results divided by the average of the two results X 100); <35% RPD = "good/acceptable", >35% but < 50% = variability is "slightly high", >50%= "high".

Based on the data qualifiers provided by the laboratory, and on the sample/sample duplicate comparison described above; data will be categorized as fully quantified, qualified, or unusable. Unusable data will not be utilized in the project decision process. Raw data will be included in all submitted project reports.

Precision, accuracy and completeness calculations are as follows, respectively:

1. RPD = 200*l(BS %R- BSD Result) I (BS %R + BSD Result)l
2. BS Recovery = 1OO*(BS Result)/[Spike Added]
3. BSD Recovery = lOO*(BSD Result)/[Spike Added]

RPD: Relative Percent Difference %R: Percent Recovery
BS: Blank Spike BSD: Blank Spike Duplicate

An evaluation of laboratory analysis procedures and review of: holding times, blanks, control samples, duplicate analysis, detection limits, holding times, laboratory controls, and overall assessment of data will be conducted.

The data usability will compare proposed sample locations to actual sample locations. The review also will verify that the predefined number of samples were analyzed and will confirm that the predefined analytical methods and detection limits were used. The Project Manager and Risk Assessor will review the quality control samples, hold times, calibration, surrogate recovery, as well as the precision and accuracy data for the sampled analytes of concern to determine whether the data will be accepted or rejected. In the event results are rejected, the Quality Assurance Officer, Project Manager, and the Brownfields Grantee Project Manager will meet to discuss the reasons for the rejection of data and what steps should be initiated including additional site sampling if deemed necessary.

Problems associated with the laboratory will be documented in the laboratory QA report provided with all analytical results, which will be provided to all end users in the form of summary reports.

Table 8- Validation Activities

Item	Activity
Data Deliverables and QAPP	Ensure that all required information on sampling and analysis was provided (including planning documents).
Analytes	Ensure that required lists of analytes were reported as specified.
Chain-of-Custody	Examine the traceability of the data from time of sample collection until reporting of data. Examine chain-of-custody records
Holding Time	Identify holding time criteria, and either confirm that they were met or documented any deviations. Ensure that samples were analyzed within holding times specified in method, procedure, or contract requirements. If holding times were not met, confirm that deviations were documented, that appropriate notifications were made (consistent with procedural requirements), and that approval to proceed was received prior to analysis.
Sample Handling	Ensure that required sample handling, receipt, and storage procedures were followed, and that any deviations were documented.
Sampling Methods and Procedures	Establish that required sampling methods were used and that any deviations were noted. Ensure that the sampling procedures and field measurements met performance criteria and that any deviations were documented.
Analytical Methods and Procedures	Establish that required analytical methods were used and that any deviations were noted. Ensure that the QC samples met performance criteria and that any deviations were documented.
Data Qualifiers	Determine that the laboratory data qualifiers were defined and applied as specified in methods, procedures, or contracts.

Deviations	Determine the impacts of any deviations from sampling or analytical methods and SOPs. Consider the effectiveness and appropriateness of any corrective action.
Sampling Plan	Determine whether the sampling plan was executed as specified (i.e., the number, location, and type of field samples were collected and analyzed as specified in the QAPP).
Sampling Procedures	Evaluate whether sampling procedures were followed with respect to equipment and proper sampling support (e.g., techniques, equipment, decontamination, volume, temperature, preservatives, etc.).
Co-located Field Duplicates	Compare results of collocated field duplicates with criteria established in the QAPP.
Project Quantitation Limits	Determine that quantitation limits were achieved, as outlined in the QAPP and that the laboratory successfully analyzed a standard at the QL.
Confirmatory Analyses	Evaluate agreement of laboratory results.
Performance Criteria	Evaluate QC data against project-specific performance criteria in the QAPP (i.e., evaluate quality parameters beyond those outlined in the methods.).
Data Qualifiers	Determine that the data qualifiers applied were those specified in the QAPP and that any deviations from specifications were justified.
Validation Report	Summarize deviations from methods, procedures, or contracts. Include qualified data and explanation of all data qualifiers.

D.3 DATA USABILITY AND PROJECT EVALUATION

The Project Manager will validate the field data and discuss any problems identified during the project with the Field Team Leader. Any problems and associated corrective actions will be documented in the field activity report. The Project Manager will discuss any problems along with proposed corrective actions with the QA/QC Officer.

The Laboratory Director (ESC, EHS, S&ME or W.L Gore & Associates) will review and verify the laboratory data generated under their corrective action system for accuracy according to the laboratory's QAM/LQM. Any problems identified during this process will be reported to the Project Manager in the analytical data report. Information on QC criteria will be included in the Site-Specific QAPP Addendum. The quality assurance officer along with the project manager validates laboratory data upon receipt of the analytical results.

The Laboratory Director/QA Manager will evaluate the sample/sample duplicate data and equipment blank data to determine if data precision is of an acceptable quality. Pending these three data validation procedures, the data will be determined to be of a specified quality and reported as such. For instance, data will typically be reported with no qualifiers if the data are determined to be fully useable. However, a discussion of data limitations will be added to the

data summary tables and data discussion within the reports if data validity is compromised in any way.

When applicable the TDEC Brownfields Project Manager will also review and verify the field sheets, the final report, and the analytical data report. Any problems or deviations are typically reported to the Project Manager in the form of a comment and a formal action and response is provided back to the TDEC. Issues are resolved through staff TQM meetings or through the TDEC comment and response process.

Table 9-Data Usability Assessment

Item	Assessment Activity
Data Deliverables and QAPP	Ensure that all necessary information was provided, including but not limited to validation results
Deviations	Determine the impact of deviations on the usability of data.
Sampling Locations,	Determine if alterations to sample locations continue to satisfy the project objectives.
Chain-of-Custody, Deviation	Establish that any problems with documentation of custody procedures do not prevent the data from being used for the intended purpose.
Holding Times, Deviation	Determine the acceptability of data where holding times were exceeded.
Damaged Samples, Deviation	Determine whether the data from damaged samples are useable. If the data cannot be used, determine whether resampling is necessary.
PT Sample Results, Deviation	Determine if the implications of any unacceptable analytes (as identified by the PT sample results) on the usability of the analytical results. Describe any limitations on the data.
SOPs and Methods, Deviation	Evaluate the impact of deviations from SOPs and specified methods on data quality.
QC Samples	Evaluate the implications of unacceptable QC sample results on the data usability for the associated samples. For example, consider the effects of blank contamination.
Matrix	Evaluate matrix effects (interference or bias).
Meteorological Data and Site Conditions	Evaluate the possible effects of meteorological (e.g., wind, rain, temperature) and site conditions on sample results. Review field reports to identify whether any unusual conditions were presented and how the sampling plan was executed.
Comparability	Ensure that results from different data collection activities achieve an acceptable level of agreement.

Completeness	Evaluate the impact of missing information. Ensure that enough information was obtained for the data to be useable (completeness as defined in PWOs documented in the QAPP.
Background	Determine if background levels have been adequately established (if appropriate).
Critical Samples	Establish that critical samples and critical target analytes/COCs, as defined in the QAPP, were collected and analyzed. Determine if the results meet criteria specified in the QAPP.
Data Restrictions	Describe the exact process for handling data that do not meet PQOs (i.e., when measurement performance criteria are not met). Depending on how those data will be used, specify the restrictions on the use of those data for environmental decision-making.
Usability Decision	Determine if the data can be used to make a specific decision considering the implications of all deviations and corrective action.
Usability Report	Discuss and compare overall precision, accuracy representativeness comparability, completeness, and sensitivity for each matrix, analytical group, and concentration level. Describe limitations on the use of the project if criteria for data quality indicators are not met.

Field modifications regarding sampling analysis may be necessary for circumstances such as auger refusal, limited access areas or when enough sample volume could not be collected for various reasons. Re-sampling may be necessary if results are deemed unacceptable for various reasons such as exceeding laboratory holding times, etc. These variables will be further defined in the Site-Specific QAPP Addendum when the project description is detailed based on the specific contaminants of concern.

REFERENCES

1. U.S. Environmental Protection Agency. 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process.* EPA QA/G-4. EPA 240/B-06/001. February.

2. U.S. Environmental Protection Agency. 2002. *Guidance for Quality Assurance Project Plans.* EPA QA/G-5. EPA 240/R-02/009. December.

3. U.S. Environmental Protection Agency. 2006. *EPA Requirements for Quality Assurance Project Plans.* EPA QA/R-5. EPA 240-B-01-003. Reissued May.

4. U.S. Environmental Protection Agency. 2006. *Data Quality Assessment: Statistical Methods for Practitioners*. EPAQA/G-9S. EPA 240-B-06-003. February.

5. U.S. EPA Region 4, SESD, Field Branches Quality System and Technical Procedures, February 2008.

6. U.S. Environmental Protection Agency Region 4 Brownfields Quality Assurance Project Plans (QAPPs) Interim Instructions, Generic QAPP and Site-Specific QAPP Addendum for Brownfield Site Assessments and/or Cleanup, Revision No.3, July 13, 2010.

LIST OF ABBREVIATIONS

ASTM:	American Society for Testing and Materials
BS:	Blank Spike
BSD:	Blank Spike Duplicate
BSA:	Brownfields Site Assessment
BSRA:	Brownfields Site Rehabilitation Agreement
BTEX:	Benzene, Toluene, Ethylbenzene, and Total Xylenes
CD:	Compact Disc
CM:	Centimeters
COC:	Contaminants of Concern
CTL:	Cleanup Target Levels
DAO:	Designated Approving Official
DEFT:	Decision Error Feasibility Trials
DEP/FDEP:	Florida Department of Environmental Protection
DPT:	Direct Push Technology
DQO:	Data Quality Objective
ESA:	Environmental Site Assessment
ECD:	Electron Capture Device
FID:	Flame Ionization Detector
GC:	Gas Chromatography
GC-MS:	Gas Chromatography- Mass Spectrometry
GCTLs:	Groundwater Cleanup Target Levels
GIS:	Geographic Information Systems
GPS:	Global Positioning Satellite
HAZWOPER:	Hazardous Waste Operations
HPLC:	High Performance Liquid Chromatography
ICP:	Inductively Coupled Plasma
ID:	Identification
i.e.:	*id est* - that is
IUPAC:	International Union of Pure and Applied Chemistry
L:	Liter
LQM:	Laboratory Quality Manual
MDL:	Method Detection Limits
MIP:	Membrane Interface Probe
mL:	Milliliter
MTBE:	Methyl tert-butyl ether
MW:	Monitor Well
NA:	Not Applicable
NELAC:	National Environmental Laboratory Accreditation Conference
NTU:	Nephelometric Turbidity Units (turbidity)
OSHA:	Occupational Safety and Health Administration
OVA:	Organic Vapor Analyzer
PAHs:	Polynuclear Aromatic Hydrocarbons
PE:	Performance Evaluation

LIST OF ABBREVIATIONS (continued)

P.E.:	Professional Engineer
P.G.:	Professional Geologist
PQLs:	Practical Quantification Limits
QA:	Quality Assurance
QAM:	Quality Assurance Manual
QAPP:	Quality Assurance Project
QC:	Plan Quality Control
%R:	Percent Recovery
RCRA:	Resource and Conservation Recovery Act
RPD:	Relative Percent Difference
RL:	Reporting Limit
RQAO:	Regional Quality Assurance Designated Approving Official
SCTLs:	Soil Cleanup Target Levels
SESD:	Sience and Ecosystem Support
SPLP:	Division Synthetic Precipitate Leaching
SS:	Procedures Soil Sample
STOF:	State of Florida
SVOC:	Semi-volatile Organic Compounds
SOP:	Standard Operating Procedure
TBE:	TBE Group, Inc. (aka Cardno TBE)
TCLP:	Toxicity Characteristics Leaching Procedure
TQM:	Total Quality Management
USC:	Unified Soil Classification
U.S.EPA:	United State Environmental Protection Agency
UST:	Underground Storage Tank
VOC:	Volatile Organic Compound

Aerial Provided by; ArcGis Online/Bing Maps	
SCALE: AS SHOWN	
CHECKED: EMS	
DRAWN: JPR	
DATE: 3-11-11	

S&ME

Database Inventory Map

South Knoxville Waterfront Brownfield Assessment

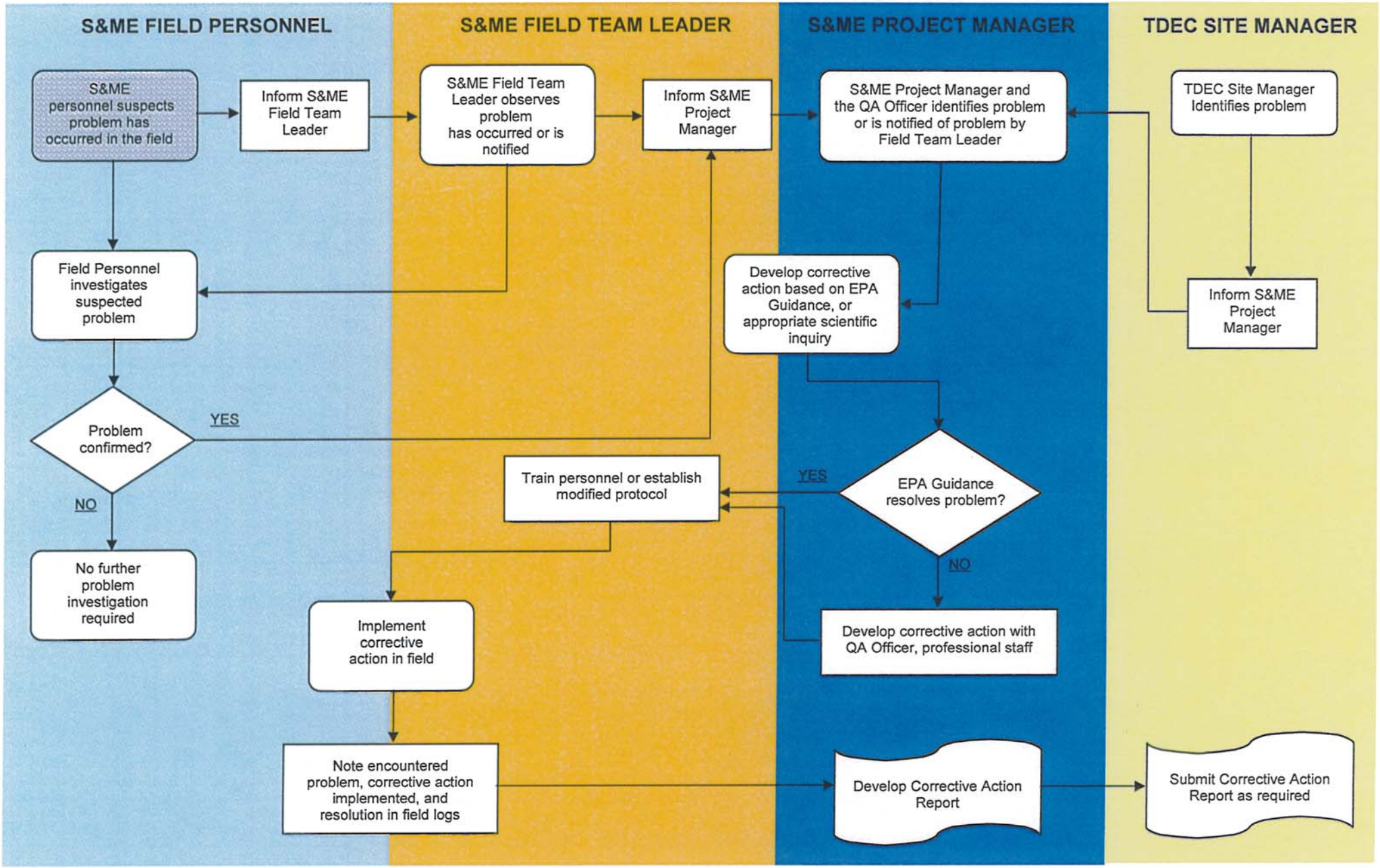
Knoxville, Tennessee

Project No: 1434-09-382

FIGURE NO: **1**

S&ME

FIGURE 2: CORRECTIVE ACTION PROCESS



POTENTIAL PETROLEUM ASSESSMENT CANDIDATE SITES

ID #	Ranking Rationale	Site Name	KGIS Current Owner Listing	Site Address	Contaminant	Report Source	Remediation	TDEC Facility ID	UST Corrective Action	TDEC Notes	Sanborn Date(s)	Assessment(s) Completed
A-P	Historical petroleum UST site adjacent to Goose Creek and Vision Plan Area *Goose Creek Landing*	Finn Corp	Ray H Pate - JBM Inc.	2651 Scottish Pike	Unknown	TDEC	No	2470216	N/A	Per Notification Done registered tank was removed 3/28/88. Predates closure procedures.	N/A	N/A
B-P	Historical petroleum pipeline release site adjacent to Goose Creek and Vision Plan Areas *Quarry Lake and Cherokee Rail Underpass*	Colonial Pipeline	Colonial Pipeline Company	230 Pitner Place	Unknown	TDEC	Yes	N/A	N/A	N/A	N/A	N/A
C-P	Historical petroleum UST site adjacent to Vision Plan Area *Goose Creek Landing* and proposed *Pedestrian Bridge*	Southern Coffin and Casket Co.	Billie E. Taylor (Specialty Metals)	2547 Scottish Pike	Unknown	TDEC	No	2470990	N/A	Clean Closure (tanks only)	N/A	N/A
D-P	Historical petroleum UST site adjacent to Vision Plan Area proposed *Pedestrian Bridge*	American Limestone Co. (Tri-City Quarry)	Ready Mix USA LLC	2209 Blount Avenue	Unknown	TDEC	No	2470021	N/A	Notification DB tanks registered 1,2,& 10 were removed 1/1/85. No mention	N/A	N/A
E-P	Historical petroleum sites adjacent to Vision Plan Area *River Road-Lincoln Street Landing and Sevier Ave. Roundabout*	Value Textiles Warehouse	Knoxville's Community Development Corporation	901 Langford Avenue	Yes - Petroleum	Susanna Bass	No	N/A	N/A	N/A	N/A	Phase II by Mactec 6/1/09
		Cargill, Inc.	Knoxville's Community Development Corporation	915 Langford Avenue	Unknown	TDEC	No	2470074	N/A	No File. Per Notification DB two registered tanks were removed 7/1/88. Predates closure procedures.	N/A	N/A
		Sehorn & Kennedy Construction	Knoxville's Community Development Corporation	939 Langford Avenue	Yes - Petroleum	Susanna Bass	No	N/A	N/A	N/A	N/A	Phase II by Professional Environmental Consulting, Inc. 3/31/08 and Mactec 6/1/09
F-P	Historical petroleum UST site adjacent to Vision Plan Area proposed *City View*	Gulf Refining Co. Of LA.	CJ River Holdings LLC	417 W. Blount Avenue	Unknown	Sanborn Map	No	N/A	N/A	AST Bulk Refining	1917-1924	N/A
G-P	Historical petroleum UST site near Vision Plan Area proposed *River Road-Lincoln Street Landing and Sevier Ave. Roundabout*	Marathon Ashland Oil	Marathon Ashland Petroleum LLC	1808 Jones Street	Unknown	Sanborn Map	No	N/A	N/A	Bulk Terminal - Oil house for Tn. Packaging Co.	1917-1950	N/A
H-P	Historical petroleum UST site located South and adjacent to Baptist Hospital	Filling Station/Auto Repair	ETB Realty Inc.	100 E. Blount Ave.	Unknown	Sanborn Map	No	N/A	N/A	Filling Station	1924-1950	N/A
I-P	Former petroleum site with 5 abandoned USTs predating closure guidelines	Simpson, Inc.	Gary L. Ridinger	3201 Chapman Highway	Unknown	TDEC	No	2470618	N/A	5 tanks CIP 1981-86. Predates UST program.	N/A	N/A
J-P	Former petroleum site USTs removed but product lines and islands not sampled- predating closure guidelines	Claiborne Houser Texaco	Billy Joe & Lisa B. Webb	3109 Chapman Highway	Unknown	TDEC	No	2470098	N/A	Clean Closure (tanks only)	N/A	N/A

K-P	Historical petroleum UST site identified on Sanborn Map (1924-1950)	Filling Station	McDonalds Real Estate Co.	2505 Chapman Highway	Unknown	Sanborn Map	No	N/A	N/A	Filling Station	1924-1950	N/A
L-P	Historical petroleum UST site identified on Sanborn Map (1924-1950)	Auto Repair/Filling Station	Zoe Alice Scates, W M Scates & Carolyn S. Hicks	2315 &2321 Chapman Highway	Unknown	Sanborn Map	No	N/A	N/A	Filling Station & Auto Repair	1924-1950	N/A
M-P	Historical petroleum UST site identified on Sanborn Map (1924-1950)	Filling Station	Thomas W. & Lisa Allen	2408 Chapman Highway	Unknown	Sanborn Map	No	N/A	N/A	Filling Station	1924-1950	N/A
N-P	Historical petroleum UST site identified on Sanborn Map (1924-1950)	Filling Station	Margaret M & Goodman Wayland	2001 Chapman Highway	Unknown	Sanborn Map	No	N/A	N/A	Filling Station	1924-1950	N/A
O-P	Historical petroleum site identified on Sanborn Map (1924-1950)	Auto Repair	Baxter Properties LP	1478 S GAY STá	Unknown	Sanborn Map	No	N/A	N/A	UST / Auto Repair	1917-1924	N/A
P-P	Former petroleum site with one UST removed-predating closure guidelines	William S. Trimble Co., Inc.	William S. Trimble Co., Inc.	2200 Atchley Street	Unknown	TDEC	No	2470695	N/A	Notification DB one registered tank was removed 12/22/88. Predates closure	N/A	N/A
Q-P	Historical petroleum UST site identified on Sanborn Map (1924-1950)	Filling Station	East Tennessee Baptist Hospital, Inc	Gay St.	Unknown	Sanborn Map	No	N/A	N/A	Filling Station	1924-1950	N/A
R-P	Historical petroleum UST site identified on Sanborn Map (1924-1950)	Filling Station	Cardinal South LLC	726 Sevier Avenue	Unknown	Sanborn Map	No	N/A	N/A	Filling Station	1924-1950	N/A
S-P	Former petroleum site with 3 existing "red-tagged" out of service USTs	Creative Customs(Lil Ole Market)/ Filling Station	Brina Bonam-Tate	1014 Sevier Avenue	Unknown	Gary Deitsch/TDEC, Sanborn Map	No	2470933	N/A	1982. 1983 deed mentions USTs and lifts. No Files. Per Notification Db	1952 update	N/A

POTENTIAL HAZARDOUS ASSESSMENT CANDIDATE SITES

ID #		Site Name	KGIS Current Owner Listing	Site Address	Contaminant	Report Source	Remediation	TDEC Facility ID	UST Corrective Action	TDEC Notes	Sanborn Date(s)	Assessment(s) Completed
A-H	Properties with potential for hazardous substance impacts based upon previous industrial related property uses adjacent to Vision Plan Areas *River Road-Lincoln Street Landing and Sevier Ave. Roundabaout*	Undeveloped	Knoxville's Community Development Corporation	1101 Philips Avenue	Unknown	Susanna Bass	No	N/A	N/A	N/A	N/A	Phase I and II by Professional Environmental Consulting, Inc. 2/21/08 and 3/31/08
		Undeveloped	Riverview Properties Inc.	1201 Island Home Avenue	Unknown	Susanna Bass	No	N/A	N/A	N/A		Phase II by Professional Environmental Consulting, Inc. 3/31/08
		Undeveloped	Riverview Properties Inc.	1100 Philips Avenue	Unknown	Susanna Bass	No	N/A	N/A	N/A	N/A	Phase I and II by Professional Environmental Consulting, Inc. 2/21/08 and 3/31/08
		Conley Residence	Knoxville's Community Development Corporation	1015 Philips Avenue	Unknown	Susanna Bass	No	N/A	N/A	N/A	N/A	Phase I by Professional Environmental Consulting, Inc. 2/21/08. Phasae II by MacTec 6/1/09
		Chevron/Phoenix Dye Work	Knoxville's Community Development Corporation	701 Lankford	Yes - Petroleum	TDEC	Yes	2470668	Yes	N/A	N/A	Phase II by Professional Environmental Consulting, Inc. 3/31/08 and Mactec 6/1/09
B-H	Property with potential for hazardous substance impacts based upon previous medical related property uses adjacent to Vision Plan Area *Shoals Promenade*	East Tennessee Baptist Hospital	East Tennessee Baptist Hospital, Inc	137 Blount Ave	Petroleum	TDEC	Yes	2-470168	Yes	N/A	N/A	N/A

C-H	Property with potential for hazardous substance impacts based upon previous industrial related property uses adjacent to Vision Plan Area *Goose Creek Landing and proposed Pedestrian Bridge*	Jefferson Mills/Woolen Mills	Knox River Warehouses LTD	511 Clancy Ave. 2511 Scottish Pike	Unknown	Sanborn Map	No	N/A	N/A	Fuel - Coal for furnace	1917-1924	N/A
D-H	Property with potential for hazardous substance impacts based upon previous industrial related property uses adjacent to Vision Plan Area *Shoals Promenade*	D.M. Rose & Co.	Baxter Properties LP	222 Council Place	Unknown	Sanborn Map	No	N/A	N/A	N/A	1917-1950	N/A
DD-H	Historical potential hazardous RR easement near Vision Plan Area proposed *River Road-Lincoln Street Landing*	Former Gulf and Ohio Railroad Easement	Pete Clausen	Jones Street	Unknown	City of Knoxville	No	N/A	N/A	N/A	N/A	N/A
E-H	Property with potential for hazardous substance impacts based upon proximity to industrial related properties and adjacent to *Vision Plan Area Goose Creek Landing*	Southdown Inc. Property	Southdown, Inc.	0 Scottish Pike	Unknown	Michael Rose	No	N/A	N/A	N/A	N/A	N/A
FF-H	Property with potential for hazardous substance impacts based upon buried waste and debris discovered on property.	Riverwalk Right-of-Way	Knoxville's Community Development Corporation	417 W. Blount Avenue	Unknown	City of Knoxville	No	N/A	N/A	N/A	N/A	N/A
F-H	Property with potential for hazardous substance impacts based upon previous metals salvage yard related property uses adjacent to Goose Creek	Swann's Salvage Yard Properties	N/A	3127 Blount Avenue	Unknown	D. Hagerman	No	N/A	N/A	N/A	N/A	N/A
G-H	Property with potential for hazardous substance impacts based upon previous bulk plant related property uses adjacent to Vision Plan *Island Home Avenue*	Louis Dreyfus Energy Corporation	CMP Island Homes LLC	1720 Island Home Ave.	Petroleum	TDEC	Yes	2-470713	Yes	N/A	N/A	N/A
H-H	Property with potential for hazardous substance impacts based upon previous bulk plant related property uses near Vision Plan *City View*	Garron Oil, Inc.	Gary W. A. & Ronald Legate	424 Blount Ave.	Petroleum	TDEC	Yes	2-470358	Yes	N/A	N/A	N/A

I-H	Property with potential for hazardous substance impacts based upon previous outboard motor service and repair related property uses adjacent to Tennessee River	Outboard Motor Svc/Auto Repair	Riverview Properties Inc.	1401 Island Home Ave.	Unknown	Sanborn Map	No	N/A	N/A	Outboard Motor Repair & Auto Svc Shop	1924-1950	N/A
J-H	Property with potential for hazardous substance impacts based upon previous industrial related property uses adjacent to Tennessee River	Norco Metal Finishing	Mark Adams - Lakeside Co., Inc.	1536 Island Home Avenue	Unknown	Gary Deitsch	No	N/A	N/A	N/A	N/A	N/A
K-H	Property with potential for hazardous substance impacts based upon previous auot body repair/painting related property uses on West Blount Avenue	Service Body Shop	A C Byrd	2612 West Blount Avenue	Unknown	Michael Rose	No	N/A	N/A	N/A	N/A	N/A
L-H	Property with potential for hazardous substance impacts based upon previous auto body repair/painting related property uses near Chapman Highway	Auto Repair/Painting	Abraham & Nora Ramos	110 Hawthorne Ave	Unknown	Sanborn Map	No	N/A	N/A	Auto Repair/Painting	1924-1950	N/A
M-H	Property with potential for hazardous substance impacts based upon previous coal yard related property uses near Chapman Highway	Coal Yard	Terry Floyd	135 Hawthorne Ave	Unknown	Sanborn Map	No	N/A	N/A	Coal	1924-1950	N/A
N-H	Property with potential for hazardous substance impacts based upon previous laundry cleaninig and dying related property uses on Chapman Highway	Cleaning & Dyeing	Thomas W. & Lisa Allen	2418 Chapman Highway	Unknown	Sanborn Map	No	N/A	N/A	Cleaning & Dyeing	1924-1950	N/A
O-H	Property with potential for hazardous substance impacts based upon previous automotive repair related property uses near Chapman Highway	Auto Repair	Kenneth Zacharczyp	502 Hawthorne Ave	Unknown	Sanborn Map	No	N/A	N/A	Auto Repair	1924-1950	N/A
P-H	Property with potential for hazardous substance impacts based upon previous impacts associated with drum and barrel refurbishing related property uses.	Vacant	Gerald W. & Madelyn G Millen - Dixie Barrel & Drum Co.	2117 Davenport Avenue	Unknown	Gary Deitsch	No	N/A	N/A	Former Dixie Barrel & Drum on 3 parcels up to RR.	N/A	N/A
Q-H	Property with potential for hazardous substance impacts based upon previous automotive repair and machine shop related property uses on Sevier Avenue	Tennessee Coach Co./All Alloys Fabrication / Brooks Equip. Manufacuting	Cardinal South LLC	726 Sevier Avenue	Unknown	Gary Deitsch	No	N/A	N/A	Former Trailways Bus Site. Sold in 1987, Bus Maintenance / Machine Shop	1924-1950	N/A

R-H	Property with potential for hazardous substance impacts based upon previous machine shop, UST, cabinet manufacturing, and metal fabrication related property uses on Sevier Avenue	Lucus Bros. Screen & Cabinet Co./Auto Repair Shop, UST/Machine Shop (SAP)/Advance Metal Fabrication	Joseph B. & Jane D. Yancey - Trustee	2018 Davenport Road	Unknown	Gary Deitsch/Sanborn Map	No	N/A	N/A	Former Trailways Bus Parking Garage. Owned 1968-1989	1917-1924 1924-1950	N/A
S-H	Property with potential for hazardous substance impacts based upon previous laundry cleaninig and dying related property uses on Sevier Avenue	Model Laundry Co.	Knoxville Bolt & Screw, Inc.	614 Sevier Avenue	Unknown	Sanborn Map	No	N/A	N/A	Laundry Co.	1924-1950	N/A
T-H	Property with potential for hazardous substance impacts based upon previous machine shop related property uses on Sevier Avenue	Machine Shop	John H. & Ruth E. Walker	814 Sevier Avenue	Unknown	Sanborn Map	No	N/A	N/A	Machine Shop	1924-1950	N/A
U-H	Property with potential for hazardous substance impacts based upon previous coal yard related property uses near Sevier Avenue	South Side Coal Co.	Pedro Saez & Laura Stagna	2020 and 2100 Jones St.	Unknown	Sanborn Map	No	N/A	N/A	Coal	1924-1950	N/A
V-H	Property with potential for hazardous substance impacts based upon previous industrial related property uses on Sevier Avenue	Foundry, Mach. Shop, Tar Pit	Yancey Family Partnership	906, 1004, 1014 Sevier Ave.	Unknown	Sanborn Map	No	N/A	N/A	N/A	1917-1924	N/A
W-H	Property with potential for hazardous substance impacts based upon previous industrial related property uses on Island Home Avenue	Cast Stone/Tile Co.	William Eugene Monday III	1402 Island Home Ave.	Unknown	Sanborn Map	No	N/A	N/A	Fuel - Coal for furnace	1917-1924	N/A
X-H	potential for hazardous substance impacts based upon proximity to previous bulk plant related property uses near Vision Plan *City View*	City View	N/A	ROW along West Blount Avenue	Unknown	Michael Rose	No	N/A	N/A	N/A	N/A	N/A
Y-H	Property with potential for hazardous substance impacts based upon previous bulk plant related property uses near Vision Plan *City View*	Team Sales USA	Todd & Jeff Whitaker	Team Sales USA	Unknown	Michael Rose	No	N/A	N/A	N/A	N/A	N/A
Z-H	Property with potential for hazardous substance impacts based upon previous industrial related property uses on Island Home Avenue	Power Equipment Co.	Odum Construction Systems	1430 and 1436 Island Home Ave.	Unknown	Sanborn Map		N/A	N/A	Motor Repair Shop	1924-1950	N/A

OTHER SITES INITIALLY DEEMED INELIGIBLE FOR PETROLEUM ASSESSMENT

ID #		Site Name	KGIS Current Owner Listing	Site Address	Contaminant	Report Source	Remediation	TDEC Facility ID	UST Corrective Action	TDEC Notes	Sanborn Date(s)	Assessment(s) Completed
A-IP	Former UST Petroleum Site	Gulf Service Station #280289	Sam H. G. Araghi	2017 Chapman Highway	Petroleum	TDEC	No	2-470289 & 2-471168	N/A	N/A	N/A	N/A
B-IP	Former UST Petroleum Site	Earth Grains Baking Co. - Kerns	Brown Greer & Co., Inc.	2110 Chapman Highway	Petroleum	TDEC	Yes	2-470377	Yes	N/A	N/A	N/A
C-IP	Former UST Petroleum Site	Roehl Construction Company, Inc.	Roehl Construction Company, Inc.	2201 Atchley Street	Petroleum	TDEC	Yes	2-470575	Yes	N/A	N/A	N/A
D-IP	Former UST Petroleum Site	Former Unocal Service Station	Wayland-Goodman Properties LP	2406 Chapman Highway	Petroleum	TDEC	Yes	2-471114	Yes	N/A	N/A	N/A
E-IP	Former UST Petroleum Site	Kenjo #31	Wayland-Goodman Properties LP	3120 Chapman Highway	Petroleum	TDEC	Yes	2-470290	Yes	N/A	N/A	N/A
F-IP	Former UST Petroleum Site	Bruce Montgomery BP, Inc.	Knoxville Bolt & Screw, Inc.	614 & 615 Sevier Ave.	Petroleum	TDEC	Yes	2-470063	Yes	N/A	N/A	N/A
G-IP	Former UST Petroleum Site	Sevier Mart / Pilot Oil #116	Sevier Ventures LLC	915 & 916 Sevier Ave.	Petroleum	TDEC	Yes	2-470668	Yes	N/A	N/A	N/A

Project Role:
Project Manager

Company:
S&ME, Inc. - Knoxville, TN

Education:
B.S., Geology, Murray State University, 1983

A.S., University of Kentucky, Hopkinsville, 1981

Years of Experience:
Joined S&ME in 2006 with 22 years of previous experience

Professional Registrations:

- Professional Geologist, Kentucky (#0958)
- Professional Geologist, Tennessee (#0738)
- Kentucky Corrective Action Contractor (#1019)
- IHMM Certified Hazardous Materials Manager (#14564)
- NREP Indoor Air Quality Manager (#1268)

JAMES R. BRUCE, P.G., CHMM
PROJECT MANAGER

Mr. Bruce is a Project Manager for S&ME. He joined S&ME, Inc. in 2006 with 16 years previous environmental and regulatory experience, and 6 years previous petroleum exploration experience. He is skilled in the following disciplines: Technical operations management; project management; Phase I and II Environmental Site Assessment; NPDES permitting; UST/AST closure, and soil and groundwater assessment; geologic evaluation; soil and groundwater remedial evaluation; soil and groundwater remediation system design and construction; hazardous materials management; RCRA permitting; chemical inventories; PCB and RCRA Annual Report development; hazardous and solid waste disposal; integrated pollution prevention and SPCC Plan development; emergency spill response management; stream restoration construction management; landfill remediation construction management; Brownfield construction management; Brownfield assessment; indoor air quality assessment, petroleum exploration, production management, and well completion design and implementation. Mr. Bruce has successful long term working relationships (particularly with Tennessee regulatory agencies and regulatory authorities) with regulatory personnel involved in implementing regulatory requirements for projects in which he has been involved.

KEY PROJECTS AND ASSIGNMENTS

Brownfield Assessment Project, Community Wide Assessment, East Tennessee

Project Manager for 16-county community wide assessment under EPA Brownfields Assessment Grant Program. Project included the implementation of 9 Phase I ESA's for properties previously operated as a knitting mill, furniture manufacturer, historical landfill, petroleum bulk plant, scrap metal yard, former gasoline service stations and riverfront corridor. Other project activities included successful implementation of a Phase II ESA at a former historical landfill site and a Phase II ESA at a property encompassing both a petroleum bulk plant and furniture manufacturer. Both Phase II ESA's included the collection of passive soil vapor collector samples, surface and subsurface soil samples, groundwater samples and soil gas samples. Facilitated interactions between owners, regulators, and other stakeholders to obtain property access for assessment implementation. Project required coordination with federal EPA and state regulatory personnel involved in oversight of the Brownfields grant.

Brownfield Assessment Project, Lenoir City, Tennessee

Project Manager for the assessment of 95 acre abandoned rail yard under EPA Brownfields Assessment Grant Program. This project was of particular importance to the Loudon County Economic Community Development Corporation thus requiring close interaction with the local and state authorities responsible for approval of alternative cleanup options. Project included investigation to determine the distribution of

S&ME

Continuing Education:

- 40-Hour Hazardous Waste Operations Training, 1990, Law Environmental, Inc., Kennesaw, Ga., Supervisor Training and annual 8-hour refresher courses
- Confined Space Entry and Rescue Training, April 1994
- Hazardous Training Materials and Testing, April 1994
- Lead Standards Training, July 1994
- Bloodborne Pathogens Training, July 1994
- Risk Management Training, ARCADIS G&M, Oak Ridge, Tn., June 2002
- Stream Restoration Workshop, May 2004

lead and arsenic in soils and foundry sands historically deposited across approximately 60 acres of the site. Facilitated interactions between owners, consultants, regulators, and other stakeholders to obtain property access for assessment implementation and preparation of conceptual redevelopment design. On site project activities included the clearing of sampling corridors along densely vegetated areas of site, installation of 330 surveyed test pits to facilitate surface and subsurface sampling for chemical and geotechnical parameters, and characterization of foundry sand thickness across site. Investigative activities performed also included off site soil vapor, sediment, and surface water sampling to measure for potential impacts on adjacent properties.

Brownfield Assessment Project, Newport, Tennessee

Project Manager for the assessment of 2.5 acre historical industrial property under EPA Brownfields Assessment Grant Program. The site operations date to late 1800's when it was utilized as a flour mill and was later used to store hazardous chemicals. Project included investigation to determine the presence and distribution of various constituents of concern historically released at the site including metals, VOC's, SVOC's, and pesticides. On site project activities included installation of six test pits to facilitate surface and subsurface sampling for chemical and geotechnical parameters, installation of four groundwater monitoring wells to assess groundwater, and sediment and surface water sampling. Facilitated interactions between owners, consultants, regulatory agencies, and other stakeholders for site access, assessment implementation and preparation of conceptual redevelopment design.

Multimedia Compliance Audit, Tennessee Valley Authority (TVA), Fort Loudoun Group Facilities

Team audit member for external independent review of TVA regulatory files for the Fort Loudoun Hydro Group facilities (Melton Hill, Fontana, Fort Loudoun). Utilized breadth of previous manufacturing experience to assess whether procedures were being properly applied in the management of the hydro facility, maintenance, and material-handling operations at each facility. Responsibilities included multimedia audit of the Fort Loudoun facility files covering the following regulatory areas: Resource Conservation and Recovery Act (RCRA), Toxic Substances Control Act (PCBs), Oil Pollution Prevention, Solid Waste, and Used oil. Interviewed key personnel to better understand site operations and substantiate compliance with written programs and procedures. Performed facility inspections to examine all current operations and processes. Determined applicable legal and procedural requirements and assisted with the preparation of a preliminary list of concerns at each plant, including record-keeping, reporting, and training.

SPCC and IPP Plan Technical Updates, TVA, Various Hydroelectric Facilities in Tennessee, North Carolina, Georgia, and Kentucky

Project Coordinator and agent for the certifying engineer for the update of Integrated Pollution Prevention (IPP) and Spill Prevention Controls and Countermeasures (SPCC) plans for various TVA Hydro facilities. Project activities included conducting inspections necessary to become familiar with hydro facility operations and personnel and reviewed the technical changes implemented at the site since completion of the previous plan. Updated each plan based on information received during the site visit for final submittal to TVA. Project responsibilities also included segregation of applicable portions of existing IPP plans to compile stand alone regulatory compliant SPCC plans for various Hydro facilities. Trained, supervised, and supported other S&ME personnel to perform technical updates of IPP and SPCC plans for select facilities.

Buried Waste Drum Assessment Project, TVA, Bear Creek Dam, Hodges, Alabama

Project Coordinator and geologist for the assessment of buried drums containing hazardous waste discovered during grading operations in the vicinity of a stormwater retention pond at the site. Project requirements included the evaluation of waste characterization data to assist with waste classification determination, development of assessment approach and field investigation to determine the potential presence of VOC's, SVOC's, metals, cyanide, and PCBs in surrounding media. On site project activities included the sampling of sediment, surface water, and subsurface soils utilizing a Geoprobe® rig in vicinity of the buried drums. Additional investigative activities performed included implementation of a geophysical survey using non-invasive electromagnetic imaging techniques to identify the potential presence of additional drums over 5 acre project area. Project requirements also included the installation of test pits to identify the source of 10 target anomalies identified during the geophysical survey.

Commercial and Industrial Facilities in Kentucky and Tennessee

Perform comprehensive hazardous waste management services including developing hazardous waste and solid waste permits, waste stream characterization, waste stream profiling, determining material compatibility, containerizing, loading, transporting, disposing and regulatory reporting for impacted media including labpacks, PCB wastes, plating wastes, PCB transformers, printing wastes, characteristic metals wastes, PCE wastes, creosote wastes, paint wastes, lead batteries, ballasts, pesticides, and various hazardous solvents and chemical storage tanks including sodium hydroxide, TCE, toluene, acetone, nitro-propane, varsol, and lacquer thinner.

Nuclear Fuel Facility, Erwin, Tennessee

Project Manager for pilot-scale enhanced anaerobic bioremediation application in East Tennessee for uranium/chlorinated solvent-impacted groundwater. The nuclear processing facility had been in operation since the late 1950's and historical activities at the facility resulted in the presence of uranium and PCE in the groundwater. The size of the PCE groundwater plume that exceeded the National Drinking Water Maximum Contaminant Level (MCL = 0.005 mg/L) was approximately 19 acres (1200' by 700'). The uranium groundwater plume which exceeded the EPA Proposed MCL (30 pCi/L) was about 0.7 acre (250' by 120'). The anaerobic degradation of PCE and the precipitation of uranium was achieved by creating a highly anaerobic and reducing environment utilizing a patented technology involving the injection of diluted molasses as a carbon source.

Waste Management Compliance and Construction Support Services, Bayou Steel, Harriman, Tennessee

Project Manager for compliance support services associated with the evaluation of various methods for managing approximately 2,200 cubic yards of iron oxide scale sludge that had accumulated over an approximate 15 year period in two steel mill recirculation and spray ponds at the project site. Conducted numerous interviews with site personnel to develop a thorough understanding of the process generating the scale waste, discuss the client's current methods of managing the waste, assisted with a cost effective scale management approach that had minimal impact to mill operations, and assisted with contractor selection. Proposed and provided oversight for pilot test for scale removal utilizing filter press technology, and provided oversight for full scale waste removal activities.

Underground Storage Tanks, Alabama, Georgia, Kentucky, North Carolina, Tennessee and Virginia

Project Manager/Geologist for removal assessment and regulatory compliance for over 400 petroleum and chemical underground storage tanks. Interpreted and negotiated regulatory requirements with appropriate state and federal regulatory agencies during removal operations. Work has been performed for clients including manufacturing, utilities, government, transportation and petroleum.

Closed Landfill Project, Rogersville, Tennessee

Project Manager for closed landfill project located in Rogersville, Tennessee. Project responsibilities include work plan and monitoring report preparation, remedial evaluation, and negotiations with state regulatory agency. Post closure related activities performed include the management of an assessment monitoring program through a groundwater monitoring system consisting of six on-site wells, seven off-site wells, and three springs. Quarterly monitoring requirements include groundwater sampling, statistical analysis of monitored groundwater constituents, and evaluation of the groundwater flow conditions. Additional responsibilities include the implementation of an annual area groundwater user survey and

off-site drinking and non-drinking water source monitoring. Current project requirements include the development of and Assessment of Corrective Measures plan to address groundwater constituents that exceed their respective groundwater protection standard.

Porcelain Products Manufacturing Facility, Knoxville, Tennessee

Project Manager for the development and installation of a vegetative cover system for an unpermitted industrial landfill located in Knoxville, Tennessee. Waste material primarily consisted of porcelain insulators deposited over several decades in a densely vegetated area of the property. Cover system components consisted of geosynthetic materials, clay barrier and protective cover layers. Project requirements included remedial evaluation, negotiations with state and local regulatory agencies, cover system design, work plan preparation, permitting, installation and maintenance of erosion controls, construction of cover system components and establishment of final vegetative cover.

Commercial Facilities, Pigeon Forge, Tennessee, Automotive Component Manufacturing Facility, Daytona, Florida

Project Manager and investigator for the design and implementation of indoor air quality investigations for both facilities. Project scopes included the design and implementation of IAQ investigations for the identification and characterization of airborne viable and non-viable mold spores within company work areas where employees complained of respiratory ailments. Investigative results derived from personal interviews and implementation of air quality sampling programs revealed locations of historical moisture problems, identified the current sources of mold growth, characterized the indoor dispersion throughout each facility and isolated the species of concern. Provided recommendations concerning abatement of existing impact that were compliant with all regulatory guidelines.

Multiple Corrective Action Plans

Responsible for preparation of multiple Corrective Action plans for soil and groundwater including evaluation of remedial alternatives, cost-effectiveness and equipment selection.

Petroleum Tanker Accident, Maynardville, Tennessee

Project Manager/Supervisor for emergency response associated with a release of approximately 5,000 gallons of diesel fuel in a rural community in East Tennessee. Responsible for coordinating with state and local agency representatives and implementing initial response including initial clean-up and providing alternative drinking water supplies to affected residents. Other activities included performance of water use survey, soil investigation and remediation, comprehensive sampling/analysis of area water wells, comparison of analytical results with appropriate drinking water standards, and installation and monitoring of sixty carbon filtration units to restore well water to local residents for domestic use.

Former Drycleaner Facility, Savannah, Tennessee

Project Manager for the assessment and remediation of PCE impacted soil and groundwater under the regulatory jurisdiction of the Tennessee Drycleaner Environmental Response Program (DCERP). Project involved highly accelerated schedule for the assessment and remediation of PCE impacted soils to facilitate commercial redevelopment of property. Soil remediation included the strategic removal and on site treatment of 771 tons of highly impacted soils to depths of 23 feet and installation of groundwater injection gallery beneath footprint of proposed commercial facility. Waste management included on site treatment of removed soils to pretreatment standards and preparation of regulatory position to support the contained-in determination request to facilitate disposal in subtitle D landfill. Performed in-situ injection of reagents for enhanced anaerobic bioremediation for the reduction of parent and daughter chlorinated constituents in groundwater. Project requirements involved continuous interactions with developer, contractors, and regulatory personnel for the planning, scheduling, and execution of assessment and interim action remedial activities. Accelerated investigative and remedial project schedule goals were exceeded which enabled building contractor to meet their completion schedule for successful redevelopment activities.

City Landfill, Lexington, Kentucky

Construction/CQA Manager for 65-acre landfill improvement/closure project in central Kentucky. Site improvements included the installation of a perimeter leachate management system, methane gas collection system, the placement of a vegetated low permeability cover system, construction of 5-acre asphalt-covered vehicular training area, storm water conveyance systems, and construction of two building foundations. Responsibilities included oversight of all CQA/CQC testing, evaluation of contractors adherence to project design, review and approval of contractor invoices, design of field modifications, and certification report preparation.

Manufacturing Facilities, Lawrenceburg and Memphis, Tennessee

Project Manager for cover system repair projects for two industrial landfills located in Lawrenceburg and Memphis, Tennessee. Projects included the removal of compromised vegetative, clay barrier and geosynthetic layers, followed by replacement of new or imported construction materials and installed in accordance with engineers specifications. Provided client with CQC testing information verifying as-built data.

NRCS Stream Restoration Project, Greenville, Tennessee

Project Manager for USDA/NRCS stream restoration project in Greeneville, Tennessee. Project included the construction of seven gabion structures and associated wing-walls on three separate second-order streams with as-built volumes totaling 1700 cubic yards. Structures ranged from 60 to 250 feet in length and 6 to 12 feet in height.

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Community Development Project, Sevierville, Tennessee
Project Manager for two compensatory stream mitigation construction projects in Sevier County, Tennessee. Projects included the installation of select sediment controls and removal of a 100-ton sediment plume from stream channel, performed regrading and stream bank stabilization and restoration. Second project included the removal of rip rap and sediment from a 350 foot stream section, performed stream bank stabilization and restoration.

Railyard, Oneida, Tennessee
Project Manager for operation and maintenance of pilot-scale phytoremediation and enhanced intrinsic bioremediation system for soil and groundwater impacted by PAH's in East Tennessee.

Automotive Component Manufacturing Facility, Rogersville, Tennessee
Project Manager for pilot-scale in-situ enhanced anaerobic bioremediation application in East Tennessee for commingled petroleum hydrocarbon and chlorinated solvent-impacted groundwater.

Petroleum Exploration Experience, Oklahoma and Illinois Basin

Performed oil and gas lease evaluations in Oklahoma and Indiana. Work performed included evaluation of subsurface geologic settings for the potential presence of oil and gas reserves and calculated reserve estimates for existing well/fields based on primary recovery. Mr. Bruce generated exploration prospects for new production fields as well as developed existing fields.

Performed the supervision of drilling operations and mud-logging of 55 oil and gas exploration and class II injection wells in Mid-Continent region of Oklahoma and southwest Indiana portion of the Illinois Basin. Responsibilities included preparation of pre-drilling prognosis for elevations of subsurface horizons, ongoing evaluation of stratigraphic position during drilling operations, ongoing evaluation of status of drilling mud, microscopic evaluation of drill cuttings to determine lilthologic characteristics and indications of hydrocarbon presence or potential injection zones and determination of termination depth of wells.

Performed analysis and interpretation of geophysical logs for oil and gas production and class II injection wells. Geophysical logs evaluated included electric logs (e-logs), single and dual induction logs, compensated density/neutron logs, sonic logs, spontaneous potential logs, gamma ray logs, fracture identification logs, and caliper logs. His responsibilities included calculation of oil and saltwater saturation percentage for production feasibility.

Responsible for the design and supervision of installation of production casing and associated float equipment systems prior to cementing. His responsibilities included the design and implementation of completion

programs for oil and gas exploration and class II injection wells including formation acidizing and hydraulic fracture stimulation utilizing formation connate water, diesel, xylenes, and liquid nitrogen .

Production Supervisor responsible for supervision and maintenance of oil and gas lease production. Responsibilities included price negotiation and facilitating sales of oil and gas production to local and regional purchasers, organizing and supervising subcontracted treatment of crude for impurities prior to sales, saltwater management, and inspecting and maintaining above and below-ground production equipment. Responsible for supervision of reclamation of drill sites as well as production and class II injection well locations.

Project Role:
Field Geologist

Company:
S&ME, Inc.- Knoxville, TN

Education:
BS, Geology, 1999
University of Tennessee

Years of Experience:
Joined S&ME in 2006 with 6 years of previous experience.

Professional Registrations:
Registered Geologist,
- Tennessee (#4764)

NATHAN J. PETERSON, R.G.
GEOLOGIST/GEOTECHNICAL/ENVIRONMENTAL SCIENTIST

Mr. Peterson is a Geologist/Geotechnical/Environmental Scientist for S&ME's Knoxville, Branch. With more than eight years of environmental project experience he is skilled in the following disciplines:

Drilling Supervisor - Coordinated the drilling equipment, subcontractors, labor, and other logistics of large geotechnical projects for DOE, Alabama DOT, Virginia DOT, Tennessee DOT, Kellog Brown and Root (KBR), Dulles Transit Engineers (DTE), Ameren UE Power Company, and Enercon Power. Proficient at observing, logging, and interpreting soil and rock core from drilling operations.

Environmental Site Assessments - Performed numerous preliminary environmental site assessments in rural, urban, metropolitan, and industrial settings. Investigations have included field investigations, historical land use research, and report preparation.

Environmental Testing and Analysis - Extensive project experience coordinating and operating a Geoprobe direct-push sampling system while obtaining soil and groundwater samples. Installed numerous soil borings and Type I and Type II groundwater monitoring wells. Properly purged and sampled groundwater monitoring wells for various parameters which include petroleum hydrocarbons, RCRA metals, priority pollutants and various organic compounds.

KEY PROJECTS AND ASSIGNMENTS

Heritage Center Industrial Park
Oak Ridge, Tennessee
The project is located in the southern portion of the former U.S. Department of Energy K-25 Facility in Oak Ridge, Tennessee. Phase 1 of the project included an approximately 30-acre parcel, which when developed, will include up to 300,000 sq ft. of office and light industrial construction. This development occurred under a Brownfield agreement. Coordinated the field drilling, sampling, and laboratory testing for the proposed building locations and produced the associated geotechnical report.

Biomass Steam Generator Plant
Oak Ridge, Tennessee
The project was located on the campus of Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. The geotechnical investigation for the new Biomass Steam Generator Plant occurred south of the existing coal powered Steam Plant. The new plant consisted of an approximately 11,250 square foot structure for the Biomass Plant Building and an adjoining 4,750 square foot Biomass Receiving Building. Coordinated the field drilling, access of drill equipment around demolition of existing coal

powered steam plant, sample identification and testing, and geotechnical report preparation and production.

Tennessee Valley Authority (TVA) Bull Run Fossil Plant Dry Fly Ash Landfill Expansion, Clinton Tennessee

Assisted with coordination of geotechnical services on proposed ash and soil borrow materials for use in construction of dikes, including design parameters for a reinforced earth retaining wall for expansion of dry fly ash landfill. Responsible for assisting the field coordinator with logging/classifying soil and rock samples and coordinating the daily activities of drilling equipment.

Tennessee Valley Authority (TVA) Kingston Fossil Plant Gypsum Disposal Area Exploration, Well Installation and Lab Testing, Kingston Tennessee

Geotechnical field exploration and well installation in conjunction with proposed development of gypsum disposal area. Work included 22 soil test borings (bedrock coring in 12 borings), 120 undisturbed sample attempts, 14 bulk samples, CPT testing (by subcontractor) at 11 locations, and 12 monitoring well installations. Responsible as field geologist for supervising field activities, logging/classifying soil and rock samples.

Grand Gulf Nuclear Facility

Assisted with field coordination of geotechnical drilling for the installation of a new power block for the AP1000 and ESBWR and associated cooling towers as part of the NU Start program. Inspected soil samples collected from the borings for the new power block and cooling towers, which required drilling depths ranging from 150 feet to 350 feet below ground surface and continuous sampling in the top 80 feet. A series of monitoring wells were also installed to provide hydrologic data for the excavation and construction of the reactor system.

Dulles Corridor Project (DTE)

Assisted with field coordination of the Dulles Corridor project, a 22 mile, 24% extension of the Metro line, adding 16 new stations from the Tysons Corner area of Virginia to the Dulles International Airport. The new line included 2 miles of tunnels, both elevated and at-grade track, and elevated structures. Field testing included standard penetration test borings, rock coring, and in-situ deformation and strength testing (dilatometer, pressuremeter, borehole shear device testing, etc.). Temporary monitoring wells and in-situ permeability testing (i.e., pump tests or slug tests) were required in areas where tunneling or other significant construction extended below the water table.

Coalfields Expressway (KBR)

Assisted with field coordination of geotechnical explorations along 51-mile stretch of roadway with 33 bridges (up to 300 feet in height and ranging from 400 to 1,200 feet long), some over mined land. Section A work (8 miles) included geotechnical investigation and over 600 borings through mountainous terrain.

Project Role
Senior Geologist

Company
S&ME, Inc.- Knoxville, TN

Education
B.S. Geology, Tennessee Technological University, 1987

Years of Experience
Joined S&ME in 2001 with 13 years of previous experience

Professional Registrations
Professional Geologist:
- Tennessee #1802
- Kentucky #881
- North Carolina #1717
- Georgia #1572

Kentucky Corrective Action Contractor Certification #1143

Professional Memberships
- National Groundwater Association
- Geological Society of America

ERIC M. SOLT, PG.
SENIOR GEOLOGIST
ENVIRONMENTAL SERVICES DEPARTMENT MANAGER

Mr. Solt is a Senior Geologist and Manager of the Environmental Services Department in S&ME's Knoxville office. His areas of proficiency include: project management, operations management, Phase I Environmental Site Assessments, Phase II Environmental Site Assessments, solid and hazardous waste evaluation and management, geologic investigations, soil and groundwater remediation system design, remediation construction management, remediation operation and maintenance.

KEY PROJECTS AND ASSIGNMENTS

Brownfield Assessment Project, Community Wide Assessment, *East Tennessee*
Senior Reviewer for 16-county community wide assessment under EPA Brownfields Assessment Grant Program. Project is ongoing and includes the implementation of Phase I ESA's for properties including a knitting mill, petroleum bulk plant, furniture manufacturer, historical landfill, and riverfront corridor.

Pilot Oil Corporation and Pilot Travel Centers, LLC, (various southeast locations), Knoxville, Tennessee
Project Manager for Phase I and Phase II pre-purchase due diligence environmental services. Responsibilities include contract management, development and implementation of site assessment plans. Property assessments include both developed and undeveloped parcels.

Former Industrial Complex
Elizabethton, Tennessee
Project Geologist for Phase II Environmental Site Assessment for site development. Project included review of historic facility operations and environmental compliance issues, assessment design, subsurface investigation and reporting.

Blount County Highway Department
Alcoa, Tennessee
Project Manager for facility investigation that included the assessment of soil and groundwater and delineation of old municipal landfill cells on site. Used historic aerial photographs and differential global positioning system and test pit confirmation to expedite the landfill delineation. Environmental assessment information was used to negotiate a Brownfield Agreement.

Former Zintec Metal Finishing Facility
Knoxville, Tennessee
Project Manager for pre- purchase due diligence investigation that included Phase I ESA and Limited Phase II Geoprobe shallow soil assessment for metals.

S&ME

Former Injection Molding Facility
Blount County, Tennessee
Project Manager responsible for facility assessment to determine the extent of migration of hydraulic oils beneath the process area floor slabs. Assessment also included air rotary drilling to evaluate site groundwater.

Former Lay Packing Facility
Knoxville, Tennessee
Project Manager for Phase II Environmental Site Assessment and the sampling and in-place closure of two 20,000 gallon fuel oil heating tanks.

Former Brookside Mills Site
Knoxville Tennessee
Project Manager for the subsurface evaluation of a historic knitting mill. Assessment included the identification of relevant sampling points using Sanborn maps, historic aerial photographs and differential global positioning system.

Former Metal Fabrication Facility
Knoxville, Tennessee
Project Manager for Phase II Environmental Site Assessment of a former large-scale metal fabrication facility. Assessment also included test pit and drilling evaluation of a former coal tar disposal area associated with historic gas light production facility.

Anniston Army Depot
Anniston, Alabama
Project Manager for free product recovery system evaluation using mobile enhanced multi-phase extraction to determine aquifer parameters and free product production at various vacuum and flow rates.

Proposed Municipal Service Center
Aloca, Tennessee
Project Manager for Phase II Environmental Assessment of a former manufacturing facility with former municipal landfill cells located on the property. Utilized test pit, soil boring and Geoprobe® investigation techniques to document subsurface soil conditions and define boundaries of landfill cells relative to proposed structures. Environmental services relative to the development also included a methane and landfill cover thickness evaluation, a hazardous materials survey in the powerhouse, production and drying kiln buildings, as well as a wetlands evaluation.

Aluminum Manufacturing Facility
Blount County, Tennessee
Project Manager for comprehensive building material inventory at multiple facilities that included the identification, sampling, analysis and labeling of all identified asbestos-containing materials.

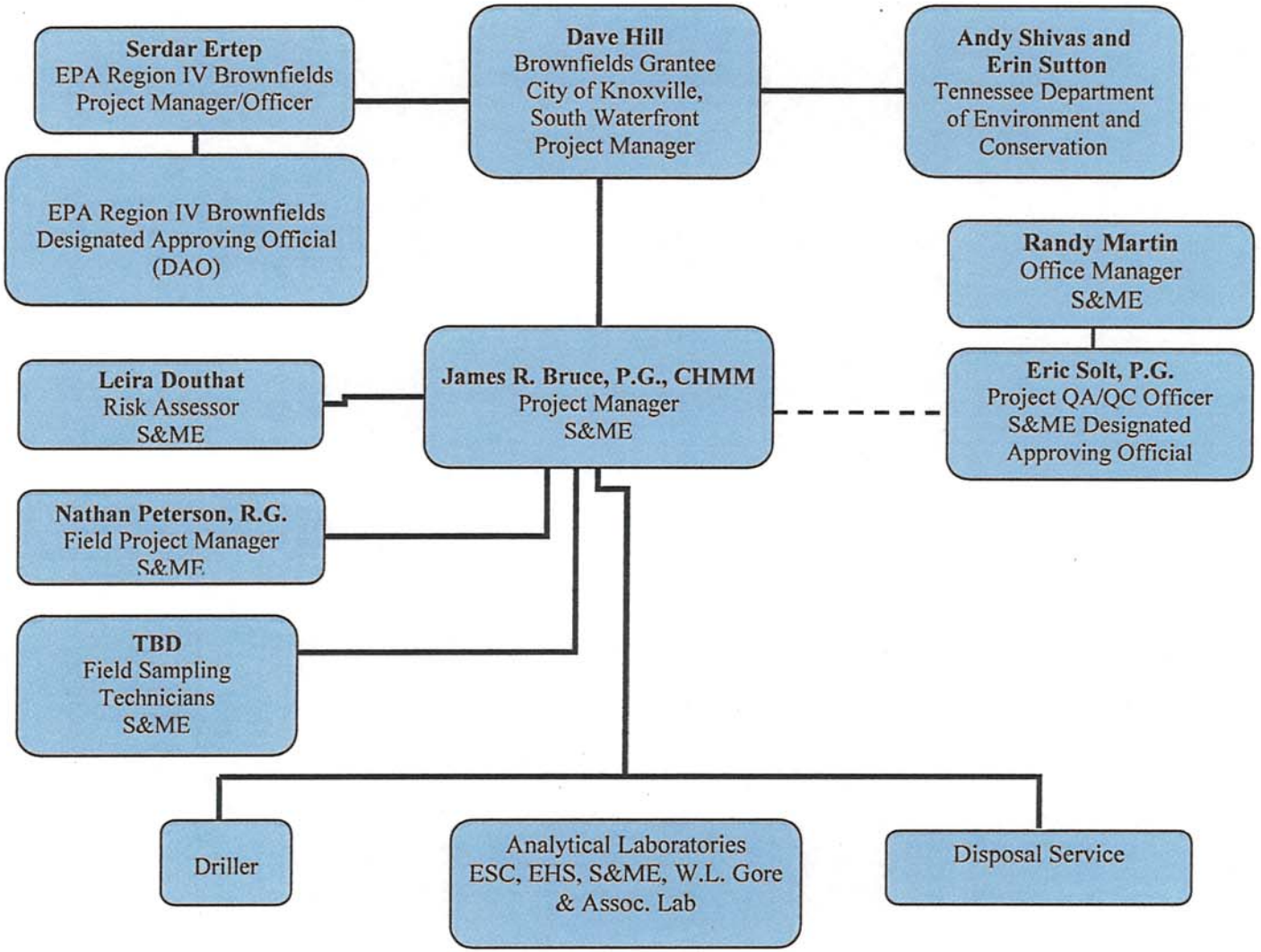
Former Plasti-Line Facility
Knoxville, Tennessee

Project Manager for pre-purchase due diligence Phase I and Phase II Environmental Site Assessment of a former thermoplastic molding facility.

CONTINUING EDUCATION

- Stream Restoration and Natural Channel Design, 2004

- S&ME Phase I ESA Training, 2003-2006
- Natural Attenuation for Site Remediation, 1998
- Groundwater Pollution and Hydrology, 1994
- Bio-Venting, Principles and Applications, 1994
- Air Sparging for Site Remediation, 1994
- 40-Hour Hazardous Waste Operations Training, 1993 and annual 8-Hour refresher courses



Appendix C - Organizational Chart

Quality Assurance Manual

12065 LEBANON RD. | MT. JULIET, TN 37122 | (800) 767-5859 | WWW.ESCLABSCIENCES.COM

Version 9.0 4/15/11

Disclaimer

The ESC Lab Sciences Quality Assurance Manual is a living document. It is reviewed at least annually and revised when needed. The information stated herein is subject to change at any time due to updates to QC Limits, methods, operations, equipment, staff, etc. At the time of distribution the requestor will receive the most recent version of the manual and will be assigned a control number. The control number will help ESC to track what version is sent. The revision number is stated on the cover page of the manual.

Expiration

This manual expires 1 year from the date listed at the front of the manual on the “Approvals” page. If you have a copy that is not dated within this time period, please contact the laboratory and obtain the most recent version.

COMPREHENSIVE QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37207
(615)758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37207
(615)758-5858

NOTE: The QAM has been approved by the following people. A signed cover page is available upon request

Peter A. Schulert, CEO 615-773-9660

Judith R. Morgan, M.S., VP, Director of Technical & Regulatory Affairs 615-773-9657

Eric Johnson, VP, Laboratory Director 615-773-9654

Tom Mellette, Client Operations 615-773-9676

Dixie Marlin, B.S., QC Manager, 615-773-9681

Jeff Chandler, B.S., CIO (Information Systems) 615-773-9696

The ESC QAM has been prepared in accordance with the following standards: AIHA (LQAP), A2LA (Env. Prog. Req.), ANSI/ISO 17025-2005, NELAC, DOD QSM.

Quality Manual: Table of Contents

Tables and Figures

1.0 GENERAL

1.1 INDEX AND REVISION STATUS

The numbering of this quality manual corresponds directly to the numbering of ISO 17025:2005 with cross-references to the 2003 NELAC Standard and the 2009 standard of The NELAC Institute (TNI).

This quality manual is only valid if all pages are at the same issue level as shown in the index of the quality manual.

Updates to this manual are made by re-issuing the relevant section of this manual and adapting the issue level in the index. New version numbers are assigned upon revision.

NOTE: This manual expires 1 year from the date listed at the beginning of the manual on the "Approvals" page.

1.2 PURPOSE

This quality manual documents the laboratory's management system and demonstrates the ability to execute the indicated tests and/or procedures and to meet regulatory requirements.

This manual establishes compliance with ISO 17025, NELAC, DOD QSM, and AIHA.

2.0 LABORATORY BACKGROUND

2.1 ACTIVITIES

2.1.1 Analytical Support and Service Areas

ESC Lab Sciences is an environmental analytical firm providing technical and support services to clients nationwide. Specific service areas include the following:

- drinking water analysis
- industrial wastewater analysis
- hazardous waste characterization and identification
- groundwater analysis
- air analysis
- regulatory document guidance
- biological assessments
- mold identification
- solid/soil analysis and characterization
- industrial hygiene/environmental lead

2.1.2 Regulatory Compliance and Quality Standards

ESC is devoted to providing reliable and accurate data recognizing the necessity to establish sound, objective, and legally defensible positions or opinions for clients regarding compliance with governing regulations. ESC maintains quality systems that are compliant with the following Quality Standards: AIHA LQAP, A2LA, ANSI/ISO 17025, NELAC, DOD QSM. The effectiveness of the quality system is measured by internal and external audits, management review meetings, internal error logs and an active preventive and corrective action system.

2.1.3 Analytical Capabilities:

Where mandated, only approved EPA procedures are used for environmental analyses. ESC utilizes a number of method sources to accomplish project requirements. For NPDES and SDWA, methodologies are taken directly from 40 CFR parts 136 and 141.

For industrial hygiene analytical procedures, ESC utilizes guidance from NIOSH and OSHA published methods.

The following list is an example of the methodology ESC routinely performs:

Routine Methodology and Programs	
PROGRAM	***METHOD SOURCE***
NPDES	***EPA 821/R-93-010-A*** *Methods for the Determination of Nonconventional Pesticides in Municipal and Industrial Wastewater, Volume I. Revision 1, August 1993.*
	EPA 821/R-02-019 *Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry. August 2002.*
	40 CFR part 136
	Methods for Chemical Analysis of Water and Wastes (March 1983)
	Standard Methods for the Examination of Water and Wastewater (18th, 19th, 20th editions)
AQUATIC TOXICITY	*7-Day Fathead Minnow (Pimephales promelas) Larval Survival and Growth Test; Test Method 1000.0 from "Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" (EPA 821-R-02-013).*
	3-Brood Ceriodaphnia dubia Survival and Reproduction Test; Test Method 1002.0 from "Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" (EPA 821-R-02-013).
	Fathead Minnow (Pimephales promelas) Acute Toxicity Test (24, 48 or 96 hour duration); referenced in "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms" (EPA 821-R-02-012, 10-02).
	Ceriodaphnia dubia Acute Toxicity Test (24, 48 or 96 hour duration); referenced in "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms" (EPA 821-R-02-012, 10-02).
SDWA	40 CFR parts 141
	Methods for Chemical Analysis of Water and Wastes (March 1983)
	Standard Methods for the Examination of Water and Wastewater (18th, 19th, 20th editions)
	Methods for the Determination of Organic Compounds in Drinking Water -EPA/600/4-88/039 - December 1988 (Revised July 1991)
	Methods for the Determination of Organic Compounds in Drinking Water Supplement I, EPA/600/4-90/020 - July 1990
	Methods for the Determination of Organic Compounds in Drinking Water Supplement II, EPA/600/R-92/129 - August 1992
	EPA. Method 1623: *Cryptosporidium and Giardia in Water by Filtration/IMS/FA, December 2005.*
RCRA	*SW-846, Test Methods for Evaluating Solid Wastes (3rd, 4th and online editions)*
IH	*NIOSH Manual of Analytical Methods (4th edition) & OSHA Sampling and Analytical Methods (online)*
AIR	*Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*
	Emission Measurement Center (Air Emissions Methods)
	NIOSH Manual of Analytical Methods (4th edition)
	Journal of Chromatographic Science, Vol. 36, May 1998.
CLP	*USEPA CONTRACT LABORATORY PROGRAM - STATEMENT OF WORK* FOR ORGANICS ANALYSIS Multi-Media, Multi-Concentration OLM04.3
	USEPA CONTRACT LABORATORY PROGRAM - STATEMENT OF WORK FOR INORGANIC ANALYSIS Multi-Media, Multi-Concentration ILM05.3

Routine Methodology and Programs	
PROGRAM	***METHOD SOURCE***
MOLD	*American Industrial Hygiene Association*
	NIOSH Manual of Analytical Methods (4th edition)
Miscellaneous	*American Society for Testing and Materials (ASTM)*
	State Specific Methodologies from the following: *Florida, Oregon, Iowa, Washington, Texas, Arizona, Massachusetts, North Carolina, Louisiana, Missouri, Kansas, Wisconsin, Ohio*
Miscellaneous	*Analytical Methods for the Determination of Pollutants in Pharmaceutical Manufacturing Industry Wastewater, Revision A EPA-821-B-98-016 - July 1998 (Approved at 40 CFR Part 136, Not Approved at Part 141)*

2.2 HISTORY

ESC Lab Sciences was founded in 1970 by Dr. Arthur Schulert, a professor of Biochemistry at Vanderbilt University Medical School. The laboratory's first location was a 2,000 square foot building located in Mt. Juliet, TN.

ESC initially conducted several research contracts for the National Science Foundation. EPA Clean Water and Safe Drinking Water legislation of the early 1970s provided an additional market of Tennessee utilities and industries. ESC grew slowly for several years by increasing the share of the drinking and wastewater markets in Tennessee. In the late 1980s, ESC expanded its capabilities to include Underground Storage Tank testing and Biomonitoring/Toxicity testing.

Strategic expansion of the laboratory allowed ESC to provide support to large RCRA sites and add capabilities to offer analytical support for air and mold analyses. ESC is currently the nation's largest, single-location environmental laboratory and is the only laboratory facility certified/approved to operate in all US states. Our staff of over 250 employees works out of our 87,000 square feet, nine-building facility approximately 20 minutes east of Nashville International Airport.

3.0 INTRODUCTION, SCOPE, AND DEFINITIONS

3.1 SCOPE OF CAPABILITIES

A list of approved and certified analytical capabilities can be found at the end of this section in Table 3.3b.

3.2 TABLE OF CONTENTS, REFERENCES AND APPENDICES

The table of contents is found at the beginning of this Manual. This *Quality Manual* uses the references from the 2003 NELAC Standard, Chapter 5, Appendix A.

3.3 DEFINITIONS AND TERMINOLOGY

The quality department is responsible for establishing and maintaining a list of definitions and conventions.

Table 3.3a Definitions

TERM	***DEFINITION***
Acceptance Criteria (Analytical QC Limits)	Specified limits placed on characteristics of an analytical process as defined in analytical methodology or guidance.
Accuracy	The amount of agreement between an observed value and an accepted reference value. Accuracy is represented as percent recovery.
Analytical Reagent Grade	Designation for the high purity of certain chemical reagents and solvents assigned by the American Chemical Society.
Analytical Sensitivity	The lowest concentration that can be detected by the method. (e.g., for methods involving a count = 1 raw count calculated to the reporting units). Analytical sensitivity is commonly used in Mold analysis.
Batch Analysis	Analysis of 1 – 10 or 20 samples, depending on the published method requirements, including all required QC. When there are 21 or more samples to be analyzed, the QC criteria for the next 20 samples is the same as it is with a single batch.
Batch	1 – 10 or 20 samples, depending on the published method requirements. A group of samples that behave similarly and are analyzed as a unit.
Blank	See FIELD, TRIP, METHOD, EQUIPMENT
Blind Sample	A sample submitted for analysis with a composition known only to the individual requesting the analysis. The analyst/laboratory may know the identity of the sample, but not its composition. It is used to verify the analyst or laboratory's proficiency in the execution of the analytical measurement process.

Table 3.3a Definitions	
Calibration	To determine, by measurement or comparison with a known standard, the correct value of each scale reading on a meter or other device, or the correct value for each setting of an instrument control. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements.
Calibration Curve	The graphic representation of the relationship between the known values, such as concentrations of a series of calibration standards and instrument responses.
Calibration Factor	The ratio of the detector response (peak areas or peak heights) to the amount (mass) of analyte in the calibration standard. $$CF = \frac{A_s}{C_s}$$ where: A_s - Average Peak Area over the number of peaks used for quantitation C_s – Concentration of the analyte in the standard.
Continuing Calibration Blank (CCB)	The CCB is used to confirm the absence of contaminants within the analytical system prior to and during the analysis of field samples. The CCB must be <½ RL, concentrations of common laboratory contaminants cannot exceed the reporting limit. The CCB is analyzed on at regular intervals within a batch and is typically utilized in Metals and Wet Chemistry analyses.
Continuing Calibration Verification (CCV)	A standard, usually near the mid-point of the calibration curve, made from the primary stock used for the calibration curve. The CCV is used to verify the calibration stability of the instrument and must perform within method stated criteria, which is usually ±10 to 15%. The CCV must be analyzed at regular intervals within a batch.
Continuing Demonstration of Capability (CDOC)	Continuing Demonstration of Capability – Annual* verification of analyst skill. *unless required more frequently by program or method
Chain of Custody	A record that documents the possession of the samples from the time of collection to receipt by the laboratory. This record generally includes: the number and types of containers, the mode of collection; collector ID; time of collection; preservation; and requested analysis.
Corrective Action	An action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.
Data Quality Objective (DQO)	A statement of the overall level of uncertainty that a data user is willing to accept in results derived from analytical data.
Duplicate	Second aliquots of field samples carried through the entire preparation and analytical process that are used as an indication of sample precision or consistency in the field sample matrix.
Equipment Blank	A sample of analyte free water (usually laboratory DI) which has been used to rinse the sampling equipment. It is collected after decontamination procedures but prior to sampling. The purpose is to demonstrate complete decontamination of the equipment.

Table 3.3a Definitions	
External Calibration Model	Comparison of instrument responses from the sample to the responses from the target compounds in the calibration standards. Sample peak areas (or peak heights) are compared to peak areas (or heights) of the corresponding analytes in calibration standards.
Field Blank	A sample of analyte free water (usually laboratory DI) is poured into the appropriate collection vessel and preserved according to method guidelines. The purpose of the field blank is to serve as a check on reagent and environmental contamination.
Initial Calibration Verification (ICV) See also SSCV	An independently prepared standard used to verify the accuracy of the initial calibration (for ongoing calibration). The ICV is used to represent the calibration efficiency of the instrument and must perform within method stated criteria, which is usually ±10 to 15%. For metals analysis, the ICV is a secondary source.
Initial Demonstration of Capability (IDOC) See also CDOC	A demonstration of capability (DOC) must be made prior to using any analytical method and any time there is a change in instrument type, personnel or testing method. Such performance must be documented and the four preparation batches following the change in personnel must not result in the failure of any batch acceptance criteria, e.g., method blank and laboratory control sample, or the demonstration of capability must be repeated.
Instrument Detection Limit (IDL)	IDL is the smallest signal above background noise that an instrument can reliably detect.
Interference Check Sample (ICS)	A series of two solutions, used in ICP and ICPMS analysis, to verify that inter-element interferences are compensated for correctly. This standard is referred to as the Spectra Interference Check (SIC) in EPA Method 200.7 ICSA – A solution containing only the interfering analytes at high concentrations. ICSAB – A solution containing interferents plus other method analytes at the level of concern, which corresponds to the project specific action limits. ICSA and ICSAB provide and adequate test of inter-element correction (IEC) factors.
Internal Calibration Model	Internal standard calibration involves the comparison of instrument responses from the target compounds in the sample to the responses of specific internal standard analytes added to the sample or sample extract prior to injection.
Internal Standards	Analytes not expected to occur naturally in field samples that are spiked to provide a consistent basis for comparison with target analytes. ISTDs are used in internal calibration models.

Table 3.3a Definitions

Laboratory Control Sample (LCS) - 2ND Source	A known matrix is spiked with known amounts of the analyte(s) of interest used to verify the efficiency of the analytical system without interference from the sample matrix. The LCS provides the best estimate of analytical system accuracy and may also be used to verify the validity of the on-going calibration. The source is usually a secondary source. The LCS matrix must closely represent the matrix of the sample batch and undergo all preparations required by the method prior to analysis. The following list are acceptable matrices for the LCS: ***Batch Matrix*** — ***LCS Matrix*** Water — Laboratory DI water Soil — Spiked Ottawa sand or Glass beads or commercially prepared LCS in a soil matrix Paint Chips — Laboratory prepared paint chip/lead mixture Commercially prepared & certified paint chip LCS Filters/Sorbent Media/Dust Wipes — Unused Industrial Hygiene sampling media that represents the substrate submitted by the client. Where possible, the media should be the same lot as that of the field samples.
Limit Of Detection (LOD)	The lowest concentration that can be determined by a single analysis to be statistically different from a blank, within a defined level of confidence. This concentration is recommended to be three standard deviations above the measured average difference between the sample and blank signals, which corresponds to the 99% confidence level. In practice, detection of an analyte by an instrument is often based on the extent to which the analyte signal exceeds peak-to-peak noise (Keith et al. 1983). Samples that do not bear residues at or above the LOD are referred to as non-detects (ND).
Limit of Quantitation (LOQ)	The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The LOQ may be equal to the RL, MRL, or PQL. Routinely the PQL/LOQ is at least 3-5 times the statistically derived MDL/LOD.
Linear Dynamic Range (LDR)	In Inorganic analyses, the LDR is defined as the concentration range where absorbance and concentration remain directly proportional to each other. A wide linear dynamic range permits the analysis of a wide range of sample concentrations (optical densities) and reduces sample preparation (dilution) requirements.

Table 3.3a Definitions	
Matrix	The component, or substrate, which contains the analyte of interest. For purposes of batch determination, the following matrix types are used: • *Aqueous:* Any aqueous sample excluded from the definition of a drinking water matrix or saline/estuarine source. Includes surface water, groundwater, and effluents. • *Drinking Water:* Any aqueous sample that has been designated as a potable or potentially potable water source. • *Saline/Estuarine:* Any aqueous sample from an ocean or estuary, or other saltwater source, such as the Great Salt Lake. • *Non-aqueous Liquid:* Any organic liquid with <15% settleable solids. • *Biological Tissue:* Any sample of a biological origin such as fish tissue, shellfish or plant material. Such samples are grouped according to origin. • *Solids:* Includes soils, sediments, sludge and other matrices with >15% settleable solids. • *Chemical Waste*: A product or by-product of an industrial process that results in a matrix not previously defined. • *Air Samples:* Media used to retain the analyte of interest from an air sample such as sorbent tubes or summa canisters. Each medium is considered as a distinct matrix. • *Solids (Other than defined above):* Includes filters, dust wipes, sorbent tubes, paint chips.
Matrix Spike (MS)	A separate aliquot of field sample spiked with a known amount of the target analyte. Accuracy is determined by comparing the recovery of the spike added to the known concentration in the sample divided by the expected analyte concentration. $$Percent Spike Recovery = \frac{O_i - O_s}{T_i} X\ 100$$ O_i = observed sample concentration with the spike added O_s = the observed value for the sample without the spike $$T_i = \frac{Spike\ Concentration\ \text{in}\ (mg/L)\ X\ Volume\ \text{of Spike in}\ (ml)}{Volume\ of\ Sample\ in\ (ml) + Volume\ of\ Spike\ in\ (ml)}$$ T_i = True value of the spike added
Matrix Spike Duplicate (MSD)	The second aliquot of the field sample spiked as the matrix spike and carried through all sample preparation/analytical steps. The MS/MSD pair are spiked with identical amounts of the target analyte and precision is calculated based on the results.
Method Detection Limit (MDL)	The minimum concentration of a substance that can be analyzed with 99% confidence that the analyte concentration is greater than zero. MDLs are performed in conjunction with 40CFR 136, Appendix B. The MDL is the absolute minimum level of reporting that is allowed. Values reported between the MDL and RL are flagged with a "J" qualifier.

Table 3.3a Definitions	
Method Blank	A laboratory produced blank is carried through each step of the analytical procedure for each batch of samples. Blanks are prepared for each preparation method and matrix (i.e., solids assay, dissolved metals, TCLP extraction, etc.). Blanks are used to confirm the absence of contaminants within the preparation and/or analytical system prior to and during the analysis of field samples.
Negative Control	Measures taken to ensure that an analytical process, its components, or the environment do not cause adverse effects or lead to incorrect quantitation.
Percent Recovery	A comparison between the observed value and the true value of a known spiked concentration, represented as a percentage. This evaluation applies to the calculation of ICV, CCV, LCS, MS/MSD, Surrogates, etc. and is calculated as follows: $$\%\ \text{Recovery} = \left[\frac{\text{Observed Value}}{\text{True Value}}\right] \text{X}\, 100$$
Positive Control	Measures taken to ensure that an analysis and/or its components are working properly and producing correct or expected results.
Post Digestion Spike	In metals analysis, a standard prepared from a previously analyzed spiked sample digestate that yielded reduced recovery for the target analyte due to a suspected matrix interferent.
Practical Detection Limit (PDL)	An in-house protocol that is used to determine a practical and real number for method detection. This is not a statistically derived number. It is a verified number that is validated using a 20% coefficient of variation.
Practical Quantitation Limit (PQL) ***See also Reporting Limit (RL)***	Generally, the lowest standard of the calibration curve. The PQL, or RL, is defined as the lowest level that can be reliably achieved within the established limits of precision and accuracy during routine laboratory operating conditions. The PQL is the default reporting limit (RL) when no other limits are required by the project. The PQL is usually a factor of 3-10 times greater than the determined MDL. The value of the PQL changes with subsequent sample dilutions and final volumes. The multiplier (dilution) of the sample is applied to the PQL for reporting. Values reported between the MDL and PQL are flagged with a "J" qualifier.
Precision	The agreement between 2 or more duplicate measurements. There is no assumption of the true value of the sample. Precision is expressed as RPD (Relative Percent Difference).
Proficiency Testing	The action of providing controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results in comparison to peer laboratories and the collective demographics and results summary of all participating laboratories.
Qualifier	A general explanation associated with deviations from established method criteria for a given analyte. The qualifiers are alpha-numeric designations that are related to specific comments. (i.e. J1 - "Surrogate recovery limits have been exceeded, values are outside of upper control limits.")
Quality Assurance	A plan for laboratory operation that specifies the measures used to produce data of known precision and bias.
Quality Control	A set of measures within a sample analysis methodology to assure that the process is operating from a controlled analytical system.

Table 3.3a Definitions	
Reference Material	A material or substance in which one or more properties are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.
Reference Toxicant	The toxicant used in aquatic toxicity analyses to indicate the sensitivity of a test organism and to demonstrate the laboratory's ability to perform the procedure correctly and obtain consistent results.
Replicate Sample	The analytical measurement of a sample that has been split after it has been processed through the preparation stage. A replicate can also originate from a single sample that has been sub-sampled two or more times during the same analytical process time.
Reporting Limit (RL) See also PQL	The RL is equal to the PQL unless project specific limits are supplied/required by the client.
Relative Percent Difference (RPD)	$$RPD = \frac{\lvert Dup\ 1 - Dup\ 2 \rvert}{\left[\frac{(Dup\ 1 + Dup\ 2)}{2}\right]} X\ 100$$ The comparison of two values based on the mean of the two values. It is always reported as a positive number. The result is an assessment of precision. For sample duplication, the RPD is calculated using the actual analytical results of the field sample. LCS & MS calculations are also based on the actual sample result of spiked samples.
Response Factor (RF)	A measure of the relative response area of an analyte compared to its internal standard. The response factor is determined by the equation below, and if the calculated value meets the method guidelines it can be used to determine concentration for organic analyses. $$RF = \frac{(Conc._{IStd})(Area_{Analyte})}{(Conc._{analyte})(Area_{IStd})}$$ where: A_s = Response for analyte to be measured A_{is} = Response for the internal standard C_{is} = Conc. of the internal std.in ug/L C_s = Conc. of the analyte to be measured in ug/L.
Sample Blank	The purpose of a sample blank is to account for spectrophotometric interferences such as sample color, cloudiness, viscosity, etc. The sample blank must be analyzed at the same dilution as the sample. The sample blank is analyzed without any addition of reagents.
Selectivity	The capability of an analytical method or instrument to respond to a target substance or constituent in the presence of non-target substances.
Sensitivity	The capability of an analytical method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a property of interest.

Table 3.3a Definitions	
Secondary Source Calibration Verification (SSCV)	A mid-point or low standard made from the secondary source (lot or manufacturer) that is not used to construct the calibration curve. The SSCV is used to represent the calibration accuracy of the instrument and must perform within method stated guidelines. This sample is used to document calibration accuracy. The SSCV can be the same solution as the LCS, but is analyzed as an instrument standard, rather than a method prepared standard.
Serial Dilution	A subsequent dilution of a high concentration field sample that should agree within 10% of the original undiluted analysis. In metals analysis, a serial dilution is included in each preparation batch if target analyte concentration is at least fifty times the IDL. This is generally used as a test for matrix interferents or matrix effects.
Standard Operating Procedure (SOP)	A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks.
Standard Reference Material	A certified reference material produced by the U.S. National Institute of Standards and Technology (NIST) and characterized for absolute content independent of analytical method.
Standards Addition	The process of spiking a known amount of analyte into an extract/digestate to observe the increase in concentration of the analyte in question. This process can be used to confirm analyte identification or suspected matrix interferences.
Surrogate	A compound that is similar to the target analytes in chemical composition and behavior and not expected to occur naturally in field samples. Surrogates are spiked by preparation/analytical personnel to assess sample preparation and analytical efficiency in each individual field sample.
Tentatively Identified Compound (TIC)	Compounds detected in samples that are not target compounds, internal standards, system monitoring compounds, or surrogates. TICs can be tentatively identified using mass spectrometers in spectral comparisons with NBS library searches. Quantitation of TICs provides a rough approximation of the concentration of these non-target analytes.
Trip Blank	A sample of analyte-free media (usually laboratory DI) that is taken from the laboratory to the sampling site and then returned unopened to the laboratory. The trip blank is used to ensure that cross contamination does not occur during shipment/storage and is used mainly for VOC analyses.

Table 3.3b
Analytical Capabilities
AE=Air Emissions, DW=Drinking Water, NPW=Non-potable Water, SCM=Solid Chemical Materials

The information listed is subject to change.
Always check with the laboratory for the most updated information.

Matrix	Approved Method	Parameter Description
AE	[EPA 3C]	Carbon Dioxide
AE	[EPA 3C]	Methane
AE	[EPA 3C]	Nitrogen
AE	[EPA 3C]	Oxygen
AE	[EPA 0040]	Hazardous organics
AE	[EPA TO-15]	Acetaldehyde
AE	[EPA TO-15]	Acetone
AE	[EPA TO-15]	Acetonitrile
AE	[EPA TO-15]	Allyl chloride
AE	[EPA TO-15]	Benzene
AE	[EPA TO-15]	Benzyl chloride
AE	[EPA TO-15]	Bromodichloromethane
AE	[EPA TO-15]	Bromoform
AE	[EPA TO-15]	Bromomethane
AE	[EPA TO-15]	Butadiene (1,3-)
AE	[EPA TO-15]	Carbon disulfide
AE	[EPA TO-15]	Carbon tetrachloride
AE	[EPA TO-15]	Chlorobenzene
AE	[EPA TO-15]	Chloroethane
AE	[EPA TO-15]	Chloroform
AE	[EPA TO-15]	Chloromethane
AE	[EPA TO-15]	Chlorotoluene (2-)
AE	[EPA TO-15]	Cyclohexane
AE	[EPA TO-15]	Dibromochloromethane
AE	[EPA TO-15]	Dibromoethane (1,2-) (EDB)
AE	[EPA TO-15]	Dichlorobenzene (1,2-)
AE	[EPA TO-15]	Dichlorobenzene (1,3-)
AE	[EPA TO-15]	Dichlorobenzene (1,4-)
AE	[EPA TO-15]	Dichlorodifluoromethane
AE	[EPA TO-15]	Dichloroethane (1,1-)
AE	[EPA TO-15]	Dichloroethane (1,2-)
AE	[EPA TO-15]	Dichloroethene (1,1-)
AE	[EPA TO-15]	Dichloroethene (cis-1,2-)
AE	[EPA TO-15]	Dichloroethene (trans-1,2-)
AE	[EPA TO-15]	Dichloropropane (1,2-)
AE	[EPA TO-15]	Dichloropropene (cis-1,3-)
AE	[EPA TO-15]	Dichloropropene (trans-1,3-)
AE	[EPA TO-15]	Dichlorotetrafluoroethane (1,2-)

The information listed is subject to change.
Always check with the laboratory for the most updated information.

Matrix	Approved Method	Parameter Description
AE	[EPA TO-15]	Dioxane (1,4-)
AE	[EPA TO-15]	Ethylbenzene
AE	[EPA TO-15]	Ethyltoluene (4-)
AE	[EPA TO-15]	Gasoline range organic
AE	[EPA TO-15]	Hexachlorobutadiene (1,3-)
AE	[EPA TO-15]	Hexanone (2-)
AE	[EPA TO-15]	Heptane (n-)
AE	[EPA TO-15]	Hexane (n-)
AE	[EPA TO-15]	Isopropanol
AE	[EPA TO-15]	Isopropylbenzene
AE	[EPA TO-15]	Methyl alcohol (Methanol)
AE	[EPA TO-15]	Methyl ethyl ketone
AE	[EPA TO-15]	Methyl iodide
AE	[EPA TO-15]	Methyl isobutyl ketone
AE	[EPA TO-15]	Methyl methacrylate
AE	[EPA TO-15]	Methyl tert-butyl ether
AE	[EPA TO-15]	Methylene chloride (Dichloromethane)
AE	[EPA TO-15]	Naphthalene
AE	[EPA TO-15]	Propylene
AE	[EPA TO-15]	Styrene
AE	[EPA TO-15]	Trichlorobenzene (1,2,4-)
AE	[EPA TO-15]	Trimethylbenzene (1,3,5-)
AE	[EPA TO-15]	Trimethylbenzene (1,2,4-)
AE	[EPA TO-15]	Trimethylpentane (2,2,4-)
AE	[EPA TO-15]	Tert-butyl alcohol
AE	[EPA TO-15]	Tetrachloroethane (1,1,2,2-)
AE	[EPA TO-15]	Tetrachloroethene
AE	[EPA TO-15]	Tetrahydrofuran
AE	[EPA TO-15]	Toluene
AE	[EPA TO-15]	Trichloroethane (1,1,1-)
AE	[EPA TO-15]	Trichloroethane (1,1,2-)
AE	[EPA TO-15]	Trichloroethene
AE	[EPA TO-15]	Trichlorofluoromethane
AE	[EPA TO-15]	Trichloro (1,1,2-) trifluoroethane (1,2,2-)
AE	[EPA TO-15]	Vinyl acetate
AE	[EPA TO-15]	Vinyl bromide
AE	[EPA TO-15]	Vinyl chloride
AE	[EPA TO-15]	Xylene (m-)
AE	[EPA TO-15]	Xylene (o-)
AE	[EPA TO-15]	Xylene (p-)
AE	[EPA TO-15]	Xylenes (total)

The information listed is subject to change.
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Matrix	Approved Method	Parameter Description
DW	[EPA 1622] [EPA 1623]	Cryptosporidium
DW	[EPA 180.1] [SM 2130 B]	Turbidity
DW	[EPA 353.2] [SM 4500-NO3 F]	Nitrate
DW	[EPA 300.0] [SM 4110 B]	Nitrate
DW	[EPA 353.2] [SM 4500-NO3 F]	Nitrite
DW	[EPA 300.0] [SM 4110 B]	Nitrite
DW	[EPA 300.0] [SM 4110 B]	Fluoride
DW	[SM 4500-CN C,G]	Cyanide
DW	[SM 4500-CN C,E]	Cyanide
DW	[OTHER Kelada-01]	Cyanide
DW	[EPA 335.4]	Cyanide
DW	[EPA 300.0] [SM 4110 B]	Sulfate
DW	[EPA 200.7]	Sodium
DW	[SM 2540 C]	Total dissolved solids (TDS)
DW	[EPA 200.7]	Calcium
DW	[SM 3500-Ca D (18/19th ed)] [SM 3500-Ca B (20th ed)]	Calcium-hardness
DW	[EPA 200.7]	Calcium-hardness
DW	[EPA 200.7] [SM 3120B/3111B or 2340 B]	Total hardness
DW	[SM 2340 C]	Total hardness
DW	[SM 2320 B]	Alkalinity
DW	[EPA 350.1] [SM 4500-NH3 G]	Ammonia
DW	[EPA 300.0]	Bromide
DW	[EPA 300.0] [SM 4110]	Chloride
DW	[EPA 300.0]	Chlorate
DW	[EPA 314.0]	Perchlorate
DW	[EPA 300.0] [EPA 300.1]	Chlorite (monthly)
DW	[SM 2120 B]	Color
DW	[SM 5540 C]	Foaming agents
DW	[SM 2150 B]	Odor
DW	[SM 2510 B]	Conductivity
DW	[SM 4500-P E]	Orthophosphate
DW	[SM 5310 C]	Total organic carbon (TOC)
DW	[SM 5320 B]	Total organic halides (TOX)
DW	[SM 5910B]	UV-absorbing compounds
DW	[SM 4500-Cl G]	Chlorine - residual
DW	[SM 4500-H B] [EPA 150.1]	pH
DW	[EPA 200.7]	Aluminum
DW	[EPA 200.8]	Antimony
DW	[EPA 200.8]	Arsenic
DW	[EPA 200.7]	Barium

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Matrix	Approved Method	Parameter Description
DW	[EPA 200.8]	Barium
DW	[EPA 200.7]	Beryllium
DW	[EPA 200.8]	Beryllium
DW	[EPA 200.7]	Cadmium
DW	[EPA 200.8]	Cadmium
DW	[EPA 200.7]	Chromium
DW	[EPA 200.8]	Chromium
DW	[EPA 200.7]	Copper
DW	[EPA 200.8]	Copper
DW	[EPA 200.7]	Iron
DW	[EPA 200.8]	Lead
DW	[EPA 200.7]	Magnesium
DW	[EPA 200.7]	Manganese
DW	[EPA 200.8]	Manganese
DW	[EPA 245.1]	Mercury
DW	[EPA 200.7]	Nickel
DW	[EPA 200.8]	Nickel
DW	[EPA 200.8]	Selenium
DW	[EPA 200.7]	Silver
DW	[EPA 200.8]	Silver
DW	[EPA 200.8]	Thallium
DW	[EPA 200.7]	Zinc
DW	[EPA 200.8]	Zinc
DW	[EPA 507]	Alachlor
DW	[EPA 507]	Atrazine
DW	[EPA 507]	Simazine
DW	[EPA 507]	Butachlor
DW	[EPA 507]	Metolachlor
DW	[EPA 507]	Metribuzin
DW	[EPA 504.1]	Dibromoethane (1,2-) (EDB)
DW	[EPA 504.1]	Dibromo-3-chloropropane (1,2-)
DW	[EPA 504.1]	Trichloropropane (1,2,3-)
DW	[EPA 515.1]	D (2,4-)
DW	[EPA 515.1]	Dalapon
DW	[EPA 515.1]	Dinoseb
DW	[EPA 515.1]	TP (2,4,5-) (Silvex)
DW	[EPA 515.1]	DB (2,4-)
DW	[EPA 515.1]	Dicamba
DW	[EPA 515.1]	Dichlorprop
DW	[EPA 515.1]	T (2,4,5-)
DW	[EPA 552.2]	Bromochloroacetic acid

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Matrix	Approved Method	Parameter Description
DW	[EPA 552.2]	Dibromoacetic acid
DW	[EPA 552.2]	Dichloroacetic acid
DW	[EPA 552.2]	Monobromoacetic acid (MBAA)
DW	[EPA 552.2]	Monochloroacetic acid (MCAA)
DW	[EPA 552.2]	Trichloroacetic acid
DW	[EPA 508]	Endrin
DW	[EPA 508]	Heptachlor
DW	[EPA 508]	Heptachlor epoxide
DW	[EPA 508]	Hexachlorobenzene
DW	[EPA 508]	Hexachlorocyclopentadiene
DW	[EPA 508]	Lindane (gamma BHC)
DW	[EPA 508]	Methoxychlor
DW	[EPA 508]	Chlordane (technical)
DW	[EPA 508]	Toxaphene
DW	[EPA 508]	Aldrin
DW	[EPA 508]	Alpha BHC
DW	[EPA 508]	Beta BHC
DW	[EPA 508]	Delta BHC
DW	[EPA 508]	DDD (4,4'-)
DW	[EPA 508]	DDE (4,4'-)
DW	[EPA 508]	DDT (4,4'-)
DW	[EPA 508]	Dieldrin
DW	[EPA 508]	Endosulfan I
DW	[EPA 508]	Endosulfan II
DW	[EPA 508]	Endosulfan sulfate
DW	[EPA 508]	Endrin aldehyde
DW	[EPA 508]	Endrin ketone
DW	[EPA 524.2]	Bromoform
DW	[EPA 524.2]	Chloroform
DW	[EPA 524.2]	Dibromochloromethane
DW	[EPA 524.2]	Bromodichloromethane
DW	[EPA 524.2]	Benzene
DW	[EPA 524.2]	Carbon tetrachloride
DW	[EPA 524.2]	Chlorobenzene
DW	[EPA 524.2]	Dichlorobenzene (1,2-)
DW	[EPA 524.2]	Dichlorobenzene (1,3-)
DW	[EPA 524.2]	Dichlorobenzene (1,4-)
DW	[EPA 524.2]	Dichloroethane (1,1-)
DW	[EPA 524.2]	Dichloroethane (1,2-)
DW	[EPA 524.2]	Dichloroethene (cis-1,2-)
DW	[EPA 524.2]	Dichloroethene (trans-1,2-)

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Matrix	Approved Method	Parameter Description
DW	[EPA 524.2]	Methylene chloride (Dichloromethane)
DW	[EPA 524.2]	Dichloropropane (1,2-)
DW	[EPA 524.2]	Ethylbenzene
DW	[EPA 524.2]	Methyl tert-butyl ether
DW	[EPA 524.2]	Naphthalene
DW	[EPA 524.2]	Styrene
DW	[EPA 524.2]	Tetrachloroethane (1,1,2,2-)
DW	[EPA 524.2]	Tetrachloroethene
DW	[EPA 524.2]	Trichloroethane (1,1,1-)
DW	[EPA 524.2]	Trichloroethene
DW	[EPA 524.2]	Toluene
DW	[EPA 524.2]	Trichlorobenzene (1,2,4-)
DW	[EPA 524.2]	Dichloroethene (1,1-)
DW	[EPA 524.2]	Trichloroethane (1,1,2-)
DW	[EPA 524.2]	Vinyl chloride
DW	[EPA 524.2]	Xylenes (total)
DW	[EPA 524.2]	Bromobenzene
DW	[EPA 524.2]	Bromochloromethane
DW	[EPA 524.2]	Bromomethane
DW	[EPA 524.2]	Butyl benzene (n-)
DW	[EPA 524.2]	Sec-butylbenzene
DW	[EPA 524.2]	Tert-butylbenzene
DW	[EPA 524.2]	Chloroethane
DW	[EPA 524.2]	Chloromethane
DW	[EPA 524.2]	Chlorotoluene (2-)
DW	[EPA 524.2]	Chlorotoluene (4-)
DW	[EPA 524.2]	Dibromo-3-chloropropane (1,2-)
DW	[EPA 524.2]	Dibromoethane (1,2-) (EDB)
DW	[EPA 524.2]	Dibromomethane
DW	[EPA 524.2]	Dichlorodifluoromethane
DW	[EPA 524.2]	Dichloropropane (1,3-)
DW	[EPA 524.2]	Dichloropropane (2,2-)
DW	[EPA 524.2]	Dichloropropene (1,1-)
DW	[EPA 524.2]	Dichloropropene (cis-1,3-)
DW	[EPA 524.2]	Dichloropropene (trans-1,3-)
DW	[EPA 524.2]	Hexachlorobutadiene (1,3-)
DW	[EPA 524.2]	Isopropylbenzene
DW	[EPA 524.2]	Isopropyltoluene (4-)
DW	[EPA 524.2]	Propylbenzene (n-)
DW	[EPA 524.2]	Tetrachloroethane (1,1,1,2-)
DW	[EPA 524.2]	Trichlorobenzene (1,2,3-)

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Matrix	Approved Method	Parameter Description
DW	[EPA 524.2]	Trichlorobenzene (1,3,5-)
DW	[EPA 524.2]	Trichlorofluoromethane
DW	[EPA 524.2]	Trichloropropane (1,2,3-)
DW	[EPA 524.2]	Trimethylbenzene (1,2,4-)
DW	[EPA 524.2]	Trimethylbenzene (1,3,5-)
DW	[EPA 524.2]	Acetone
DW	[EPA 524.2]	Butanone (2-)
DW	[EPA 524.2]	Carbon disulfide
DW	[EPA 524.2]	Dichloro-2-butene (trans-1,4-)
DW	[EPA 524.2]	Hexachloroethane
DW	[EPA 524.2]	Hexanone (2-)
DW	[EPA 524.2]	Methyl iodide
DW	[EPA 524.2]	Pentanone (4-methyl-2-)
NPW	[SW-846 3005A]	Metals, Total Rec and Dissolved
NPW	[SW-846 3010A]	Metals, Total
NPW	[SW-846 3020A]	Metals
NPW	[SW-846 3015A] [SW-846 3015]	Metals
NPW	[SW-846 6020A] [SW-846 6020]	Beryllium
NPW	[SW-846 7199]	Chromium (VI)
NPW	[SW-846 3510C]	Semivolatile organics
NPW	[SW-846 3511]	Semivolatile organics
NPW	[SW-846 3520C]	Semivolatile organics
NPW	[USER DEFINED 5030C] [SW-846 5030B]	Volatile organics
NPW	[OTHER J. Chrom. Sci. RSK-175]	Ethane
NPW	[OTHER J. Chrom. Sci. RSK-175]	Ethene
NPW	[OTHER J. Chrom. Sci. RSK-175]	Methane
NPW	[SW-846 9020B]	Total organic halides (TOX)
NPW	[SW-846 9050A]	Specific conductance
NPW	[SW-846 9066]	Phenols
NPW	[USER DEFINED SW-846 8330]	Nitroguanidine
NPW	[USER DEFINED EPA 353.2 Modified]	Nitrocellulose
NPW	[SM 9222 D]	Fecal coliform
NPW	[SM 9222 B]	Total coliform
NPW	[SM 9230 C]	Fecal streptococci
NPW	[SM 9215 B]	Heterotrophic plate count
NPW	[ASTM D1067] [SM 2310 B(4A)]	Acidity as CaCO3
NPW	[SM 2320 B]	Alkalinity as CaCO3
NPW	[EPA 310.2]	Alkalinity as CaCO3
NPW	[EPA 350.1] [SM 4500-NH3 B+G (19/20th ed.)]	Ammonia

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Matrix	Approved Method	Parameter Description
NPW	[SM 5210 B]	Biochemical oxygen demand
NPW	[EPA 200.7]	Boron
NPW	[EPA 300.0]	Bromide
NPW	[EPA 200.7]	Calcium
NPW	[SM 5210 B]	Carbonaceous BOD (CBOD)
NPW	[EPA 410.4] [SM 5220 D]	Chemical oxygen demand
NPW	[EPA 300.0] [SM 4110 B]	Chloride
NPW	[SM 2120 B]	Color
NPW	[SM 4500-CN C, E]	Cyanide
NPW	[OTHER Kelada-01]	Cyanide
NPW	[EPA 335.4]	Cyanide
NPW	[SM 4500-CN C,G]	Cyanide - amenable to Cl2
NPW	[OTHER Kelada-01]	Cyanide - amenable to Cl2
NPW	[EPA 300.0] [SM 4110 B]	Fluoride
NPW	[EPA 130.1]	Hardness - total as CaCO3
NPW	[SM 2340 B or C]	Hardness - total as CaCO3
NPW	[EPA 200.7]	Hardness - total as CaCO3
NPW	[SM 4500-N Org B or C + NH3 B + NH3 C (19/20th ed)]	Kjeldahl nitrogen - total
NPW	[EPA 351.2]	Kjeldahl nitrogen - total
NPW	[EPA 200.7]	Magnesium
NPW	[EPA 300.0] [SM 4110 B]	Nitrate
NPW	[EPA 353.2] [SM 4500-NO3 F]	Nitrate - nitrite
NPW	[EPA 300.0] [SM 4110 B]	Nitrate - nitrite
NPW	[EPA 300.0] [SM 4110 B]	Nitrite
NPW	[SM 5520 B]	Oil & grease - total recov
NPW	[EPA 1664A] [SM 5520 B]	Oil & grease - hem-LL
NPW	[EPA 1664A]	Oil & grease - hem-SPE
NPW	[EPA 1664A]	Oil & grease - sgt-non polar
NPW	[EPA 1664A]	Oil & grease - non polar
NPW	[SM 5310 B, C or D]	Total organic carbon (TOC)
NPW	[SM 5320 B]	Total organic halides (TOX)
NPW	[EPA 351.1,.2, .3,.4 - 350.1 .2 .3] [SM 4500-NH3 B, C, D, E, F, G, H]	Organic nitrogen
NPW	[SM 4500-P, E]	Orthophosphate
NPW	[EPA 420.1 + .4]	Phenols
NPW	[SM 4500-P B5 + E]	Phosphorus (total)
NPW	[EPA 200.7]	Potassium
NPW	[SM 2540 B]	Residue - total
NPW	[SM 2540 C]	Residue - filterable (TDS)
NPW	[SM 2540 D]	Residue - nonfilterable (TSS)
NPW	[SM 2540 F]	Residue - settleable

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Matrix	Approved Method	Parameter Description
NPW	[EPA 160.4]	Residue - volatile
NPW	[EPA 200.7]	Silica - dissolved
NPW	[EPA 200.7]	Sodium
NPW	[EPA 120.1] [SM 2510 B]	Specific conductance
NPW	[EPA 300.0] [SM 4110 B]	Sulfate
NPW	[SM 4500-S D]	Sulfides
NPW	[SM 5540 C]	Surfactants
NPW	[EPA 180.1] [SM 2130 B]	Turbidity
NPW	[SM 4500-Cl G]	Chlorine
NPW	[SM 4500-Cl G]	Chlorine
NPW	[SM 4500-O C]	Oxygen (dissolved)
NPW	[SM 4500-O G]	Oxygen (dissolved)
NPW	[SM 4500-H B]	pH
NPW	[SM 4500-SO3 B]	Sulfite - SO3
NPW	[SM 2550 B]	Temperature
NPW	[EPA 200.7]	Aluminum
NPW	[EPA 200.7]	Antimony
NPW	[EPA 200.8]	Antimony
NPW	[EPA 200.7]	Arsenic
NPW	[EPA 200.8]	Arsenic
NPW	[EPA 200.7]	Barium
NPW	[EPA 200.8]	Barium
NPW	[EPA 200.7]	Beryllium
NPW	[EPA 200.8]	Beryllium
NPW	[EPA 200.7]	Cadmium
NPW	[EPA 200.8]	Cadmium
NPW	[SM 3500-Cr D (18/19th ed)] [SM 3500-Cr B (20th ed)]	Chromium (VI)
NPW	[EPA 218.6] [SM 3500-Cr C (20th ed)]	Chromium (VI)
NPW	[EPA 200.7]	Chromium
NPW	[EPA 200.8]	Chromium
NPW	[EPA 200.7]	Cobalt
NPW	[EPA 200.7]	Copper
NPW	[EPA 200.8]	Copper
NPW	[EPA 200.7]	Iron
NPW	[SM 3500 Fe B (SM 20)]	Iron
NPW	[SM 3500-Fe B (20th ed)]	Iron, Ferrous
NPW	[EPA 200.7]	Lead
NPW	[EPA 200.8]	Lead
NPW	[EPA 200.7]	Manganese
NPW	[EPA 200.8]	Manganese
NPW	[EPA 245.1]	Mercury

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Matrix	Approved Method	Parameter Description
NPW	[EPA 1631E]	Mercury
NPW	[EPA 200.7]	Molybdenum
NPW	[EPA 200.8]	Molybdenum
NPW	[EPA 200.7]	Nickel
NPW	[EPA 200.8]	Nickel
NPW	[EPA 200.7]	Selenium
NPW	[EPA 200.8]	Selenium
NPW	[EPA 200.7]	Silver
NPW	[EPA 200.8]	Silver
NPW	[EPA 200.7]	Thallium
NPW	[EPA 200.8]	Thallium
NPW	[EPA 200.7]	Tin
NPW	[EPA 200.8]	Tin
NPW	[EPA 200.7]	Titanium
NPW	[EPA 200.7]	Vanadium
NPW	[EPA 200.8]	Vanadium
NPW	[EPA 200.7]	Zinc
NPW	[EPA 200.8]	Zinc
NPW	[EPA 602] [USER DEFINED SM 6200C 20th ED]	Benzene
NPW	[EPA 602] [USER DEFINED SM 6200C 20th ED]	Ethylbenzene
NPW	[EPA 602] [USER DEFINED SM 6200C 20th ED]	Methyl tert-butyl ether
NPW	[EPA 602] [USER DEFINED SM 6200C 20th ED]	Tert-butyl alcohol
NPW	[EPA 602] [USER DEFINED SM 6200C 20th ED]	Toluene
NPW	[EPA 602] [USER DEFINED SM 6200C 20th ED]	Xylenes (total)
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	Aldrin
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	Alpha BHC
NPW	[EPA 608] [SM 6630 C]	Beta BHC
NPW	[EPA 608] [SM 6630 C]	Delta BHC
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	Lindane (gamma BHC)
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	Chlordane
NPW	[EPA 608] [USER DEFINED SM 6630C]	Chlordane (alpha)
NPW	[EPA 608] [USER DEFINED SM 6630C]	Chlordane (gamma)
NPW	[EPA 608]	Chloroneb
NPW	[EPA 608]	Chlorothalonil

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Matrix	Approved Method	Parameter Description
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	DDD (4,4'-)
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	DDE (4,4'-)
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	DDT (4,4'-)
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	Dieldrin
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	Endosulfan I
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	Endosulfan II
NPW	[EPA 608] [SM 6630 C]	Endosulfan sulfate
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	Endrin
NPW	[EPA 608] [USER DEFINED SM 6630C]	Endrin aldehyde
NPW	[EPA 608] [USER DEFINED SM 6630C]	Endrin ketone
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	Heptachlor
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	Heptachlor epoxide
NPW	[EPA 608] [USER DEFINED SM 6630C]	Hexachlorobenzene
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	Methoxychlor
NPW	[EPA 608] [SM 6630 B] [SM 6630 C]	Toxaphene
NPW	[EPA 608]	PCB 1016
NPW	[EPA 608]	PCB 1221
NPW	[EPA 608]	PCB 1232
NPW	[EPA 608]	PCB 1242
NPW	[EPA 608]	PCB 1248
NPW	[EPA 608]	PCB 1254
NPW	[EPA 608]	PCB 1260
NPW	[EPA 610] [SM 6440 B]	Acenaphthene
NPW	[EPA 610] [SM 6440 B]	Acenaphthylene
NPW	[EPA 610] [SM 6440 B]	Anthracene
NPW	[EPA 610] [SM 6440 B]	Benzo(a)anthracene
NPW	[EPA 610] [SM 6440 B]	Benzo(a)pyrene
NPW	[EPA 610] [SM 6440 B]	Benzo(b)fluoranthene
NPW	[EPA 610] [SM 6440 B]	Benzo(ghi)perylene
NPW	[EPA 610] [SM 6440 B]	Benzo(k)fluoranthene
NPW	[EPA 610] [SM 6440 B]	Chrysene
NPW	[EPA 610] [SM 6440 B]	Dibenzo(a,h)anthracene
NPW	[EPA 610] [SM 6440 B]	Fluoranthene
NPW	[EPA 610] [SM 6440 B]	Fluorene
NPW	[EPA 610] [SM 6440 B]	Indeno(1,2,3-cd)pyrene
NPW	[EPA 610] [SM 6440 B]	Naphthalene
NPW	[EPA 610] [SM 6440 B]	Phenanthrene
NPW	[EPA 610] [SM 6440 B]	Pyrene
NPW	[EPA 624] [SM 6200 B]	Allyl chloride

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Matrix	Approved Method	Parameter Description
NPW	[EPA 624]	Amyl alcohol (n-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Acetone
NPW	[EPA 624] [SM 6200 B]	Acrolein
NPW	[EPA 624] [SM 6200 B]	Acrylonitrile
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Benzene
NPW	[EPA 624] [SM 6200 B]	Bromobenzene
NPW	[EPA 624] [SM 6200 B]	Bromochloromethane
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Bromodichloromethane
NPW	[EPA 624] [SM 6200 B]	Bromoethane
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Bromoform
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Bromomethane
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Butanone (2-)
NPW	[EPA 624] [SM 6200 B]	Butadiene (2-chloro-1,3-)
NPW	[EPA 624] [SM 6200 B]	Butyl benzene (n-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Carbon disulfide
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Carbon tetrachloride
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Chlorobenzene
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Chloroethane
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Chloroethyl vinyl ether (2-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Chloroform
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Chloromethane
NPW	[EPA 624] [SM 6200 B]	Chlorotoluene (2-)
NPW	[EPA 624] [SM 6200 B]	Chlorotoluene (4-)
NPW	[EPA 624] [SM 6200 B]	Cyclohexanone
NPW	[EPA 624] [SM 6200 B]	Dibromo-3-chloropropane (1,2-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dibromochloromethane
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dibromoethane (1,2-) (EDB)
NPW	[EPA 624] [SM 6200 B]	Dibromomethane

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Matrix	Approved Method	Parameter Description
NPW	[EPA 624] [SM 6200 B]	Dichloro-2-butene (cis-1,4-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dichlorobenzene (1,2-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dichlorobenzene (1,3-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dichlorobenzene (1,4-)
NPW	[EPA 624] [SM 6200 B]	Dichloro-2-butene (trans-1,4-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dichlorodifluoromethane
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dichloroethane (1,1-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dichloroethane (1,2-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dichloroethene (1,1-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dichloroethene (cis-1,2-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dichloroethene (trans-1,2-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dichloropropane (1,2-)
NPW	[EPA 624] [SM 6200 B]	Dichloropropane (1,3-)
NPW	[EPA 624] [SM 6200 B]	Dichloropropane (2,2-)
NPW	[EPA 624] [SM 6200 B]	Dichloropropene (1,1-)
NPW	[EPA 624] [SM 6200 B]	Diethyl ether (Ethyl ether)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dichloropropene (cis-1,3-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Dichloropropene (trans-1,3-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Ethyl acetate
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Ethylbenzene
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Hexane (n-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Isopropanol
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Methylene chloride (Dichloromethane)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Methyl tert-butyl ether
NPW	[EPA 624] [USER DEFINED SM 6200	Methyl isobutyl ketone

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Matrix	Approved Method	Parameter Description
	B]	
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Tert-butyl alcohol
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Tetrahydrofuran
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Styrene
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Tetrachloroethane (1,1,2,2-)
NPW	[EPA 624] [SM 6200 B]	Tetrachloroethane (1,1,1,2-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Tetrachloroethene
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Toluene
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Trichloroethane (1,1,1-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Trichloroethane (1,1,2-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Trichloroethene
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Trichlorofluoromethane
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Trichloro (1,1,2-) trifluoroethane (1,2,2-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Vinyl acetate
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Vinyl chloride
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Xylenes (total)
NPW	[EPA 624] [SM 6200 B]	Xylene (m-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Xylene (o-)
NPW	[EPA 624] [SM 6200 B]	Xylene (p-)
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Acetonitrile
NPW	[EPA 624]	Cyclohexane
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Hexanone (2-)
NPW	[EPA 624]	Methyl acetate
NPW	[EPA 624]	Methylcyclohexane
NPW	[EPA 624] [USER DEFINED SM 6200 B]	Methyl iodide

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Matrix	Approved Method	Parameter Description
NPW	[EPA 624] [SM 6200 B]	Ethyl-tert-butyl Ether [ETBE]
NPW	[EPA 624] [SM 6200 B]	Diisopropyl Ether [DIPE]
NPW	[EPA 624] [SM 6200 B]	Dioxane (1,4-)
NPW	[EPA 624]	Butanol (1-)
NPW	[EPA 624] [SM 6200 B]	Ethanol
NPW	[EPA 624] [SM 6200 B]	Ethyl methacrylate
NPW	[EPA 624] [SM 6200 B]	Hexachlorobutadiene (1,3-)
NPW	[EPA 624] [SM 6200 B]	Iso-butyl alcohol
NPW	[EPA 624] [SM 6200 B]	Isopropylbenzene
NPW	[EPA 624] [SM 6200 B]	Isopropyltoluene (4-)
NPW	[EPA 624] [SM 6200 B]	Methacrylonitrile
NPW	[EPA 624] [SM 6200 B]	Methyl methacrylate
NPW	[EPA 624] [SM 6200 B]	Naphthalene
NPW	[EPA 624]	Octane (-n)
NPW	[EPA 624]	Nitropropane (2-)
NPW	[EPA 624] [SM 6200 B]	Propionitrile
NPW	[EPA 624] [SM 6200 B]	Pentachloroethane
NPW	[EPA 624] [SM 6200 B]	Propylbenzene (n-)
NPW	[EPA 624] [SM 6200 B]	Sec-butylbenzene
NPW	[EPA 624] [SM 6200 B]	tert-Amylmethyl ether [TAME]
NPW	[EPA 624] [SM 6200 B]	Tert-butylbenzene
NPW	[EPA 624] [SM 6200 B]	Trichlorobenzene (1,2,3-)
NPW	[EPA 624] [SM 6200 B]	Trichlorobenzene (1,2,4-)
NPW	[EPA 624] [SM 6200 B]	Trichloropropane (1,2,3-)
NPW	[EPA 624] [SM 6200 B]	Trimethylbenzene (1,2,3-)
NPW	[EPA 624] [SM 6200 B]	Trimethylbenzene (1,2,4-)
NPW	[EPA 624] [SM 6200 B]	Trimethylbenzene (1,3,5-)
NPW	[EPA 625] [SM 6410 B]	Acenaphthene
NPW	[EPA 625] [SM 6410 B]	Acenaphthylene
NPW	[EPA 625] [SM 6410 B]	Anthracene
NPW	[EPA 625] [SM 6410 B]	Benzo(a)anthracene
NPW	[EPA 625] [SM 6410 B]	Benzo(b)fluoranthene
NPW	[EPA 625] [SM 6410 B]	Benzo(k)fluoranthene
NPW	[EPA 625] [SM 6410 B]	Benzo(a)pyrene
NPW	[EPA 625] [SM 6410 B]	Benzo(ghi)perylene
NPW	[EPA 625] [SM 6410 B]	Butyl benzyl phthalate
NPW	[EPA 625] [SM 6410 B]	Bis (2-chloroethyl) ether
NPW	[EPA 625] [SM 6410 B]	Bis (2-chloroethoxy) methane
NPW	[EPA 625] [SM 6410 B]	Bis (2-ethylhexyl) phthalate
NPW	[EPA 625] [SM 6410 B]	Bis (2-chloroisopropyl) ether
NPW	[EPA 625] [SM 6410 B]	Bromophenyl-phenyl ether (4-)

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Matrix	Approved Method	Parameter Description
NPW	[EPA 625] [SM 6410 B]	Biphenylamine (4-)
NPW	[EPA 625] [SM 6410 B]	Chloronaphthalene (2-)
NPW	[EPA 625] [SM 6410 B]	Chlorophenyl-phenyl ether (4-)
NPW	[EPA 625] [SM 6410 B]	Chrysene
NPW	[EPA 625] [SM 6410 B]	Chloronaphthalene (1-)
NPW	[EPA 625] [SM 6410 B]	Dibenzo(a,h)anthracene
NPW	[EPA 625]	Dibenzofuran
NPW	[EPA 625] [SM 6410 B]	Di-n-butyl phthalate
NPW	[EPA 625] [SM 6410 B]	Dichlorobenzidine (3,3'-)
NPW	[EPA 625] [SM 6410 B]	Diethyl phthalate
NPW	[EPA 625] [SM 6410 B]	Dimethyl phthalate
NPW	[EPA 625] [SM 6410 B]	Dinitrotoluene (2,4-)
NPW	[EPA 625] [SM 6410 B]	Dinitrotoluene (2,6-)
NPW	[EPA 625] [SM 6410 B]	Di-n-octyl phthalate
NPW	[EPA 625] [SM 6410 B]	Famphur
NPW	[EPA 625] [SM 6410 B]	Fluoranthene
NPW	[EPA 625] [SM 6410 B]	Fluorene
NPW	[EPA 625] [SM 6410 B]	Hexachlorobenzene
NPW	[EPA 625] [SM 6410 B]	Hexachlorobutadiene (1,3-)
NPW	[EPA 625] [SM 6410 B]	Hexachloroethane
NPW	[EPA 625] [SM 6410 B]	Hexachlorophene
NPW	[EPA 625] [SM 6410 B]	Hexachloropropene
NPW	[EPA 625] [SM 6410 B]	Indeno(1,2,3-cd)pyrene
NPW	[EPA 625] [SM 6410B]	Isophorone
NPW	[EPA 625] [SM 6410 B]	Kepone
NPW	[EPA 625]	Methylnaphthalene (2-)
NPW	[EPA 625] [SM 6410 B]	Naphthalene
NPW	[EPA 625] [SM 6410 B]	Napththylamine (1-)
NPW	[EPA 625] [SM 6410 B]	Napththylamine (2-)
NPW	[EPA 625]	Chloroaniline (4-)
NPW	[EPA 625]	Nitroaniline (2-)
NPW	[EPA 625]	Nitroaniline (3-)
NPW	[EPA 625]	Nitroaniline (4-)
NPW	[EPA 625] [SM 6410 B]	Nitrobenzene
NPW	[EPA 625] [SM 6410 B]	N-Nitroso-di-n-propylamine
NPW	[EPA 625] [SM 6410 B]	Phenanthrene
NPW	[EPA 625] [SM 6410 B]	Pyrene
NPW	[EPA 625]	Pentachlorobenzene
NPW	[EPA 625]	Tetrachlorobenzene (1,2,4,5-)
NPW	[EPA 625] [SM 6410 B]	Trichlorobenzene (1,2,4-)
NPW	[EPA 625] [SM 6410 B]	Methyl phenol (4-chloro-3-)

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Matrix	Approved Method	Parameter Description
NPW	[EPA 625] [SM 6410 B]	Chlorophenol (2-)
NPW	[EPA 625] [SM 6410 B]	Dichlorophenol (2,4-)
NPW	[EPA 625] [SM 6410 B]	Dimethylphenol (2,4-)
NPW	[EPA 625] [SM 6410 B]	Dinitrophenol (2,4-)
NPW	[EPA 625] [SM 6410 B]	Dinitrophenol (2-methyl-4,6-)
NPW	[EPA 625] [SM 6410 B]	Nitrophenol (2-)
NPW	[EPA 625] [SM 6410 B]	Nitrophenol (4-)
NPW	[EPA 625] [SM 6410 B]	Pentachlorophenol
NPW	[EPA 625] [SM 6410 B]	Phenol
NPW	[EPA 625]	Trichlorophenol (2,4,5-)
NPW	[EPA 625] [SM 6410 B]	Trichlorophenol (2,4,6-)
NPW	[EPA 625] [SM 6410 B]	Benzoic acid
NPW	[SM 6410 B] [EPA 625]	Methylphenol (4-)
NPW	[EPA 625] [SM 6410 B]	Acetophenone
NPW	[EPA 625] [SM 6410 B]	Alpha - terpineol
NPW	[EPA 625] [SM 6410 B]	Aniline
NPW	[EPA 625] [SM 6410 B]	Benzidine
NPW	[EPA 625] [SM 6410 B]	Carbazole
NPW	[EPA 625] [SM 6410 B]	Dichloroaniline (2,3-)
NPW	[EPA 625]	Diphenylhydrazine (1,2-)
NPW	[EPA 625] [SM 6410 B]	Methylphenol (2-)
NPW	[EPA 625] [SM 6410 B]	Decane (n-)
NPW	[EPA 625] [SM 6410 B]	Hexachlorocyclopentadiene
NPW	[EPA 625]	N-Nitroso-di-n-butylamine
NPW	[EPA 625]	N-Nitrosodiethylamine
NPW	[EPA 625] [SM 6410 B]	N-Nitrosodimethylamine
NPW	[EPA 625] [SM 6410 B]	N-Nitrosodiphenylamine
NPW	[EPA 625]	N-Nitrosopyrrolidine
NPW	[EPA 625] [SM 6410 B]	Octadecane (n-)
NPW	[EPA 625] [SM 6410 B]	Pentachloroethane
NPW	[EPA 625] [SM 6410 B]	Pyridine
NPW	[EPA 625] [SM 6410 B]	Napthoquinone (1,4-)
NPW	[EPA 507]	Alachlor
NPW	[USER DEFINED EPA 1657]	Azinphos methyl
NPW	[EPA 1657 or 622]	Bolstar
NPW	[EPA 1657, 508, or 622]	Chloropyrifos
NPW	[EPA 622] [EPA 1657]	Coumaphos
NPW	[SM 6640 B]	D (2,4-)
NPW	[EPA 515.5, 515.2, 615, 1658 or 555]	DB (2,4-)
NPW	[SM 6640B]	Dalapon
NPW	[EPA 1658]	Dalapon

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Matrix	Approved Method	Parameter Description
NPW	[EPA 622] [USER DEFINED EPA 1657]	Demeton (o-)
NPW	[EPA 622] [USER DEFINED EPA 1657]	Demeton (s-)
NPW	[USER DEFINED EPA 1657]	Diazinon
NPW	[EPA 615] [USER DEFINED SM 6640B 18/19th ED]	Dicamba
NPW	[EPA 1658]	Dichlorprop
NPW	[EPA 1657, 507, or 622]	Dichlorvos
NPW	[EPA 622] [EPA 1657]	Dimethoate
NPW	[EPA 515.5, 515.2, 1658, or 615] [USER DEFINED SM 6640B]	Dinoseb
NPW	[USER DEFINED EPA 1657]	Disulfoton
NPW	[EPA 1657]	EPN
NPW	[EPA 507, 1657 or 622]	Ethoprop
NPW	[SM 6630 C]	Etridiazole
NPW	[EPA 1657 or 622]	Fensulfothion
NPW	[EPA 1657 or 622]	Fenthion
NPW	[USER DEFINED EPA 1657]	Malathion
NPW	[EPA 555, 1658, or 615]	MCPA
NPW	[EPA 555, 1658, or 615]	MCPP
NPW	[EPA 507, 1657, or 622]	Merphos
NPW	[EPA 507]	Metribuzin
NPW	[EPA 507, 1657, or 622]	Mevinphos
NPW	[EPA 1657 or 632]	Naled
NPW	[EPA 1657 or 614] [EPA 622]	Parathion
NPW	[EPA 622] [USER DEFINED EPA 1657]	Parathion methyl
NPW	[EPA 1657 or 622]	Phorate
NPW	[EPA 1657]	Ronnel
NPW	[EPA 622] [EPA 1657]	Stirofos
NPW	[EPA 622] [EPA 1657]	Sulfotepp
NPW	[SM 6640 B]	T (2,4,5-)
NPW	[EPA 622] [EPA 1657]	TEPP
NPW	[SM 6640 B]	TP (2,4,5-) (Silvex)
NPW	[EPA 622] [EPA 1657]	Tokuthion [Protothiofos]
NPW	[EPA 1657]	Trichloronate
NPW	[SM 6630 B]	Trifluralin
NPW	[EPA 2002.0]	Toxicity - acute, FW organism
NPW	[EPA 2000.0]	Toxicity - acute, FW organism
NPW	[EPA 1000.0]	Toxicity - chronic, FW organism
NPW	[EPA 1002.0]	Toxicity - chronic, FW organism

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Matrix	Approved Method	Parameter Description
NPW, SCM	[SM 9222D + EPA 625/R-92/013 Appendix F]	Fecal coliform
NPW, SCM	[SM 9260D + EPA 625/R-92/013 Appendix F]	Salmonella sp. Bacteria
NPW, SCM	[SW-846 1010A] [SW-846 1010] [USER DEFINED ASTM D93]	Ignitability
NPW, SCM	[SW-846 9040B] [SW-846 9040C]	Corrosivity - pH waste, >20% water
NPW, SCM	[SW-846 1110] [SW-846 1110A]	Corrosivity toward steel
NPW, SCM	[SW-846 1311]	Volatile organics
NPW, SCM	[SW-846 1311]	Semivolatile organics
NPW, SCM	[SW-846 1311]	Metals
NPW, SCM	[SW-846 1310B] [SW-846 1310A]	Metals - organics
NPW, SCM	[SW-846 1312]	Metals - organics
NPW, SCM	[SW-846 1320]	Metals - organics
NPW, SCM	[SW-846 9040B] [SW-846 9040C]	pH
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Aluminum
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Antimony
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Antimony
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Arsenic
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Arsenic
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Barium
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Barium
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Beryllium
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Boron
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Cadmium
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Cadmium
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Calcium
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Chromium
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Chromium
NPW, SCM	[SW-846 7196A]	Chromium (VI)
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Cobalt
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Copper
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Copper
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Iron
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Lead
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Lead
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Lithium
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Magnesium
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Manganese
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Manganese
NPW, SCM	[SW-846 7470A]	Mercury - liquid waste
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Molybdenum

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Matrix	Approved Method	Parameter Description
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Molybdenum
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Nickel
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Nickel
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Potassium
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Selenium
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Selenium
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Silver
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Silver
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Sodium
NPW, SCM	[SW-846 6010B] [SW-846 6010C]	Strontium
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Thallium
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Thallium
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Tin
NPW, SCM	[SW-846 6020] [SW-846 6020A]	Tin
NPW, SCM	[SW-846 6010B] [SW-846 6010C]	Titanium
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Vanadium
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Vanadium
NPW, SCM	[SW-846 6010C] [SW-846 6010B]	Zinc
NPW, SCM	[SW-846 6020A] [SW-846 6020]	Zinc
NPW, SCM	[SW-846 8011]	Dibromoethane (1,2-) (EDB)
NPW, SCM	[SW-846 8011]	Dibromo-3-chloropropane (1,2-)
NPW, SCM	[SW-846 8015D] [SW-846 8015B]	Methyl alcohol (Methanol)
NPW, SCM	[SW-846 8015D] [SW-846 8015B]	Ethyl alcohol
NPW, SCM	[USER DEFINED MA-DEP-VPH, WI GRO, NW TPH Gx] [SW-846 8015D] [SW-846 8015B]	Gasoline range organic
NPW, SCM	[USER DEFINED MA-DEP-EPH, TN-EPH, WI DRO, NW TPH Dx] [SW-846 8015D] [SW-846 8015B]	Diesel range organic
NPW, SCM	[OTHER FL - PRO] [USER DEFINED TX 1005, TX 1006, CT ETPH, NW TPH ID]	Petroleum Organics
NPW, SCM	[OTHER IA - OA-1]	Petroleum Organics
NPW, SCM	[OTHER IA - OA-2]	Petroleum Organics
NPW, SCM	[USER DEFINED CA LUFT - diesel]	Petroleum Organics
NPW, SCM	[OTHER NJ-OQA-QAM-025, Rev. 7]	Petroleum Organics
NPW, SCM	[SW-846 8021B]	Benzene
NPW, SCM	[SW-846 8021B]	Ethylbenzene
NPW, SCM	[SW-846 8021B]	Toluene
NPW, SCM	[SW-846 8021B]	Xylene (o-)
NPW, SCM	[SW-846 8021B]	Xylene (m-)
NPW, SCM	[SW-846 8021B]	Xylene (p-)

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Matrix	Approved Method	Parameter Description
NPW, SCM	[SW-846 8021B]	Xylenes (total)
NPW, SCM	[SW-846 8021B]	Methyl tert-butyl ether
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Alachlor
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Aldrin
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Alpha BHC
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Beta BHC
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Delta BHC
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Lindane (gamma BHC)
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Chlordane (technical)
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Chlordane (alpha)
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Chlordane (gamma)
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Chloroneb
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Chlorothalonil
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	DDD (4,4'-)
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	DDE (4,4'-)
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	DDT (4,4'-)
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Dieldrin
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Endosulfan I
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Endosulfan II
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Endosulfan sulfate
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Endrin
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Endrin aldehyde
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Endrin ketone
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Etridiazole
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Heptachlor
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Heptachlor epoxide
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Hexachlorobenzene
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Hexachlorocyclopentadiene
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Methoxychlor
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Permethrin
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Propachlor
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Toxaphene
NPW, SCM	[SW-846 8081B] [SW-846 8081A]	Trifluralin
NPW, SCM	[SW-846 8082A] [SW-846 8082]	PCB 1016
NPW, SCM	[SW-846 8082A] [SW-846 8082]	PCB 1221
NPW, SCM	[SW-846 8082A] [SW-846 8082]	PCB 1232
NPW, SCM	[SW-846 8082A] [SW-846 8082]	PCB 1242
NPW, SCM	[SW-846 8082A] [SW-846 8082]	PCB 1248
NPW, SCM	[SW-846 8082A] [SW-846 8082]	PCB 1254
NPW, SCM	[SW-846 8082A] [SW-846 8082]	PCB 1260
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Azinphos methyl

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Matrix	Approved Method	Parameter Description
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Bolstar
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Chloropyrifos
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Coumaphos
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Demeton (o-)
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Demeton (s-)
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Diazinon
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Dichlorvos
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Dimethoate
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Disulfoton
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	EPN
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Ethoprop
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Fensulfothion
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Fenthion
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Malathion
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Merphos
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Mevinphos
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Naled
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Parathion
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Parathion methyl
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Phorate
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Ronnel
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Stirofos
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Sulfotepp
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	TEPP
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Tokuthion [Protothiofos]
NPW, SCM	[SW-846 8141B] [SW-846 8141A]	Trichloronate
NPW, SCM	[SW-846 8151A]	Dalapon
NPW, SCM	[SW-846 8151A]	Dicamba
NPW, SCM	[SW-846 8151A]	Dichlorprop
NPW, SCM	[SW-846 8151A]	Dinoseb
NPW, SCM	[SW-846 8151A]	D (2,4-)
NPW, SCM	[SW-846 8151A]	DB (2,4-)
NPW, SCM	[SW-846 8151A]	T (2,4,5-)
NPW, SCM	[SW-846 8151A]	TP (2,4,5-) (Silvex)
NPW, SCM	[SW-846 8151A]	MCPA
NPW, SCM	[SW-846 8151A]	MCPP
NPW, SCM	[SW-846 8310]	Acenaphthene
NPW, SCM	[SW-846 8310]	Acenaphthylene
NPW, SCM	[SW-846 8310]	Anthracene
NPW, SCM	[SW-846 8310]	Benzo(a)anthracene
NPW, SCM	[SW-846 8310]	Benzo(a)pyrene

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Matrix	Approved Method	Parameter Description
NPW, SCM	[SW-846 8310]	Benzo(b)fluoranthene
NPW, SCM	[SW-846 8310]	Benzo(ghi)perylene
NPW, SCM	[SW-846 8310]	Benzo(k)fluoranthene
NPW, SCM	[SW-846 8310]	Chrysene
NPW, SCM	[SW-846 8310]	Dibenzo(a,h)anthracene
NPW, SCM	[SW-846 8310]	Fluoranthene
NPW, SCM	[SW-846 8310]	Fluorene
NPW, SCM	[SW-846 8310]	Indeno(1,2,3-cd)pyrene
NPW, SCM	[SW-846 8310]	Naphthalene
NPW, SCM	[SW-846 8310]	Phenanthrene
NPW, SCM	[SW-846 8310]	Pyrene
NPW, SCM	[SW-846 8330A] [SW-846 8330]	HMX
NPW, SCM	[SW-846 8330A] [SW-846 8330]	RDX
NPW, SCM	[SW-846 8330A] [SW-846 8330]	Trinitrobenzene (1,3,5-)
NPW, SCM	[SW-846 8330A] [SW-846 8330]	Dinitrobenzene (1,3-)
NPW, SCM	[SW-846 8330A] [SW-846 8330]	PETN
NPW, SCM	[SW-846 8330A] [SW-846 8330]	Tetryl
NPW, SCM	[SW-846 8330A] [SW-846 8330]	Nitrobenzene
NPW, SCM	[SW-846 8330A] [SW-846 8330]	Trinitrotoluene (2,4,6-)
NPW, SCM	[SW-846 8330A] [SW-846 8330]	Dinitrotoluene (4-amino-2,6-)
NPW, SCM	[SW-846 8330A] [SW-846 8330]	Dinitrotoluene (2-amino-4,6-)
NPW, SCM	[SW-846 8330A] [SW-846 8330]	Dinitrotoluene (2,4-)
NPW, SCM	[SW-846 8330A] [SW-846 8330]	Dinitrotoluene (2,6-)
NPW, SCM	[SW-846 8330A] [SW-846 8330]	Nitrotoluene (2-)
NPW, SCM	[SW-846 8330A] [SW-846 8330]	Nitrotoluene (3-)
NPW, SCM	[SW-846 8330A] [SW-846 8330]	Nitrotoluene (4-)
NPW, SCM	[SW-846 8330] [SW-846 8330A]	Nitroglycerine
NPW, SCM	[SW-846 8260C] [SW-846 8260B] [USER DEFINED LUFT]	Benzene
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Bromobenzene
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Butyl benzene (n-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Sec-butylbenzene
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Tert-butylbenzene
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Chlorobenzene
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Chlorotoluene (2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Chlorotoluene (4-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichlorobenzene (1,2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichlorobenzene (1,3-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichlorobenzene (1,4-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B] [USER DEFINED LUFT]	Ethylbenzene
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Isopropylbenzene

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Matrix	Approved Method	Parameter Description
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Propylbenzene (n-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B] [USER DEFINED LUFT]	Toluene
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Isopropyltoluene (4-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Trichlorobenzene (1,2,3-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Trimethylbenzene (1,2,4-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Trimethylbenzene (1,3,5-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Trimethylbenzene (1,2,3-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B] [USER DEFINED LUFT]	Xylenes (total)
NPW, SCM	[SW-846 8260C] [SW-846 8260B] [USER DEFINED LUFT]	Xylene (m-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B] [USER DEFINED LUFT]	Xylene (o-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B] [USER DEFINED LUFT]	Xylene (p-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	tert-Amylmethyl ether [TAME]
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Allyl chloride
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Bromochloromethane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Bromodichloromethane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Bromoethane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Bromoform
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Bromomethane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Cyclohexane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Cyclohexanone
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Butadiene (2-chloro-1,3-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloro-2-butene (cis-1,4-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Carbon tetrachloride
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Chloroethane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Chloroethyl vinyl ether (2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Chloroform
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Chloromethane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Diethyl ether (Ethyl ether)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloropropene (trans-1,3-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dibromochloromethane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dibromoethane (1,2-) (EDB)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dibromomethane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dibromo-3-chloropropane (1,2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichlorodifluoromethane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloroethane (1,1-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloroethane (1,2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloroethene (1,1-)

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Matrix	Approved Method	Parameter Description
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloroethene (trans-1,2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloroethene (cis-1,2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloropropane (1,2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloropropane (1,3-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloropropane (2,2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloropropene (1,1-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloropropene (cis-1,3-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dichloro-2-butene (trans-1,4-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Diisopropyl Ether [DIPE]
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Butanol (1-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Ethanol
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Methylene chloride (Dichloromethane)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Nitropropane (2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Tetrachloroethane (1,1,2,2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Tetrachloroethene
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Tetrahydrofuran
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Trichloroethane (1,1,1-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Trichloroethane (1,1,2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Trichloroethene
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Trichlorofluoromethane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Trichloro (1,1,2-) trifluoroethane (1,2,2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Trichloropropane (1,2,3-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Vinyl acetate
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Vinyl chloride
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Acetone
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Carbon disulfide
NPW, SCM	[USER DEFINED SW846 8260B]	Butanol (3,3-Dimethyl-1-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Butanone (2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Butyl formate (t-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Ethyl-tert-butyl Ether [ETBE]
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Ethyl acetate
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Ethyl methacrylate
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Hexanone (2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Methacrylonitrile
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Methyl acrylate
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Methyl methacrylate
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Methyl acetate
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Methyl iodide
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Iso-butyl alcohol
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Isopropanol
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	N-Nitroso-di-n-butylamine

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Matrix	Approved Method	Parameter Description
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Pentachloroethane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Pentanone (4-methyl-2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Pentanol (2-Methyl-2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Propionitrile
NPW, SCM	[SW-846 8260C] [SW-846 8260B] [USER DEFINED LUFT]	Methyl tert-butyl ether
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Amyl alcohol (t-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Tert-butyl alcohol
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Acetonitrile
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Acrolein
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Acrylonitrile
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Hexachlorobutadiene (1,3-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Hexachloroethane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Methylcyclohexane
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Naphthalene
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Octane (-n)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Styrene
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Tetrachloroethane (1,1,1,2-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Trichlorobenzene (1,2,4-)
NPW, SCM	[SW-846 8260B]	Trimethylpentane (2,2,4-)
NPW, SCM	[SW-846 8260C] [SW-846 8260B]	Dioxane (1,4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Acetophenone
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Acetylaminofluorene (2-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Aminobiphenyl (4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Aramite
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzal chloride
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzo(j)fluoranthene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzotrichloride
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzyl chloride
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Chlorobenzilate
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Chloronaphthalene (1-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Diallate (cis)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Diallate (trans)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dibenzo(a,e)pyrene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dibenz(a,h)acridine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dibenzo(a,h)pyrene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dibenz(a,j)acridine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dibenzo(a,i)pyrene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dibenzo(c,g)carbazole (7H-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dichlorophenol (2,6-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dimethoate
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dimethylaminoazobenzene

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Matrix	Approved Method	Parameter Description
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dimethylbenz(a)anthracene (7,12-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dimethyl benzidine (3,3-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dinitrobenzene (1,3-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dinoseb
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Disulfoton
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Famphur
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Hexachlorophene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Isodrin
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Isosafrole (cis-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Isosafrole (trans-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Kepone
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Methanesulfonate (Ethyl-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Methanesulfonate (Methyl-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Methapyrilene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Methylcholanthrene (3-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Napthoquinone (1,4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Napththylamine (1-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Napththylamine (2-)
NPW, SCM	[SW-846 8270C]	Nitrodiphenylamine (2-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	N-Nitroso-di-n-butylamine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	N-Nitrosomorpholine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	N-Nitrosopiperidine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Parathion
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Parathion methyl
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Pentachlorobenzene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Pentachloroethane
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Pentachloronitrobenzene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Phenacetin
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Phenylenediamine (1,4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Phenylethylamine (alpha, alpha-Dimethyl)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Phorate
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Phosphorothioate (O,O,O-triethyl)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Phosphorothioate (O,O-diethyl-O-2-pyrazinyl) [Thionazin]
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Picoline (2-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Pronamide
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Quinoline -1-Oxide (4-Nitro)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Safrole
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Sulfotepp
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Tetrachlorobenzene (1,2,3,4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Tetrachlorobenzene (1,2,3,5-)

The information listed is subject to change.
Always check with the laboratory for the most updated information.

Matrix	Approved Method	Parameter Description
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Tetrachlorobenzene (1,2,4,5-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Tetrachlorophenol (2,3,4,6-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Toluidine (2-) (2-Methylaniline)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Toluidine (5-Nitro-2-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Trinitrobenzene (1,3,5-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	N-Nitrosodiethylamine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	N-Nitrosodimethylamine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	N-Nitroso-di-n-propylamine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	N-Nitrosodiphenylamine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	N-Nitrosomethylethylamine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	N-Nitrosopyrrolidine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Diphenylamine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Carbazole
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzidine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dichlorobenzidine (3,3'-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Diphenylhydrazine (1,2-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Aniline
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Chloraniline (4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Nitroaniline (2-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Nitroaniline (3-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Nitroaniline (4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Chloronaphthalene (2-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Hexachlorobenzene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Hexachlorobutadiene (1,3-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Hexachlorocyclopentadiene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Hexachloroethane
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Hexachloropropene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Trichlorobenzene (1,2,4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Bis (2-chloroethoxy) methane
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Bis (2-chloroethyl) ether
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Bis (2-chloroisopropyl) ether
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Chlorophenyl-phenyl ether (4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Bromophenyl-phenyl ether (4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dinitrotoluene (2,4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dinitrotoluene (2,6-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Isophorone
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Nitrobenzene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Butyl benzyl phthalate
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Bis (2-ethylhexyl) phthalate
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Diethyl phthalate
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dimethyl phthalate

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Always check with the laboratory for the most updated information.

Matrix	Approved Method	Parameter Description
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Di-n-butyl phthalate
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Di-n-octyl phthalate
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Acenaphthene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Anthracene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Acenaphthylene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzo(a)anthracene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzo(a)pyrene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzo(b)fluoranthene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzo(ghi)perylene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzo(k)fluoranthene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Chrysene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dibenzo(a,h)anthracene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Fluoranthene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Fluorene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Indeno(1,2,3-cd)pyrene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Methylnaphthalene (2-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Naphthalene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Phenanthrene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Pyrene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Methyl phenol (4-chloro-3-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Chlorophenol (2-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dichlorophenol (2,4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dimethylphenol (2,4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dinitrophenol (2,4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dinitrophenol (2-methyl-4,6-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Methylphenol (2-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Methylphenol (4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Nitrophenol (2-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Nitrophenol (4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Pentachlorophenol
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Phenol
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Trichlorophenol (2,4,5-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Trichlorophenol (2,4,6-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dibenzofuran
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dichlorobenzene (1,2-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dichlorobenzene (1,3-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dichlorobenzene (1,4-)
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzoic acid
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzyl alcohol
NPW, SCM	[SW-846 8270D]	Decane (n-)
NPW, SCM	[SW-846 8270D]	Octadecane (n-)

The information listed is subject to change.
Always check with the laboratory for the most updated information.

Matrix	Approved Method	Parameter Description
NPW, SCM	[USER DEFINED CA LUFT - diesel]	Petroleum Organics
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Pyridine
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzo(a)anthracene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzo(a)pyrene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzo(b)fluoranthene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Benzo(k)fluoranthene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Dibenzo(a,h)anthracene
NPW, SCM	[SW-846 8270D] [SW-846 8270C]	Indeno(1,2,3-cd)pyrene
NPW, SCM	[SW-846 9010C] [USER DEFINED 9010B]	Cyanide
NPW, SCM	[SW-846 9010C] [USER DEFINED 9010B]	Cyanide - amenable to Cl2
NPW, SCM	[SW-846 9012B] [USER DEFINED 9012A]	Cyanide
NPW, SCM	[SW-846 9030B]	Sulfides, acid sol. & insol.
NPW, SCM	[SW-846 9034]	Sulfides, acid sol. & insol.
NPW, SCM	[SW-846 9056] [SW-846 9056A]	Sulfate
NPW, SCM	[SW-846 9040C]	pH - waste, >20% water
NPW, SCM	[SW-846 9060A] [SW-846 9060]	Total organic carbon (TOC)
NPW, SCM	[SW-846 9056] [SW-846 9056A]	Nitrite
NPW, SCM	[SW-846 9056] [SW-846 9056A]	Nitrate
NPW, SCM	[SW-846 9056] [SW-846 9056A]	Bromide
NPW, SCM	[SW-846 9056] [SW-846 9056A]	Chloride
NPW, SCM	[SW-846 9056] [SW-846 9056A]	Fluoride
NPW, SCM	[EPA 300.0]	Guanidine nitrate
NPW, SCM	[SW-846 8330]	Guanidine nitrate
NPW, SCM	[SM 2540 G]	Total, fixed, and volatile solids (SQAR)
SCM	[SW-846 1030]	Ignitability of solids
SCM	[SW-846 3031]	Metals
SCM	[SW-846 3040A]	Metals
SCM	[SW-846 3050B]	Metals
SCM	[SW-846 3051A] [SW-846 3051]	Metals
SCM	[SW-846 3052]	Metals
SCM	[SW-846 3060A]	Metals
SCM	[SW-846 7471B] [SW-846 7471A]	Mercury - solid waste
SCM	[SW-846 3540C]	Semivolatile organics
SCM	[SW-846 3550C] [SW-846 3550B]	Semivolatile organics
SCM	[SW-846 3546]	Semivolatile organics
SCM	[SW-846 3580A]	Organics
SCM	[SW-846 3585]	Organics
SCM	[SW-846 5035A] [SW-846 5035L]	Volatile organics - low conc.
SCM	[SW-846 5035A] [SW-846 5035H]	Volatile organics - high conc.

The information listed is subject to change.
Always check with the laboratory for the most updated information.

Matrix	Approved Method	Parameter Description
SCM	[SW-846 3610B]	Semivolatile organics
SCM	[SW-846 3611B]	Semivolatile organics
SCM	[SW-846 3620C] [SW-846 3620B]	Semivolatile organics
SCM	[SW-846 3630C]	Semivolatile organics
SCM	[SW-846 3660B]	Semivolatile organics
SCM	[SW-846 3665A]	Semivolatile organics
SCM	[SW-846 8440]	Total rec. petroleum hydrocarbons
SCM	[SW-846 9013] [USER DEFINED 9013A]	Cyanide
SCM	[SW-846 9023]	Extractable organic halides (EOX)
SCM	[SW-846 9045D] [SW-846 9045C]	pH - soil and waste
SCM	[SW-846 9071 B]	Oil & grease - sludge-hem
SCM	[SW-846 9071 B]	Oil & grease - sludge-hem-npm
SCM	[ASTM D5468 and D482]	% ash
SCM	[ASTM D240]	Heat of combustion (BTU)
SCM	[SW-846 9095] [USER DEFINED 9095A]	Free liquid
SCM	[SW-846 9056] [SW-846 9056A]	Orthophosphate

3.4 ABBREVIATIONS/ACRONYMS

The quality department is responsible for setting up and maintaining a list of abbreviations used in the quality manual.

ABBREVIATION	***DESCRIPTION***
A2LA	*AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION*
AIHA	*AMERICAN INDUSTRIAL HYGIENE ASSOCIATION*
BLANK	*See FIELD, TRIP, METHOD, EQUIPMENT*
CAL	*CALIBRATION*
CCB	*CONTINUING CALIBRATION BLANK*
CCV	*CONTINUING CALIBRATION VERIFICATION*
CDOC	*CONTINUING DEMONSTRATION OF CAPABILITY*
COC	*CHAIN OF CUSTODY*
CA	*CORRECTIVE ACTION*
DQO	*DATA QUALITY OBJECTIVES*
DUP	*DUPLICATE*
EB	*EQUIPMENT BLANK*
FB	*FIELD BLANK*
GC	*GAS CHROMATOGRAPHY*
GCMS	*GAS CHROMATOGRAPHY MASS SPECTROMETRY*
HPLC	*HIGH PRESSURE LIQUID CHROMATOGRAPHY*
IC	*ION CHROMATOGRAPHY*
ICP	*INDUCTIVELY COUPLED PLASMA*
ICPMS	*INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY*
ICS	*INTERFERENCE CHECK SAMPLE*
ICV – See SSCV	*INITIAL CALIBRATION VERIFICATION*
IDOC	*INITIAL DEMONSTRATION OF CAPABILITY (SEE ALSO CDOC)*
IDL	*INSTRUMENT DETECTION LIMIT*
IS	*INTERNAL STANDARD*
LCS	*LABORATORY CONTROL SAMPLE (Typically 2ND Source)*
LOD	*LIMIT OF DETECTION*
LDR	*LINEAR DYNAMIC RANGE*
MAT	*MATRIX*
MS	*MATRIX SPIKE*
MSD	*MATRIX SPIKE DUPLICATE*
MDL	*METHOD DETECTION LIMIT*
MB	*METHOD BLANK*
NC	*NEGATIVE CONTROL*
NELAP	*NATIONAL ENVIRONMENTAL LABORATORY ACCREDITATION*
% Rec	*PERCENT RECOVERY*

ABBREVIATION	***DESCRIPTION***
PC	*POSITIVE CONTROL*
PDL	*PRACTICAL DETECTION LIMIT*
PQL	*PRACTICAL QUANTITATION LIMIT also See Reporting Limit (RL)*
PT	*PROFICIENCY TEST SAMPLE*
QUAL	*QUALIFIER*
QA	*QUALITY ASSURANCE*
QAM	*QUALITY ASSURANCE MANUAL*
QAO	*QUALITY ASSURANCE OFFICER*
QC	*QUALITY CONTROL*
RL	*REPORTING LIMIT*
RPD	*RELATIVE PERCENT DIFFERENCE*
RF	*RESPONSE FACTOR*
SSCV	*SECONDARY SOURCE CALIBRATION VERIFICAION*
SOP	*STANDARD OPERATING PROCEDURE*
SRM	*STANDARD REFERENCE MATERIAL*
SURR	*SURROGATE*
UV	*ULTRAVIOLET*
VOC	*VOLATILE ORGANIC COMPOUND*

4.0 MANAGEMENT REQUIREMENTS

4.1 ORGANIZATION

4.1.1 Legal identity

The laboratory is authorized under Title 62 of the Tennessee Code Annotated and is identified as Environmental Science Corporation (d.b.a. ESC Lab Sciences) located at 12065 Lebanon Road, Mount Juliet, TN 37122

4.1.2 Organization

The laboratory is a public entity and is structured to provide environmental support services in compliance with numerous federal, state, and local regulations as well as to meet the analytical needs of the client.

4.1.3 Facilities Under Management System

The scope of the ESC management system is comprehensive and covers all technical and supporting work conducted at all facilities at the primary Lebanon Road location as well as customer support and shipping operations across the US.

4.1.4 Independence

ESC Lab Sciences is an independent analytical facility and therefore remains uninfluenced by external factors, such as financial or political considerations.

4.1.5 Management Responsibilities and Policies

The assignment of responsibilities, authorities, and interrelationships of the personnel who manage, perform, or verify work affecting analytical quality is documented in the job descriptions maintain by the Human Resources department. Management bears specific responsibility for maintenance of the Quality System. This includes defining roles and responsibilities of personnel, approving documents, providing required training, providing a procedure for confidential reporting of data and ensuring data integrity, along with periodically reviewing data, procedures, and documentation. Management ensures that audit findings and corrective actions are completed within required time frames. Alternates are appointed by management during the absence of the Laboratory Manager, Technical Director or the Quality Manager. The organizational structure indicated in this section is designed to minimize the potential for conflicting or undue stresses that might influence the technical judgment of analytical personnel. Additionally, it provides adequate management for consistent supervision of laboratory practices and procedures.

Operations Management is responsible for defining the minimal level of education, qualifications, experience, and skills necessary for all analytical positions in the laboratory and assuring that technical staff has demonstrated capabilities in their tasks. Training is kept up-to-date by periodic review of training records and through employee performance reviews.

4.1.5.1 ***Chief Executive Officer***

Peter Schulert, Bachelor of Science in Chemistry, is the laboratory's Chief Executive Officer (CEO). He joined ESC in 1987 after the completion of his service with the United States Naval Submarine Service. In his five years of nuclear submarine experience in the Navy, Mr. Schulert qualified as an officer. This qualification included supervision of nuclear reactors and power plant operations. His vision for automation and client services has been a key component of ESC's rise to the top ranks of the industry. Mr. Schulert is responsible for developing and executing ESC's strategic plan. Under his leadership, ESC has become a large single location laboratory, with a comprehensive national certification program and industry leading data management tools. In his absence, all operational responsibilities are delegated to the Chief Financial Officer, Laboratory Director, Director of Technical & Regulatory Affairs, and the Chief Information Officer.

4.1.5.2 ***Director of Technical & Regulatory Affairs***

Judith R. Morgan, Master of Science in Analytical Chemistry and Registered Environmental Manager, is the Laboratory Director of Technical & Regulatory Affairs and serves as the laboratory Quality Assurance Officer (QAO). She has been serving the environmental industry since 1986 and is a respected expert witness. The majority of her experience is specific to quality and regulatory matters; however, she does have previous experience as an analyst in both organic and inorganic methods. In matters of laboratory QA/QC, she reports directly to Peter Schulert, CEO, thus making her QAO functions separate from laboratory operations. Her primary responsibility is the oversight of administrative and technical operations of the laboratory. She specifies and/or approves all methodologies used in the laboratory and ensures continued accreditation of the laboratory. She is responsible for maintaining the laboratory QA manual, initiating and overseeing audits, activating corrective measures (when necessary), implementing numerous international quality standards and preparing internal QA/QC reports. Additionally, she oversees the Technical Specialist group, which includes personnel who are considered to be experts in one or more facets of the laboratory. The Technical group maintains specific regulatory information that impacts quality, client relations, and strategic marketing. Dixie Marlin assumes responsibility for all QA functions, in the absence of the director.

4.1.5.3 ***Laboratory Director***

Eric Johnson, B.S. in Chemistry, is the Laboratory Director and is responsible for the supervision of each laboratory division and the overall compliance of the laboratory to this Quality Manual. Mr. Johnson provides ESC with necessary experience for all aspects of sample handling from sample shipping and receiving through sample disposal. He has been involved in many aspects of environmental analyses since 1991. He coordinates all production areas and is responsible for operational scheduling, process specifications, and implementation of quality standards. He focuses his background and experience on the improvement of existing systems in order to maximize efficiency and improve quality. He reports directly to the CEO. In his absence, all operations responsibilities are delegated to Tom Mellette and then to individual department managers.

4.1.5.4 ***Quality Control Manager***

Dixie Marlin, B.S. in Biology, is the laboratory Quality Control Manager. She has more than 20 years of combined laboratory experience in research, regulatory, and production lab environments. This experience has spanned the environmental lab in both privately owned, university facilities, and Federal Superfund sectors, with additional experience gained in state regulatory agencies. Her primary function is to assist production chemists/technicians regarding quality assurance/control measures, ensure compliance with method requirements and procedures, and perform audits of internal laboratory functions. Where necessary, she identifies, develops, and implements improvement of the laboratory measurement capability to meet the requirements of governing authorities, department programs, and laboratory clients. She is responsible for the supervision of the laboratory QC group and technical specialists. Judith Morgan assumes responsibility for these functions in her absence.

4.1.5.5 ***Chief Information Officer***

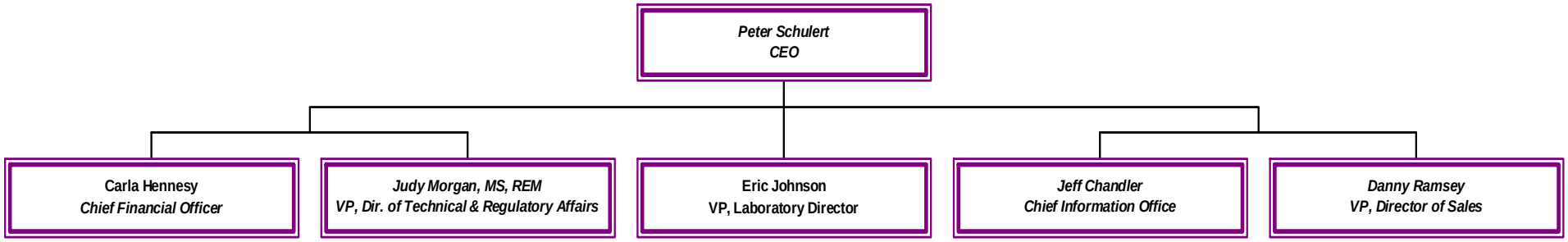
Jeff Chandler, B.S. in Computer Science, is the ESC CIO. His responsibilities include direction of laboratory computer systems, internal and external software development, database management, records management system and control of ESC's laboratory information management system. Prior to joining ESC, Mr. Chandler served as VP of eCommerce for a large internet retailer for seven years, preceded by three years in management within a major consulting company. He has over twenty-three years experience in information technology disciplines, including project management, software development, hardware infrastructure planning /deployment, and voice/data analysis. Tom White is responsible for the department in Mr. Chandler's absence.

4.1.6 Management System Effectiveness

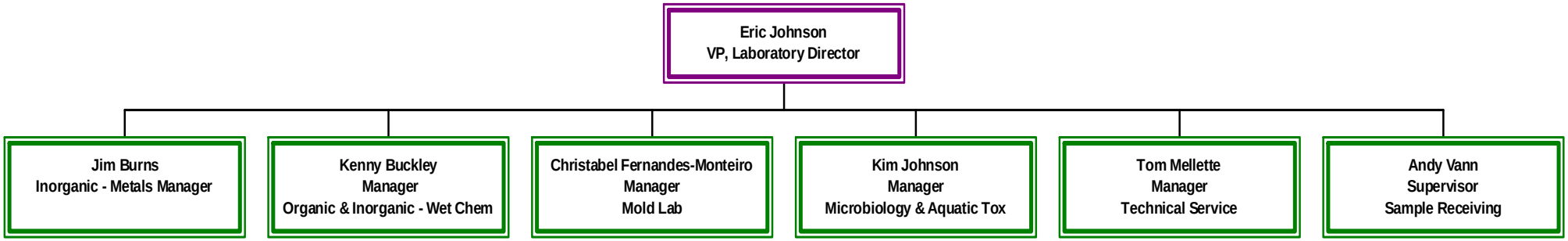
Senior management ensures that appropriate communication processes are established within the laboratory for implementation of the management system and that communication takes place regarding the effectiveness of the management system.

Figure 4.1 is the corporate organizational chart, which lists key individuals and relevant departmental structure.

Figure 4.1 Corporate Organizational Chart (Subject to change)



Laboratory Department Managers



4.2 MANAGEMENT SYSTEM

4.2.1 Management Documentation

Management system documentation consists of different levels:

- Documented statements of the quality policy (issued under the authority of the chief executive officer) and the quality objectives of this manual
- Documented procedures required by all applicable standards that detail the implementation of requirements and operation guidelines.
- Instructions: details of quality or inspection information and specific instructions for performance of individual tasks.
- Documents needed by the organization to ensure the effective planning, operation and management of its processes
- Records required by all applicable standards per the records procedure.

When the term “documented procedure” appears within this quality manual, the procedure is established, documented, implemented and maintained.

The laboratory maintains its documents in various formats including paper and various electronic formats.

4.2.2 Quality Management Policy

The management of ESC is committed to maintaining a quality assurance/quality control program that allows data generated by ESC, or any subcontractors under ESC's supervision, to meet both required and stated accuracy goals. The most important aspect of the program is to ensure that all activities whether involving sampling, analytical, or engineering activities, are congruent with EPA laboratory practices and regulatory guidelines. Issues relating to the quality program are reviewed during weekly operations meetings with upper management and in quarterly management reviews. ESC personnel who have direct responsibility for overseeing the quality assurance program report to ESC's president.

ESC has a diverse accreditation/certification program, which requires continuous monitoring of changes and modifications within a variety of state and federal organizations. The certification program represents greater than 48 separate state and national certifications. ISO 17025 is maintained as the minimum foundation to meet each program requirement. This requires an extreme dedication to the overall quality system and analytical testing.

4.2.3 Management Commitment

ESC management is committed to the development and implementation of the laboratory's management system as well as compliance with all statutory and regulatory requirements. These commitments, along with the importance of meeting client requirements, are continually communicated to all levels within the laboratory.

4.2.4 Commitment to the QAM and Related Procedures

Data Integrity is the result of the processes that work together to assure the production of data of known and documented quality.

The ESC Policy Manual requires a strict adherence to ethics and confidentiality. This policy covers all aspects of the laboratory function from client contact to sample analysis and analytical reporting, invoicing, and archive. Each staff member must maintain a professional attitude towards all colleagues, regulators, auditors, and laboratory clients while continuously striving to improve technical knowledge and professional competence.

ESC supports individual authority and provides the necessary resources for each staff member to carry out their duties. Each staff member is responsible for the identification of departures, from the quality system and/or established analytical procedures, within their area of concern, and for the initiation of actions to prevent or minimize such departures. In addition, ESC strives to ensure that its management and personnel are free from any undue internal and external commercial, financial, and other pressures and influences that may adversely affect the quality of their work.

All ESC personnel, including contract and temporary, are required to sign an "Attestation of Ethics and Confidentiality" at the time of employment and during annual refresher training. This document clearly identifies inappropriate and questionable behavior. Violations of this document result in serious consequences, including prosecution and termination, if necessary. The ESC Policy Manual addresses this subject in detail. See SOP# 010102, *Ethics, Data Integrity, and Confidentiality.*

4.2.4.1 Quality Manual (QAM)

ESC has established and maintains a quality manual that:

- Defines the structure of the management system.
- Makes reference to the quality policy, the supporting procedures (also technical) and instructions.
- Defines the roles and responsibilities of technical and quality staff

The management system documentation is communicated to each laboratory staff member. All employees sign a document, kept in their personnel file, which states that they have read and understood the *Quality Manual*, including the quality policy.

4.2.4.2 Commitment to the QAM and Related Procedures

This Quality Assurance Manual outlines the procedures that have been developed to implement laboratory policies and to fulfill the laboratory's commitment to the client. These procedures are further defined and integrated into ESC's standard operating procedures. The policies are stated such that this manual serves as a QA handbook of responsibilities for all laboratory personnel. The manual is reviewed and approved under the authority of the highest level of laboratory management. Where the *Quality Manual* documents laboratory requirements, a separate SOP or policy is not required. This document is also used as a supplement for project planning, client reference, and personnel training.

4.2.5 Procedure List

A list of the procedures, the instructions and the quality records, which are included in the management system, is maintained by the Quality Department and is available via the ESC intranet.

4.2.6 Management Commitment

4.2.6.1 Programs

The management of ESC is the main support of the quality program. Each manager is aware of the requirements of each external auditing agency and is responsible to ensure that their respective departments meet the requirements of each agency. ESC maintains full compliance and agreement with the following organizations/regulations: A2LA, ISO 17025, AIHA, EPA, GALP/GLP, NELAP, and individual states who carry primacy concerning certification and regulation.

4.2.6.2 ESC Policy Manual

ESC has policies and procedures, in the ESC Policy Manual, to insure that there is no employee involvement in any activities that would diminish confidence in their competence, impartiality, judgment or operational integrity.

All staff members employed by ESC are issued a Company Policy Manual that covers a wide array of topics and defines the expectations and policies of ESC. The Manual addresses both corporate and professional conduct, including confidentiality, professional ethics, and discipline. No deviations from the company policy are permitted without the approval of the CEO.

4.2.7 Management of System Changes

Top management ensures that the integrity of the management system is maintained when changes to the management system are planned and implemented.

4.3 DOCUMENT MANAGEMENT

This Section describes procedures for document management, which includes controlling, distributing, reviewing, and accepting modifications. The purpose of document management is to ensure that adequate instruction is readily available for laboratory employees and to preclude the use of invalid and/or obsolete documents.

The laboratory manages three types of documents: 1) controlled, 2) approved, and 3) obsolete.

A CONTROLLED DOCUMENT is one that is uniquely identified, issued, tracked, and kept current as part of the quality system. Controlled documents may be internal documents or external documents.

APPROVED means reviewed, and either signed and dated, or acknowledged in writing or secure electronic means by the issuing authority(ies).

OBSOLETE DOCUMENTS are documents that have been superseded by more recent versions.

4.3.1 Required Documents

Documents required by the management system, as well as analytical records are managed per the SOP #010103, *Document Control and Distribution Procedure*.

4.3.2 Document Control

The documentation management procedure is established to define the means needed to:

- Approve documents for adequacy prior to issue
- Review, update and re-approve existing documents as necessary
- Ensure that changes and the current revision status of documents are identified
- Ensure that relevant versions of applicable documents are available at points of use
- Ensure that documents remain legible and readily identifiable
- Ensure that documents of external origin are identified and their distribution managed using the documentation master list
- Prevent the unintended use of obsolete documents and to apply suitable identification to them if they are retained for any purpose.

4.3.2.1 Document Review and Approval

Documents are reviewed and approved for use by the individual department managers and QAO, or designee, prior to issue.

Documents are reviewed at least annually or sooner, as deemed necessary to ensure their contents are suitable, comply with the current quality systems requirements and accurately describe current operations.

Approved copies of documents are available at all locations where operations are essential to the effective functions of the laboratory.

4.3.2.2 Document Distribution

Controlled internal documents are uniquely identified with:

1) date of issue
2) revision identification
3) page number
4) total number of pages or a mark to indicate the end of the document
5) the signatures of the issuing authority (i.e. management).

A master list of controlled internal documents is maintained that includes distribution, location, and revision dates. A master list of controlled external documents is also maintained that includes title, version or copyright date, and and location. The controlled document list is maintained by the QA Department and is continually updated. All invalid or obsolete documents are removed from circulation and clearly marked to prevent use. Obsolete documents retained for legal use or historical knowledge preservation are appropriately marked and retained.

4.3.3 Changes to Controlled Documents

4.3.3.1 Review and Approval of Changes

Document changes are re-approved by the original approving authority.

4.3.3.2 Identification of New or Altered Text

Where practicable, the altered text or new text in the draft is identified during the revision or review process to provide for easy identification of the modifications. Pending changes in each revision are indicated in the ESC SOP/Minor Revision Form that is attached to the SOP. Historical changes are described in the SOP Attachment I, Revision History.

4.3.3.3 Procedure for Document Revision

Document revision is controlled under SOP# 010103, *Document Control*. Suggested revisions to electronic documents are presented to management for review and approval. Changes to electronic documents can only be made by the QAO, or designee. The document management process allows for "minor revisions" or amendments to documents where changes are not sufficient to cause a full procedure change. Minor revisions may take the form of handwritten notes on an approved SOP Minor Revision form. Document changes are approved with signature and date by management. The modified document is then copied and distributed, and obsolete documents are removed. Minor revisions to documents are incorporated into the next full revision as soon as practicable.

4.3.3.4 Changes in Electronic Documents

The QA Manual, SOPs, Safety Plan, and other controlled documents are maintained electronically on a protected directory. Access rights are restricted to QA personnel and the IT Director. Electronic copies of current and previous versions of all controlled documents are maintained on the computer network system. They are stored with the same security settings as the most recent version; however previous versions of documents are access controlled to prevent employee use of outdated material. The documents are archived to tape storage with regular back up of the entire network system

4.3.3.5 Standard Operating Procedures

Standard Operating Procedures (SOPs) are written procedures that describe in detail how to accurately and consistently reproduce laboratory processes or provide additional direction for laboratory personnel. Copies of all SOPs are accessible to all personnel. SOPs consist of three types:

- Technical SOPs, pertaining to a laboratory process which have specifically required details
- Administrative SOPs which document the more general organizational procedures.
- Quality SOPs that provide background and process for quality policy.

SOPs do not have to be formal documents with pre-defined section headings and contents. They can be less formal descriptions of procedures described in the *Quality Manual* or other documents.

4.3.3.5.1 Format

Each SOP indicates the effective date, the revision number, and the signature(s) of the QA Department and Department Manager/Laboratory Director. Department Manager approval is also required on technical procedures. Detailed information can be found in SOP# 010100, *Writing, Revising, and Maintaining Standard Operating Procedures*

All Standard Operating Procedures, QA Manuals, and Safety Plans are written in a format that incorporates the document name, date revised, pages included, and section.

Deviations from SOPs and Quality documents are not allowed without the permission of the QAO, or designee. In the event that a deviation is requested, the circumstance is considered and the procedure is evaluated for necessary change and allowance.

Determinative Method SOPs

The laboratory has SOPs for all analytical methods within its scope, which is listed in Table 3.1. Where equipment manuals or published methods accurately reflect laboratory procedures in detail, a separate SOP is not required. Any deviation from a method is documented in the method modifications section of the respective SOP, including both a description of the change made and a technical justification. The deviation is reported to the client. Each determinative method SOP includes or references (as applicable) the following:

- Scope and Application;
- Method Summary and Definitions;
- Health and Safety;
- Sample Preservation, Containers, Handling and Storage;
- Interferences;
- Equipment and Supplies;
- Reagents and Standards;
- Procedure;
- Data Analysis and Calculations;
- Quality Control and Method Performance;
- Data Validation and Corrective Action;
- Pollution Prevention and Waste Management;
- Method Modifications/Clarifications;
- References;
- Procedure Revision/Review History;

4.4 REVIEW OF REQUESTS, TENDERS, AND CONTRACTS

4.4.1 Procedure for Contract Review

When ESC enters into a contract to provide laboratory services, it follows SOP# 020303, *Contract Review*. On receipt of a request or invitation to tender, the clients' requirements are examined by the contract review personnel to establish that the necessary details are adequately outlined and that the laboratory is able and willing to meet them.

4.4.2 Records of Reviews

Records of reviews of requests, tenders and contracts (including significant changes) are maintained. Records are also maintained of pertinent discussions with the client relating to the client's requirements and the results of the work during the period of execution of the contract.

4.4.3 Subcontracted Work

Clients' requirements for custom analyses and for work subcontracted to other laboratories are reviewed by the appropriate technical staff for logistics and feasibility.

4.4.4 Deviations from the Contract

The client and the affected personnel are informed of any deviation from the contract.

4.4.5 Contract Amendments

If a contract requires amendment after work has commenced, the same contract review process is repeated and any amendments are communicated to all affected parties.

4.5 SUBCONTRACTING

A subcontract laboratory is defined as a laboratory external to ESC, or at a different location than the address indicated on the front cover of this manual, that performs analyses for this laboratory.

4.5.1 Subcontractor Competence

ESC only performs analytical techniques that are within its documented capability, when this is not possible, the laboratory follows SOP# 030209, *Subcontracting.* Subcontracting occurs in the special circumstances where technical, safety, or efficiency issues dictate need. When subcontracting analytical services, the laboratory assures work requiring specific accreditation is placed with an accredited laboratory or one that meets applicable statutory and regulatory requirements.

4.5.2 Client Notification

ESC notifies the client of the intent to subcontract the work in writing. The laboratory typically gains the approval of the client to subcontract their work prior to implementation, preferably in writing.

4.5.3 ESC Responsibility

ESC assumes responsibility for the qualifications of the subcontractor (except when the client or an authority specifies a subcontractor) and the client is advised.

All reports, which contain data from subcontracted laboratories, include a statement on the final report, which references the subcontractor laboratory/service. As part of the initial subcontractor approval process, a copy of the applicable certificates and scopes for subcontractor's accreditation/certifications is maintained as evidence of compliance.

4.5.4 Subcontractor List

ESC maintains a list of all approved subcontract laboratories.

4.6 PURCHASING SERVICES AND SUPPLIES

4.6.1 Purchasing Policies and Procedures

ESC maintains SOP# 030210, *Materials Procurement for Analytical Processes*, which describes the purchasing process, including vendor selection and acceptance criteria, for the purchase, storage, and evaluation of supplies and services. Where specifications of outside services and supplies are relevant to the measurement integrity of analyses, ESC uses services and supplies of adequate quality. The various department managers are responsible for ordering supplies/chemicals that meet the method stated requirements.

4.6.2 Quality of Purchased Items

Where assurance of the quality of outside support services or supplies is unavailable, the laboratory uses these items only after they have been inspected or otherwise verified for adequate quality. Records of inspections, verifications, and suppliers are maintained in the laboratory.

4.6.3 Purchasing Documents

Purchasing documents contain data clearly describing the product and/or services.

4.6.4 Approved Supplier List

An approved list of material/service suppliers is maintained where products/services purchased affect the quality of analyses produced by the laboratory.

4.7 SERVICE TO THE CLIENT

The ESC Technical Service Department provides specific project service through the use of Technical Service Representatives (TSRs). The TSR is responsible for all contract requirements and laboratory/client communication, including information concerning schedules, delays, and major deviations in the testing process.

4.7.1 Meeting Client Expectations

The TSR works closely with the client to clarify the client's requests and to monitor the laboratory's performance in relation to the work requested, while ensuring confidentiality to other clients. The laboratory confidentiality policy prohibits divulging or releasing any information to a third party without proper authorization. See SOP# 010102, *Ethics, Data Integrity, and Confidentiality*. All electronic data (storage or transmissions) are kept confidential, based on technology and laboratory limits, as required by client or regulation. All electronic transmissions contain a confidentiality notice that represents the following: *Notice: This communication and any attached files may contain privileged or other confidential information. If you have received this in error, please contact the sender immediately via reply email and immediately delete the message and any attachments without copying or disclosing the contents. Thank you.*

For additional information see SOP# 020301, *TSR (Project Management).*

4.7.2 Client Feedback

Service related feedback is obtained from clients by surveys. This feedback is used to improve the management system, quality system, testing and calibration activities and client services. The feedback is discussed in management reviews.

4.7.3 Client Access

ESC provides reasonable access, as needed by outside parties, to relevant areas of the lab for witnessing tests.

4.7.4 Client Project Information

Clients may be provided supplementary documents, as needed, to further strengthen the project information. This may include: preparation documents, packaging information, verification of calibrations, and certification information.

4.7.5 Communication with the Client

ESC's Technical Service Representatives maintain good communication with outside parties and are able to provide sound advice/guidance in technical matters and opinions/interpretations based on results. Communication with the client, especially in large assignments, is maintained throughout the work. The client is informed of any delays or deviations in the performance of the tests and/or calibrations.

4.8 COMPLAINTS

The purpose of this section is to ensure that customer complaints are addressed and corrected. This includes requests to verify results or analytical data. All client concerns are initially addressed by the Technical Service Representatives. If further resolution is required, the QAO (or designee) and other pertinent personnel, as deemed necessary by the depth of the problem, conduct needed investigations and provide client support. See SOP# 020302, *Client Complaint Resolution Procedure*.

4.8.1 Investigation of Complaints

In the event of a complaint, negative audit finding, or any other circumstance, which raises doubt concerning the laboratory's competence or compliance with required procedures, the laboratory ensures that those areas of activity are promptly investigated. A resolution of the situation is promptly sought and, where necessary, retesting is conducted.

4.8.2 Causes and Corrective Actions

The personnel in the quality department examine all documents and records associated with complaints and the department manager investigates audit findings and other circumstances. This investigation seeks to identify specific root causes and initiate any necessary corrective action.

4.8.3 Documentation

Records of events and the actions taken by the laboratory to resolve issues and to prevent future occurrences are maintained (see Section 4.11).

4.9 CONTROL OF NON-CONFORMING WORK

4.9.1 Policies and Procedures

A nonconformance is an event that does not meet the requirements of the governing documents. Nonconformances can include unacceptable quality control results (See SOP# 030208, *Corrective Action)* or departures from standard operating procedures or test methods. Requests for departures from laboratory procedures are approved by the QAO, or designee, and documented.

Types of non-conformances are:

- Deviations from written procedures that were not pre-approved by QA.
- Changes to an existing SOP that is not included in the current revision
- A single and/or continuous trend of inappropriate habits
- A single and/or continuous trend of bias in the QC results
- Unusual changes in detection limit
- Deficiencies identified during an internal/external audit
- Unacceptable results on performance testing samples
- Valid issues reported by clients, data reviewers, or auditors
- General activities that demonstrate the possibility of a negative impact to the quality of the data

A policy has been established to ensure the use of analytical techniques that do not conform to specified requirements are prevented. This control provides for identification, documentation, evaluation, segregation (when practical) and disposition of nonconforming tests/calibrations. The control also calls for notification to the appropriate laboratory divisions. Any non-conforming tests/calibrations are reported to the supervisor of the affected laboratory division who is responsible for corrective actions. Records are documented on corrective action requests.

4.9.2 Correcting Non-conforming Work

The correction action system is used to identify nonconforming tests and/or calibrations. See SOP 030208, *Corrective and Preventive Action.*

4.9.3 Review and Disposition of Nonconforming Tests/Calibrations

Since the laboratory has adopted a continuous improvement philosophy, it has established a procedure for reviewing and disposing of nonconforming tests/calibrations. This procedure includes:

- Reworking the test/calibration to meet the requirements
- Rejecting the test/calibration
- Informing the client (if necessary)

4.10 IMPROVEMENT

The laboratory continually improves the effectiveness of its management system through the use of the quality policy, quality objectives, audit results, analysis of data, corrective and preventive actions and management review.

4.11 CORRECTIVE ACTIONS

ESC strives for the continual improvement of its organization and its services. Corrective Action is the process used to eliminate the causes of an existing nonconformity, defect, or other undesirable situation in order to prevent recurrence.

ESC recognizes that the data supplied by the professional staff must be legally and technically defendable. The Regulatory Affairs personnel continually monitor the quality assurance program to ensure that this goal is achieved. Each analyst is responsible for initiating corrective actions in their areas of expertise. The QAO, or designee, and Department Managers administer corrective action approval. It is the Manager's responsibility to evaluate the Corrective Action, appoint the appropriate person within the department to be responsible for completion of the CAR and submit it to the QA Department for processing.

4.11.1 General

The initiation, management, tracking, and closure of corrective actions is described in SOP# 030208, *Corrective and Preventive Action.*

4.11.2 Investigation of Corrective Actions

Each lab division is encouraged to take any corrective action to determine and eliminate the causes of actual nonconformances to the degree appropriate to the magnitude of problems and commensurate with the risks encountered.

4.11.3 Selection and Implementation of Corrective Actions

In addition to SOP# 030208, *Corrective and Preventive Action*, more specific guidance can be found in each determinative method.

In general, the corrective action procedure includes:

- The effective handling of client complaints and reports of nonconformities
- Investigation of the root cause of nonconformities relating to process, service, and management systems, and recording of results
- Determination of the corrective action needed to eliminate the cause of nonconformities
- Application of controls to ensure that corrective action is taken and that it is effective.

4.11.4 Monitoring of Corrective Actions

The closure and follow-up activities of corrective actions are approved and documented in ESC's tracking system to ensure that the actions have been effective in addressing and correcting the problem.

4.11.5 Additional Audits

When the identification of non-conformities or the corrective action investigation casts doubt on compliance with policies and procedures or the management system, laboratory management ensures that appropriate areas of activity are audited in accordance with Section 4.14.1. The results of corrective action are submitted for laboratory management review.

4.11.6 Cessation and Restarting of Work

All technical personnel are capable of invoking a "stop work" order, in the event that a situation impacts data validity or safety. It is the responsibility of the following personnel to (1) evaluate a "stop work" order whenever a severe non-conformance warrants a cessation of analysis and (2) ensure that the cause of the stop work order has been satisfactorily resolved and approve the restarting of work:

- Laboratory Manager/Director
- QA Department
- Technical Director/Supervisor
- Technical Service Representative

Technical directors review corrective action reports and suggest improvements, alternative approaches, and amended/revised procedures, where needed. If the data reported are affected adversely by the nonconformance, the client is notified in writing. The discovery of a nonconformance for results that have already been reported to the client must be immediately evaluated for significance of the issue, its acceptability to the client, and determination of the appropriate corrective action.

4.11.7 Release of Non-conforming Work

The laboratory allows the release of nonconforming data only with approval on a case-by-case basis by the appropriate Technical Director, or their designee. Planned departures from procedures or policies do not require audits or investigations. Permitted departures for nonconformances, such as QC failures, are fully documented and include the reason for the deviation and the impact of the departure on the data.

4.11.7 Other Sources That May Initiate Corrective Action

Deficiencies cited in external assessments, internal quality audits, data reviews, complaints, or managerial reviews are documented and require corrective action. Corrective actions taken are appropriate for the magnitude of the problem and the degree of risk.

Appendix II lists the current federal and state agencies that perform audits of ESC. This table also lists the required performance evaluations that may initiate corrective actions. ESC implements any reasonable corrective action deemed necessary by the regulatory QA/Certification Officers. In addition, the following types of samples may also initiate corrective action: split samples sent to another qualified laboratory, monthly blind field duplicates, quarterly purchased round robin samples, client submitted QC samples and periodic internal blind samples.

4.11.8 Corrective Action Documents

In general, corrective action documents are maintained by the Regulatory Affairs Department. These documents include the following: corrective action resulting from both internal and external audits, corrective action resulting from performance evaluation testing, corrective action as deemed necessary by the QA Department.

Corrective action resulting from analytical failure is kept with the analytical data and is recorded on the bench sheet or raw data. The Department Manager is responsible for making sure that suitable measures have been taken to ensure that the problem is identified and corrected.

Corrective action involving sample receiving is recorded on a Nonconformance form and is then filed with the original Chain of Custody.

4.12 PREVENTIVE ACTIONS

Preventive Action, rather than corrective action, aims at minimizing or eliminating inferior data quality or other nonconformance through scheduled maintenance and review, before the actual nonconformance occurs.

4.12.1 Management of Preventive Actions

ESC Management encourages preventive action measures. Each staff member is empowered to make suggestions for improving or fool-proofing processes throughout ESC. Where process areas show potential for nonconformance, measures are taken to identify the problem and formulate a plan to implement the defined change needed. The QAO, or designee, reviews any recommended changes before implementation to ensure the effectiveness of the modification.

4.12.2 SOP# 030208, *Corrective and Preventive Action*, is also employed for preventive actions.

In general, the procedure for preventive action includes:

- The use of appropriate sources of information, such as processes and work operations, which affect product or service quality, concessions, audit results, quality records, service reports, and client complaints to detect, analyze, and eliminate potential causes of non-conformities.
- Determination of the steps needed to deal with any problems requiring preventive action
- Initiation of preventive action and application of controls to ensure that it is effective.

Preventive action includes, but is not limited to, review of QC data to identify quality trends, regularly scheduled staff quality meetings, annual budget reviews, annual managerial reviews, scheduled column trimming, running a new LIMS system in tandem with the old system to assure at least one working system, and other actions taken to prevent potential problems.

4.12.3 Trend Analysis

A trend analysis is an investigation that involves the collection of data in a manner that reveals deviations over time. Examples of laboratory processes that can be analyzed for trend analysis are:

- Sample receipt or chain of custody discrepancies
- Sample storage or preservation errors
- Holding time violations
- Instrument calibration
- Control Charts – Charts that are generated from historical data that plot percent recovery vs. time
- Method QC failures and problems

4.13 CONTROL OF RECORDS

Records are a subset of documents, usually data recordings that include annotations, such as daily refrigerator temperatures, posted to laboratory forms, lists, spreadsheets, or analyst notes on a chromatogram. Records may be on any form of media, including electronic and hardcopy. Records allow for the historical reconstruction of laboratory activities related to sample handling and analysis.

4.13.1 General

Technical and quality assurance records are established and maintained to provide evidence of conformity to requirements and of the effective operation of the quality system. Mechanisms are established for records to remain legible, readily identifiable and retrievable. The laboratory maintains a record system appropriate to its needs, records all laboratory activities, and complies with applicable standards or regulations as required.

The laboratory has defined the length of time various records, pertaining to the management system and examination results, are to be retained. Retention time is defined by the nature of examination or specifically for each record. The laboratory retains all original observations, calculations and derived data, calibration records, chain of custody and a copy of the test report for a minimum of ten years, unless otherwise required by regulatory authority.

A documented records procedure SOP# 010103, *Document Control and Distribution Procedure*, and SOP# 020304, *Protection and Transfer of Records*, is established to define the means needed for the identification, storage, protection, retrieval, retention time, transfer, and/or disposition of records.

4.13.2 Technical and Quality Records

NOTE: ALL records/data are stored for a minimum of 10 years, unless otherwise noted.

All hardcopy department logbooks, such as temperature, maintenance, and preparation logs are placed into storage boxes and archived via a unique numbering system, to the ESC storage facility. Additional information regarding reagents/standards can be found in the Standards Logger (Tree) digital archive system. This digital system is backed up according to the ESC IT backup procedure.

Archived information and access logs are protected against fire, theft, loss, environmental deterioration, vermin, and in the case of electronic records, electronic or magnetic sources.

Data Storage Criteria	
Data Type	**Storage Criteria**
Manual Data Wet Chemistry	All manually generated data are stored in specific laboratory analysis workbooks. Each individual analysis is located in a separate notebook which contains all data relating to the test including, calibration curves/data, QC charts/limits, SOP, and completed analysis sheets. These notebooks are centrally located and contain completed data that is filed by analysis and date analyzed. Monthly – Data is removed from the notebook and placed in a dedicated filing cabinet. Semi-annually – Data is removed from the filing cabinet, placed in storage boxes and archived, via a unique numbering system, in the ESC storage facility
Manual Data Prep Labs	All logbooks utilized in manually recording sample preparation information are placed into storage boxes and archived, via a unique numbering system, in the ESC storage facility. This includes organic prep, metals prep, and TCLP.
Manual Data Env. Micro, Mold	All manually generated data is stored in specific laboratory files and notebooks. These files are centrally located and contain completed data that is filed by analysis and date analyzed. Data is placed into storage boxes and (when full) archived, via a unique numbering system, in the ESC storage facility.
All Data Aquatic Toxicity	All manually generated data is stored in specific laboratory files and notebooks. These files are centrally located and contain completed data that is filed by analysis and date analyzed. Data is placed into storage boxes and (when full) archived, via a unique numbering system, in the ESC storage facility. Final reports and Reference Toxicant results are also scanned into ESC's electronic document management system. The data storage device on which this data resides is backed up daily. Data files are archived on to magnetic tape and retained per laboratory policy.
Computerized Data - Organic Dept.	Injection logs are printed and kept in a notebook with the instrument. The instrument data is printed to a secure server and remains in a format that cannot be changed after printed. Upon printing, the data in the original file is generated. This storage system is backed up nightly utilizing a seven-day rotation cycle. The data is immediately available for up to two years. After two years, raw instrument data files are archived onto a separate secure server and kept a minimum of ten years. Original raw data files cannot be edited.
Computerized Data – Inorganic Metals Dept.	All data produced by metals instrumentation is backed up to a secure drive, nightly, utilizing a seven-day rotation cycle. Hard copies are printed and filed by date and instrument. All data is archived on a network attached storage device and is immediately available for up to two years. After two years, raw instrument data files are archived on to a separate secure server and kept a minimum of ten years. Original raw data files cannot be edited.
Final Report Storage - LIMS	The LIMS facilitates access to any finished data and sample information by client code, sample number, and parameter run number. Furthermore, any data pertaining to a sample or client can be obtained. The LIMS also contains the information from the COC such as sample description, time and date collected, sampler ID, container type, preservative, sample receipt data, finished/approved analytical data, analyst, etc. The LIMS Oracle Database is backed up daily on tape. The back up tape is kept in secure storage. While all LIMS data are accessible, data older than six months is moved from the active production database and is available in an archive database.
Final Report Storage - PDF	Copies of all reports are stored according to client code in PDF format on a network attached storage device and are immediately available for up to ten years**.** After ten years data files are archived onto magnetic tape and kept an additional ten years. These reports include chain of custody forms, login confirmation reports, the final approved printed report, invoices and any other associated documents. Samples that require subcontract work also have a copy of the final report in the client file.
Misc. Data Storage	Company records that are not stored on a secure electronic device are placed in storage boxes and archived, via a unique numbering system, in the ESC storage facility. This includes quality records, such as audits, state certifications, PT results, internal audits, corrective actions, training files, logbooks, etc.

4.13.3 Records Disposal

Records that have exceeded the required storage requirement are disposed of through the use of professional records destruction firm. ESC retains the manifest of documents destroyed and files the verification receipt that is generated at the time of destruction.

4.13.4 Records Transfer

In the event that corporate ownership is transferred or that laboratory activities are terminated for any reason, all records become property of the transferee in accordance with ESC SOP# 020304, *Protection and Transfer of Laboratory Records*.

4.13.5 Legal Chain of Custody Records

Evidentiary Sample Data are used as legal evidence. Procedures for evidentiary samples are documented in a separate SOP.

4.14 AUDITS

4.14.1 Internal Audits

SOP# 010104, *Internal Audits*, addresses the implementation and maintenance procedure for a comprehensive system of internal audits at planned intervals to verify the on-going effectiveness of the management system.

4.14.1.1 The QA Department is responsible for administering the internal audit system per the documented procedures. The department develops a schedule for internal audits according to management system requirements and conducts unscheduled audits (internal and external) when reasons for such audits exist.

4.14.1.2 Audits are conducted utilizing documented checklists and/or audit plans. Audit results are documented in audit reports per established procedures. Copies of all audit reports including completed corrective action requests are forwarded to management of the audited area and maintained by the quality assurance department.

4.14.1.3 Audit plans are structured according to the following:

State/Certifying Agencies - Internal audits are conducted according to the various requirements set forth by the state and international agencies that accredit ESC. In addition, work procured from non-certifying states, also determine other requirements set forth by the state of origin. The audits are conducted to maintain compliance with the following Quality Standards: AIHA LQAP, A2LA, ANSI/ISO 17025, NELAC, and DOD QSM.

Method Specific Criteria – Technique, analytical method, standard operating procedures, and effectiveness are also reviewed during the internal audit. ESC maintains compliance with methods as listed in section 2.1.3.

Data Integrity and Analyst Ethics - In addition to established standard and method related criteria; the internal audit is designed to review the analytical data for integrity and defensibility. Any suspicion of ethics violations result in a confidential investigation involving only the QAO, or designee, Director of Technical & Regulatory Affairs, and any specialist personnel necessary to conduct a complete and thorough investigation. Investigations, of this type, are conducted in a timely manner and all details and supporting documentation are recorded and maintained for a period of at least 10 years. All investigations that result in findings of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications to clients. Clients are notified promptly when audit findings cast doubt on the validity of the data.

Support Systems – The internal audit process is also designed to assess support systems that are not a direct part of analytical activities. This includes, but is not limited to, the following:

- Contract Review
- Procurement and Vendor Approval
- Inventory Control
- Document Control
- Subcontracting
- Environmental, Safety, Security, and Health (ESSH)

4.14.1.4 Audit personnel are qualified per documented procedures and do not have direct responsibility for or control over the area being audited.

4.14.1.5 Management personnel responsible for the audited area determine and implement timely corrective actions for any reported nonconformance.

Follow-up audit activities include verification of the corrective actions taken and reporting of the results.

4.14.2 Performance Audits

Performance audits require evaluation of control and blind results. On a quarterly basis, documentation of results and corrective actions are evaluated as part of the management review process.

4.14.3 Proficiency Testing

The laboratory participates in various proficiency testing samples (PT) as required by each accreditation, and obtains test samples from approved providers. Corrective action procedures are initiated for all failed PT samples. All studies are conducted independently and no attempts are made to compare or obtain results from other labs or the provider. Proficiency Testing (PT) or Proficiency Evaluation (PE) samples are treated as typical samples in the normal production process where possible, including the same preparation, calibration, quality control and acceptance criteria, sequence of analytical steps, number of replicates, and sample log-in. PT samples are not analyzed multiple times unless routine environmental samples are analyzed multiple times.

- ***Annual Studies***

Study	***Frequency***	***Vendor***
WP (Water Pollution)	Semi-annually	Environmental Resource Associates
WS (Water Supply)	Semi-annually	Environmental Resource Associates
Matrix – Soil RCRA	Semi-annually	Environmental Resource Associates
Matrix – UST Soil/Water	Semi-annually	Environmental Resource Associates
Matrix – Air Canisters	Semi-annually	Environmental Resource Associates
DMRQA – Chemistry	Annually	Environmental Resource Associates
DMRQA – Aquatic Tox.	Annually	Environmental Resource Associates
ELLAP	Quarterly	AIHA
IHLAP	Quarterly	AIHA
EMLAP	Quarterly	AIHA
EMLAP – Direct Exam	Quarterly	AIHA
EMLAP – Fungal / Bacterial	Triannually	AIHA
Cryptosporidium / Giardia	Quarterly	US EPA
Aquatic Toxicity Performance Evaluation	Annually	North Carolina

- ***Blind Field Duplicates*** **–** ESC collects blind duplicates periodically to evaluate field collection and laboratory precision. ESC routinely receives unmarked field duplicates from clients to evaluate sample batches.

- ***Split Samples*** – ESC periodically participates in split samples with outside laboratories to confirm analytical results. This is performed on a project specific basis.

4.14.4 External Audits

ESC agrees to host on-site system audits from external organizations and currently participates in various system and performance audits. It is the laboratory's policy to cooperate and assist with all external audits, whether performed by clients or an accrediting authority. All external audits are fully documented and tracked to closure.

Management ensures that all areas of the laboratory are accessible to auditors as applicable and that appropriate personnel are available to assist in conducting the audit. Any findings related to an external audit follow corrective action procedures. Management ensures that corrective actions are carried out within the timeframe specified by the auditor(s).

SDWA

The ESC laboratory (EPA No. TN00003) is certified by the State of Tennessee under the Safe Drinking Water Act. The State of Tennessee routinely audits the ESC laboratory procedures, quality control and methods and has found the laboratory practices to be consistent with EPA requirements. ESC is also audited under the Safe Drinking Water Act by Arizona, Iowa, North Carolina, New Jersey - NELAP, and the A2LA. ESC maintains several other DW certifications, which have been granted in reciprocity. ESC participates in WS PE studies in support of drinking water certifications.

CWA/RCRA

ESC is certified for wastewater and solid waste through audits by the following states/organizations: A2LA, Arizona, Iowa, Minnesota, New Jersey (NELAP), North Carolina, OHIO VAP, West Virginia, Wisconsin, and USACE. In addition to Water Pollution or Non-Potable water studies, ESC is required to analyze additional blind samples for West Virginia. The laboratory is also periodically audited by the Metropolitan Government of Nashville and Davidson County and certified for wastewater sampling and analysis. ESC participates in WP Studies, DMR QA program, and Solid Matrix PE studies.

INDUSTRIAL HYGIENE

The American Industrial Hygiene Association routinely audits ESC to maintain certification for analytical support of organic chemical exposure monitoring, microbiological testing and metals exposure activities. ESC currently participates

in the required performance testing studies and maintains the quality systems to satisfy the requirements necessary for certification in the following: Environmental Lead (air, soil, paint and wipes), Industrial Hygiene (air filters, diffusive samplers, and sorbent tubes), Environmental Microbiology (fungal/bacterial testing and identification)

CLIENT AUDITS

Due to participation in a number of national contracts, ESC is audited by several clients; who are also ISO certified and are required to assess their suppliers.

ESC is subject to several external audits on an annual basis. The audits cover all disciplines, SDWA, CWA, CAA and RCRA/UST. In addition, the laboratory also participates in additional performance testing, where required by individual clients and for new method development purposes.

4.15 MANAGEMENT REVIEW

4.15.1 Items in Management Review

Regular management review meetings take place quarterly during the months of January, April, July and October and cover the events from the preceding quarter. The Quality Assurance Officer (QAO), the Laboratory Director, and all Department Managers are responsible for attending each meeting. Guidance, including agenda items, is given in ESC SOP# 010105, *Management Review*.

4.15.2 Records of Management Review

The Director of Technical & Regulatory Affairs and QA Department collects objective evidence on the effectiveness of the management system. This includes audit results, client feedback, contract performance data, nonconformance data, problem reports, changes affecting the management system and previous management review reports.

4.15.3 Evaluation

On the basis of this input, the management system is tested for its effectiveness, for its relevance, and for its implementation. In particular, quality objectives and the objectives set within the management system are examined. Adjustments are considered due to changes in the conduct or scope of business.

4.15.4 Improvement

Decisions are made regarding actions needed to improve the effectiveness of the quality management system.

4.15.5 Procedure

Details of this review, how it is be performed and recorded and the associated responsibilities can be found in the procedure for ESC SOP# 010105, *Management Review*.

5.0 TECHNICAL REQUIREMENTS

5.1 GENERAL

5.1.1 ESC recognizes that many factors determine the correctness and reliability of the analyses performed by a laboratory. These factors include contributions from: human factors (5.2), accommodations and environmental conditions (5.3), analytical/calibration methods and method validation (5.4), equipment (5.5), measurement traceability (5.6), and sample management - handling of test/calibration items (5.8).

5.1.2 The extent to which the factors contribute to the total uncertainty of measurement differs considerably between types of analyses. ESC takes into account these factors in developing analytical procedures, in the training and qualifications of personnel, and in the selection and calibration of the equipment utilized.

5.2 PERSONNEL

5.2.1 General Personnel Management

ESC management ensures the competency of all who operate specific equipment, who perform analyses, and who evaluate results and approve data reports. Approved signatories for support documents and final reports are kept by the Regulatory Affairs Department and, likewise, documents are maintained within each analytical department for the analysts. Personnel performing specific tasks are qualified on the basis of appropriate education, training, experience, and/or demonstrated skills, as required.

5.2.2 Training

All training and education requirements are outlined in SOP# 030205, *Technical Training and Personnel Qualifications*. Training requirements for safety and health are listed in the *Chemical Hygiene and Laboratory Safety Plan.* When staff members undergo training, adequate and appropriate supervision by fully trained analysts is provided.

5.2.2.1 Corporate Documents

All employees are required to read relevant corporate documents. At a minimum this includes:

- ESC Policy Manual
- ESC QA Manual
- Chemical Hygiene and Laboratory Safety Plan
- SOPs (As specified/required for work area)

Records of verification are required for each individual and are retained on file for a minimum of 10 years.

5.2.2.2 Specific Documents

Analysts are also required to undergo training specific to their position. This includes the following:

- Documented review & acknowledgement of Method Specific SOPs
- Documented review & acknowledgement of published methods related to the specific SOP
- Documented review & acknowledgement of other supporting methods related to the specific determinative SOP
- Certification Statement of acceptable performance of an Initial Demonstration of Capability (according to method criteria)
- Continuous acceptable performance on daily/batch control samples
- Performance Testing, where required, is reviewed as continued verification of analyst proficiency.
- Educational/training courses are provided where required by the position.
- Certification Statement of acceptable performance of a Continuing Demonstration of Capability (according to method criteria)

Records of verification are required for each individual and are retained on file for a minimum of 10 years.

5.2.2.3 Routine Training

Any routine training and re-training necessary for a person to perform a particular job effectively is specified in job descriptions, process procedures, maintenance procedures, etc., as appropriate.

5.2.2.4 Special Training

Special training required as a result of new technologies, contracts, expanding markets, company-wide improvement programs, new method development, etc. is conducted as the need arises.

5.2.2.5 Annual Training

An annual training plan is established by management and in conjunction with regulatory requirements. The plan is maintained by the Regulatory Affairs Department, which specifies details of the training to be carried out in each department to permit effective implementation of the management system. Managers ensure that the plan is implemented within their areas of responsibility.

5.2.3 General Responsibilities

See Organization Chart in Section 4.0 for more detailed information regarding company organizational structure.

Chemist/Analyst:

- Performs sample analyses
- Verifies detail and accuracy
- Records pertinent information in laboratory notebooks
- Stores all data (files and discs)
- Updates QC charts – where applicable
- Prepares and completes benchsheets/raw data for review

Laboratory Director:

The Laboratory Director is responsible for all operational laboratory activities. The Laboratory Director must approve the *Quality Manual*.

Laboratory Group Leader, Department Manager:

Day to day supervision of technical laboratory operations is the responsibility of these leaders who are full-time members of the staff and who assure reliable data through the following activities: monitoring quality control, corroborating the analysis performed, and approving demonstrations of capability. Additionally they certify that personnel with appropriate educational and/or technical background perform all analyses for which the laboratory is accredited. The laboratory group leader or supervisor oversees analytical raw data, ensures calculation/calibration correctness, and reviews instrument and sample preparation logs.

Laboratory QA Officer (Also called QA Manager)

The QAO has the authority and responsibility for ensuring that the quality system is implemented and followed. The QAO has direct access to the Laboratory Director and is independent of operations.

The QAO routinely reviews QA/QC policies for all analyses to ensure that the data is evaluated within method requirements. The QAO is also responsible for assessing data that is out of compliance and ensuring that necessary corrective action measures are taken and are effective.

***Laboratory QC Manager* (Also called QC Officer, QCO)**

The QCO shares the authority and responsibility for ensuring that the quality system is implemented and followed. The QCO has direct access to the Laboratory Director and is independent of operations.

The QCO routinely reviews QC policies for all analyses to ensure that the data is evaluated within method requirements. The QCO is also responsible for data review and is responsible for ensuring method/program compliance and that necessary corrective action measures are taken, completed, and remain effective.

QC Specialist (QCS)

Each ESC Analytical Division employs the use of a QC Specialist (QCS). This individual has analytical experience in their assigned area and reports to the QCO. Working knowledge of the instrumentation, printouts, and processes is key to successful approval of data being generated in that area. The QCS gives final approval of the initial raw data. The QCS is responsible for the review of data for method compliance. In addition, the application of qualifiers is verified and approved. If the QCS determines a result to be questionable, the data is given to the Department Manager to initiate appropriate action based on the severity of the problem.

Technical Specialist

Technical Specialists are a part of the Regulatory Affairs Department. These individuals have comprehensive experience in their areas of expertise. The Technical Specialist may be called upon for data interpretation, where compliance issues arise. In addition, these individuals often interface with the clients where questions arise concerning methods, data interpretation, and recommendations concerning alternate analyses.

Technical Service Representative (TSR)

The TSR is responsible for final report review. Once the data has completed the laboratory validation steps, the final report is generated. The TSR reviews the data for completeness and any outstanding anomalies. If an error is suspected, the report is delayed until the appropriate Department Managers can be contacted to resolve the question. Each TSR has laboratory experience in one or more departments.

LIMS Specialist

The LIMS Specialist tracks internal sample custody, computerizes data, and stores it in the LIMS system.

5.2.4 Job Descriptions

Employee qualification requirements are maintained by the Human Resources Department and are facilitated through the use of written job descriptions. Educational requirements and experience are included in the job description. The Department Manager determines specific education and experience requirements for individual positions based on the particular department need.

5.2.5 Training Records

Details of any employee training performed at ESC are recorded on training records. Procedural training records are maintained within each department, while policy records are maintained by Human Resources. Training on new or revised Standard Operating Procedures is maintained with the Master copy of the procedure by the Regulatory Affairs Department.

5.3 ACCOMMODATION & FACILITY DESIGN

5.3.1 Laboratory Facilities

The design of the laboratory supports good laboratory practices and does not adversely affect measurement integrity.

5.3.2 Environmental Conditions

All ESC laboratory facilities, analytical areas, energy sources, lighting, heating, and ventilation facilitate proper performance of calibrations and tests. The laboratory ensures that dust, electromagnetic interference, humidity, line voltage, temperature, sound and vibration levels are appropriately controlled for specific measurement results and do not adversely affect accuracy or increase the uncertainty of each measurement.

Environmental conditions are recorded on all data sheets, when monitoring is required. The laboratory documents deviations and corrective actions when environmental conditions are not within specified conditions.

Environmental conditions maintained by the laboratory, listed in Section 5.3.5 are within the limits recommended in **ANSI/AIHA Z9.5-2003**. Measurements are not made if environmental conditions deviate from those stated.

Laboratory staff ensures adequate conditions in the facility using the steps listed below:

- Verify that air conditioning, lighting, heating, and ventilation are controlled and monitored.
- Maintain good housekeeping practices to promote a clean, uncluttered laboratory.
- Have sufficient space to minimize the risk of injury to staff and/or damage to standards or equipment
- Maintain a convenient and efficient work environment with effective separation of incompatible activities.
- Limit the amount of paper products used or stored in sensitive and/or clean areas to prevent dust contamination.

5.3.3 Separation of Incompatible Activities

The ESC complex facilitates the physical separation of analytical activities to prevent possible contamination between departments.

Each laboratory structure is specifically designed for the type of analytical activity that it contains. The air handling systems, power supplies, and gas supplies are specific for each laboratory department.

The following areas are designated and maintained under proper conditions and security:

- Sample Receiving
- Sample/supply shipping
- Chemical Storage
- Waste storage/disposal
- Data Handling
- Data Archiving

Routinely, the departments are required to maintain cleanliness and exercise good housekeeping measures to further minimize potential for contamination that could adversely affect analytical processes.

5.3.4 Facilities Access Management

Entrance into any ESC building requires an electronic ID badge with appropriate assigned access. Access is controlled to each area depending on the required personnel, the sensitivity of the operations performed, and possible safety concerns. Chemical/receipt and storage is assigned to the purchasing department and is access controlled by an attendant who organizes and maintains the inventory.

5.3.5 Good Housekeeping

ESC ensures good housekeeping practices in all facilities to maintain a standard of cleanliness necessary for analytical integrity and personnel health and safety. Some areas are periodically monitored to detect and resolve specific contamination and/or safety issues**.**

5.4 TEST METHODS AND VALIDATION

Method Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

5.4.1 General

5.4.1.1 ESC uses appropriate methods and procedures for all analyses within its scope. These include sampling, handling, transport, storage and preparation of items to be analyzed and/or calibrated, as well as statistical techniques for analysis of data and, where appropriate, an estimation of the associated measurement uncertainty.

5.4.1.2 ESC has instructions on the use and operation of all relevant equipment and on the handling and preparation of items for analysis, where the absence of such instructions could jeopardize the results. All instructions, standards, manuals and reference data relevant to the work of the laboratory are maintained current and be made readily available to personnel (see 4.3).

5.4.1.3 Deviation from methods occur only if the deviation has been documented, technically justified, authorized, and accepted by the client.

5.4.2 Selection of Methods

5.4.2.1 The laboratory uses analytical methods, including methods for sampling, which meet the needs of the client and are appropriate for the analyses performed. Methods utilized are preferably those published as international, regional, or national standards. The laboratory ensures that it uses the latest valid edition of a method unless it is not appropriate or possible to do so or unless regulatory requirements dictate specific revision use. Methods are supplemented with Standard Operating Procedures that list additional details to ensure consistent application.

Where mandated, only approved procedures are used. ESC utilizes a number of method sources to accomplish project requirements. See Section 2.1.3 for a list of method references.

5.4.2.2 When the client does not specify the method to be used or if a client selects an inappropriate or out of date method, the laboratory selects appropriate and approved methods that have been designated by the project regulatory program. The client is informed as to the method chosen and client confirmation is required.

5.4.3 Laboratory Developed Methods

5.4.3.1 Introduction of analytical methods developed by the laboratory for its own use is a planned activity and is assigned to qualified personnel equipped with adequate resources.

5.4.3.2 Plans are updated as development proceeds and effective communication is maintained with all personnel involved in the development process.

5.4.4 Non-Standard Methods

5.4.4.1 When it is necessary to employ methods not covered by approved industry standard methods, these are subject to agreement with the client and must include a clear specification of the client's requirements and the purpose of the analysis. The method developed must be validated appropriately before use.

5.4.4.2 For new analytical methods, procedures are developed prior to the analysis and contain at least the following information:

- appropriate identification
- scope
- description of the type of item to be analyzed
- parameters or quantities and ranges to be determined
- apparatus and equipment, including technical performance requirements
- reference standards and reference materials required
- environmental conditions required and any stabilization period needed
- description of the procedure, including:
  - affixing identification marks, handling, transporting, storing and preparing of items,
  - checks to be made before the work is started,
  - verifying equipment function and, where required, calibrating and/or adjusting the equipment before each use,
  - method of recording the observations and results
  - any safety measures to be observed;
- criteria and/or requirements for approval/rejection;
- data to be recorded and method of analysis and presentation;
- uncertainty or procedure for estimating uncertainty.

5.4.5 Validation of Methods – ESC SOP #030211, *Method Validation*

5.4.5.1 Validation Description

Validation is process of confirmation by examination and the provision of objective evidence that the stated requirements for a specific method/procedure are fulfilled.

5.4.5.2 Validation Summary

The laboratory validates all methods, including the following: EPA, NIOSH, OSHA, and program mandated methods, approved methods used outside their intended scope, non-standard methods and amplifications, and modifications of approved methods to confirm that the methods are fit for the intended use. The validation is as extensive as is necessary to meet the needs in the given application or field of application. The laboratory records the results obtained, the procedure used for the validation, and a statement as to whether the method is fit for the intended use.

5.4.5.3 Validation for Client Need

The range and accuracy of the values obtainable from validated methods (e.g. the uncertainty of the results, detection limit, selectivity of the method, linearity, limit of repeatability and/or reproducibility, robustness against external influences and/or cross sensitivity against interference from the matrix of the sample.) are assessed for the intended use as relevant to the clients' needs.

5.4.5.4 Limits

Descriptions of analytes, preparative and analytical methods, matrices, accuracy and precision targets, and MDLs and RLs are presented in the QAM Appendices.

Method Detection Limits (MDLs) – 40CFR, Part 136, Appendix B - SOP# 030206, *Method Detection Limits*

All detection limits are comparable to those established by the EPA and are not typically lower than recommended detection limits. To determine whether the EPA detection limit is being achieved, an MDL study is performed according to 40 CFR Part 136, Appendix B. The standard deviation of, at least,seven standards at or near the expected detection limit is calculated. MDLs are determined such that the risk of reporting a false positive is less than 1%. The method detection limit (MDL) is calculated as follows:

$$MDL = TS$$

where: S is the Standard Deviation of replicate measurements and
T is the value of Student’s T for n-1.

If the MDL is higher than the EPA-method-suggested MDL, the calculated value is used as a basis for establishing the reporting limit (RL) for reporting. MDLs are re-calculated on an annual basis or sooner if a material change in the instrumentation or method is enacted, or a change in the calibration response factor is noted. Additional studies may also be conducted to enhance the program.

Published MDLs may be set higher than experimentally determined MDLs to: 1) avoid observed positive interferences from matrix effects or common reagent contaminants or 2) for reporting convenience (i.e., to group common compounds with similar but slightly different experimentally determined MDLs).

Reporting Limits (RLs)

Reporting Limits (RLs) are typically set 3 - 10 times the standard deviation calculated in the MDL process listed above. Because reporting level checks are required, ease of preparation of commercial analytical mixes may dictate, to some extent, the reported RL. Generally, the RL is not set at less than 3 times the MDL. The final RL is determined based on the matrix, method, and analyst experience. RLs are verified daily using a calibration standard at a level equal to or less than the established RL.

ESC – Practical Detection Limit

Where necessary, ESC uses in-house protocol to determine a practical and real number for method detection. This is not a statistically derived number. It is a verified number that is validated using a 20% coefficient of variation. Signal to noise ratios and baseline behaviors are assessed and considered for each instrument type. Instrument performance is assessed based on the lowest possible detectable concentration that is 3X above the noise level. A series of samples are prepared at the determined level, using the method protocol. The samples must perform within a 20% coefficient of variation. The lowest concentration that meets the criteria is the Practical Detection Limit. This determination either confirms or replaces the MDL as determined using 40CFR Part 136.

5.4.5.5 Demonstration of Capability

Initial and Continuing Demonstration of Capability (IDOC & CDOC) (General Testing Other Than Environmental Lead)

NOTE: All IDOC & CDOC records are kept on file by the laboratory. Supporting data is filed with each demonstration. Completion is recorded on the form found in the NELAP Standard Appendix C. Records of verification are required for each individual and are retained for a minimum of 10 years.

General Requirements:

- A DOC is performed for each analyte whenever the method, analysts, analytes, or instrument type is changed.
- The Department Supervisor certifies that technical staff members in their area of expertise are trained and authorized to perform all analyses for which the laboratory is accredited by signing the DOC form. The QA department is the final approval of all IDOCs and CDOCs
- More specific information can be found in SOP# 030205: *Technical Training and Personnel Qualifications*

IDOC

An initial demonstration of capability (IDOC) must be made prior to using any analytical method, at any time there is a significant change in instrument or method, and when a new analyst is trained. An analyst can achieve the IDOC requirement for a specific method by using sample spike results. The following guide is a general outline of the IDOC requirements:

- A quality control sample is obtained from an outside source. If not available, the QC sample may be prepared by the laboratory using stock standards that are prepared independently from those used in instrument calibration.
- The analyte(s) is diluted in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified, or if unspecified, to a concentration approximately 10 times the method stated or laboratory-calculated method detection limit.
- At least four aliquots are prepared and analyzed according to the method either concurrently or over a period of days.
- Using all of the results, calculate the mean recovery (x) in the appropriate reporting units (such as µg/L) and the standard deviations of the population sample (n-1) (in the same units) for each parameter of interest. When it is not possible to determine mean and standard deviations, such as for presence/absence values in micro and mold analyses, the laboratory must assess performance against established and documented criteria.

- Compare the information from above to the corresponding acceptance criteria for precision and accuracy in the published method. If no method criteria exist, the IDOC performance must be compared to in-house QC limits for laboratory control samples (LCS). Where appropriate, limits may be compared to the criteria listed in DOD QSM. If all parameters meet the acceptance criteria, the analysis of actual samples may begin. If any one of the parameters does not meet the acceptance criteria, the performance is unacceptable for that parameter. The analyst completes further training before attempting the IDOC process again.

CDOC

Continuing Demonstration of Capability (CDOC) are performed at least annually by documentation that technical personnel have read, understood and agreed to perform the most recent version of the analytical method (the approved method or standard operating procedure) and documentation of continued proficiency by at least one of the following once per year:

- Acceptable performance of a blind sample (single blind to the analyst);
- Another demonstration of capability using at least four consecutive laboratory control samples with acceptable levels of precision and accuracy
- Successful analysis of a blind performance study sample

Initial and Continuing Demonstration of Capability (IDOC & CDOC)
(Environmental Lead Only)

IDOC

Analysts/Technicians in training complete a minimum of four independent test runs of sample preparation and/or instrumental analysis. Independent runs are defined as analytical runs consisting of at least five known samples, one of which is a certified reference material or proficiency testing material, separated by a period of time sufficient to evaluate the testing material.

- Sample Preparation and Analytical Personnel - the recoveries of the associated reference materials or proficiency training samples for each run must be within ±10% of the certified value, 75% of the time.

NOTE: The reference/proficiency test samples utilized are: 1) similar to matrices the analyst encounters during routine sample analysis, 2) cover the sample mass range for which the analytical SOP has been designed and 3) cover the Lead (Pb) concentration for which the analytical SOP has been designed. In cases where there are several matrices of potential concern, four independent runs are not be sufficient to provide adequate demonstration of performance.

CDOC

Annual demonstrations are performed by Analysts/Technicians involved in Lead (Pb) analyses to showed continued ability to adequately analyze samples for Lead (Pb) based on standard reference materials (SRMs) or certified reference materials. This demonstration is done at a minimum of every six months and can be a part of the analysis of proficiency testing materials or quality control samples associated with routine sample runs.

5.4.6 Measurement Uncertainty - ESC SOP# 030221, *Measurement of Uncertainty*

5.4.6.1 Uncertainty Definition

Uncertainty is defined as a variable associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurement type. This definition of uncertainty focuses on the range of values that is relevant to the analytical technique being utilized for the analysis of field samples.

The uncertainty of testing results are calculated and documented in accordance with the requirements of ISO 17025 Clause 5.4.6. The Estimation of Uncertainty of Measurement Procedure is applied to all in-house analytical methods, where practical. The uncertainty of measurement determination is also required of all ESC subcontractors.

5.4.6.2 Uncertainty Procedure

The Estimation of Uncertainty of Measurement Procedure is applied for estimating uncertainty of measurement, except when the analytical methods preclude such rigorous calculations. In certain cases it is not possible to undertake metrologically and statistically valid estimations of uncertainty of measurement. In these cases the laboratory attempts to identify all the components of uncertainty and make the best possible estimation, and ensure that the form of reporting does not give an exaggerated impression of accuracy. Reasonable estimation is based on knowledge of the performance of the method and on the measurement scope, and makes use of previous experience and validation data.

The degree of rigor needed in an estimation of uncertainty of measurement depends on factors such as:

- Requirements of the method
- Requirements of the client
- The existence of narrow limits on which decisions on conformance are based

In practice the uncertainty of the result may arise from many possible sources, including an incomplete definition, sampling, matrix effects and interferences, environmental conditions, uncertainties of weights and volumetric equipment, reference values, approximations and assumptions incorporated in the measurement method and procedure, and random variation.

In cases where a well-recognized method specifies limits to the values of the major sources of uncertainty of measurement and specifies the form of presentation of calculated results, the laboratory is considered to have satisfied the estimation uncertainty of measurement by following the method and reporting instructions (see section 5.10).

5.4.6.3 Uncertainty Determination

Where possible, ESC utilizes data from Laboratory Control Samples (LCS) to determine the minimal uncertainty estimates in each matrix. LCSs are matrix dependent and are consistent representatives of the method effects on the particular matrix of choice. Uncertainty is determined per analytical technique, where applicable, and is performed using a population of 50 or more data points. Since the uncertainty is essentially constant, for each method, across a given matrix, ESC's method of choice is to determine uncertainty at the 95% confidence interval.

Procedure Summary:

- Select a group of representative data, from a single matrix. Data set must be 50 individual measurements or greater.
- Determine the relative standard deviation of recovery data
- Calculate the expanded uncertainty as two times the relative standard deviation

5.4.6.4 Uncertainty Results

ESC does not report uncertainty measurements on the final report. However, uncertainty determinations are available for review, when specifically requested for a project. The measurements are only applicable to the specific analytical procedure and matrix. No effects of sampling activities or related processes are considered in this determination.

5.4.7 Control of Data

5.4.7.1 Transfer Checks

Calculations and data transfers are subject to appropriate checks in a systematic manner.

5.4.7.2 Automated Acquisition

When computers or automated equipment are used for the acquisition, processing, recording, reporting, storage or retrieval of data, the laboratory ensures that:

- computer software developed by the user is documented in sufficient detail and suitably validated as being adequate for use
- procedures are established and implemented for protecting the data; such procedures includes, but not be limited to, integrity and confidentiality of data entry or collection, data storage, data transmission and data processing
- computers and automated equipment are maintained to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of data.

5.4.7.3 Commercial Software

Commercial “off the shelf” software, e.g., word processing, database and statistical programs in general use within its designed application range may be considered sufficiently validated. However, laboratory software configuration/modifications are validated as in 5.4.7.2.

5.4.7.4 ESC Software Systems

Table 5.4.7.4a LIMS

System	Description
LIMS	The LIMS is a computerized database for data management. Access to the system is protected by coded password and access is granted based on user need.
Security	Level 1. Login, lookup sample status, generates worksheets. General access, every station has access. Level 2. Enter data, proofread and change data. The data entry person has access to this level. Level 3. Review and validate data, generate reports. Access is limited to the TSR, lab supervisors and QA. Once data is approved in the LIMS, it cannot be altered. Only the status of the sample may be changed to either "reported" or "invoiced."
Hardcopy Records	• Login summary - includes all information on sample and requested analyses • Lab preparation preview and benchsheets for digestions, extractions • Lab assignment/benchsheets to generate work assignments and record data • Data approval reports • Final reports for clients • QA summary
Hardcopy Records	All paper records are retained by ESC. As the pages become historical (prior to the current working range of log numbers), they are removed from the logbook, prep book, or workbook in sequential order and permanently bound for storage in banker's boxes. The Lab Support Supervisor maintains a log of numbered boxes and their contents. They are cross-referenced by sample log number, date and storage number.

Table 5.4.7.4a LIMS	
System	**Description**
Data Records	*Data* is available on electronic media. *Revisions* to the LIMS software are documented within the code. Each revision indicates the change in function, programmer's initials, and date of change. Programming has limited access and is accessible only by approved individuals through the use of passwords.
Manual Data Entry (verified by 4-step system)	• The section supervisor first approves raw data. • The data entry portion of the LIMS can only be accessed by authorized individuals, therefore allowing limited access to protect the integrity and maintain the confidentiality of the data. • The data entry person and a qualified laboratory analyst then proofread each group of entered data. • When all results for a sample are complete, a report is printed and examined by a Technical Service Representative for final approval.
Calculations	All calculations performed by the LIMS are approved and submitted by the Laboratory Supervisors. Each calculation is tested parallel to manual calculations to ensure proper function.
Automatic Data Transfer	Data is transferred electronically from instrumentation directly to the LIMS. Once the data has been transferred, it undergoes a screen review. The data is then printed and reviewed again. If data needs to be changed, a data entry specialist changes it and a hardcopy is printed of the final data.

Table 5.4.7.4b AUXILIARY SOFTWARE	
System	**Description**
Auxiliary	Auxiliary Computer and Software Used to Generate and Validate Data
General	Several instruments have their own dedicated single computer and manufacturer-designed software to run them. Instruction manuals and other documentation provided by each manufacturer are maintained. ESC receives updates as they become available from the manufacturer. All raw and filtered data is stored on media (with uniquely titled data files on floppy discs) and all associated printouts and paperwork is filed. The original raw data is not accessed again unless it is subjected to uncertainty.
Method Files	Creation of any method or analyte files, necessary to run the appropriate analyses is the responsibility of the group leader. The lab supervisor verifies that the compounds, wavelengths, retention time windows, calculation criteria, and other relevant parameters are correctly input into the specific method file. Analysts may only use the method files that have been specifically generated by the group leader.
Supplier Info	All purchased software that is used in conjunction with software specific instruments is guaranteed by the supplier to function as required. The supplier of the software performs all troubleshooting or software upgrades and revisions.
Validation	Computer software is validated for proper performance. The result of the validation is recorded, when in-house programming is the source of the calculation.

5.5 EQUIPMENT

5.5.1 Usability

Laboratory standards, equipment, and associated apparatus are suitable for the validation of acceptable performance of analyses and are maintained in accordance with this quality manual to include protection from dirt, dust, corrosion, and other causes of deterioration. Laboratory personnel investigate any equipment or standards, which are suspect in contributing to out-of-control conditions. Records of corrective actions for discrepancies are maintained in the laboratory (see Section 4.11).

5.5.2 Calibration of Equipment

5.5.2.1 To maintain the integrity of standards, all maintenance operations are performed according to documented procedures and the laboratory standards are:

- Selected for use according to the level of precision, accuracy, and uncertainty required
- Limited in access and use, to trained and authorized laboratory staff only
- Handled and safely stored according to method requirements

5.5.2.2 Primary standards, directly traceable to NIST standards, are obtained from a vendor approved by the A2LA or NELAP and all certificates of analysis are maintained on file in the laboratory.

5.5.2.3 Secondary standards are also obtained from a vendor approved by the A2LA or NELAP and all certificates of analysis are maintained on file in the laboratory. They are calibrated by comparison to primary standards. Calibration reports are maintained on file in the laboratory.

5.5.2.4. Working standards are prepared from certified stock standards. Standard preparation logs are maintained electronically via the Standards Logger in the ESC LIMS.

5.5.2.5 Support Equipment Calibration: Including, but is not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices, volumetric dispensing devices, and thermal/pressure sample preparation devices. All support equipment is maintained in proper working order and records are kept of all repair and maintenance activities, including service calls.

5.5.2.6 Equipment used with nominal values and corrections is verified by calibration labs having ISO 17025, or other suitable, accreditation. A calibration interval is established for the equipment (i.e., environmental equipment, balances).

5.5.2.7 Calibration of equipment is conducted at a frequency to ensure that the equipment remains in tolerance during its use in the laboratory. Frequency of calibration is based on a review of calibration, maintenance, and repair history. Reviews are conducted by the Department Manager and records are maintained.

5.5.3 Equipment Operation and Maintenance – See Table 5.5.3.3 for General Information

5.5.3.1 ESC's preventative maintenance program provides guidelines to ensure that every effort is made to keep equipment well maintained and prepared for the next project. Most equipment is kept in duplicate and spare parts are kept in stock. Instrument/equipment manuals are kept in each department for quick reference to aid in problem diagnosis. ESC maintains service contracts on major laboratory equipment, so that in the event of failure, repairs can be made within a few days. The appropriate Department Manager is consulted if an instrument repair is required. If a solution to the problem is not found immediately, a call may be placed to the instrument manufacturer or maintenance support provider for assistance in diagnosing the problem, determining the extent of repair needed and a possible timeframe for repairs to be completed.

5.5.3.2 If analyses are scheduled and it appears that the equipment may be down for a longer period, ESC arranges for analyses to be performed by another qualified lab. This action is utilized if client required definite turnaround time or sample holding times would be exceeded.

5.5.3.3 General Equipment (All Labs)

If method calibration requirements for a particular procedure are more stringent than those listed here, they are followed when that procedure is performed.

Table 5.5.3.3a General Equipment Calibration			
Equipment	**Activity**	**Frequency ***	**Record Type**
Balances	Verified with Class I NIST traceable weights when used	Before use	Logbook – Located in each respective lab
Balances	• Clean • Check alignment • Service Contract Top-loading balances are allowed a tolerance of ±1%, while analytical balances are allowed a tolerance of ±0.1%.	Semi-annually under a service contract.	Certificates from contractor.
Weights – Class I	• Only use for the intended purpose • Use plastic forceps to handle • Keep in case • Store in desiccator • Re-calibrate	Checked for accuracy by an external source, annually, or sooner if necessary.	Certificates from contractor.
pH meters and probes	Calibration: • pH buffer aliquot are used only once • Buffers used for calibration bracket the pH of the media, reagent, or sample analyzed. • Check must perform within 0.05 pH units. Temperature correction is performed either automatically by the instrument or manually depending upon the instrument used.	Before use	Calibrations are recorded in a logbook.
Automatic pipettes	Verify for accuracy and precision using reagent water and analytical balance	In-house – Monthly Contract – Semi Annually Tolerance is set at 2.0%, (ASTM standard = 3%).	Monthly verifications are recorded in a logbook. Semi-annual cal. is verified by certificates from the cal. service.
Refrigerators, Freezers, Hot plates and BOD incubators	• Thermometers are immersed in liquid to the appropriate immersion line • The thermometers are graduated in increments of 1°C or less	Temperatures are recorded each day in use	Logbook
Ovens	• Thermometers are immersed in sand to provide even measurement • The thermometers are graduated in increments of 1°C or less	Temperatures are recorded each day in use	Logbook

Table 5.5.3.3a General Equipment Calibration			
Equipment	**Activity**	**Frequency ***	**Record Type**
Thermometers	ESC NIST certified thermometers	Calibrated annually by a NIST calibration service, accredited to ISO/IEC 17025 and ANSI/NCSL Z540-1.	Calibration certificates from the calibration service.
DO Meter	Calibrated according to manufacturer's specifications. Using the recorded temperature and barometric pressure the meter is calibrated to the air saturation of dissolved oxygen using a conversion chart provided by the manufacturer.	Before use	Calibration of each meter is recorded in a separate logbook.
Specific Conductivity Meter	The conductivity meter is calibrated according to manufacturer's specifications. Temperature correction is performed either automatically by the instrument or manually depending upon the instrument used. • Biomonitoring, potassium chloride with a conductivity value of 100 and 1000 umhos/cm is used as the calibration standard. • Wet Lab, potassium chloride with a value of 1413 umhos/cm is purchased from NSI for calibration purposes.	Before use	Calibration of each meter is recorded in separate daily logbooks.
Fume Hoods	Check semi-annually and must meet the OSHA minimum recommended face velocity of 60 – 100 fpm.		Recorded in Logbook

Table 5.5.3.3b Class 1 Weight Tolerance				
Value	**ASTM Class 1 Tolerance**	**Unit**	**ASTM Class 1 Tolerance**	**Unit**
1mg	0.01	mg	0.00001	g
2mg	0.01	mg	0.00001	g
3mg	0.01	mg	0.00001	g
5mg	0.01	mg	0.00001	g
10mg	0.01	mg	0.00001	g
20mg	0.01	mg	0.00001	g
30mg	0.01	mg	0.00001	g
50mg	0.01	mg	0.00001	g
100mg	0.01	mg	0.00001	g
200mg	0.01	mg	0.00001	g
300mg	0.01	mg	0.00001	g
500mg	0.01	mg	0.00001	g
1g	0.034	mg	0.000034	g
2g	0.034	mg	0.000034	g
3g	0.034	mg	0.000034	g
5g	0.034	mg	0.000034	g
10g	0.05	mg	0.00005	g
20g	0.074	mg	0.000074	g
30g	0.074	mg	0.000074	g

5.5.4 Identification of Equipment

Each item of equipment is uniquely labeled, marked or otherwise identified. Maintenance and calibration records for equipment and standards are maintained.

5.5.5 Records of Equipment

Equipment lists are department specific and are found in the associated appendices to the QA Manual.

5.5.6 Equipment Handling, Storage, Use, and Maintenance

All laboratory equipment is maintained, stored, and used in accordance with manufacturer's instructions. Operation manuals and instructions for proper maintenance of equipment are available to the staff and located in the laboratory.

Equipment is used or operated only when in a safe and reliable condition, by personnel who have been trained and are qualified. User instructions are available.

Table 5.5.6 - GENERAL PREVENTATIVE MAINTENANCE	
Type	***Description***
Glassware	Routine laboratory glassware is washed in a non-phosphate detergent and warm tap water. Before washing, all writing and large deposits of grease are removed with acetone. Glassware is then rinsed with: tap water, "No Chromix" solution, tap water, and deionized (DI) water. Glassware is stored in designated drawers or on shelves, inverted if possible. All organic glassware is rinsed with the required solvent, prior to use. Inorganic glassware is rinsed with DI water prior to use, which is a precaution against airborne cont.
Logbooks	Maintenance logs are kept on all major laboratory equipment. The logbook is updated and signed when maintenance is performed (i.e., new rings, column or septum change, etc.). Maintenance logbooks are located in the immediate area of the instrument. All preventive maintenance is noted either in the maintenance logbook or in the runlog notebook. At a minimum, all maintenance logs contain the following: • All entries in the maintenance logs must be initialed and dated by the person performing the maintenance. • All maintenance logs must be bound and paginated. • All pages of the maintenance logs must have “ESC” at the top of page. • The instrument ID number, or serial number. • Make and model of the instrument. • Date of installation, or the date the instrument was put in service (if available). • Condition of the instrument when installed (new or used) • A unique number for each notebook
Service Records	Maintenance that requires a service call from the vendor should contain the following: • Must state details when the problem began, and what the problem was. • When a service call was placed. • When the service engineer came to repair the instrument. • When the problem was solved. • How the problem was solved. To verify that the instrument is running properly after service has been performed, recalibrate and analyze QC samples before the service engineer leaves.
Additional Records – Misc. Monitoring	Additional records are kept, updated and signed when technicians are assigned to perform the following tasks: • Monitor laboratory devices such as air compressors, vacuum pumps, heaters, etc., to ensure that they are properly lubricated and in good working condition. • Monitor on a daily basis: general lab QC areas, such as BOD incubators, temperature, drying ovens, desiccators, deionized water, sample cooler temperature, etc., and record appropriate parameters in the assigned QC logbooks. • Monitor the supply and quality of purchased chemicals, reagents and glassware, and keep inventory at established levels. All chemicals are dated in relation to receipt and date opened.

5.5.7 Equipment Out of Service

When equipment is found to be in unacceptable condition or has been subjected to overloading or mishandling or if an instrument gives suspect results or has been shown by verification or otherwise to be defective, the equipment is clearly marked as out-of-service. Only the analyst responsible for the repair, or the Department Manager, can place equipment back in service. Once repaired and validated by calibration, verification, or other appropriate reviews, and found to perform satisfactorily, the equipment can be placed back in service. The laboratory examines the possible effect of defective equipment on any previous calibrations.

5.5.8 Status of Calibration

When appropriate, each item of equipment is labeled, marked, or otherwise identified to indicate its calibration status.

All equipment used with nominal values and corrections is labeled indicating the calibration status. Examples of this equipment include thermometers, calibration weights, and balances.

5.5.9 Equipment Returning to Service

When for any reason, equipment goes outside the direct control of the laboratory, the laboratory ensures that the function and calibration status of the equipment are checked and shown to be satisfactory before the equipment is returned to service.

5.5.10 Calibration Checks

Analytical instruments are calibrated per method requirements. Balances and temperature-indicating devices are verified semiannually. Records are maintained as quality assurance documents.

5.5.11 Calibration Factors

Where calibrations give rise to a set of correction factors, the laboratory has procedures to ensure that copies (e.g., in computer software) are correctly updated.

5.5.12 Safeguarding of Equipment Integrity

Analytical and supporting equipment is protected from inadvertent adjustments that could affect the integrity of the laboratory results. Instruments are located in access-protected areas. Software is tested and approved before use. Spreadsheets used in the calculation of analytical results are tested, approved, and locked before being placed into service.

5.6 MEASUREMENT TRACEABILITY

5.6.1 Policy (See SOP# 030202, *Receipt and Records of Stock, Intermediate, and Working Standards)*

5.6.1.1 Standards and equipment significantly affecting the measurement integrity of analyses conducted by the laboratory are monitored for stability as part of the measurement control program. Standards and equipment are calibrated and/or verified before use to ensure acceptable performance. Any standard or equipment that appears unreliable or has exceeded the calibration interval is evaluated and/or removed from service.

5.6.1.2 When standards, reagents, or other certified consumables are received, they are assigned a unique number. The number is recorded in the LIMS Standards Logger with other important information concerning receipt date, supplier, expiration date, description, and volume. The number is then placed on the item and the Certificate of Analysis. The Certificate of Analysis is maintained electronically. Each item is dated upon opening. Each laboratory appendix contains a list of standard sources, receipt, and preparation information. Field personnel obtain several field standards from the lab and the standards are NIST traceable.

5.6.2 Measurement Traceability

5.6.2.1 ESC has established a program of calibration and verification that is designed to ensure that the measurements made by the laboratory are documented and traceable to national standards.

5.6.2.2 To provide external evidence of traceability, the laboratory participates in measurement control programs, such as proficiency tests, and other interlaboratory and collaborative round robins, as required (See SOP# 030212, *PT Program*).

5.6.3 Calibration/Verification

5.6.3.1 Standards (Calibration)

5.6.3.1.1 Primary standards are calibrated to the standards set forth by the National Institute of Standards and Technology (NIST) or by an ISO 17025-accredited provider.

5.6.3.1.2 Primary standards are verified by secondary standards and are monitored through the measurement control programs established in the laboratory.

5.6.3.1.3 Standards are re-calibrated if there is damage to the standards or any significant change is observed in the measurement control program.

5.6.3.2 Standards (Verification)

5.6.3.2.1 Continuous verification of standards, through the measurement control program, ensures required measurement integrity of testing and includes:

- Statistical data from check standards and/or control charts (See SOP# 030207, *Quality Control Charting and Tracking)*
- Results from interlaboratory comparisons and/or proficiency tests (See SOP# 030212, *PT Program*).

5.6.3.2.2 Measurement assurance procedures for verification of standards are maintained in the laboratory, according to the individual method SOPs.

5.6.3.3 Measuring and Test Equipment

5.6.3.3.1 Equipment used with nominal values and corrections is calibrated by calibration labs having ISO 17025 accreditation, other suitable accreditation, or mutual recognition. A calibration interval is established for the equipment.

5.6.3.4 Standard/Reagent Sources, Records, & Preparation

Standard /Reagent Selection

Standards and reagents are selected according to the method requirements. A minimum of analytical reagent grade is used when not method stated. The Laboratory Director or designee(s) makes the actual determination concerning quality and manufacturer. The purchasing agent maintains a list of approved vendors that have been evaluated and approved as suppliers of critical consumables, supplies and services that may affect the quality of environmental testing and calibration. All supplies that are directly used for analysis are inspected and verified upon arrival at the Laboratory. ESC SOP# 030210, *Materials Procurement for Analytical Processes,* details the entire procedure.

Standard/Reagent Inventory

An inventory of consumables and reagents are stocked in the individual laboratory areas. Any overstock items are kept in a controlled area, maintained by the purchasing department. Items are taken from the inventory area to the laboratories upon request.

Standard/Reagent Preparation

When standards are prepared in-house, they are weighed on an analytical balance, calibrated against Class “I” weights, diluted in Class "A" glassware, and compared against an external reference standard. The standard is marked with concentration, then signed and dated by the analyst, and placed in the appropriate storage area.

All dilutions of stock standards are prepared in Class A volumetric glassware. Where dilutions are made to volume, TC (to contain) glassware is used. All volumetric pipettes are Class A and designated as TD (to deliver). If the intermediate or working standards are to be saved and used again, the standard container is marked with concentration, date, source standard, expiration, and the analyst's initials.

All purchased stock standards are kept in a designated area within the appropriate section. Each chemical is marked in relation to date received, date opened, and expiration date.

Standard/Reagent Logbooks

A standard log is kept with each analysis book, indicating date of preparation, which standard (by lot number, if applicable) used, the amount used to prepare the solution, when it was made and expiration date or the recommended holding time. Reagents are recorded in the same manner as standards. Reagents that are prepared on a daily basis are recorded directly onto the raw data sheet. The analyst preparing the reagent initials and dates the raw data sheet. Where appropriate, an electronic LIMS Standard Logger is used in lieu of handwritten logbooks.

5.7 SAMPLING

5.7.1 Sampling Plan

When the laboratory carries out sampling of substances, materials or products for subsequent testing or calibration, it has a sampling plan and procedure for sampling. The sampling plan as well as the sampling procedure are available at the location where sampling is undertaken. Sampling plans are, whenever reasonable, based on appropriate governing methods. The sampling process addresses the factors to be controlled to ensure the validity of the analytical results.

5.7.2 Client Requirements

ESC has no jurisdiction over client deviations from any sampling plan but clients are encouraged to maintain proper records and to include appropriate information in all documents and communications.

5.7.3 Sampling Records

See Appendix III for information regarding the records of relevant field data.

5.7.4 Field Sampling - General Summary

Sample Labels

All sample labels contain the following information: Client name, project name or ID, site ID, sampling point, time collected, and date collected. In addition the label includes information regarding preservation and method assignment. The project ID number is a unique ID number that can be associated with the client overseeing the project. Clients are designated in the ESC LIMS by a unique name referred to as a COCODE. The COCODE always precedes the project ID so that ESC personnel can easily relate a project ID to a particular client. As samples are logged in, they are assigned a unique sequential number. NO login number can be used twice. When the samples are logged in, all field label information is entered. All sample information can be accessed by entering the LIMS and viewing the sample login number. ESC has the capability to access all samples with the same project ID and print a summary of the samples. All field information can be reviewed in the field notebook by date and client.

Field Notebooks

Field notebooks are an essential part of the COC. Every detail concerning the sampling event must be documented. All documentation must be written with waterproof ink. All records are signed and dated by the individuals responsible for making the entry. Errors made during the documentation process are deleted by a single line with the initials of the person who corrected it and the date made.

Crucial information to be recorded in the field notebook includes:

- Site identification
- Sample location
- Date and time of sample collection.
- Names of individual(s) collecting and documenting each sample.
- Names of all individuals present at the time of collection.
- Pertinent field conditions, including weather, site, traffic, other events, problems, etc.
- A copy of the Shipping Batch Detail Report is included as an attachment to the COC with each kit prepared and shipped.
- Specific sampling equipment used for the collection of each individual sample or sample group (Unique equipment identification numbers can be used.)

- If field analyses are performed, calibrations and results are recorded in field workbooks.
- When sampling monitoring wells, the field notes (whether in notebooks or on standard forms) must also document:
  - *Well casing composition and diameter*
  - *Water table depth*
  - *Well depth*
  - *Calculations to determine the volume of water to be purged*
  - *The total volume of water purged and how accomplished*
  - *The date and time well was purged, beginning to end*
  - *Use of fuel-powered units, bailers, etc.*
- When collecting surface water samples, the field notes must include the depth at which the sample was taken and the type of sampling equipment used.
- When water samples are collected over a period of time, it is necessary to indicate the following information in the field notes:
  - Collection beginning and ending time and date
  - Specific equipment used (manual or automatic)
  - Abnormal conditions of the sampling location
  - Safety precautions taken.

Field Chain of Custody (COC)

All field records include the signature of the person(s) responsible for the collection of the samples.

COC forms are completed and returned with the samples collected by ESC personnel. COC forms are also made available to clients collecting their own samples. A copy of the COC is retained in pdf form along with a pdf copy of the final report in the LIMS. The original is returned to the client with the final report. The COC is signed by the sampling personnel in the space referred to as "Collected by:".

A sample label is affixed to the side of each sample container before or at the time of sample collection. Pertinent information on the label includes a unique field identification number, sample description, preservative, method requested, date and time the sample was collected.

5.7.5 Field Quality Control Checks

Blanks collected in the field are considered to be specific quality control for a set of samples. Analytical data that is consequential from the blanks is used to assess the integrity of field sampling and cleaning operations. This data can be used to confirm the use of contaminant-free sample containers and preservation reagents, and/or successful equipment cleaning. Potential on-site contamination, personnel sample collection technique accuracy, and problems that may occur in sample storage and transportation may also be revealed. Field blanks are treated in the same manner as regular samples: preserved with the same reagents, stored and transported in the same containers with samples, etc. For soil or solid samples, deionized water is used for blanks in similar containers.

5.7.5.1 Field/Equipment Blanks

The purpose of field blanks is to evaluate the purity of preservation or additive reagents. Field blanks also represent the collection techniques, general sample containers to be filled, and the effects of on-site environmental conditions and possible contaminants. Field blanks are prepared at sampling locations by filling sample containers with DI water, adding appropriate preservatives or additives, sealing the containers, and completing all paperwork required for the samples. Blanks are stored in the same shipping containers with the samples for transportation back to the lab.

Field blanks are generally collected at a rate of one blank per parameter group per day, or 5% of the samples in the parameter group, whichever is greater.

Equipment blanks help measure the effectiveness of pre-cleaning and field cleaning of equipment. They are used to evaluate sources of contamination that may also be found in a trip blank. Equipment blanks are collected according to the frequency shown in Table 5.7.5. Equipment blanks are prepared by rinsing the equipment with analyte-free water in the same manner as used for sample collection. The equipment blank is placed in the appropriate containers with required preservatives, if any. Blanks must be taken and preserved, where required, for each method group. The blanks are stored in the same shipping containers as samples for transportation back to the lab.

5.7.5.2 Trip Blanks

Trip blanks are used when sampling for volatile organic compounds to evaluate the cleanliness of the sample container, purity of the blank source water, and the exposure of the sample to contaminants during storage and/or transportation to and from the laboratory. The Laboratory supplies the trip blank with the sampling kit order, according to the following:

- The trip blanks are filled with analyte-free water plus any appropriate preservatives. (Matrix specific trip blanks are provided where necessary)
- The containers are sealed, labeled, and transported to the field in the same coolers or boxes with the sample containers to be used for sample collection.
- Trip blanks are not opened in the field.
- The trip blanks must be handled in the same manner as the samples being collected and are transferred (if required) with other samples for storage and transportation to the laboratory.
- If additional blanks (field and equipment) are necessary the same source water as the trip blanks are used.
- One trip blank per parameter group per cooler are used in the sampling event.
- The client is notified if the trip blank does not return with the sample set and a nonconformance is issued.

TABLE 5.7.5.2 EQUIPMENT BLANK COLLECTION PROCEDURE FOR EACH TYPE OF SAMPLING EQUIPMENT

No. of Samples	Precleaned Equipment Blank Per Parameter Group Prior to Sample Collection	Field-Cleaned Equipment Blanks Per Parameter Group
Less than 10	1 equipment blank if no field cleaning on site; OR	1 equipment blank for field-cleaned equipment
Greater than 10	1, or 5% of equipment sets, whichever is greater	1, or 5% of equipment sets cleaned, whichever is greater

NOTE: Equipment blanks must accompany samples in the same container used for transportation.

5.7.5.3 Field Duplicates

Field duplicates are collected for each analyte group and are required whenever five or more samples are being collected. If more than ten samples are to be collected, the field duplication rate is 10%.

5.7.5.4 Field QC Check Samples

All field instruments are calibrated at the beginning of each sampling day. Calibration is checked following every 10 samples or at maximum intervals of 4 hours. Calibration is verified at the end of the day. Recalibration is required if the QC check samples do not meet calibration criteria. The pH meter is evaluated after every ten samples using a buffer different than the ones used to calibrate the meter. The conductivity meter is evaluated by measuring the performance of the standard and the result must not vary by more than 5% from the true value after applying the cell constant.

5.7.5.5 Field Duplicate Analysis

All analyses run in the field have duplicates performed at a rate of 10% of the total samples.

5.8 SAMPLE MANAGEMENT

5.8.1 Sample Management Instructions

Clients supply environmental samples from various sources/programs for analysis. ESC utilizes method SOPs and contract requirements as the instructions to properly handle and process these samples.

5.8.1.1 Holding Time Verification

- The Login Technicians are trained to recognize analyses with immediate, 24-hour, and 48-hour holding times. When short-hold samples arrive at the laboratory, the Login procedure for those samples takes place immediately. All analysts are trained to assess incoming samples for holding time limitations.
- If a sample has a holding time limitation, the LIMS issues a due date on the bench sheet to ensure that the extraction or analysis is completed within time allowed.
- In the event that a holding time is exceeded, the TSR contacts the client, informs them of the situation, and requests further direction. If instructed by the client to proceed with the analysis, a qualifier is added to the benchsheet, which is then carried on to reporting. The final report bears the explanation in the form of a qualifier.

5.8.1.2 Sample container and Sub-Sampling

- Each container displays the following information once it has been released from sample login to the laboratory: the original sample container label and the sample login label showing the sample log number.
- If the sample requires special DOT labeling, the label remains with the sample through receiving and disposal. If the sampling personnel note any special handling or precautions due to the nature of the sample, it is recorded on the sample label. The login person, at that time, makes a note in the LIMS to ensure that all departments have the information.
- The importance of sample label review is stressed to all chemists/analysts and sample handling personnel.
- When a sample is obtained for analysis the chemist records in the appropriate prep book or benchsheet the log number, the date removed, his initials, and the volume or mass of sample removed.
- Samples are mixed prior to taking sub-samples for analysis, with the exception of VOC analyses. Sub-sampling within the laboratory is performed according to SOP# 030220, *Sample Homogenization and Sub-Sampling.*

5.8.1.3 Sample Preparation

The LIMS keeps track of samples and their corresponding log numbers to be analyzed. The analysts responsible for sample preparation maintain preparatory documentation, whether organic or inorganic. The analyst asks the LIMS to generate a prep sheet for a specific prep code. The LIMS provides all samples assigned to that prep code and prints a worksheet to record the required information.

- ESC currently maintains the following prep information: wet chemistry, metal digestions, organic extractions (by method), and GC and GC/MS injection logs.
- The chemist preparing the samples, dates and initials the entry, records any non-standard procedure (e.g., an aliquot for metal digestion other than 100mL for a water sample) or unusual observation, and which samples are spiked or duplicated.
- The organic extraction prep book contains all details concerning the sample extraction procedure.
- When a preparation is complete, the chemist assigned to perform the analysis is notified and the prepped sample is placed in the appropriate holding area.
- Each extract/digestate/distillate is labeled to provide the following information: date prepped, amount prepared (volume/weight), dilutions, etc.
- The various prep books, workbooks, and injection logs document every manipulation of the sample through receipt, preparation, and analysis.

5.8.1.4 Analysis & Analysts

- Each chemist has been assigned primary analytical procedures.
- Before beginning analysis they request a Laboratory Run Preview sheet from the LIMS and receive a printed page for the specific analysis in the form of a benchsheet. This Run Preview sheet lists all sample log numbers, sample type, and due dates relating to the samples that are ready for analysis. At that time the analyst can then select "all" or choose certain samples. Once the samples have been selected they are assigned to a unique run number and are then printed to a run benchsheet.
- The benchsheet provides all necessary information to complete the analysis such as: date and initials, flask numbers (where applicable), standards ID, instrument readings, response factors, aliquots, dilutions, final results, and all QC spike and duplicate information.
- When all data is recorded and the calculations are complete, a second chemist, a QC Specialist, performs a second analytical review. If all calculations and other performance objectives pass method criteria, the second reviewer dates and initials the data and then releases the data for final reporting.
- For data that cannot be transferred electronically, a Data Entry Specialist enters the results into the LIMS. The entered results are reviewed for transcription errors against the original worksheet by a chemist. If the lab supervisor or senior chemist rejects the work, he discusses the corrective action measures with the analyst.

5.8.1.5 Laboratory Documentation

- Laboratory notebooks and related documentation are an essential part of the analytical procedure. Every detail concerning the sample analysis must be documented.
- All documentation must be written with permanent/waterproof ink. All records are signed and dated by the individuals responsible for making the entry.
- Errors made during the documentation process are deleted by a single line, with the date and initials of the person making the change. The correct result is clearly recorded adjacent to the incorrect result.

5.8.1.6 Sample Storage and Transportation

- When a Chemist completes the preparation or analysis of a sample, he returns the sample container to the Sample Custodian.
- Samples transported under the responsibility of the laboratory are done so safely and according to storage conditions.
- Specific safety operations are addressed outside of this document.

5.8.1.7 Final Reporting

- When all analyses on a sample number have been completed, the LIMS prints the final report.
- The TSR reviews the final report for discrepancies. If discrepancies are found, re-analysis may be requested.
- The TSR gives the final approval on the report and indicates approval by signature.
- Routinely, data reports are transmitted to the client through email as a PDF file. Reports are sent as PDFs to prevent alteration of the document. The hardcopy report can be mailed to the client, when necessary. Reports may also be sent to the client by fax, or via secure access through the ESC website.
- Reports that are sent electronically are protected using the latest technology available to protect the confidentiality of the results and the client.

5.8.1.8 Sample Retention and Disposal

- Samples and related extracts/digestates are retained for 45 days.
- Non-hazardous samples containing preservative are neutralized and disposed through the conventional municipal waste system.
- Non-hazardous solids are heated at 400 degrees Fahrenheit for two minutes and disposed of in a commercial waste container.
- All other waste is disposed of according to Section 6.

5.8.1.9 Sample Subcontracting

- When samples are transferred to subcontracted facility, a COC accompanies the samples. The COC contains the following required information: collection date and time, ESC login ID number, quantity and type of container, date of sample collection, and the requested analysis.
- A copy of the COC and the sub-contract lab report is filed for permanent record.
- A subcontracted analysis log records date sent, where sent, log number, analysis requested, price, date report received, and date invoice received.

5.8.2 Sample Information and Labeling

A unique sample identification number is generated for each sample and is used throughout the analytical and disposal cycle. A record of all client-supplied samples is established and maintained. The samples are stored according to published method requirements and determinative SOP.. While in storage, the client samples are stored by sample ID and analyses required.

- When samples are logged in, the information entered into the LIMS includes sample description, date and time collected, collector ID, field ID, project ID, date and time received, receiver's ID, analysis requested, specific QC requirements, type of container and preservative, sample type, due date, and remarks.
- Each sample is assigned a unique and consecutive log number. After a sample is entered into the LIMS database and assigned a specific number identifier, the LIMS login screen automatically presents the next consecutive number for logging in the subsequent sample. Log numbers are not available for reuse and cannot be altered, although descriptive information, as well as sample specific comments can be modified until the final report is issued.
- A sample label with the log number is printed by the LIMS and affixed to the sample. Each label contains a unique container ID, represents the sample ID number, and is clearly marked with preservative and requested analysis.
- Duplicate samples, collected in the field, are logged with a separate laboratory ID. Laboratory personnel are typically unaware of field duplication.
- Replicate samples with multiple analyses and containers have the same login ID number.
- The login person records the sample numbers assigned onto the COC. The LIMS provides documentation on the person authorized to enter sample log information.

5.8.3 Sample Inspection and Receipt

Any sample supplied by the client is verified upon receipt as meeting its description and being free from damage. In the event of a client sample being lost, damaged or otherwise unsuitable for use, full details of the incident are recorded and reported to the client by the Technical Service Representative via a nonconformance form, prior to any analytical action being taken. Any further action taken is at the direction of the client.

The Login Technician is responsible for sample login and assessing sample container integrity, documentation, and identification. Samples are inspected and noted for temperature, pH using narrow-range pH paper, headspace, proper container type, container integrity (broken or leaking), and volume levels. Samples requiring preservation at 4°C must arrive at the laboratory above freezing but ≤6°C. If the samples are not appropriately preserved, the problem is noted on a sample nonconformance form, the sampler is notified, and, if the lab is instructed to proceed, proper preservation is performed. The sample nonconformance sheet becomes a permanent part of the COC. Samples, which require refrigeration, are placed in a laboratory cooler immediately after login. If extractions are necessary, the laboratory supervisor is notified, via daily management reports, to ensure that holding times are not exceeded for samples, extracts, or digestates.

5.8.3.1 Sample Objectives

ESC receives samples for analysis for a variety of reasons, such as planning, estimating, process control, treatability as well as permit compliance reporting, site investigation, and remediation. When general screening is the goal of the client/project, analysis of improperly preserved or collected samples may proceed provided that the client is notified. In this instance, the chemist is notified and the proper documentation is placed onto the final report.

5.8.3.2 Sample Rejection Criteria

Where the analytical results are to be used for regulatory or compliance purposes, samples are rejected under the following conditions:

- If there is insufficient sample volume
- If the preservation and container requirements were not followed correctly
- If there is headspace in a sample collected for volatiles analysis
- If the COC is missing, incomplete, or filled out in pencil
- If the holding time for the desired analysis has expired
- If the integrity of the sample container or custody seal has been violated, if samples are broken or leaking, or if apparent contamination has occurred.
- If the temperature is outside of the method stated requirement
- If the samples are known to contain high levels of chemicals that present a health/safety risk (i.e. dioxins, radioactivity above background, etc.)

5.8.3.3 Nonconformance Issues

- If there are problems with the samples, the event details are documented on the sample nonconformance form/COC; then, the sampler and/or client is notified.
- If the client insists on proceeding with analyses, even though he has full knowledge of the possible invalidity of the sample, a qualifier detailing the problem is added in the LIMS and it is also noted on the nonconformance form.
- The TSR, affected chemists, and reporting personnel are also notified.

5.8.3.4 Login Confirmation

- On a daily basis, login confirmations are printed and auto-emailed to the client. A pdf copy is maintained in the ESC LIMS.
- A dual check is performed by Login and the Technical Service Group to insure proper analytical login from the COC.
- The original COC is forwarded to the reporting personnel to be reviewed and included with the final report.

5.8.4 Sample Storage and Handling

Client samples remain in their original packaging until analysis. Any samples that need to be dispensed or removed from their original packaging are stored in conditions that provide the same degree of protection.

Sample/Extract Storage:

- Samples, extracts, distillates and digestates have specific storage locations arranged in log number order unless rush analysis is required.
- Access to these areas is limited to authorized personnel.
- Samples are stored either in the cooler or in ambient-temperature storage, according to method preservation requirements

- Extracts, digestates, and standards are stored separately from calibration and other QC Standards in dedicated areas as follows:
  - Organic extractions for pesticides and PCBs are stored in glass vials in a designated refrigerator in the SVOC GC lab.
  - Organic extractions for SVOCs are stored in glass vials in a designated refrigerator in the semivolatile GC/MS lab.
  - TCLP extracts for metals only and metal digestates are stored in the metals lab.
  - TCLP extracts for SVOCs, pesticide, and herbicide analysis are stored on designated sample shelves in the cooler. After the extraction, the extract is stored in a designated refrigerator in the semivolatile GC/MS lab.
  - Zero headspace extracts and samples for volatiles are stored in VOC vials and segregated in a designated cooler. Where necessary, samples collected by Method 5035 are frozen.
  - Volatile standards are stored in a designated freezer in the VOC lab.
  - Pesticide and PCB standards are stored in a designated refrigerator in the SVOC GC lab.
  - SVOC standards are stored in a designated freezer in the SVOC GC/MS lab.

5.8.5 Special Requirements

The following entities mandate any required needs for special handling, storage, packaging, preservation, shipping, and marking provisions:

- EPA Approved Methods
- 40CFR Part 136.3
- 29 CFR (OSHA)
- 49 CFR (DOT)
- IATA (Dangerous Goods)

5.8.6 Sample Transportation

When a sample is received by the laboratory, the method of transportation is recorded on the COC. ESC routinely uses FED-EX, UPS, USPS, Velocity Express and various air carriers. Locally collected samples are sometimes carried in by the client collection personnel or by ESC courier. When ESC is involved in the actual sample collection, the samples are packed with ice on site and transported by ESC field personnel utilizing proper COC protocol.

5.8.7 Sample Custody

Chain of Custody

An important part of any sampling/analytical plan is ensuring sample integrity from collection to data reporting. Figure 5.8.7a is a flow diagram that represents the sample custody process. All records and documentation required to track a sample from point of origin through disposal must be available. The documentation of the life of the sample is referred to as "chain of custody." Formal chain of custody (COC) starts when the sample containers are requested. Such documentation includes container/shipping sheets, COC forms, field notebooks, field sample labels and custody seals, laboratory sample log sheets, sample extraction and digestion prep books, analytical workbooks and instrument logs, QC data associated with the sample set, and the final report. Examples of these documents are presented in Figures 5.8.7b through 5.8.7k.

Legal Chain of Custody

Legal COC involves all of the above, but actually begins in the laboratory with container preparation. All sample containers for collection purposes are purchased from the vender as certified clean per EPA protocols. When a kit is prepared for delivery to the field a Shipping Batch Detail Report is filled out stating the number and type of bottles, required preservatives, date prepared, date sent, and person preparing kit. A copy of the Shipping Batch Detail Report is generally kept beyond the estimated time of receipt of the kit back into the laboratory. The Shipping Batch Detail Report is sent with the kit for sampling guidance. The COC/Shipping BDR also represents the number of bottles sent to the client and the person preparing the kit. The containers are sent to the field in a portable cooler that is sealed with the COC/Shipping BDR inside by the person involved with preparation and remains sealed until the recipient opens the kit. The individual receiving the containers for field use, signs the COC at the time the kit and containers are released for shipment to the laboratory. COC forms and sample container labels identify the analyses, dates, times, and individuals who remove samples.

The COC represents all persons who have the sample in their custody at a given time. The client designates common carriers on the COC when the sample is shipped back to the laboratory.

FIGURE 5.8.7a
CHAIN OF CUSTODY PROCESS

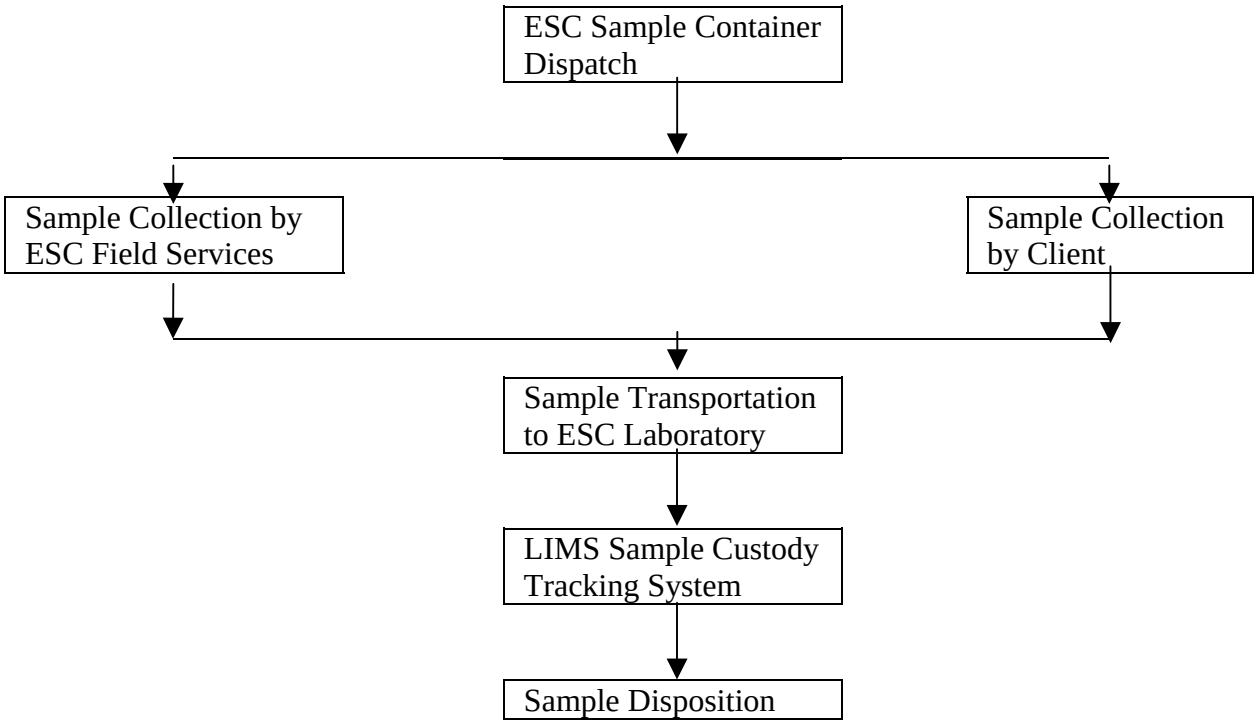
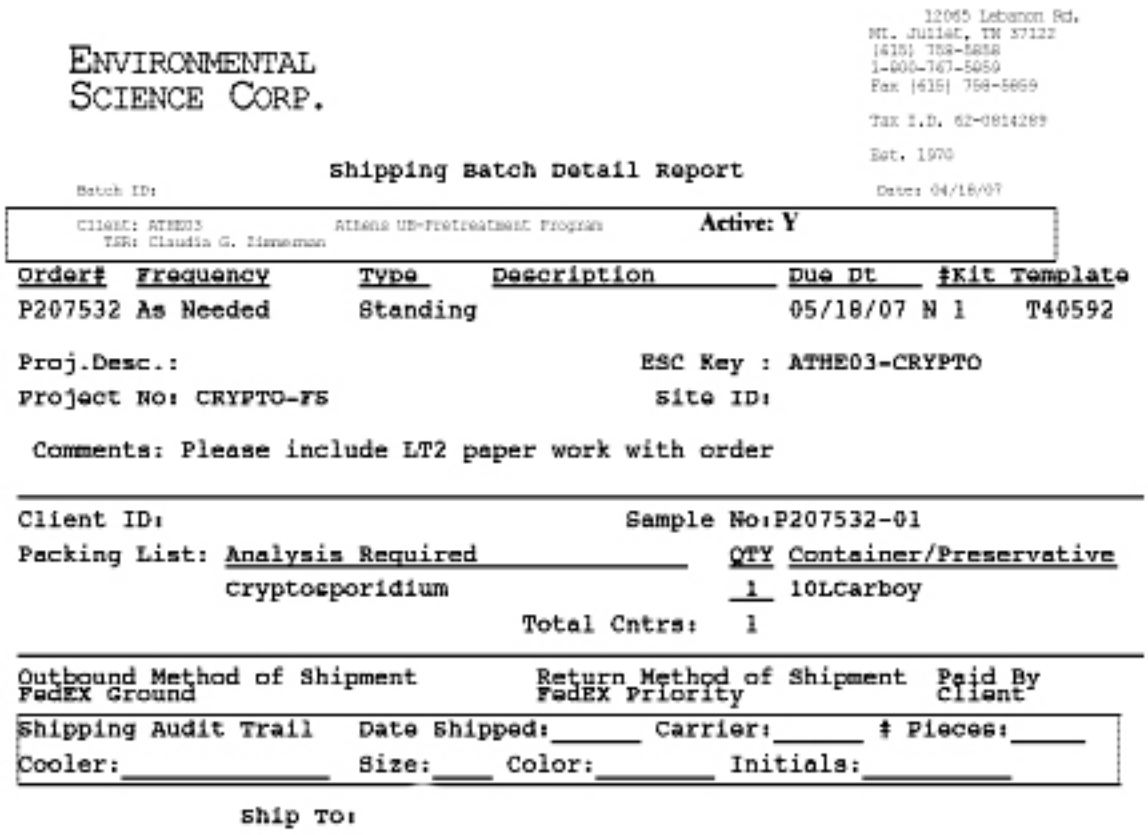


FIGURE 5.8.7b
INDIVIDUAL CONTAINER LOG
EXAMPLE
(Contents varies depending on client kit requirements)



ENVIRONMENTAL SCIENCE CORP.

12065 Lebanon Rd.
Mt. Juliet, TN 37122
(615) 758-5858
1-800-767-5859
Fax (615) 758-5859

Tax I.D. 62-0814289

Est. 1970

shipping Batch Detail Report

Batch ID:

Date: 04/18/07

Client: ATHE03 Athens UD-Pretreatment Program **Active: Y**
TSR: Claudia G. Zimmerman

Order#	Frequency	Type	Description	Due Dt	#Kit	Template
P207532	As Needed	Standing		05/18/07	N 1	T40592

Proj.Desc.: ESC Key : ATHE03-CRYPTO
Project No: CRYPTO-F5 Site ID:

Comments: Please include LT2 paper work with order

Client ID: Sample No:P207532-01

Packing List: Analysis Required	QTY	Container/Preservative
Cryptosporidium	1	10LCarboy
Total Cntrs:	1	

Outbound Method of Shipment	Return Method of Shipment	Paid By
FedEX Ground	FedEX Priority	Client

Shipping Audit Trail Date Shipped:_____ Carrier:_____ # Pieces:_____
Cooler:_____ Size:____ Color:_____ Initials:_____

Ship To:

Page 1 of 1

FIGURE 5.8.7c
CHAIN OF CUSTODY
GENERAL EXAMPLE
(Required Analysis is printed by ESC or Client)

Emerald Manufacturing
12065 Lebanon Road
Mount Juliet,TN 37122

Alternate billing information:

Analysis/Container/Preservative

Chain of Custody
Page ___ of ___

Prepared by:
ENVIRONMENTAL SCIENCE CORP.
12065 Lebanon Road
Mt. Juliet, TN 37122
Phone (800) 767-5859
FAX (615) 758-5859

Report to: Mr. Tom White
Email: twhite@envsci.com
Project Description: Demo report
City/State Collected
Phone: (615) 758-5858
FAX: (615) 758-5859
Client Project #: UPPB
Lab Project #: EMERALD-UPPB
Collected by (print):
Site/Facility ID#: 12345
P.O.#: 99999999999
Collected by (signature):
Packed on Ice N ___ Y ___
Rush? (Lab MUST Be Notified)
___Same Day 200%
___ Next Day 100%
___ Two Day 50%
Date Results Needed
Email? ___No X Yes
FAX? ___No ___Yes

Acctnum: EMERALD (lab use only)
Template/Prelogin: T33311/ P158345
Cooler #:
Shipped Via: FedEX Ground

Sample ID	Comp/Grab	Matrix*	Depth	Date	Time	No. of Cntrs	Metals 250mlHDPE-HNO3	SV8081 250ml Amb-No Pres	SV8270 1L-Amb-NoPres	SVOCS 1L-Amb NoPres SV8310	V8260 40ml Amb-HCl	SV8141 1L - AMB	SV8151 1L - AMB	Remarks/Contaminant	Sample # (lab only)
MW-1		GW				6	X	X	X	X	X	X	X		L219795-01
MW-2		GW				6	X	X	X	X	X	X	X		-02
MW-3		GW				6	X	X	X	X	X	X	X		-03
MW-4		GW				6	X	X	X	X	X	X	X		-04

*Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other_____

Remarks:

pH _____ Temp _____
Flow _____ Other _____

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Samples returned via: ☐UPS ☒FedEx ☐Courier ☐	Condition:	(lab use only)
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Temp: 4°C Bottles Received:		
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)	Date: 12/25 Time:	pH Checked:	NCF:

FIGURE 5.8.7d

SAMPLE CONTAINER LABEL

ABC WASTEWATER PLANT

Prepared by Environmental Science Corp.

Project: Annual Sludge - SOUR/Class "B" Fecal

Proj #: 57243

Sample Location/ID: Sludge Digester

Analysis Req'd: Class "B" Fecal Coliform

NaThio Preservative Included

Date:_____ Time:_____

FIGURE 5.8.7e

SAMPLE CONTAINER CUSTODY SEAL

CUSTODY SEAL

Date:_____ **I-CHEM**

Chemists In The Container Business™

Signature: _____

FIGURE 5.8.7f

SAMPLE LOGIN LABEL

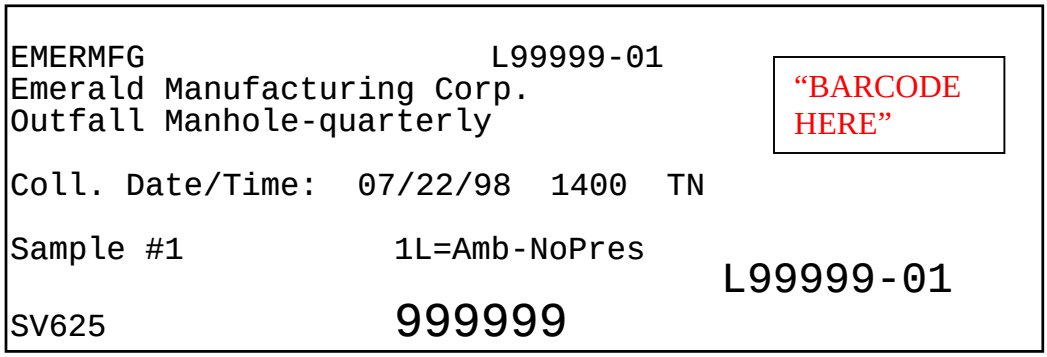


FIGURE 5.8.7g

EXAMPLE LAB PREPARATION SHEET

ENVIRONMENTAL SCIENCE CORP.

Laboratory Sample Prep Sheet

Date Created: 4/13/2007
Analyst: 196
Method: Hg
Matrix: Solid

Mercury by CVAA

Workgroup: WG295556

Samples

Account	Sample Name	Method	Weight(g)	Volume(mL)	Sample Description
[redacted]	L288458-01	7471A	0.58	30	Brown sludge
[redacted]	L288518-01	7471A	0.58	30	Brown clay
[redacted]	L288519-01	7471A	0.60	30	Brown clay
[redacted]	L288868-10	7471A	0.58	30	dark-brown clay
[redacted]	L288920-03	7471A	0.55	30	Purple paint
[redacted]	L288936-01	7471A	0.63	30	Brown clay
[redacted]	L288936-02	7471A	0.63	30	Brown clay
[redacted]	L288936-03	7471A	0.57	30	Brown clay
[redacted]	L288936-04	7471A	0.63	30	Brown clay
[redacted]	L288936-05	7471A	0.62	30	Brown clay
[redacted]	L288968-01	7471A	0.59	30	Black sludge
[redacted]	L288996-05	7471A	0.58	30	Brown sediment, rocks
[redacted]	L288997-20	7471A	0.57	30	Black sediment, rocks
[redacted]	L288997-21	7471A	0.57	30	Dark-brown sediment, rocks
[redacted]	L289003-01	7471A	0.59	30	Brown sludge
[redacted]	L289030-01	7471A	0.61	30	Grey clay
[redacted]	L289030-03	7471A	0.59	30	Grey clay
[redacted]	L289076-01	7471A	0.60	30	Brown sand, rocks
[redacted]	L289076-02	7471A	0.60	30	sand, rocks
[redacted]	L289095-01	7471A	0.58	30	Multicolored, rocks

QC Samples

Blank	BLKWG295556	7471A	0.60	30	Brown sand
LCS	LCSWG295556	7471A	0.10	30	Brown soil
DUP	L289076-01DUP	7471A	0.60	30	Brown sand, rocks
MS	L289076-02MS	7471A	0.60	30	Brown sand, rocks
MSD	L289076-02MSD	7471A	0.60	30	Brown sand, rocks

4/13/2007 11:05:50 PM 1 of 1

FIGURE 5.8.7h

EXAMPLE LAB ASSIGNMENT/WORKSHEETS

ENVIRONMENTAL SCIENCE CORP.

Laboratory Bench Sheet

TOTAL PHENOL BY 4AAP

Date Created: 4/2/2007
Analyst: 156
Method: 4AAP
Matrix: Water

Instrument: Lachat5

Workgroup: WG293700
Calibration Date: 03/15/07
Calib. Corr.: 0.999990
Units: mg/L

Prep Date: 4/2/2007

PrepStart: 11:20 PM
PrepEnd: 1:00 PM

Reagents

Reagent Name	Standard Number	Expiration Date
4 AAP	7D02049	04/03/07
PHENOL BUFFER	7C28009	04/04/07

Samples

Sample Name	Workgroup	Results	Dilution	Report Value	Qualifiers
L285470-02	WG293700	0.076	1	0.076**	
L286297-02	WG293700	-0.0208	1	<0.04	
L286321-02	WG293700	-0.0079	1	<0.04	
L286335-02	WG293700	0.0274	1	<0.04	
L286401-02	WG293700	0.0076	1	<0.04	
L286618-02	WG293700	0.0125	1	<0.04	
L286703-01	WG293700	0.042	1	0.042**	
L286703-02	WG293700	0.006	1	<0.04	
L286788-01	WG293700	0.0066	1	<0.04	
L286788-02	WG293700	0.0087	1	<0.04	
L286788-03	WG293700	0.0128	1	<0.04	
L286807-01	WG293700	0.162	1	0.162**	
L286807-02	WG293700	1.16	1	1.16**	
L286807-03	WG293700	0.069	1	0.069**	
L286807-04	WG293700	0.149	1	0.149**	

FIGURE 5.8.7i
EXAMPLE SAMPLE CONFIRMATION REPORT

Environmental Science Corp.
Login Confirmation Report
Apr 17 2007, 06:17 pm
Login Number: L3547 Template Number: N/A
Account: EMERALD Emerald Manufacturing

Report To: Tom White
: 12065 Lebanon Road
:
: Mount Juliet, TN, 37122
Telephone #: 615-758-5858
Fax #: -758-5859
Email: twhite@envsci.com;tomwhite@comcast.net
Project/Account Comments:

Client Project #: APP1
Project Description:
PO#: 1234
PO# Required: N
Lab Project #: EMERALD-123
Client Design: DEFAULT

TSR:151
Payment Terms: Net 30
Regulatory State: TN
Fax Report: N
Quote#:
Report Design:

Lab Sample #	Test	Sample ID	Desc.	Collect Date & Time	Collected By	Site	Receive Date	PR	Est.DueDate(1)	Method		Unit Price
L3547-01		MW-1		01-Nov-04, 12:00	Tom White	TN56383752	02-NOV-04	QR	09-NOV-04			
GW	P AP1		Appendix I List								$	250.00
GW	C AGICP		Silver		4625010	250mlHDPE-HNO3	DEFAULT			6010B	$	0.00
GW	C BAICP		Barium		4625010	250mlHDPE-HNO3	DEFAULT			6010B	$	0.00
GW	C BEICP		Beryllium		4625010	250mlHDPE-HNO3	DEFAULT			6010B	$	0.00
GW	C CDICP		Cadmium		4625010	250mlHDPE-HNO3	DEFAULT			6010B	$	0.00
GW	C COICP		Cobalt		4625010	250mlHDPE-HNO3	DEFAULT			6010B	$	0.00
GW	C CRICP		Chromium		4625010	250mlHDPE-HNO3	DEFAULT			6010B	$	0.00
GW	C CUICP		Copper		4625010	250mlHDPE-HNO3	DEFAULT			6010B	$	0.00
GW	C HG		Mercury		4625010	250mlHDPE-HNO3	DEFAULT			7470A	$	0.00
GW	C NIICP		Nickel		4625010	250mlHDPE-HNO3	DEFAULT			6010B	$	0.00
GW	C PBICP		Lead		4625010	250mlHDPE-HNO3	DEFAULT			6010B	$	0.00
GW	C SEICP		Selenium		4625010	250mlHDPE-HNO3	DEFAULT			6010B	$	0.00
GW	C SV8011		EDB/DBCP		4625011	40mlAmb-HCl	DEFAULT			8011	$	0.00
GW	C TLG		Thallium by ICPMS		4625010	250mlHDPE-HNO3	DEFAULT			6020	$	0.00
GW	C V8260AP1		App I Volatiles		4625011	40mlAmb-HCl	DEFAULT			8260B	$	0.00
GW	C ZNICP		Zinc		4625010	250mlHDPE-HNO3	DEFAULT			6010B	$	0.00
L3547-02		MW-2		01-Nov-04, 12:00	Tom White	TN56383752	02-NOV-04	QR	09-NOV-04			
Groundwater project												
GW	P AP1		Appendix I List								$	250.00
GW	C AGICP		Silver				DEFAULT		1 Bottles	6010B	$	0.00
GW	C BAICP		Barium				DEFAULT		1 Bottles	6010B	$	0.00
GW	C BEICP		Beryllium				DEFAULT		1 Bottles	6010B	$	0.00
GW	C CDICP		Cadmium				DEFAULT		1 Bottles	6010B	$	0.00
GW	C COICP		Cobalt				DEFAULT		1 Bottles	6010B	$	0.00
GW	C CRICP		Chromium				DEFAULT		1 Bottles	6010B	$	0.00
GW	C CUICP		Copper				DEFAULT		1 Bottles	6010B	$	0.00
GW	C HG		Mercury				DEFAULT		1 Bottles	7470A	$	0.00
GW	C NIICP		Nickel				DEFAULT		1 Bottles	6010B	$	0.00
GW	C PBICP		Lead				DEFAULT		1 Bottles	6010B	$	0.00
GW	C SEICP		Selenium				DEFAULT		1 Bottles	6010B	$	0.00
GW	C SV8011		EDB/DBCP				DEFAULT		2 Bottles	8011	$	0.00
GW	C TLG		Thallium by ICPMS				DEFAULT		1 Bottles	6020	$	0.00
GW	C V8260AP1		App I Volatiles				DEFAULT		2 Bottles	8260B	$	0.00
GW	C ZNICP		Zinc				DEFAULT		1 Bottles	6010B	$	0.00
L3547-03		MW-3		01-Nov-04, 12:00	Tom White	TN56383752	02-NOV-04	QR	09-NOV-04			

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Entered 28-JUN-02 By SEEDPAK

(1) Due Date listed is an estimate based on average workloads. Please communicate required due dates to your TSR.

5.9 QUALITY CONTROL

5.9.1 Quality Control Procedures

ESC has established quality control procedures for monitoring the validity of stated analytical methods. The resulting data are recorded in such a way that trends are detectable.

5.9.2 Quality Control Activities

Monitoring of quality may include the following:

- regular use of certified reference materials and/or internal quality control using secondary reference materials;
- participation in interlaboratory comparison or proficiency testing programs;
- replicate analyses
- re-testing or re-calibration
- logic check or correlation of results from related analyses

5.9.2.1 Quality control data are analyzed using statistical techniques and, where they are found to be outside pre-defined criteria, planned action is taken to correct the problem and to prevent incorrect results from being reported.

5.9.2.2 Laboratory Checks

See Section 3 for a description of QC samples and related definitions.

Table 5.9.2.2 BASIC LABORATORY QC CHECKS

QC Check Sample	Source	Prep Required
Method/reagent blanks - One blank is carried through each step of the analytical procedure for each batch of samples. Blanks are prepared for each preparation method and matrix (i.e., solids assay, dissolved metals, TCLP extraction, etc.). Blanks are used to confirm the absence of contaminants within the preparation and/or analytical system prior to and during the analysis of field samples.	Lab DI	Yes
Initial Calibration Verification (ICV) – An independently prepared standard used to verify the accuracy of the initial calibration (for ongoing calibration)	Primary or Secondary	No *
Laboratory Control Sample (LCS) – A known clean matrix is spiked with known amounts of the analyte(s) of interest used to verify the efficiency of the analytical system without interference from the field sample matrix. The LCS provides the best estimate of analytical system performance and may also be used to verify the validity of the on-going calibration.	Secondary	Yes
Continuing reference standard checks – Metals and Organics; *Also called SSCV (Secondary Source Calibration Verification) – An independently prepared standard used to verify the accuracy of the existing calibration.	Secondary	No
Continuing Calibration Verification (CCV) - A standard, usually near the mid-point of the calibration curve, made from the primary or same standard stock used for the calibration curve. The CCV is used to represent the ongoing calibration stability of the instrument and must perform within method stated criteria.	Primary	No *
Sample matrix spikes and spike duplicates (MS/MSD) –Prepared field samples spiked with known quantities of target analyte and carried through the entire preparation and analytical process concurrently with unspiked field samples to assess the effect of the sample matrix on the target analytes present and to provide an estimate of analytical precision. For analyses where field sample type does not allow for MS/MSD preparation (i.e. lead wipes, air samples on charcoal tubes, etc.) an LCS/LCSD pair may be substituted.	Primary or Secondary	Yes
Post Digestion Spike – (used in metals analysis) A standard prepared from a previously analyzed spiked sample digestate that yielded reduced recovery for the target analyte due to a suspected matrix interferent.	Primary	No
Sample duplicates – Second aliquots of field samples carried through the entire preparation and analytical process that used as an indication of sample precision or consistency in the field sample matrix.	Client Sample	Yes
Surrogate standards – Analytes not expected to occur naturally in field samples that are spiked by preparation/analytical personnel to assess sample preparation and analytical efficiency in each individual field sample.	NA	Yes
Internal standards– Analytes not expected to occur naturally in field samples that are spiked to provide a consistent basis for comparison with target analyte concentrations. ISTDs are used in internal calibration models.	NA	No

***** Preparation requirements can vary depending on method. Requirements are listed in each individual determinative SOP.

5.9.2.3 Batch QC Criteria

5.9.2.3.1 Environmental Samples

Sample Batch - Defined as a set of 20 or fewer samples of a similar matrix prepared and/or analyzed concurrently. The maximum number of samples possible per batch is dependent on the determinative method allowance.

Required Instrument QC per batch:

- Calibration Blank (CB or CCB)
- Initial Calibration Verification (ICV)
- (1) Continuing Calibration Verification (CCV) every 10-20 samples where and as required.
- (1) CCV at end of run where required.
- (1) Post-Digestion Spike – Metals analysis
- (1) Serial Dilution – Metals analysis

NOTE: The CCV is typically a mid-point concentration. In addition to the mid-point, where required, the CCV is run at a concentration that varies from the mid-point by +/-25% during each analytical run. The varied CCV must meet the same acceptance criteria as the mid-point.

Required Method QC per batch (Must include internal standards and surrogates, where required by the method):

- (1)Method/prep Blank
- (1) Laboratory Control Sample Duplicate Pair, LCS/LCSD must be analyzed for analytes where spiking procedures are not practical, such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, oil& grease, temperature, dissolved oxygen or turbidity
- Matrix Spike/Spike Duplicate (MS/MSD) Pair, MS/MSD must be analyzed except for analytes where spiking procedures are not practical, such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, oil& grease, temperature, dissolved oxygen or turbidity
- (1) Sample Duplicate (where sufficient field sample is available and where required by determinative method)

5.9.2.3.2 Industrial Hygiene Analyses, Including Environmental Lead

Sample Batch - Defined as a set of 20 or fewer samples of a similar matrix prepared and/or analyzed concurrently.

Required Instrument QC per batch:

- Calibration Blank (CB or CCB)
- Initial Calibration Verification (ICV)
- (1) Continuing Calibration Verification (CCV) every 10 samples
- (1) CCV at end of run.
- (1) Post-Digestion Spike – Metals analysis

NOTE: The CCV is typically a mid-point concentration. In addition to the mid-point, the CCV is run at a concentration that varies from the mid-point by +/-25% during each analytical run. The varied CCV must meet the same acceptance criteria as the mid-point.

Required Method QC per batch:

- (1) method/prep blank
- (1)Laboratory Control Sample/Laboratory Control Sample Duplicate Pair, LCS/LCSD
- Matrix Spike/Spike Duplicate (MS/MSD) pair, where matrix permits
- (1) Sample Duplicate (where sufficient sample is available)

5.9.2.3.3 Batch QC Protocols

If more stringent QC protocols are required than those outlined above for any method or project, then the more stringent method protocols are followed.

5.9.2.4 Inter-Laboratory Quality Control

- Reference samples are ordered from Environmental Resource Associates or similar provider. Samples are purchased to evaluate the following method types: Air, Water Supply, Water Pollution, and Solid Waste.
- Blind QC check samples are purchased at least semi-annually from Environmental Resource Associates or similar provider as an external source for performance evaluation samples. These samples are supplied to ESC without the true concentration values. For specific state water pollution programs, two levels are analyzed. The laboratory may perform additional studies as required by contract, regulatory agency or accreditation. ESC reviews the results as an overall check on internal QC procedures. If blind QC check sample results are unacceptable and such information impacts certification the laboratory immediately initiates corrective action and orders another check sample to ensure ongoing proficiency of that analyte.
- Blind field duplicates are collected at least annually to evaluate field collection and laboratory precision. Client field duplicates are collected based on project requirements. The field duplicates are logged in as regular samples and laboratory personnel are unaware of sample origin.
- Split samples are periodically sent to outside laboratories to confirm analytical results.

5.9.2.5 Procedures for Assessing Data Precision, Accuracy and Completeness

The following procedures apply to all analytes measured, unless more stringent QC has been specified. All field measurements must meet the same QC criteria as those run in the lab.

5.9.2.6 Use and Preparation of QC Samples

Certified standards, generated from reference materials, are used to check calibration throughout the analytical run. The standards are obtained from suppliers who are NIST recognized and ISO compliant. A Certificate of Analysis or other documentation verifying purity accompanies the standards.

Sample matrix spikes are prepared using actual samples prior to digestion, extraction, etc. Separate matrix spike limits are calculated for each type of sample (i.e., water, solid, TCLP extract, personnel filter, etc.). Sample duplicate analyses are also initiated prior to digestion, extraction, etc. Duplicate spikes and duplicate laboratory control samples are used to generate precision data.

Table 5.9.2 lists methods used to generate precision and accuracy targets.

TABLE 5.9.2.6 METHODS USED TO GENERATE PRECISION AND ACCURACY TARGETS		
Method	**Purpose**	**Method References**
Reference Standards (Laboratory Control Sample - LCS)	Accuracy	All analyses
Reference Standards (Dup. Laboratory Control Sample – LCSD)	Precision and Accuracy	All analyses
Matrix Spikes	Accuracy	All quantitative Wet Chemistry analyses. All Metals and Organics.
Duplicate Matrix Spikes	Precision and Accuracy	All quantitative Wet Chemistry analyses. All Metals and Organics.
Sample Duplicates	Precision	All analyses

5.9.2.7 QC Charts

When an analyst completes a reference standard check, a duplicate, or a matrix spike, the result is calculated and compared to the appropriate QC chart and evaluated against the established limits. A rough x-bar or duplicate QC graph, with mean, warning and control limits, is available. If the results are out of control limits, the analyst notes this problem for appropriate corrective action. Corrective action is taken, based on an established list of identified corrective action procedures.

Outliers

Control limits are calculated at least annually, where required. The data are evaluated using ± 4 times the standard deviation or 4σ criteria for outliers. Data that falls outside of ± 4 times the standard deviation are eliminated from the calculation. Data points are not eliminated otherwise, unless an obvious system failure has occurred and the error can be documented and identified.

Control Data Entry

For non-data transfer results, the data entry specialist gathers data directly from the benchsheet and enters it into the computer LIMS or Excel, depending on the origin of the data. For instrumentation with data transfer, the data is obtained directly from LIMS. The data is then brought into a spreadsheet and the charts can be plotted and evaluated by the computer software.

5.9.2.8 Accuracy

Laboratory Control Standards (LCS)

- Laboratory Control Standards are run with every analytical batch.
- X-bar control charts are generated using a minimum of the last 20 data points, based upon percent recovery.
- Warning limits are set at the 95% confidence interval and are plus/minus two standard deviations from the arithmetic mean.
- Control limits are set at the 99% confidence interval and are plus/minus three standard deviations.
- LCS limits are calculated at least annually where necessary. See the individual laboratory appendices for the list of established limits. Method stated limits override in-house calculated limits.

Percent Recovery:

$$Percent\ \ Recovery\ = \frac{Observed\ \ Concentrat\ ion}{True\ \ Concentrat\ \ ion} \text{ X } 100$$

Standard Deviation for Percent Recovery:

$$Sp = \sqrt{\frac{(P_1^2 + P_2^2 + P_3^2 + ...) \frac{(P_1 + P_2 + P_3 + ...)^2}{num\ of\ \ entries}}{num\ of\ \ entries - 1}}$$

Where: Sp = Standard deviation for percent recovery

$P_{1,2,3,..}$ = Percent recovery results

Matrix Spiked Samples

Spiked samples are typically ten percent of all samples, where matrix and sampling permits. Spiked samples are entered onto similar QC charts with the percent recovery. The target spike concentration routinely used is one to five times the initial concentration of the unspiked sample. This basis for the spike target provides analyte concentrations that do not exceed the range of the analysis and are not too small to be significantly affected by normal data variability. One exception for higher ratios is if an MS is spiked at one to five times the client sample concentration based on historical data but the client sample concentration turns out to be much lower or non-detect, the MS/MSD recovery results would still be usable.

- Matrix spiked samples are run with every analytical batch of samples.
- X-bar control charts are generated using a minimum of the last 20 data points, based upon percent recovery.
- Warning limits are set at the 95% confidence interval and are plus/minus two standard deviations from the arithmetic mean.
- Control limits are set at the 99% confidence interval and are plus/minus three standard deviations.
- MS limits are calculated at least annually or sooner where necessary. See the individual laboratory appendices for the list of established limits.
- Method stated limits supercede in-house calculated limits.

MS/MSD Percent Recovery:

$$\%\ Spike\ Recovery = \frac{Spiked\ sample\ value - initial\ sample\ value}{Concentration\ of\ spike}\ X\ 100$$

Standard Deviation for Percent Recovery:

Calculate using the same formula provided in the previous LCS section.

5.9.2.9 Precision

Precision is assessed through the use of duplicate client and/or QC samples, which constitute approximately 10% of all samples run. The relative percent difference (RPD) is calculated as follows:

$$RPD = \frac{\left|Duplicate\,1 - Duplicate\,2\right|}{\left[\frac{(Duplicate\,1 + Duplicate\,2)}{2}\right]} X\ 100$$

- Duplicates are analyzed with every analytical batch.
- X-bar control charts are generated using a minimum of the last 20 data points, based upon percent recovery.
- Warning limits (WL) are set at the 95% confidence interval using

$$WL = \text{Mean Value} + (2.456 \bullet \text{SD})$$

- Control limits are set at the 99% confidence interval and are plus three standard deviations.

$$CL = \text{Mean Value} + (3.268 \bullet \text{SD})$$

- Limits are calculated at least annually or sooner where necessary. See the individual laboratory Appendices for the list of established limits.
- For Laboratory Control Samples and Matrix Spikes - Calculate RPD using the actual analytical result.
- For Sample Duplicates – Calculate RPD using the actual analytical result.
- Calculate the standard deviation, separately for LCS, MS and Sample Duplicates by matrix, where appropriate.
- Method stated limits override in-house calculated limits.

5.9.2.10 Marginal Excedence Limits

Due to the large number of compounds analyzed using some analytical methods, it is statistically likely that accuracy and precision failures occur. Failures that occur on a random basis are deemed as marginal excedences and must meet the criteria below. Not all regulatory programs allow for the use of marginal excedence limits. In addition, not all analytical methods meet the requirements for the use of ME limits. Refer to the specific determinative SOP for more guidance regarding use and limitations.

Marginal excedences must be random events. If failures can demonstrate a pattern or occur with the same target analyte in a trend, the failure is actionable and not considered to be marginally exceeding the method requirements.

In addition, ME limits are utilized for methods with large numbers of target analytes being analyzed concurrently, as in the 8270/625 determinative method.

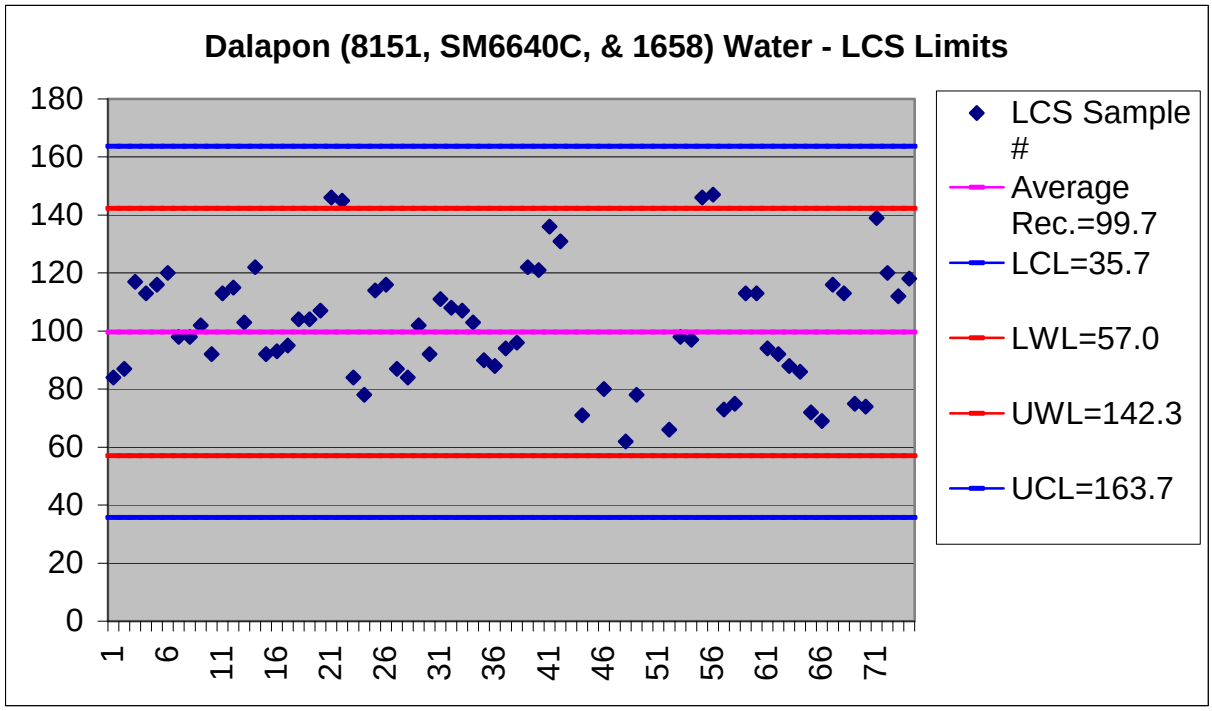
For example, the normal compound list for 8270/625 typically contains 90+ analytes; therefore, per the criteria listed below, only 5 analytes can be considered as marginally exceeding the acceptance criteria. If more than 5 failures occur or if the failures demonstrate a pattern that is causing the outliers, the entire sample batch with associated QC must be re-extracted and re-analyzed.

Upper and lower marginal excedence (ME) limits are established by +/- four times the standard deviation of historical accuracy data and the number of marginal excedences allowed is based on the number of analytes spiked in the LCS.

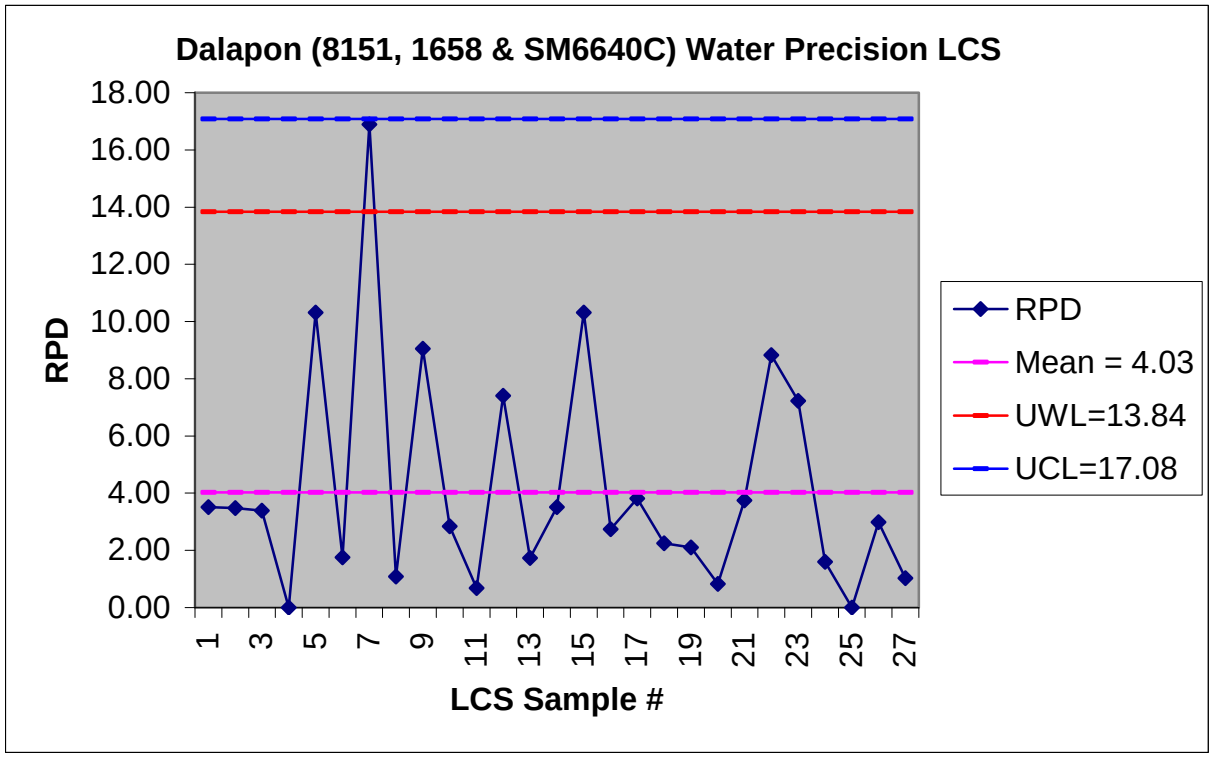
Number of Target Analytes	**Allowable Marginal Excedence Outliers**
90+	5 analytes allowed in the ME limit
71-90	4 analytes allowed in the ME limit
51-70	3 analytes allowed in the ME limit
31-50	2 analytes allowed in the ME limit
11-30	1 analytes allowed in the ME limit
<10	0 analytes allowed in the ME limit

FIGURE 5.9.2.10 PRECISION AND ACCURACY CHARTS

Dalapon LCS Duplicate Accuracy - Example



Dalapon LCS Duplicate Precision - Example



5.10 FINAL REPORTS/CERTIFICATES

5.10.1 General

The results of each analysis carried out by the laboratory are reported accurately, clearly, unambiguously, objectively, and in accordance with any specific instructions in the regulatory documents or standard operating procedures. The results are normally reported as a final client report and include all the information requested by the client and necessary for the interpretation of the analytical method results and all information required by the method of analysis.

5.10.2 Test Reports

In the case of a written agreement with the client, the results may be reported in a non-standard way and may not require the formalized information, but all associated analytical data is readily available and kept permanently on file for a minimum of 10 years. Specific programs or projects may require a longer data archive period.

Laboratory reports issued to the client for regulatory work, includes, at a minimum, the following information:

- Title – "Report of Analysis"
- Laboratory name, address and phone number
- Client name, address, and contact
- Client name and/or site name
- Client or field identification number
- Collection personnel
- Analyte Name
- Method number for each sample analyses
- Analytical result for each analysis with applicable Data Qualifier as outlined in Table 5.14
- Dilution factor (where applicable)
- Method Detection Limit (when requested)
- Practical Quantitation Limit – designated on final report as RDL
- Date of sample preparation (when requested)
- Time of sample preparation if the holding time is <48 hours (when requested)
- Date of sample analysis
- Temperature at which pH measurements are made
- Date and time of sample collection from the Chain of Custody form
- Units of measurement
- Wet/Dry weight ID – Dry weight includes total solids value
- Identification of all laboratories providing analytical results in the report, including the appropriate laboratory certification numbers from all certifying agencies. The "S" qualifier is used when analyses have been subcontracted.

- Individual report statements: "The reported analytical results relate only to the sample submitted." and "This report shall not be reproduced, except in full, without written approval from ESC".
- Approval Signature
- Sequential page numbering with total pages identified.
- Date/Time Printed
- Revision date – if any
- Laboratory certification numbers as assigned by each certifying agency.
- In conjunction with Ohio VAP projects, a signed affidavit is also required.

An example of a final client report is presented in below.

Figure 5.10.2 Example Final Client Report

ENVIRONMENTAL
SCIENCE CORP.

12065 Lebanon Rd.
Mt. Juliet, TN 37122
(615) 758-5858
1-800-767-5859
Fax (615) 758-5859

Tax I.D. 62-0814289

Est. 1970

REPORT OF ANALYSIS

Mr. John Jones
XYZ Consulting
000 Directors Drive
Anytown, US 00000

March 26, 2007

ESC Sample # : L99999-01

Site ID : 987-654

Project # : Low key

Date Received : March 16, 2007
Description : H2O

Sample ID : INFLUENT

Collected By : Jane Doe
Collection Date : 03/12/07 13:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
TPH (GC/FID) Low Fraction	BDL	0.10	mg/l	8015GRO	03/20/07	1
Surrogate Recovery (70-130)						
a,a,a-Trifluorotoluene(FID)	87.8		% Rec.	8015GRO	03/20/07	1
Benzene	BDL	0.0010	mg/l	8260B	03/24/07	1
Toluene	BDL	0.0050	mg/l	8260B	03/24/07	1
Ethylbenzene	BDL	0.0010	mg/l	8260B	03/24/07	1
Total Xylenes	BDL	0.0030	mg/l	8260B	03/24/07	1
Methyl tert-butyl ether	BDL	0.0010	mg/l	8260B	03/24/07	1
Naphthalene	BDL	0.0050	mg/l	8260B	03/24/07	1
Surrogate Recovery						
Toluene-d8	95.7		% Rec.	8260B	03/24/07	1
Dibromofluoromethane	98.1		% Rec.	8260B	03/24/07	1
4-Bromofluorobenzene	99.7		% Rec.	8260B	03/24/07	1
Extractable Petroleum Hydrocarb	0.45	0.10	mg/l	EPH	03/20/07	1
Surrogate Recovery						
o-Terphenyl	82.8		% Rec.	EPH	03/20/07	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
Note:
The reported analytical results relate only to the sample submitted.
This report shall not be reproduced, except in full, without the written approval from ESC.
.
Reported: 03/26/07 16:29 Printed: 03/26/07 20:01

ENVIRONMENTAL SCIENCE CORP.

12065 Lebanon Rd.
Mt. Juliet, TN 37122
(615) 758-5858
1-800-767-5859
Fax (615) 758-5859

Tax I.D. 62-0814289

Est. 1970

REPORT OF ANALYSIS

Ms. Alita Fire
ABC Consultants
123 Anywhere Street
Somewhere, US 00000

December 15, 2006

Date Received : December 07, 2006
Description : Place #1

Sample ID : Influent

Collected By : John Doe
Collection Date : 12/06/06 11:30

ESC Sample # : L00000-01

Site ID :

Project # : 123-456

Parameter	Result	MDL	RDL	Units	Q	Method	Date	Dil.
BOD	8.6	1.6	5.0	mg/l	J4	SM5210B	12/07/06	1
COD	27.	2.7	20.	mg/l		410.4	12/12/06	1
Ammonia Nitrogen	0.049	0.034	0.10	mg/l	J	350.1	12/11/06	1
Suspended Solids	15.	0.33	1.0	mg/l		160.2	12/11/06	1
Copper	U	0.0035	0.020	mg/l		6010B	12/08/06	1
Lead	U	0.0024	0.0050	mg/l		6010B	12/08/06	1

U = ND (Not Detected)
MDL = Minimum Detection Limit = LOD = SQL(TRRP)
RDL = Reported Detection Limit = LOQ = PQL = EQL = MQL(TRRP)
Note:
The reported analytical results relate only to the sample submitted.
This report shall not be reproduced, except in full, without the written approval from ESC.
.
Reported: 12/14/06 16:33 Revised: 12/15/06 09:10

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The following qualifier codes are used when reporting data values that either meet the specified description outlined below or do not meet the quality control criteria of the laboratory:

(This table provided for example and is subject to revision without notice. For a list current qualifiers, contact the laboratory)

Table 5.10.2 ESC Qualifiers and Descriptions (Updated 7/15/09)

QUAL	DESCRIPTION
A	ALC(EPA)-Aldol Condensation: Labels a suspected Aldol Condensation product for TICs.
B	(EPA) - The indicated compound was found in the associated method blank as well as the laboratory sample.
B1	(ESC) - The blank depletion was greater than the recommended maximum depletion of 0.2mg/L.
B2	(ESC) - The detection limit has been elevated due to blank contamination.
B3	(ESC) - The indicated compound was found in the associated method blank, but all reported samples were non-detect.
B4	(ESC) - The indicated compound was found in the associated instrument blank, but all reported samples were non-detect.
B5	(ESC) - The indicated compound was found in the associated instrument blank as well as the laboratory sample.
C	CBC(EPA)-Cannot be calculated: The analytical result cannot be calculated because the internal standard was not found.
D	Less than lower calibration limit. Actual value is known to be less than the lower calibration range due to dilution.
E	GTL (EPA) - Greater than upper calibration limit: Actual value is known to be greater than the upper calibration range.
F	SRN (EPA) - Diluted: The original sample was diluted due to high amounts of one or more target analytes. All associated method analytes will be subject to an elevated detection limit relative to the dilution factor.
G	SRS(EPA)-Secondary Dilution: The indicated analysis results were generated from a secondary dilution of the same sample. The sample had to undergo serial dilution.
H	RIN(EPA)-Re-Analyzed: The indicated analytical results were generated from a reinjection of the same sample extract or aliquot.
I1	(ESC) Not analyzed due to interference. (Sample reacted with method reagent or could not be analyzed due to interferences that could not be corrected)
J	(EPA) - Estimated value below the lowest calibration point. Confidence correlates with concentration.
J+	The associated batch QC was outside the upper control limits; associated data has a potential positive bias
J-	The associated batch QC was outside the lower control limits; associated data has a potential negative bias
J1	Surrogate recovery limits have been exceeded; values are outside upper control limits
J2	Surrogate recovery limits have been exceeded; values are outside lower control limits
J3	The associated batch QC was outside the established quality control range for precision.
J4	The associated batch QC was outside the established quality control range for accuracy.
J5	The sample matrix interfered with the ability to make any accurate determination; spike value is high
J6	The sample matrix interfered with the ability to make any accurate determination; spike value is low
J7	Surrogate recovery limits cannot be evaluated; surrogates were diluted out
J8	The internal standard associated with this data responded abnormally low. The data is likely to show a high bias concerning the result.
J9	The internal standard associated with this data responded abnormally high. The data is likely to show a low bias concerning the result.
K	REX(EPA)- Re-prepared: The indicated analytical results were generated from a re-extraction or preparation of the sample.
L	(ESC)Sample Pretreatment: The sample reaction impaired the ability to analyze the sample using normal analytical determination. Treatment outside of method protocol was required to determine the analytical result.
L1	(ESC) The associated batch LCS exceeded the upper control limit, which indicates a high bias; The sample analyte was "not detected" and is therefore unaffected.
L2	(ESC) The associated surrogate compound falls below 10%. The data should be used with caution. A re-extraction was not possible due to limited sample volume.

Table 5.10.2 ESC Qualifiers and Descriptions (Updated 7/15/09)

QUAL	DESCRIPTION
L3	(ESC) Sample reanalysis could not be performed due to lack of additional volume.
M	AVE(EPA)-Average Value: Used to report a range of values; e.g., relative response factors
N	PRE (EPA) - Presumptive evidence of material.
N8	PRE (EPA) - Presumptive evidence. The component has been tentatively identified based on mass spectral data.
N9	PRE (EPA) - Presumptive evidence. There is indication that the analyte is present, but QC requirements for confirmation were not met
O	(ESC) Sample diluted due to matrix interferences that impaired the ability to make an accurate analytical determination. The detection limit is elevated in order to reflect the necessary dilution.
O1	(ESC) The analyte failed both the method required serial dilution test and subsequent post-spike criteria. These failures indicate matrix interference.
P	NRP(EPA)-Non-Reproducible: Results of two or more injections are not comparable
P1	RPD value not applicable for sample concentrations less than 5 times the reporting limit.
Q	(ESC) Sample held beyond the accepted holding time.
R	REJ(EPA)-Rejected: Results have been rejected by the lab and should not be used
S	Subcontracted (ESC) - This analysis was performed by a subcontractor chosen to meet the project requirements.
T	(ESC) - Additional method/sample information: Sample collected using improper field protocol
T1	(ESC) - Additional method/sample information: Sample(s) received at greater than 4 degrees C.
T2	(ESC) - Additional method/sample information: The laboratory analysis was from an unpreserved or improperly preserved sample.
T3	(ESC) - Additional method/sample information: TOX analysis. Greater than 10% Breakthrough
T4	(ESC) - Additional method/sample information: QNS - Quantity Not Sufficient
T5	(ESC) - Additional method/sample information: QNS - Quantity not sufficient for reanalysis or replication as required by method.
T6	(ESC) - Additional method/sample information: Method used is an alternative to current approved methodology
T7	(ESC) - Additional method/sample information: Method 1664 (Total Oil & Grease), performed without silica gel
T8	(ESC) - Additional method/sample information: Sample(s) received past/too close to holding time expiration.
T9	(ESC) - Additional method/sample information: The sample result represents blank correction
U	BDL (EPA) - Below Detectable Limits: Indicates that the compound was analyzed but not detected.
V	(ESC) - Additional QC Info: The sample concentration is too high to evaluate accurate spike recoveries.
V1	(ESC) - Additional QC Info: Estimated concentration: due to inability to achieve ending QC standard as a result of sample matrix interference.
V2	(ESC) - Additional QC Info: The Total Cyanide value was below the reporting limit. Amenable Cyanide is assumed not to be present.
V3	(ESC) - Additional QC Info: The internal standard exhibited poor recovery due to sample matrix interference. The analytical results will be biased high. BDL results will be unaffected.
V4	(ESC) - Additional QC Info: Cont. Calibration Verification exhibited a response outside of the QC criteria, but within a 5% window. The associated analytical results are biased high. Non-detect results are unaffected.
V5	(ESC) - Additional QC Info: The Laboratory Control Sample exhibited a response outside of the QC criteria, but within a 5% window. The associated analytical results are biased high. Non-detect results are unaffected.
V6	(ESC) - Additional QC Info: The ICV responded above the recovery range for one of the following: Al, Ca, K, Fe, Na, Zn. The associated analytical results are biased high.
V7	(ESC) - Additional QC Info: This compound is not a 524.2 compound and was therefore evaluated using 8260B QC Criteria.
V8	(ESC) - Additional QC Info: The Interference Check Standard responded above the acceptable recovery range. The associated analytical result may be biased high for this element.

Table 5.10.2 ESC Qualifiers and Descriptions (Updated 7/15/09)

QUAL	DESCRIPTION
V9	(ESC) - Additional QC Info: Please refer to the Case Narrative provided with the report.
W	(ESC)-The laboratory analysis was from a sample collected in an improper container
W1	(ESC) - The laboratory analysis was from a sample collected in containers provided by the client.
W2	(ESC) - Insufficient sample amount to perform method as required. Sample amount approved per client instruction.
W3	(ESC) - BOD cannot be determined due to apparent toxicity exhibited by the sample.
X	(ESC)-Holding time exceeded due to National Emergency
X1	(ESC)-National Emergency: Temperature requirement has been exceeded due to delayed transportation.
Y	This sample most closely matches the laboratory standard for Kerosene
Y0	Significant peaks were detected outside of the hydrocarbon range defined by the method.
Y1	This sample most closely matches the laboratory standard for Diesel
Y2	This sample most closely matches the laboratory standard for #6 Fuel Oil
Y3	This sample most closely matches the laboratory standard for Hydraulic Fluid
Y4	This sample most closely matches the laboratory standard for Motor Oil
Y5	This sample has responded in the Diesel range, however it does not appear to be a hydrocarbon product
Y6	This sample has responded in the Oil range, however it does not appear to be a hydrocarbon product
Y7	This sample most closely matches the laboratory standard for Gasoline
Y8	This sample has responded in the Gasoline range, however it does not appear to be a hydrocarbon product
Y9	Sample has one or more single components in the gasoline range but the chromatographic trace is not characteristic of gasoline.
Z	(ESC)-Too many colonies were present(TNTC), the numeric value represents the filtration volume.

QUALIFIER REPORT INFORMATION:

ESC recognizes and utilizes sample and result qualifiers as set forth by the EPA Contract Laboratory Program. ESC firmly believes that relevant information pertaining to sample analysis be made available to the ESC client. In addition to the EPA qualifiers adopted by ESC, the laboratory has implemented ESC qualifiers to provide more information pertaining to analytical results. Each qualifier is designated in the qualifier explanation as either EPA or ESC. Definitions used in this table can be found in Section 3.

5.10.3 Optional Test Report Items

Where necessary, the final report contains a statement on the estimated uncertainty of measurement.

5.10.4 Calibration Certificates

ESC does not perform calibration activities for clients and therefore does not issue calibration certificates.

5.10.5 Opinions and Interpretations

Opinions and interpretations are allowed in final reports, in the form of qualifiers, provided that it is clear that the qualifiers are present to provide additional analytical information. In the event that a report must be issued with a revision, the original report remains unaltered and the revision is clearly identified. See SOP #030223, *Report Revision.*

5.10.6 Results from Subcontractors

ESC receives analytical reports from subcontracted laboratories. Results from subcontracted laboratories are clearly identified on the ESC client report.

5.10.7 Electronic Transmission of Results

Data packages are provided when requested by the client. They range from QC summaries to "CLP-like" packages with raw data. When a data package is requested at the beginning of a project, the level of package is identified, and it is then logged into the LIMS using the appropriate product code.

The analyst performing the analysis or a QC Specialist generates the QC documentation. The package is generated using the following process:

- Data and Supporting documentation is gathered by the QC Specialist (QCS)
- The package is formatted to the client request and submitted for review:
- Section Supervisor or Senior analyst
- Technical Specialist, Department Manager, Lab Director or designee.
- Once the reviews are complete, the package is logged, copied/scanned/burned to CD, and shipped. The ESC preferred means of delivery is via ESC's secure web site (PDF format) in recognition of the paperwork reduction act.
- See Table 10.8 for typical data package information.

5.10.8 Format of Reports

ESC client reports are designed to represent the analytical results unambiguously. Each client also has the option of using our web site to design a "custom" electronic report that will present results, historical data, and show trends in a format that is downloadable to a client database.

Client reports include the following information:

Table 5.10.8 Data Package Contents

Level I Level II	**Standard QC Data Package Provided Upon Request**
	Final Analytical Report with qualifiers where necessary
	Sub-Contract Final Report if applicable
	Chain of Custody (COC) Form
	Method Blank
	Matrix Spike/Spike Duplicate Summary (MS/MSD) - with Control Limits
	Laboratory Control Sample Summary (LCS) - with Control Limits
	Reporting Limits listed on all reports
	Surrogate Recoveries for GC and GC/MS analyses (on final report)
	Case Narrative upon request
Level III	**Data Package Provided Upon Request**
	All QC Data Included in Levels I and II plus:
	MS/MSD analysis performed on specific sample upon request
	Initial and Continuing Calibration Information
	Instrument blank performance
Level III - Mod	**Data Package Provided Upon Request**
	All QC Data Included in Levels I, II and III plus:
	Chromatograms, including Batch QC, and Samples
Level III - Mod	**Data Package Provided Upon Request**
	Quantitation Reports
	Analysis Log
	Extraction Logs
Level IV	**Data Package Provided Upon Request**
	("CLP-Like" Validation Package)
	All QC Data Included in Levels I, II, III and III mod plus:
	Multiple Sample Dilutions Reported
	Before/After reports when manual integration is necessary (where requested)
	Initial and Continuing Calibration Chromatograms and Quantitation
	Surrogate, Tune, Internal Std & Method Blank summary forms
	Standard Preparation Logs

5.10.9 Amendments to Reports

Reports that are amended after issue to the client, the amended report is clearly identified as such and a reference to the original report is made. The process is described in SOP 030223, *Report Revision*.

5.11 LABORATORY DATA REDUCTION *(SOP 030201 Data Handling & Reporting)*

The primary analyst completes the majority of data reduction using the following:

- Manual calculation, as represented on the bench sheet.
- Input of raw data for computer processing.
- Direct acquisition of raw data by computer.

5.11.1 Manual Calculations

If data requires manual calculation, the analyst has the responsibility of recording all steps involved directly on the bench sheet. Each bench sheet must be completed in a manner so that during review the person checking the raw data can easily reproduce the calculations. All pertinent information is included such as: response factors, dilution factors, and calibration constants. The analyst signs and dates each page of calculations in ink. A secondary review is required for all data. The second reviewer also initials and dates the worksheet. The worksheets are bound in chronological order in a laboratory workbook designated for each analysis.

5.11.2 Computer Processing

If data is input and processed using a computer, a hard copy of the input and output is reviewed to ensure that no discrepancies exist. The person entering the data and reviewing the data sign the data. The samples analyzed are evident. The data is identified by date analyzed or sample log number; in addition, a disc or tape backup is archived. Data files are uniquely identified by log number/parameter or date analyzed.

5.11.3 Data Acquisition

If data is directly acquired from instrumentation and processed, the analyst reviews the following for accuracy: sample log numbers, calibration constants, response factors, reporting units, and established numerical values used for detection limits (if a value is reported as less than the MDL). The analyst signs and dates the resulting output.

Data that is produced by instrumentation such as calibration curves, absorbance responses, chromatograms, etc. are identified with the following information:

- Date of analysis and initials of analyst
- Initials of review analyst
- Instrument Identification
- Type of analysis

Instrument run logs can be cross-referenced by date to access information on instrument conditions.

5.11.4 Analytical Data Records

Manual data entries are done with indelible ink. All errors are corrected with a single line strikethrough followed by initials and date. The corrected entry appears adjacent to the incorrect entry.

***Manual Data**:*

All manual analytical data represents the following:

- Lab Sample ID
- Analysis Type and Method Number
- Date of analysis
- Prep Date/time
- Time of analysis (if holding time <72 hours)
- Instrument ID
- Calibration Date
- Analyst Initials
- Required QC
- Calculations
- Matrix
- Sample volume/amount
- Dilutions (if any)
- Units of measure
- Correlation coefficient
- Reagent ID – cross reference to preparation date/origin
- Standard ID – cross reference to preparation date/origin
- Calculations where required (manual)
- Qualifiers
- Comments where necessary
- Reviewer initials

Instrument Data:

The instrument printout and supporting data represents the following:

- Instrument ID – cross reference to maintenance log and instrument conditions
- Date/time of analysis
- Injection log/Sample run log
- Operator ID
- Instrument Responses
- Chromatograms/printouts (including manual integrations)
- Units of measure
- Sample amount/volume
- Dilutions
- Sample ID
- QC Samples
- Calibration Date
- Filename
- Comments
- Analyst Initials
- Review Initials
- Standard ID – cross reference to preparation date/origin
- Software version
- Method ID

5.12 DATA VALIDATION PROCESS

5.12.1 Chain of Custody Review

One of the first steps in the validation process is review of the chain of custody (COC). The COC is reviewed first when the sample arrives. It is checked for completeness as well as time accountability. If the COC is complete and accurate, it is then processed through the system. If any irregularity is found, a non-conformance sheet is filled out, with the TSR sign-off, etc. The samples are released for analysis upon approval of the COC.

5.12.2 Field Data

Field data must meet all calibration and continuing calibration requirements. All field data is reviewed for accuracy and completeness. The field data must be approved before it can be entered onto a report. The Environmental Monitoring Manager reviews recorded field data. Field QC criteria are explained in detail in Section 5.7 and in Appendix III.

5.12.3 Laboratory Analysis, QC, and Data Review

Lab Analyst

- After the COC has been reviewed and the sample has been logged in, the laboratory performs all required analyses. The Lab Supervisors are responsible for ensuring that all samples are run within holding time.
- At the beginning of each analysis or sample preparation, the analyst is responsible for making sure that all laboratory ID numbers on the sample bottles match those listed on the benchsheet or logbook.
- Sample transfer from bottle to container is periodically spot checked by a qualified senior analyst.
- Upon completion of the analysis the analyst verifies that analytical information and results are correct and complete, the appropriate SOP has been followed, manual integrations (where applicable) have been correctly interpreted, QC samples are within established limits, and supporting documentation is complete.
- The benchsheet is then given to a QC Specialist who reviews the same information and ensures all portions of the benchsheet are complete.
- The review person then initials and dates the benchsheet.

Extraction/Sample Prep

- The Department supervisor's are responsible for reviewing all extraction/ preparation logs. The review verifies completeness regarding method, sample amount, reagent amount, times, temperatures, etc.
- The extraction/prep logs are reviewed for sample prep method as well as sample extraction date versus holding time.

Final Data Responsibility

- The Department supervisor for each section of the laboratory is responsible for reviewing instrument run logs and benchsheets to ensure that the samples are being prepared and analyzed within holding times.
- The QC Specialist performs a final review before the data is approved for input into the computer.
- This review includes performance of the various blanks, precision QC and accuracy QC to determine if the set is within quality control criteria. Data reviews are conducted according to the SOP #030227, *Data Review*, that provides more detail regarding specific steps taken in the review process. In some cases, specific regulatory guidelines on the data review process include additional requirements (i.e. Ohio VAP's data review checklist use) that are also included in the SOP.
- If the data is not approved during the final review process, it is given a pending status and returned to the laboratory.
- Pending data is reviewed for corrective action and may require only re-calculation or may result in re-analysis.

Final Report Review

- For manual data, the reviewed data is entered in the LIMS; the input is reviewed against the raw data by a second person for accuracy.
- Data transfer is reviewed and approved by a QC Specialist.
- The client reports are then prepared for review by the assigned Technical Service Representative (TSR). The report is reviewed for correlation between related parameters as well as possible trends. The TSR reviews related supporting documentation such as chain of custody records, field documents, sample receipt information, compliance with client/project specific requirements, etc.
- All field documents are reviewed and approved before the final review. Field data that does not pass established criteria is not processed through the final report review.
- The Environmental Monitoring Manager is responsible for any corrective actions necessary concerning field results.
- Laboratory result values that appear anomalous are sent back to the laboratory for a second review of the raw data.
- If there is no apparent reason for the anomaly the sample is re-analyzed.
- If the sample holding time has expired, the sample is re-analyzed and flagged.
- If the client desires, a new sample can be collected and evaluated.
- The chain of custody is also reviewed for a final time to ensure that all project objectives have been met.
- The LIMS footnotes any parameters that may exceed established limits as provided by the client.
- When the LIMS notes that a limit has been exceeded, the Technical Service Representative is notified and the client is contacted.

Table 5.12.3 DATA REDUCTION AND VALIDATION FLOW		
Primary Activity	**Supporting Activity**	**Responsibility**
Review of COC	Login Confirmation to Client	Initially by Login Personnel and again by Technical Service Representative
Data Production and Reduction	Supporting documentation	Primary Analyst/Chemist
Review of Laboratory QC	Review of Data Completion and QC Limit Verification	Primary Analyst/Chemist
Approval of Laboratory QC	Review of Data Completion and QC Limit Verification	QC Specialist/Senior Chemist
Approval of ESC Field QC and Data	Review of Field Records	Environmental Monitoring Manager
Data Entry to LIMS	Data Transfer	Analyst followed by QC Specialist
Data Entry to LIMS	Data Transfer - Application of Qualifiers	Data Entry Specialist followed by QC Specialist Verification
Data Entry to LIMS	Manual Entry of Data and Qualifiers	Data Entry Specialist followed by QC Specialist Verification
Draft Final Report Generation	Report printed and given to TSR for Approval	Data Entry Specialist or Administrative Assistant
Final Report Review and Approval	TSR Approval/Signature	Technical Service Representative (TSR)

6.0 WASTE MINIMIZATION/DISPOSAL AND REAGENT STORAGE

ESC's sample disposal policy is founded on RCRA [40 CFR Part 261.4 (d)] and CWA [40 CFR Part 403 (Pretreatment)]. Part 261.4 (Figure 6.1) excludes a sample of waste while it is a sample; however, once no longer fitting the description of a sample, it becomes waste again. The policy is further strengthened by information found in "Less is Better" published by the ACS and developed by the ACS Task Force on RCRA.

The EPA requires that laboratory waste management practice to be conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes must be characterized and disposed of in an acceptable manner. Refer to ESC SOP #030309, Waste Management Plan for detailed information.

6.1 QUARANTINED SOIL SAMPLES

ESC maintains a permit to receive and analyze soils from foreign or quarantined areas. All non-hazardous soil samples are disposed of as originating from a quarantined area. All unconsumed soil samples and containers are sterilized in accordance with the current USDA regulations found in 7 CFR 301.81. Both container and contents are dry-heated at 450°F for two minutes, then crushed prior to disposal into a sanitary landfill.

6.2 MOLD/BIOHAZARD SAMPLE DISPOSAL

The laboratory has contracted a local licensed medical waste removal and disposal firm to remove all biohazard and medical waste generated by the laboratory. All waste arriving at the treatment facility is incinerated or steam sterilized complying with all Federal, State, County and local rules, regulations and ordinances. The medical waste containers are picked up at least weekly and confirmation records are available in the laboratory.

All wastes classified as non-biohazard are disposed of via the sanitary sewer following treatment with a disinfectant such as Chlorox (hypochlorite) until the disinfectant and waste liquid is one part disinfectant and five parts waste liquid. Waste disposal records indicating the disposal method are available in the laboratory.

6.3 REAGENTS, STORAGE AND WASTE DISPOSAL

6.3.1 Reagents:

- All chemicals are at least ACS reagent-grade or better.
- All reagents and chemicals are checked for quality, purity and acceptability upon arrival in the laboratory.
- Each chemical container displays the following information: date opened and the expiration date.
- All reagent solutions prepared in-house contain the following information: date prepared, analyst initials, expiration date, and reagent name. In house reagents are recorded with the same information in a reagent prep book assigned to that method.
- Purchased reagent solutions are labeled when received and opened and with the expiration date.

6.3.2 Storage:

- Reagents requiring refrigeration are stored in the area of use in a suitable refrigerated storage that is separate from sample storage.
- Reagents and standards used for volatile organic analysis are stored in a separate refrigerator and are not stored with samples.
- See the following table for more information regarding reagent storage.

Item	Reagent Storage
Acids	Designated acid storage cabinets, in original container.
Organic Reagents - Flammables	Stored in flammables cabinet on separate air system from volatiles analysis.
Liquid Bases	Stored in designated cabinet, away from acids.
Solid Reagents	General cabinet storage.
Refrigerated Aqueous Reagents/Standards	Stored in walk-in cooler on designated shelves, away from samples.
Stable Standard Solutions	Storage cabinet designated in each laboratory for standards.
Dehydrated Media	Dehydrated media is stored at an even temperature in a cool dry place away from direct sunlight. Media is discarded if it begins to cake, discolor, or show signs of deterioration. If the manufacturer establishes an expiration date, the media is discarded after that date. The time limit for unopened bottles is 2 years at room temperature. Where needed comparisons of recovery of newly purchased lots of media against proven lots, using recent pure-culture isolates and natural samples, are performed.
Pure Biological Cultures	All organisms are stored on Tryptic Soy Agar at 4°C in a dedicated refrigerator located in the biology department

6.3.3 Disposal:

- All excess, out of date or unneeded chemicals, reagents and standards are sent to the ESSH Office to ensure proper disposal. Excess chemicals designated as hazardous waste are lab packed and disposed of according to local, State and Federal regulations. Final disposal method is dependant on the classification of each individual chemical. Some sample extracts, chemicals or standards designated as hazardous waste may be disposed of into appropriate satellite accumulation areas. Any additional EPA waste codes resulting from addition of standard are applied to the satellite container, if applicable.

- ESH prohibits the sink disposal of chemicals, the intentional release of chemicals through chemical fume hoods and mixing of nonhazardous lab trash with hazardous waste.
- Sample and reagent/solvent disposal is handled in different ways according to toxicity.
  - Solvents, reagents, samples and wastes are segregated according to base/acid, reactive/non-reactive, flammable/non-flammable, hazardous/non-hazardous, soil/liquid etc. Samples are grouped together relevant to these categories and are disposed of accordingly.
  -
  -
  - Table 6.1 lists waste disposal methods for various test byproducts.
- Upon receipt and login, each sample is coded by sample matrix type. The codes divide samples into the following groups: air, industrial hygiene, wastewater, cake sludge, soil, drinking water, food and miscellaneous. As laboratory personnel review the data reported, the method of disposal is also determined.
- The TSR is notified if samples are to be returned to the client.

6.4 CONTAMINATION CONTROL

6.4.1 Metals

The metals lab conducts quarterly wipe testing in order to ensure that the environment is contaminant free. All critical areas are included and a record is kept of the sampling plan (including locations) and results. Bench tops, balances, digestion equipment, and instrument areas are evaluated against the regulatory limit. Any detectable concentration must be $\leq$1/2 of the established regulatory limit for each metal being analyzed. If any detectable amount exceeds the established criteria, then the area must be cleaned and verified before analysis can resume.

6.4.2 VOC's

The VOC Lab is physically separated from the Extraction Laboratory in order to eliminate

contamination caused by the use of extraction solvents. Contamination is monitored daily through the use of instrument/method blanks.

6.4.3 Biological Lab

The aquatic toxicity testing, mold testing, and all other biological determinations are performed in the administrative building and are therefore physically separated from processes involving solvent or other chemical use. The mold lab conducts monthly analyses to ensure that the laboratory environment is contaminant free. All critical areas are included and a record is kept of the sampling plan (including locations) and results.

TABLE 6.1 - WASTE DISPOSAL

NOTE: This information is a general guide and is not intended to be inclusive of all waste or hazardous samples.

PARAMETER	WASTE PRODUCTS	WASTE CLASSIFICATION	DISPOSAL METHOD
Acidity	slightly alkaline water	none	neutralize-sanitary sewer
Alkalinity	slightly acidic	none	neutralize-sanitary sewer
BOD, 5-day	Sample waste only	none	sanitary sewer
COD	acid waste, Hg, Ag, Cr+6	corrosive, toxic	dispose via haz waste regulations
Conductivity	None		
Cyanide, Total	acidic waste	corrosive	neutralize-sanitary sewer
Cyanide, Amenable	acidic waste	corrosive	neutralize-sanitary sewer
Flashpoint	Misc. Organic waste contiaining Chlorobenzene	Flammable	Dispose via haz waste regulations
Fluoride, Electrode	neutral waste solution	none	sanitary sewer
Hardness, Total	pH 10.0 alkaline waste	none	neutralize-sanitary sewer
Extraction/prep	methylene chloride and hexane	toxic solvents	Reclaim for resale
Methylene Blue Active Sub.	Acidic Chloroform Waste	toxic & acidic	dispose via haz waste regulations
Nitrogen-Ammonia	alkaline liquids	corrosive	neutralize-sanitary sewer
Nitrogen-Total Kjeldahl	Trace Hg in alkaline liquid	corrosive toxic	neutralize-sanitary sewer
Nitrogen-Nitrate, Nitrite	mild alkaline waste	none	sanitary sewer
Oil & Grease and Petroleum/Mineral Oil & Grease	Hexane	Toxic solvent	dispose via haz waste regulations
pH	Sample waste only	none	sanitary sewer
Phenols	slightly alkaline, non-amenable CN-	none	sanitary sewer
Phosphate-Total and Ortho	combined reagent	listed	sanitary sewer
Reactive CN & S	Acidic waste	corrosive	Neutralize - sanitary sewer; waste is monitored for CN
Solids, Total (% solids)	None		
Solids, Total Dissolved	None		
Solids, Total Suspended	None		
Turbidity	None	none	none
Metals	acids, metal solutions	corrosive, toxic	highly toxic metal standards and samples - dispose via haz waste regulations
Volatile Organics	methanol	toxic solvents	dispose via haz waste regulations
Extractable Organics	solvents, standards	toxic solvents	dispose via haz waste regulations
Biological Non-biohazardous Waste	Food samples, enrichment broth,	none	Disinfect – sanitary sewer

PARAMETER	WASTE PRODUCTS	WASTE CLASSIFICATION	DISPOSAL METHOD
Biological Non-biohazardous Waste	Gloves, plastic containers	none	Standard refuse

FIGURE 6.1 (*reprint of excerpt – current as of 3/12/08*)

40 CFR PART 261-IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

Subpart A-General Sec.

261.1 Purpose and definition.
261.2 Definition of solid waste.
261.3 Definition of hazardous waste.
261.4 Exclusions.
261.5 Special requirements for hazardous waste generated by conditionally exempt small quantity generators.
261.6 Requirements for recyclable materials.
261.7 Residues of hazardous waste in empty containers.
261.8 PCB wastes regulated under Toxic Substance Control Act.

Sec.261.4 Exclusions.

(d) **Samples.** (1) Except as provided in paragraph (d)(2) of this section, a sample of solid waste or a sample of water, soil, or air, which is collected for the sole purpose of testing to determine its characteristics or composition, is not subject to any requirements of this part or parts 262 through 268 or part 270 or part 124 of this chapter or to the notification requirements of section 3010 of RCRA, when:

(i) The sample is being transported to a laboratory for the purpose of testing; or

(ii) The sample is being transported back to the sample collector after testing; or

(iii) The sample is being stored by the sample collector before transport to a laboratory for testing; or

(iv) The sample is being stored in a laboratory before testing; or

(v) The sample is being stored in a laboratory after testing but before it is returned to the sample collector; or

(vi) The sample is being stored temporarily in the laboratory after testing for a specific purpose (for example, until conclusion of a court case or enforcement action where further testing of the sample may be necessary).

(2) In order to qualify for the exemption in paragraphs (d)(1) (i) and (ii) of this section, a sample collector shipping samples to a laboratory and a laboratory returning samples to a collector must:

(i) Comply with U.S. Department of Transportation (DOT), U.S. Postal Service (USPS), or any other applicable shipping requirements; or

(ii) Comply with the following requirements if the sample collector determines that DOT, USPS, or other shipping requirements do not apply to the shipment of the sample:

(A) Assure that the following information accompanies the sample:

(1) The sample collector's name, mailing address, and telephone number;

(2) The laboratory's name, mailing address, and telephone number;

(3) The quantity of the sample;

(4) The date of shipment; and

(5) A description of the sample.

(B) Package the sample so that it does not leak, spill, or vaporize from its packaging.

(3) This exemption does not apply if the laboratory determines that the waste is hazardous but the laboratory is no longer meeting any of the conditions stated in paragraph (d)(1) of this section.

ESC Site Plan

APPENDIX I TO THE ESC QUALITY ASSURANCE MANUAL

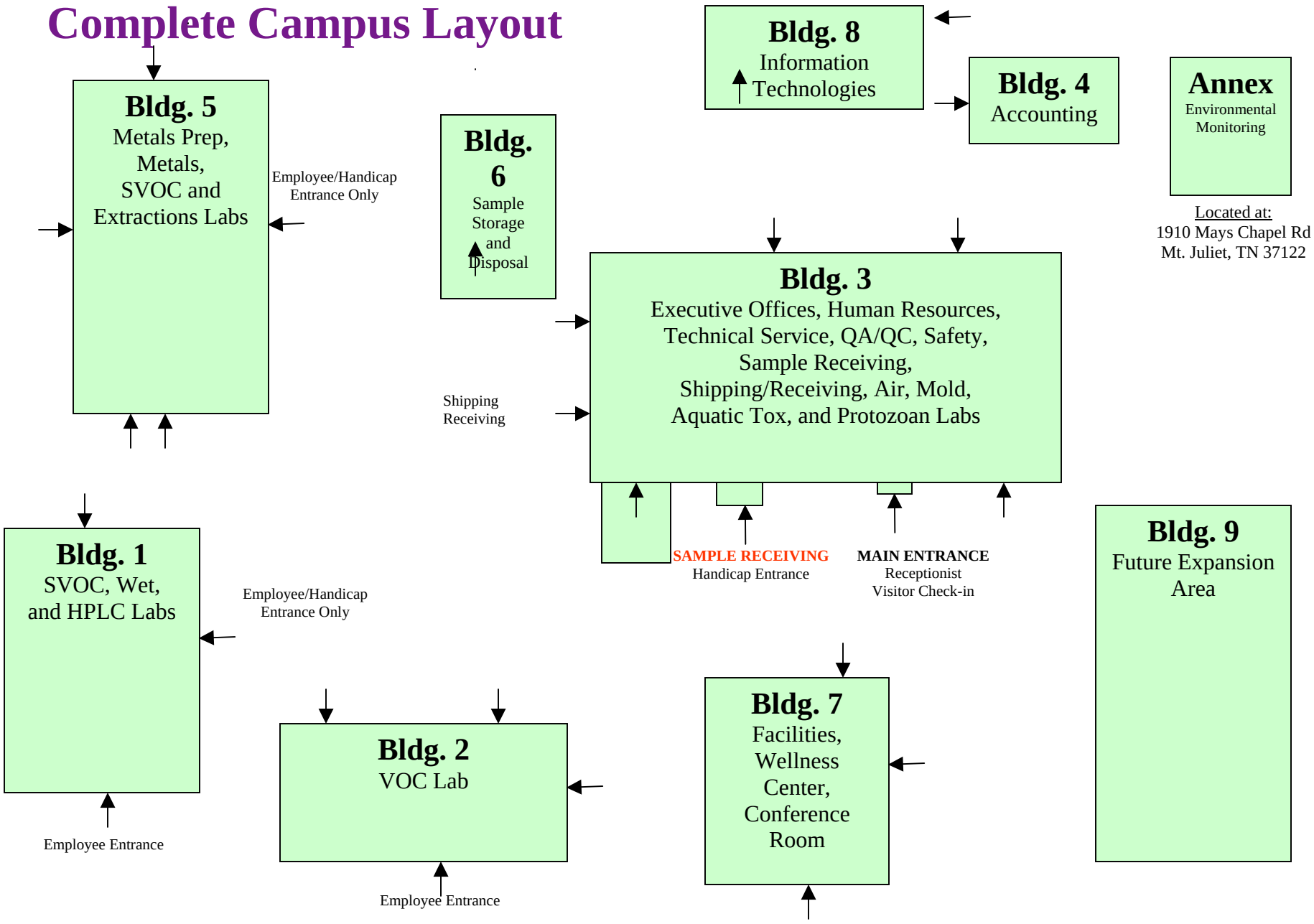
for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615)758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615)758-5858

Complete Campus Layout



ESC Certifications

APPENDIX II TO THE ESC QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615)758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615)758-5858

ENVIRONMENTAL SCIENCE CORPORATION

Certification Summary

State/Agency	Certificate Number	Expiration Date/Status	Cert. REV. Date	Date Posted	Certified Programs	Approved Programs	Cert.Type	Cert. Authority
Alabama	40660	6/30/2011		7/23/2010	DW	WW, RCRA, UST	Reciprocity	TN
Alaska	UST-080	1/11/2011		4/20/2010	UST	UST	AK	AK
Arizona	AZ0612	6/25/2011		7/8/2010	AIR, DW, WW, RCRA, UST		Audit	AZ
Arkansas	88-0469	1/21/2011		2/18/2010	WW, RCRA, UST, BIoassay		NELAP	NJ
California	01157CA	8/31/2011		9/28/2010	WW, RCRA, UST		NELAP	NJ
Colorado	None	3/31/2011		6/2/2009	DW	WW, RCRA, UST	Reciprocity	TN
Connecticut	PH-0197	3/31/2011		4/16/2009	DW	WW, RCRA, UST	Reciprocity	TN, NJ
Florida	E87487	6/30/2011		7/8/2010	AIR, DW, WW, RCRA, UST		NELAP	NJ
Georgia DW	923	Renewal	Renewal	8/17/2007	DW		Reciprocity	TN
Georgia	None	6/30/2011		7/8/2010	WW, RCRA, UST		NELAP	NJ
Idaho	TN00003	6/1/2011		8/5/2010	DW	WW, RCRA, UST	NELAP	NJ
Illinois	200008	11/30/2011		11/22/2010	DW, WW, RCRA, UST		NELAP	NJ
Indiana	C-TN-01	6/16/2013		8/5/2010	DW	WW, RCRA, UST	Reciprocity	TN
Iowa	364	5/1/2012		8/5/2010	WW, RCRA, UST		NELAP	IA
Kansas	E-10277	10/31/2011		11/2/2010	DW, WW, RCRA, UST		NELAP	NJ
Kentucky DW	90010	12/31/2010		4/13/2010	DW	WW, RCRA	Reciprocity	TN
Kentucky UST	16	10/16/2011		11/3/2010	UST		Audit	A2LA
Louisiana	Agency ID 30792	6/30/2011		11/22/2010	WW, RCRA, UST, AIR		NELAP	NJ
Maine	TN0002	7/5/2011		8/4/2009	DW, WW	RCRA, UST	Reciprocity	TN, NJ
Maryland	324	12/31/2010		2/16/2010	DW		Reciprocity	TN
Massachusetts	M-TN003	6/30/2011	7/1/10	9/28/2010	DW,WW	RCRA, UST	Reciprocity	TN
Michigan	9958	6/16/2013		8/31/2010	DW	WW, RCRA, UST	Reciprocity	TN
Minnesota	047-999-395	12/31/2011		11/3/2010	WW, RCRA, UST		Audit	MN
Mississippi	None	6/16/2013		9/28/2010	DW	WW, RCRA, UST	NELAP	NJ
Missouri	340	6/16/2013		9/28/2010	DW	WW, RCRA, UST	NELAP	NJ
Montana	CERT0086	Renewal	Renewal	7/16/2007	DW	WW, RCRA, UST	Reciprocity	TN
Nebraska	NA	6/30/2011		8/31/2010	DW	WW, RCRA, UST	Reciprocity	TN
Nevada	TN-03-2002-34	7/31/2011	Extended	8/19/2010	WW, DW, RCRA, UST		NELAP	NJ
New Hampshire	2975	5/20/2011	Jul-10	7/8/2010	DW, WW	RCRA, UST	NELAP	NJ
New Jersey - NELAP	TN002	6/30/2011		7/8/2010	DW, WW, RCRA, UST, AIR		NELAP	NJ
New Mexico	None	6/30/2011		7/9/2010	DW	WW, RCRA, UST	NELAP	NJ

New York	11742	4/1/2011	6/3/10	6/9/2010	WW, RCRA, UST, AIR		NELAP	NJ
North Carolina DW	DW21704	7/31/2011		8/5/2010	DW		Audit	NC
North Carolina	Env375	12/31/2010		1/15/2010	WW, RCRA, UST		Audit	NC
North C. Aquatic Tox	41	11/1/2011		11/22/2010	Aquatic Toxicity		Audit	NC
North Dakota	R-140	6/30/2011		7/23/2010	DW, WW, RCRA		Reciprocity	TN, WI
Ohio VAP	CL0069	4/14/2011	Jan-08	6/2/2009	WW, RCRA, UST, AIR		Audit	OH
Oklahoma	9915	8/31/2011		11/3/2010	WW, RCRA, UST, BIOASSAY		NELAP	NJ
Oregon	TN200002	1/15/2011		2/16/2010	DW, WW, RCRA, UST		NELAP	NJ
Pennsylvania	68-02979	12/31/2010		1/15/2010	DW, WW, RCRA, UST		NELAP	NJ
Rhode Island	221	12/31/2010		2/16/2010	DW, Env. Lead	WW, RCRA, UST	Reciprocity	TN, AIHA
South Carolina	84004	6/30/2011		11/22/2010	WW, RCRA, UST		NELAP	NJ
South Dakota	Pending	Pending						
Tennessee DW	2006	6/16/2013		7/23/2010	DW	WW, RCRA, UST	Audit	TN
Tennessee DW Micro	2006	10/12/2012		2/16/2010	DW Micro		Audit	TN
Texas Mold	LAB0152	3/10/2011		5/7/2007	MOLD		NA	TX
Texas - Env	T 104704245-07-TX	10/31/2011		11/3/2010	DW, WW, RCRA, AIR		Reciprocity	NJ
Utah	6157585858	6/30/2011		8/5/2010	DW, WW, RCRA, UST		NELAP	NJ
Vermont	VT2006	1/5/2011	Jan-10	1/15/2010	DW	WW, RCRA, UST	Reciprocity	TN
Virginia	109	6/30/2011		7/8/2010	DW	WW, RCRA, UST	NELAP	NJ
Washington	C1915	8/19/2011	9/18/08	11/3/2010	DW, WW, RCRA, UST, AIR		Audit	A2LA
West Virginia	233	2/28/2011		4/9/2010	WW, RCRA, UST		Audit	WV
Wisconsin	998093910	8/31/2011		9/14/2009	WW, RCRA, UST		Audit	WI
Wyoming	A2LA	11/30/2011		7/23/2010	UST	WW, RCRA	Audit	A2LA
Other Agencies								
A2LA	1461.01	11/30/2011	4/30/2010	7/23/2010	DW, WW, RCRA, UST, AIR, MICRO		Audit	A2LA
AIHA*	100789	6/1/2012		6/1/2010	IHLAP, ELLAP, EMLAP		Audit	AIHA
DOD	1461.01	11/30/2011		3/8/2010	RCRA, UST		Audit	A2LA
EPA	TN00003	None			Cryptospiridium		Audit	EPA
USDA	S-67674	8/7/2012		8/7/2009	Quarantine Permit		Audit	USDA

(1) A2LA = American Association for Laboratory Accred.
(2) AIHA = American Industrial Hygiene Association
(3) NELAP = National Environmental Laboratory Accred. Program
(4) IHLAP = Industrial Hygiene Laboratory Accred. Program
(5) ELLAP = Environmental Lead Laboratory Accred. Program
(6) EMLAP = Environmental Microbiology Laboratory Accreditation Program
(7) USDA = United States Department of Agriculture
(8) Approved Programs = The state does not have a formal certification program.
(9) Pending = The state is processing our application.
(10) EPA = Environmental Protection Agency

1.0 SIGNATORY APPROVALS

SAMPLING PROTOCOL QUALITY ASSURANCE MANUAL

APPENDIX III TO THE ESC QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

NOTE: The QAM has been approved by the following people. A signed cover page is available upon request

Judith R. Morgan, M.S., VP of Technical and Regulatory Affairs 615-773-9657

Eric Johnson, B.S., Laboratory Director 615-773-9654

Dixie Marlin, B.S, QC Manager, 615-773-9681

Tom Stinson, B.S., Environmental Monitoring Department Manager, 615-773-7551

2.0 APPENDIX TABLE OF CONTENTS

3.0 SCOPE AND APPLICATION

This appendix discusses the standard practices and procedures utilized by ESC personnel for site selection and sample collection of various matrices. Topics addressed include field QA/QC procedures, together with equipment care and calibration for field sampling activities. Proper collection and handling of samples is of the utmost importance to insure that collected samples are representative of the sampling site. With this goal, proper sampling, handling, preservation, and quality control techniques for each matrix must be established and strictly followed. Precise identification of the collected samples and complete field documentation including a chain of custody are also vital.

ESC Lab Sciences does not provide sampling services for Industrial Hygiene and Environmental Lead analyses. We do require that all samples collected for these programs be sampled using the guidelines established by NIOSH, OSHA or other published protocol.

In addition, ESC Lab Sciences personnel do not conduct sampling in conjunction with the Ohio Voluntary Action Program (VAP).

4.0 LIST OF SAMPLING CAPABILITIES

• Parameter Group	• Sample Source
Extractable Organics	Surface water, wastewater, groundwater, stormwater runoff, drinking water, sediments, soils, chemical/ hazardous wastes, domestic wastewater sludge, hazardous waste sludge
Volatile Organic Compounds (VOCs)	Surface water, wastewater, groundwater, stormwater runoff, drinking water, sediments, soils, chemical/ hazardous wastes, domestic wastewater sludge, hazardous waste sludge
Metals	Surface water, wastewater, groundwater, stormwater runoff, drinking water, sediments, soils, chemical/ hazardous wastes, domestic wastewater sludge, hazardous waste sludge
Inorganic Anions	Surface water, wastewater, groundwater, stormwater runoff, drinking water, sediments, soils, chemical/ hazardous wastes, domestic wastewater sludge, hazardous waste sludge
Organics	Surface water, wastewater, groundwater, stormwater runoff, drinking water, sediments, soils, chemical/ hazardous wastes, domestic wastewater sludge, hazardous waste sludge
Physical Properties	Surface water, wastewater, groundwater, stormwater runoff, drinking water, sediments, soils, chemical/ hazardous wastes, domestic wastewater sludge, hazardous waste sludge
Cyanide	Surface water, wastewater, groundwater, stormwater runoff, drinking water, sediments, soils, chemical/ hazardous wastes, domestic wastewater sludge, hazardous waste sludge
Microbiology	Surface water, groundwater, drinking water, wastewater
Macro Invertebrate Identification	Surface water, wastewater, sediments
Biotoxicity	Surface water and wastewater

5.0 GENERAL CONSIDERATIONS

The following procedures are used in all of ESC's sampling activities. These procedures must be considered in relation to the objectives and scope of each sampling event.

5.1 SELECTING A REPRESENTATIVE SAMPLING SITE

Selecting a representative sampling site is dependent upon the matrix to be sampled and type of analyses required. These matrix specific procedures are discussed in subsequent sections.

5.2 SELECTION AND PROPER PREPARATION OF SAMPLING EQUIPMENT

The type of sampling equipment to be used is specific to the sample matrix and the analyses to be conducted. These are discussed later in this section. Section 12.0 describes the equipment cleaning procedures utilized by ESC personnel.

5.3 SAMPLING PROCEDURES FOR INDUSTRIAL HYGIENE AND ENVIRONMENTAL LEAD SAMPLES

ESC does not provide sampling services for industrial hygiene and/or environmental lead analyses. Experienced laboratory personnel can assist with advice on sampling; however, the adequacy and accuracy of sample collection is the client's responsibility.

5.4 SAMPLING EQUIPMENT CONSTRUCTION MATERIALS

To prevent direct contamination or cross-contamination of the collected sample, great attention must be given to the construction material used for sampling equipment. Materials must be inert, non-porous and easy to clean. Preferred materials include Teflon®, glass, stainless steel and plastic. Plastics may not be used for collections where organics are the analytes of interest. Stainless steel may not be used where metallic compounds will be analyzed.

5.5 SELECTION OF PARAMETERS BEING ANALYZED

Parameters for analysis are usually dictated by and based on regulated monitoring conditions (i.e. NPDES or RCRA permits). If these do not apply, analyses are selected by ESC or the client based on federal regulations specific to the matrix being investigated.

5.6 ORDER OF SAMPLE COLLECTION

Unless field conditions demand otherwise, the order of sample collection is as follows:

1. Volatile organic compounds (VOCs)
2. Extractable Organics (includes Total Recoverable Petroleum Hydrocarbons [TRPH], Oil & Grease, Pesticides and Herbicides)
3. Total metals
4. Dissolved metals
5. Microbiological
6. Inorganic (includes Nutrients, Demand, and Physical Properties)
7. Radionuclides

5.7 SPECIAL PRECAUTIONS FOR TRACE CONTAMINANT SAMPLING

Many contaminants can be detected in the parts per billion or parts per trillion range and extreme care must be taken to prevent cross-contamination. Therefore, extra precautions apply where samples are collected for trace contaminants. These precautions include:

- A new pair of disposable latex gloves must be worn at each sampling location.
- Sample containers for samples suspected of containing high concentrations of contaminants shall be sealed in separate plastic bags immediately after collection and preservation.
- If possible, background samples and source samples should be collected by different field sampling teams. If different field teams are not possible, all background samples shall be collected first and placed in separate ice chests or shipping containers. Samples of waste or highly contaminated samples shall not be placed in the same container as environmental samples. Ice chests or shipping containers for source samples or samples that are suspected to contain high concentrations of contaminants are discarded after use.
- If possible, one member of the field team should handle all data recording, while the other members collect samples.
- When sampling surface waters, water samples should always be collected before sediment samples are collected.
- Sample collection activities should proceed from the suspected area of least contamination to the suspected area of greatest contamination.
- ESC personnel should use equipment constructed of Teflon®, stainless steel, or glass that has been properly pre-cleaned (Sections 12.3 & 12.4) for collecting samples for trace metals or organic compounds analyses. Teflon®, glass, or plastic is preferred for collecting samples where trace metals are of concern. Equipment constructed of plastic or PVC shall not be used to collect samples for trace organic compounds analyses.
- When fuel powered units are utilized, they will be placed downwind and away from any sampling activities.

- Monitoring wells with free product shall not be sampled for trace contaminant analysis.

5.8 SAMPLE HANDLING AND MIXING

Sample handling should be kept to a minimum. ESC personnel must use extreme care to avoid sample contamination. If samples are placed in an ice chest, personnel should ensure that sample containers do not become submerged or tip over as this may result in cross-contamination. Small sample containers (e.g., VOCs or bacterial samples) should be placed in airtight plastic bags to prevent cross-contamination.

Once a sample has been collected, it may have to be split into separate containers for different analyses. A liquid sample will be split by shaking the container or stirring the sample contents with a clean pipette or pre-cleaned Teflon® rod. Then the contents are alternately poured into respective sample containers. Items used for stirring must be cleaned in accordance with the guidelines set forth in Section 12.0. Samples for VOCs, Cyanide, Total Phenol, and Oil & Grease must be collected as discrete grabs.

A soil sample may be split but must first be homogenized as thoroughly as possible to ensure representative sub-samples of the parent material. This is accomplished using the quartering method. The soil is placed in a sample pan and divided into quarters. Each quarter is mixed separately then all quarters are mixed together. This is repeated several times until the sample is uniformly mixed. If a round bowl is used, mixing is achieved by stirring the material in a circular fashion with occasionally inversion of the material.

Soil and sediment samples collected for volatile organic compounds shall not be mixed. The appropriate sample container should be filled completely, allowing little to no headspace.

Moisture content inversely affects the accuracy of mixing and splitting a soil sample.

5.9 QUALITY CONTROL SAMPLES

Quality control samples must be collected during all sampling events to demonstrate that the sample materials have not been contaminated by sampling equipment, chemical preservatives, or procedures relating to the sample collection, transportation and storage. A summary of the recommended frequency for collecting field quality control samples is presented in the following:

5.9.1 Quality Control Samples

Number of samples	Precleaned equipment blank[1]	Field cleaned equipment blank	Trip blank (VOCs)	Duplicate
10 or more	minimum of 1 then 5%	minimum of 1 then 5%	one per cooler[2]	minimum one then 10%[3]
5 - 9	one	one	one per cooler[2]	one
less than 5	one	one	one per cooler[2]	Not required, but recommend a minimum of one. USACE projects require one. Client specific QAPP requirements must be considered.

[1] Pre-cleaned blanks are to be collected after the initial decontamination procedure has been completed but before the first sample is collected. Only one pre-cleaned or field-cleaned blank is required if less than 10 samples are collected. Only analyte-free water as defined in this document will be used in the preparation of any field and/or equipment blank.

[2] Where VOC methods are analyzed simultaneously, such as 601/602, only one (1) trip blank is required per cooler.

[3] Duplicate samples are collected for all VOC samples.

5.10 VOLATILE ORGANIC COMPOUND SAMPLING

Water Samples

Generally, groundwater, drinking water and wastewater samples for the analysis of volatile organic compounds are collected in duplicate pre-labeled 40mL vials. During bottle kit preparation in the laboratory, 200µL of concentrated HCl is added to each clean and empty vial. A Teflon® septum is placed in each cap and a cap is placed securely on each vial.

The sampler should check the water being sampled for residual chlorine content. This is done with residual chlorine testing strips. If no chlorine is present, the prepared vials may be filled as needed. If residual chlorine is present, add one crystal of sodium thiosulfate ($Na_2S_2O_3$) to each vial prior to sampling.

To fill the vial properly, the sample is poured slowly down the inside wall of the vial until a convex meniscus is formed. Care should be taken to minimize turbulence. The cap is then applied to the bottle with the Teflon® side of the septum contacting the sample. Some overflow is lost; however air space in the bottle should be eliminated. Check for air bubbles by inverting the capped vial and tapping against the heel of the hand. This will dislodge bubbles hidden in the cap. If any bubbles are present, repeat the procedure. If unsuccessful, discard the vial and re-sample with a new preserved vial and septum. At a minimum, duplicate vials should always be collected from each sample location.

For analysis using EPA Method 524.2, samples that are suspected to contain residual chlorine, 25mg of ascorbic acid per 40mL of sample is added to each sample vial prior to sampling. Additionally, if analytes that are gases at room temperature (i.e. vinyl chloride, etc.) or any of the analytes in following table are not to be determined, 3mg of sodium thiosulfate is recommended for use to remove residual chlorine during sampling. If residual chlorine is present in the field sample at >5mg/L, then add additional 25mg or ascorbic acid or 3mg of sodium thiosulfate for each 5mg/L of residual chlorine present. Sample vials are then filled as previously described. Following collection and dechlorination, Method 524.2 samples are adjusted to a pH of <2 with HCl.

Acetone	Acrylonitrile	Allyl chloride
2-Butanone	Carbon disulfide	Chloroacetonitrile
1-Chlorobutane	t-1,2-Dichloro-2-butene	1,1-Dichloropropanone
Diethyl ether	Ethyl methacrylate	Hexachloroethane
2-Hexanone	Methacrylonitrile	Methylacrylate
Methyl iodide	Methylmethacrylate	4-Methyl-2-pentanone
Methyl-tert-butyl ether	Nitrobenzene	2-Nitropropane
Pentachloroethane	Propionitrile	Tetrahydrofuran

For more detailed instructions, see the published method.

Soil Samples

Option 1 – Core Sampling Device
Soil samples for volatile organic analysis should be sampled using traditional core sampling methods. Once the core sample is collected, additional samples should be taken using an Encore™ sampler, either 5g or 25g, capped, sealed, and immediately cooled. The holding time for this method is 48 hours.

Option 2 – Pre-weighed Vial
In the other option for volatile soil sampling, 40mL vials with cap, Teflon® lined septum, preservative (5mL sodium bisulfate solution), and stir bar are pre-weighed, either by the user or the manufacturer. The vial is weighed on a balance capable of measuring to 0.01g and labeled with the pre-weighed value. In the field, place roughly 5g of sample into a pre-weighed vial, cap, and then immediately place on ice to achieve a temperature of 4ºC. Exact soil weights can be measured using the pre-weight of the vial and the post-sampling weight. The difference represents the actual weight of the soil sample. The holding time for this method is 14 days.

Unless specifically permitted by the regulatory authority, VOC samples (liquid or solid) should never be mixed or composited.

5.11 OIL AND GREASE SAMPLING

Aqueous samples collected for oil and grease analyses must be collected as discrete grab samples. Sample containers should not be rinsed with sample water prior to sample collection and samples should be collected directly into the sample container. Intermediate vessels should only be used where it is impossible to collect the sample directly into the sample container and, in this case, only Teflon® beakers should be used. Samples should be taken from well-mixed areas.

5.12 CYANIDE SAMPLING

Cyanide is a very reactive and unstable compound and should be analyzed as soon as possible after collection. Samples shall be collected in polyethylene or glass containers and shall be pretreated and preserved in the manner specified in the following paragraphs.

5.12.1 Test for Oxidizing Agents

1. Test the sample with residual chlorine indicator strips.
2. Add a few crystals of ascorbic acid and test until negative.
3. Add an additional 0.6 grams of ascorbic acid for each liter sampled to remove residual chlorine.
4. Preserve the pretreated sample by to a pH > 12.0 with NaOH and cool to 4 $\pm$ 2°C. Verify the pH of the samples as per Section 14.2.
5. Equipment blanks must be handled in the same manner as described in steps 1 through 4.

5.12.2 Test for Sulfide

1. Test the sample for sulfide using the sulfide test strip;(formally HACH KIT).
2. If sulfide is not removed by the procedure below, the sample must be preserved with NaOH to pH > 12.0 and analyzed by the laboratory within 24 hours.
3. Sulfide should be removed by filtering visible particulate. Retain filter (filter #1).
4. Remove the sulfide by adding lead carbonate powder to the filtrate to cause the sulfide to precipitate out.
5. Test the filtrate for the presence of sulfide. If sulfides are present, repeat steps 1 and 4 until no sulfides are shown present.
6. The precipitate can now be filtered from the sample and this filter is discarded.
7. The sample is then reconstituted by adding the sediment collected on filter #1 back to the filtrate.
8. Preserve the pretreated sample to a pH > 12.0 with NaOH and cool to 4 $\pm$ 2°C. Verify the pH of the samples as per Section 14.2

9. Equipment blanks must be handled in the same manner as described in steps 1 through 9.

5.13 BIOMONITORING SAMPLING

Aqueous samples collected for Bioassay can be collected in either glass or HDPE plastic. There is no chemical preservation for this type of sample and the required volume varies with each type of analysis. Following sampling, all samples must be cooled to 4°C and can be held for a maximum of 36 hours from the time of collection. Grab and composite sample protocols are utilized for acute and chronic bioassays and are chosen according to permit requirements. Samples should be collected with minimum aeration during collection and the container should be filled allowing no headspace. Samples may be shipped in one or more 4L (l gal.) CUBITAINERS® or unused plastic "milk" jugs. All sample containers should be rinsed with source water before being filled with sample. Containers are not reused. If the sample is a chlorinated effluent, total residual chlorine must be measured immediately following sample collection.

5.14 PROCEDURES FOR IDENTIFYING POTENTIALLY HAZARDOUS SAMPLES

Any sample either known, or suspected, to be hazardous shall be identified as such on the chain of custody. Information explaining the potential hazard (i.e., corrosive, flammable, poison, etc.) shall also be listed.

5.15 COLLECTION OF AUXILIARY DATA

All auxiliary data shall be entered in the field records. Auxiliary data relative to a particular sampling location should be recorded concurrent with the sample event. Matrix specific auxiliary data are discussed later in this section.

5.16 TIME RECORDS

All records of time shall be kept using local time in the military (24 hour) format and shall be recorded to the nearest minute.

5.17 REFERENCES

ESC maintains copies of the various sampling references in the sample equipment room. Pertinent pages of these documents may be photocopied and taken to the field during sampling investigations. A bibliography of references used in the development of this section is presented in Section 17.

6.0 ANCILLARY EQUIPMENT AND SUPPLIES

The equipment used to collect samples and conduct necessary purging activities is listed in subsequent sections for each type of sample. However, Section 6.1 lists some of the ancillary field equipment and instruments that may be required.

6.1 ANCILLARY EQUIPMENT AND SUPPLIES

Flow Measurement:	ISCO Continuous Flow Meters 3230, 3210, 2870; Flo-Poke pipe insert
Personal Protective Equipment:	Hard Hats, Face Shields, Half- and Full-Face Respirators, Rubber and Latex Gloves, Tyvex protective coveralls, rubber boots, safety glasses
Field Instruments:	Water Level Indicator, Continuous Recording pH Meter, Portable pH/Temperature Meters, Hach DR-100 Chlorine Analyzer, Hach CEL/700 Portable Laboratory, YSI Field Dissolved Oxygen/Temperature Meter w/ Submersible Probe, Portable Field Specific Conductance Meter, Hach 2100P Portable Turbidimeter
Chemical Supplies & Reagents:	Deionized Water, Tap Water, Liquinox Detergent, Isopropanol, Nitric Acid, Hydrochloric Acid, Sulfuric Acid, Sodium Hydroxide, Ascorbic acid, Sodium Thiosulfate, Ascorbic Acid, Zinc Acetate, pH calibration buffers (4.0, 7.0, and 10.0), Hach Sulfide Kit, lead carbonate powder, Specific Conductance Standard, Turbidity Standards
Tools:	Pipe Wrench, Bung Wrench, Crowbar, Hammer, Assorted Screwdrivers, Tape Measures, Channel Lock Pliers, Vise Grip Pliers, Duct Tape, Vinyl Pull Ties
Miscellaneous:	Cellular Phones, Pagers, Walkie Talkies, 12 Volt Batteries, Flashlights, Extension Cords, Brushes, Plastic sheeting, Fire extinguishers, Water Squeeze Bottles, First Aid Kit, lengths of rigid PVC conduit, aquatic sampling nets (Wildco)

7.0 WASTEWATER SAMPLING

7.1 SAMPLING EQUIPMENT

Type	Use	Materials	Permissible Parameter Groups
Continuous Wastewater Samplers-Peristaltic Pump	Sampling	Tygon tubing; glass or plastic sample container	All parameter groups except oil & grease, extractable organics, and VOCs
	Sampling	Teflon® tubing; glass sample container	All parameter groups except VOCs

7.2 GENERAL CONSIDERATIONS

The procedures used by ESC are generally those outlined in the NPDES Compliance Inspection Manual. Additional guidance is given in the EPA Handbook for Monitoring Industrial Wastewater. Some important considerations for obtaining a representative wastewater sample include:

- The sample should be collected where the wastewater is well mixed.
- Samples should not be collected directly from the surface/bottom of the wastestream.
- In sampling from wide conduits, cross-sectional sampling should be considered.
- If manual compositing is employed, the individual sample bottles must be thoroughly mixed before pouring the individual aliquot into the composite container.

7.3 SAMPLING SITE SELECTION

Wastewater samples should be collected at the location specified in the NPDES or sewer use permit if such exists. If the specified sampling location proves unacceptable, the project manager shall select an appropriate location based on site-specific conditions. An attempt should be made to contact the regulating authorities for their approval. The potential for this type of issue highlights the need for a site inspection prior to the scheduled sampling event.

7.3.1 Influent

Influent wastewaters should be sampled at points of high turbulence and mixing. These points are: (1) the upflow siphon following a comminutor (in absence of grit chamber); (2) the upflow distribution box following pumping from main plant wet well; (3) aerated grit chamber; (4) flume throat; or (5) pump wet well when the pump is operating. Raw wastewater samples should be collected upstream of sidestream returns.

7.3.2 Effluent

Effluent samples should be collected at the site specified in the permit or, if no site is specified, at the most representative site downstream from all entering wastewater streams prior to final discharge.

7.3.3 Pond and Lagoon Sampling

Composite samples of pond and lagoon effluent are preferred over grabs due to the potential for ponds and lagoons to short circuit the projected flow paths. However, if dye studies or facility data indicate a homogeneous discharge, grab samples may be taken.

7.4 SAMPLING TECHNIQUES: GENERAL

The choice of a flow-proportional or time-proportional composite sampling program depends upon the variability of flow, equipment availability, sampling point configuration and accessibility. Flow metered sampling is necessary for complete wastewater characterization and should be utilized where possible. If not feasible, a time-proportional composite sample is acceptable.

A time-proportional composite sample consists of aliquots collected at constant time intervals and can be collected either manually or with an automatic sampler.

A flow-proportional composite sample consists of aliquots collected automatically at constant flow intervals with an automatic sampler and a flow-measuring device. Prior to flow-proportional sampling, the flow measuring system (primary flow device, totalizer, and recorder) should be examined. The sampler may have to install flow measurement instrumentation if automatic sampling is to be used.

7.5 USE OF AUTOMATIC SAMPLERS

7.5.1 General

Automatic samplers are used when several points are sampled at frequent intervals, with limited personnel, or when a continuous sample is required. Automatic samplers used by ESC must meet the following requirements:

- Must be properly cleaned to avoid cross-contamination from prior sampling events.
- No plastic or metal parts shall come into contact with the sample when parameters to be analyzed could be impacted by these materials.
- Must be able to provide adequate refrigeration. Commercially available ice is placed in the sampler base and packed around the container approximately half way up the sample container.
- Must be able to collect a large enough sample for all required analyses. Composite sample containers (glass or plastic) hold up to 10 liters.
- A minimum of 100 milliliters should be collected each time the sampler is activated.
- Should provide a lift of at least 20 feet and be adjustable so that sample volume is not a function of pumping head.
- Pumping velocity must be adequate to transport solids without settling.
- The intake line must be purged a minimum of one time before each sample is collected.
- The minimum inside diameter of the intake line should be 1/4 inch.
- Have a power source adequate to operate the sampler for 48 hours at 15-minute sampling intervals.
- Facility electrical outlets may be used if available.
- Facility automatic samplers may be used for conventional parameters if they meet ESC QA/QC criteria.

Specific operating instructions, capabilities, capacities, and other pertinent information for automatic samplers presently used by ESC are included in the respective operating manuals and are not presented here.

All data relative to the actual use of automatic equipment on a specific job is recorded in sampling logbooks.

7.5.2 Equipment Installation

7.5.2.1 Conventional Sampling

Automatic samplers may be used to collect time-proportional composite or flow-proportional composite samples. In the flow-proportional mode, the samplers are activated by a compatible flow meter. Flow-proportional samples can also be collected using a discrete sampler and a flow recorder and manually compositing the individual aliquots in flow-proportional amounts.

Installation procedures include cutting and installing the proper length of tubing, positioning it in the wastewater stream, and sampler programming. All new tubing (Dow® Corning Medical Grade Silastic, or equal, in the pump and Tygon®, or equal, in the sample train) will be used for each sampler installation.

For a time-proportional composite, the sampler should be programmed to collect 100mL samples at 15-minute intervals into a refrigerated 10L plastic or glass jug, as appropriate for the particular parameters being analyzed.

For a flow-proportional composite, the sampler should be programmed to collect a minimum of 100mL for each sample interval. The sampling interval should be based on the flow of the waste stream.

7.5.3 Automatic Sampler Maintenance, Calibration, and Quality Control

To ensure proper operation of automatic samplers, the procedures outlined in this section shall be used to maintain and calibrate ESC automatic samplers. Any variance from these procedures will be documented.

Proper sampler operation will be checked by ESC personnel prior to each sampling event. This includes checking operation through three cycles of purge-pump-purge; checking desiccant and replacing if necessary; checking charge date on NiCad batteries to be used; and repairing or replacing any damaged items.

Prior to beginning sampling, the purge-pump-purge cycle shall be checked at least once. The sample volume will be calibrated using a graduated cylinder at least twice, and the flow pacer that activates the sampler shall be checked to be sure it operates properly.

Upon return from a field trip, the sampler shall be examined for damage. The operation will be checked and any required repairs will be performed and documented. The sampler will then be cleaned as outlined in Section 12.

7.6 MANUAL SAMPLING

Manual sampling is normally used for collecting grab samples and for immediate in-situ field analyses. Manual sampling may also be used when it is necessary to evaluate unusual waste stream conditions. If possible, manually collected samples should be collected in the actual sample container that will be submitted to the laboratory. This minimizes the possibility of contamination from an intermediate collection container.

Manual samples are collected by (1) submerging the container neck first into the water; (2) inverting the bottle so that the neck is upright and pointing into the direction of wastewater flow; (3) quickly returning the sample container to the surface; (4) shake to rinse. Pour the contents out downstream of sample location; (5) collect sample as described in steps 1, 2, and 3; pour out a few mLs of sample downstream of sample collection. This allows for addition of preservatives and sample expansion.

Exceptions to the above procedure occur when preservatives are present in the sampling container or when oil & grease, microbiological, and/or VOC analyses are required. In these cases, sample shall be collected directly into the container with no pre-rinsing.

If the water or wastewater stream cannot be physically or safely reached, an intermediate collection container may be used. This container must be properly cleaned (Section 12) and made of an acceptable material. A separate collection container should be used at each sampling station to prevent cross-contamination between stations. The sample is collected by lowering a properly cleaned Teflon®, plastic, or glass collection vessel into the waste stream. The intermediate vessel may be lowered by hand, pole or rope.

7.7 SPECIAL SAMPLE COLLECTION PROCEDURES

7.7.1 Trace Organic Compounds and Metals

Due to the ability to detect trace organic compounds and metals in extremely low concentrations, care must be taken to avoid contamination of the sample. All containers, composite bottles, tubing, etc., used in sample collection for trace organic compounds and metals analyses should be prepared as described in Section 12.

Personnel handling the sample should wear a new pair of disposable latex gloves with each set of samples collected to prevent cross-contamination. A more detailed discussion is given in Section 5.7 under special precautions for trace contaminant sampling.

7.7.2 Bacterial Analysis

Samples for bacterial analysis will always be collected directly into the prepared glass or plastic sample bottle. The sample bottle should be kept closed until immediately prior to sampling and never rinsed with sample. When the container is opened, care should be taken not to contaminate the cap or the inside of the bottle. The bottle should be held near the base and plunged, neck downward, below the surface and turned until the neck points upward and upstream. The bottle should be filled to within one-inch of the top and capped immediately.

Section 14 presents preservation procedures and holding times. As holding times are limited to 6 hours for microbiological analyses, special arrangements may be required to ensure that these samples reach the laboratory within this timeframe.

7.7.3 Immiscible Liquids/Oil and Grease

Oil and grease may be present in wastewater as a surface film, emulsion, solution, or a combination of these forms. A representative sample for oil and grease analysis is difficult to collect. The sampler must carefully evaluate the location of the sampling point to find the area of greatest mixing. Quiescent areas should be avoided.

Because losses of oil and grease will occur on sampling equipment, collection by composite sampler is not practical. Intermediate sampling vessels should not be used if possible. If intermediate collection vessels are required they should be made of Teflon® and be rinsed with the sample three times before transferring any sample to the sample container. Sample containers, however, should never be rinsed.

7.7.4 Volatile Organic Compounds Analyses

Water samples to be analyzed for volatile organic compounds are collected in 40mL pre-preserved (200uL of concentrated HCl) vials with screw caps. A Teflon®-silicone septum is placed in each cap prior to the sampling event. The Teflon® side must be facing the sample side.

Sampling containers with preservatives are pre-labeled prior to any field activities to reduce the chances of confusion during sampling activities. A complete list of sample preservatives, containers, holding times, and volumes is found in Section 14.

The sampler should check the water to be sampled for chlorine. This is done with residual chlorine indicator strips. If no chlorine is found, the vials may be filled. If residual chlorine is present, the sampling and preservation procedures listed in Section 5.10 of this manual must be performed.

7.8 AUXILIARY DATA COLLECTION

While conducting wastewater sampling, the following information may also be gathered:

- Field measurements -- pH, DO, conductivity, temperature
- Flows associated with the samples collected -- continuous flows with composite samples and instantaneous flows with grab samples
- Diagrams and/or written descriptions of the sample locations
- Photographs of pertinent wastewater-associated equipment, such as flow measuring devices, treatment units, etc.
- Completion of applicable forms required during specific investigations.

All observations, measurements, diagrams, etc., will be entered in field logbooks or attached thereto.

8.0 SURFACE WATER AND SEDIMENT SAMPLING

8.1 EQUIPMENT

Equipment Type	Use	Material	Permissible Parameter Groups
Surface Water Sampling			
Kemmerer Sampler	Depth sampling	PVC	All parameter groups except extractable organics, VOCs, and oil & grease
Automatic Samplers	Sampling	Teflon®	All parameter groups except VOCs, oil & grease, & micro
	Sampling	PVC	All parameter groups except extractable organics, VOCs, oil & grease, and micro
Sample Collection Container	Sampling	Stainless steel	All parameter groups
Bailers	Sampling	Teflon®	All parameter groups
	Sampling	PVC	All parameter groups except extractable organics, VOCs, and oil & grease
Sediment Sampling			
Hand Augers	Sampling	Carbon Steel	Demand, nutrients, and extractable organics (for hard packed soils only)
Sediment Core Sampler	Sampling	Stainless Steel, Teflon®	All parameter groups
Encore™	Sampling	Teflon®	VOC Sediment/soil
Scoops	Sampling	Teflon® coated	All parameter groups
Mixing Bowl	Compositing	Glass	All parameter groups except VOCs
Spoons, spatula	Sampling, compositing	Stainless Steel	All parameter groups

8.2 GENERAL

Selection of surface water sampling locations for water quality studies are determined by the objective of the study and waterway type. Factors that impact and alter water quality and characteristics (dams, bridges, discharges, etc.) must be considered. Accessibility is important.

8.3 SAMPLE SITE SELECTION

Fresh water environments are commonly divided into two types: (1) rivers, streams, and creeks; and (2) lakes, ponds, and impoundments. Since these waterways differ considerably in general characteristics, site selection must be adapted to each.

Prior to conducting a sampling event, an initial survey should be conducted to locate prime sampling points. Bridges and piers provide ready access to sampling points across a body of water. However, they should only be used when at otherwise acceptable locations and are found not to be detrimentally impacting stream characteristics.

If wading for water samples must be done, caution should be used to avoid disturbing bottom deposits that could result in increased sediment in the sample. Shallow areas may be best for sediment sampling.

8.3.1 Rivers, Streams, and Creeks

Sampling sites should be located in areas possessing the greatest degree of cross-sectional homogeneity. Such points are easily found directly downstream of a riffle or rapid. These locations are also good for sediment sampling. In the absence of turbulent areas, a site that is clear of immediate point sources, such as tributaries and effluent discharges, may be used.

Typical sediment deposition areas are located at the inside of river bends and down-stream of islands or other obstructions. Sites immediately upstream or downstream from the confluence of two streams or rivers should be avoided due to inadequate mixing of the combining flows. Also, backflow can upset normal flow patterns.

Great attention should be given to site selection along a stream reach:

- Sites should be spaced at intervals based on time-of-water-travel. Sampling sites may be located at about one-half day time-of-water-travel for the first three days downstream of a waste source for the first six sites and then approximately one day for the remaining distance.
- If the study data is for comparison to previous study data, the same sampling sites should be used.
- Sites should be located at marked physical changes in the stream channel.
- Site locations should isolate major discharges as well as major tributaries.

Dams and weirs usually create quiet, deep pools in river reaches that would otherwise be swift and shallow. When times of travel through them are long, sites should be established within them.

Some structures, such as dams, permit overflow that may cause significant aeration of oxygen deficient water. Sites should be located short distances upstream and downstream of these structures to measure the rapid, artificial increase in dissolved oxygen (DO), which is not representative of natural aeration.

A minimum of three sites should be located between any two points of major change in a stream, even if the time-of-travel between the points of change is short. Major changes include, but are not limited to, a waste discharge, a tributary inflow, or a significant change in channel characteristics. Sampling three sites is also important when testing rates of change of unstable constituents. Results from two of three sites will usually support each other and indicate the true pattern of water quality in the sampled zone. If the effect of certain discharges or tributary streams of interest is desired, sites should be located both upstream and downstream of these points.

Due to the tendency of the influent from a waste discharge or tributary to slowly mix, cross-channel, with the main stream, it is nearly impossible to measure their effect immediately downstream of the source. Thus, samples from quarter points may miss the wastes and only indicate the quality of water above the waste source. Conversely, samples taken directly in the stream portion containing the wastes would indicate excessive effects of the wastes with respect to the river as a whole.

Tributaries should be sampled as near the mouth as possible. Often, these may be entered from the main stream for sampling by boat. Care should be taken to avoid collecting water from the main stream that may flow back into the tributary as a result of density differences created by temperature, salinity, or turbidity differences.

Actual sampling locations will vary with the size and amount of turbulence in the stream or river. Generally, with streams less than 20 feet wide, well mixed areas and sampling sites are readily found. In such areas, a single grab sample taken at mid-depth at the center of the channel is adequate. A sediment sample can also be collected at the center of the channel. For slightly larger streams, at least one vertical composite should be taken from mid-stream. It should be composed of at least one sub-surface, mid-depth, and above the bottom sample. Dissolved oxygen, pH, temperature, conductivity, etc. should be measured on each aliquot of the vertical composite. Several locations should be sampled across the channel width on the larger rivers. Vertical composites across the channel width should be located proportional to flow, i.e., closer together toward mid-channel where flow is greater and less toward the banks where the flow proportionally lower.

The field crew will determine the number of vertical composites and sampling depths for each area. They should base their decisions upon two considerations.

1. The larger the number of sub-samples, the more nearly the composite sample will represent the water body.
2. Taking sub-samples is time consuming and expensive, and increases the chance of contamination.

A number of sediment samples should be collected along a cross-section of a river or stream to adequately characterize the bed material. The normal procedure is to sample at quarter points along the cross-section of the site. When the sampling technique or equipment requires that the samples be extruded or transferred at the site, they can be combined into a single composite sample. However, samples of dissimilar composition should not be combined. They should be kept separate for analysis in the laboratory. To ensure representative samples, coring tubes are employed. The quantity of each sub-sample that is composited shall be recorded.

8.3.2 Lakes, Ponds, and Impoundments

Lakes, ponds, and impoundments have a much greater tendency to stratify than rivers and streams. This lack of mixing requires that more samples be obtained from the different strata. Occasionally, extreme turbidity differences occur vertically where a highly turbid river enters a lake. This stratification is caused by temperature differences where the cooler, heavier river water flows beneath the warmer lake water. A temperature profile of the water column and visual observation of lake samples can detect these layers. Each layer of the stratified water column should be sampled.

The number of sampling sites on a lake, pond, or impoundment is determined by the objectives of the investigation dimensions of the basin. In small bodies of water, a single vertical composite at the deepest point may be sufficient. Dissolved oxygen, pH, temperature, etc., should be conducted on each vertical composite aliquot. In naturally formed ponds, the deepest point is usually near the center; in impoundments, the deepest point is usually near the dam.

In lakes and larger impoundments, several vertical sub-samples should be composited to form a single sample. These vertical sampling locations should be along a transaction or grid. The field crew will determine the number of vertical composites and sampling depths for each area. In some cases, separate composites of epilimnetic and hypolimnetic zones may be required. Additional separate composite samples may be needed to adequately represent water quality in a lake possessing an irregular shape or numerous bays and coves. Additional samples should always be taken where discharges, tributaries, agriculture, and other such factors are suspected of influencing water quality.

When collecting sediment samples in lakes, pond, and reservoirs, the sample site should be as near as possible to the center of the water mass, especially for impoundments of rivers or streams. Generally, coarser grained sediments are deposited at the headwaters of a reservoir, and the finer sediments are near the center. The shape, inflow pattern, bathymetry, and circulation affect the location of sediment sampling sites in large bodies of water.

8.3.3 Control Sites

The collection of samples from control sites is necessary to compile a basis of comparison of water quality. A control site above the point of interest is as important as the sites below, and must be chosen with equal care. Two or three sites above the waste inflow may be necessary to establish the rate at which any unstable material is changing. The time of travel between the sites should be sufficient to permit accurate measurement of the change in the material under consideration.

8.4 SAMPLING EQUIPMENT AND TECHNIQUES

8.4.1 General

Any equipment or sampling techniques used to collect a sample must not alter the integrity of the sample and must be capable of providing a representative sample.

8.4.2 Water Sampling Equipment/Techniques

The physical location of the collector will dictate the type of equipment needed to collect samples. Surface water samples may be collected directly into the sample container when possible. Pre-preserved sample containers shall never be used as intermediate collection containers. Samples collected in this manner shall use the methods specified in Section 7.6 of this manual. If wading into the stream is required, care should be taken not to disturb bottom deposits, which could be unintentionally collected, and bias the sample. Also, the sample should be collected directly into the sample bottle and **up current** of the wader. If wading is not possible or the sample must be collected from more than one depth, additional sampling equipment may be used. If sampling from a powerboat, samples must be collected upwind and upstream of the motor.

8.4.2.1 Sampling Procedure Using a Teflon® or PVC Bailer

If data requirements of surface water sampling do not necessitate sampling from a strictly discrete interval of the water column, Teflon® or PVC constructed bailers can be used for sampling. The type bailer used is dependent on the analytical requirements. A closed top bailer utilizing a bottom check valve will be sufficient for many surface water studies. Water is continually displaced through the bailer as it is lowered down through the water column until the specified depth is attained. At this point, the bailer is retrieved back to the surface. There is the possibility of contamination to the bailer as it is lowered through the upper water layers. Also, this method may not be successful in situations where strong currents are found or where a discrete sample at a specified depth is needed.

If depth specific, discrete samples are needed and the parameters do not require Teflon® coated sampling equipment, a standard Kemmerer sampler may be used. A plastic bucket can also be used to collect surface samples if parameters to be analyzed do not preclude its use. The bucket shall always be rinsed twice with the sample water prior to collection and the rinse water be disposed of downstream from the sample collection point. All field equipment will be cleaned using standard cleaning procedures.

8.4.2.2 Sampling Procedure Using a Kemmerer Sampler

Due to the PVC construction of the Kemmerer sampler, it shall not be used to collect samples for extractable organics, VOCs, and/or oil & grease analysis. The general collection procedure is as follows:

1. Securely attach a suitable line to the Kemmerer bottle.
2. Lock stoppers located at each end of the bottle on the open position. This allows the water to be drawn around the bottom end seal and into the cylinder at the specified depth.
3. The bottle is now in the set position. A separate "messenger" is required to activate the trip mechanism that releases the stopper and closes the bottle.
4. When the bottle is lowered to the desired depth, the messenger is dropped. This unlocks the trip mechanism and forces the closing of both end seals.
5. Raise the sampler, open one of the end seal, and carefully transfer the sample to the appropriate sample container.

8.4.2.3 Sampling Procedures Using Sample Collection Containers

In most cases, sample collection containers are used to collect surface water from easily accessible sampling points. This means that the sample is collected manually, always upstream of the sampling person's position. An extension may be added to the container to make the sampling point more accessible for manual sampling. Extensions can be constructed of aluminum, PVC, steel, or any other suitable material. The sample container is normally attached to the extension using a clamp, vinyl pull ties, or duct tape. Samples collected in this way are done so in the following manner:

1. Place the inverted sample container into the water and lower to the desired depth. Never use a pre-preserved container as an intermediate sample collection device.
2. Re-invert the container with the mouth facing into the direction of flow and at the appropriate depth to collect the desired sample.
3. Carefully raise the container to the surface and transfer to the appropriate container.

8.4.3 Sediment Sampling Equipment/Techniques

A variety of methods can be used to collect sediment samples from a streambed. ESC utilizes corers and scoops. Precautions must be taken to ensure that the sample collected is representative of the streambed. These methods are discussed in the following paragraphs.

8.4.3.1 Sediment Core Samplers

Core sampling is used to collect vertical columns of sediment from the stream or lakebed. Many types of coring devices are available for use depending on the depth of water from which the sample is obtained, the type of bottom material, and the length of the core to be collected. Some devices are weight or gravity driven while others are simple hand push tubes. These devices minimize the loss of fine particles and should always be used when collecting sediment samples from flowing waters.

Coring devices are particularly useful in pollutant monitoring because the shock wave created by sampler descent is minimized and the fines at the sediment-water interface are only slightly disturbed. The sample can be withdrawn primarily intact removing only the layers of interest. Core liners manufactured of Teflon® or plastic can be purchased. These liners reduce the possibility of contamination and can be delivered to the laboratory in the tube they were collected in. Coring devices sample small surface areas and small sample sizes and often require repetitive sampling to obtain a sufficient amount of sample. This is the primary disadvantage to these devices but they are recommended in the sampling of sediments for trace organic compounds or metals analyses.

When sampling sediments in shallow water, the direct use of a core liner is recommended. Stainless steel push tubes are also used because they provide a better cutting edge and higher tensile strength than Teflon® or plastic. One advantage to using the Teflon® or plastic tubes is the elimination of possible metals contamination of the sample from the core barrels or cutting heads. The length of the corer tube should correspond to the desired depth of the layer being sampled. In general, soft sediments adhere better to the inside of the tube and a larger diameter tube can be used. Coarser sediments require the use of a smaller diameter tube of two inches or less to prevent the sample from falling out of the tube. The inside bottom wall of the tube can be filed down to allow easier entry into the substrate.

When samples are obtained by wading, caution should be used to minimize disturbance in the area sampled. Core tubes are pushed directly down into softer substrates until four inches or less of the tube is above the sediment-water interface. A slight rotation of the tube may be necessary to facilitate ease of entry into harder substrates and reduce compaction of the sample. The tube is then capped and slowly extracted and the bottom of the corer is capped before it is pulled above the water surface.

Sub-sampling is performed for VOC samples using an Encore™ sampling device. This device is used to collect soil/sediment samples, while preventing container headspace. Once the core sample is collected, additional samples should be taken using an Encore™ sampler, either 5g or 25g, capped, sealed, and immediately chilled to 4ºC. The holding time for this sampling method is 48 hours. Alternatively, weigh 5g of sample into a pre-weighed vial (with a Teflon® lined screw cap) containing, 5mL sodium bisulfate solution and a magnetic stir bar, cap, and then ice to 4ºC. The holding time for this method is 14 days.

8.4.3.2 Scooping Samples

The easiest and quickest way to collect a sediment sample in shallow water is with a Teflon® coated scoop or stainless steel spoon. This type of sampling should be limited to quiescent (i.e., non-flowing) waters such as lakes or reservoirs.

8.4.3.3 Mixing

As specified in Section 5.8, sediment samples, collected for chemical analysis, should be thoroughly mixed (except for volatile organic compounds analysis) before being placed in the sample containers.

8.5 SPECIAL SAMPLE COLLECTION TECHNIQUES

8.5.1 Trace Organic Compounds and Metals

Samples for trace pollutant analyses in surface water should be collected by dipping the sample containers directly into the water. Sometimes samples are split for enforcement or quality control purposes. A sufficient volume of sample for all containers should be collected in a large glass container and then, while mixing, be alternately dispensed into the appropriate bottles. This cannot be done for volatile organic compound samples due to potential loss of volatile compounds.

Only Teflon® or stainless steel should be used in sediment sampling for trace contaminant analyses. Teflon® coring tubes are the preferred technique.

8.5.2 Bacterial Analysis

Samples for bacteriological examination must be collected in sterilized bottles and protected against contamination. The preferred technique is to collect sample directly into the sample bottle. Hold the bottle near the base and plunge, neck downward, below the surface. The container is then turned with the neck pointed slightly upward and the mouth directed toward the current. The bottle is filled to about ½ inch from the top and recapped immediately. While the bottle is open, extreme care should be used to protect both the bottle and stopper against contamination. The ½ inch air space is left in the bottle to facilitate subsequent shaking in the laboratory.

If sampling with an intermediate sampling device (i.e. bailer), the device shall be thoroughly rinsed with sample water prior to collecting the sample. For this reason, microbiological samples are among the final samples collected from a sampling site. Begin pouring sample out of the sampling device before collecting into the sterilized container. Continue pouring sample out of the device, place the container under the flowing stream, and fill the container to ½ inch from the top. Flow should remain continuous before and during the filling process.

When sampling from a bridge, the sterilized sample bottle can be weighted and lowered to the water on a rope. Collectors must be careful not to dislodge debris from the bridge that could fall into the bottle.

8.6 AUXILIARY DATA COLLECTION

A field logbook will be used to record data pertinent to sampling activities. This data shall describe all sampling locations and techniques, list photographs taken, visual observations, etc. Visual observations of sample site conditions, including weather and overall stream conditions, recorded during the investigation can be valuable in interpreting water quality study results.

8.7 SPLIT AND DUPLICATE SAMPLE COLLECTION

Split samples measure variability between analysts, methods, and laboratories and are taken as subsamples from a single sample. This is unlike duplicate samples that measure variability inherent in the collection method or waste stream and are obtained in close succession during the same sampling event.

8.7.1 Split Sample Collection

Split samples are collected as follows:

1. Sample must be collected in a properly cleaned container constructed of acceptable materials. The volume should be more than twice the volume required for one sample.
2. Add appropriate preservative where required.
3. Mix thoroughly.
4. Alternately, decant sample into subsample containers in increments of approximately 10% of total subsample volume until containers are full.
5. Seal the sample containers with appropriate, airtight caps.
6. Label each sample container with a field number and complete a chain of custody.

NOTE: Volatile organic samples shall not be collected in this manner. Samples for VOC's must be collected as simultaneous, discrete grab samples.

8.7.2 Duplicate Sample Collection

1. Collect two samples in rapid succession.
2. Preserve where required.
3. Mix thoroughly.
4. Seal the sample containers with appropriate, airtight caps.
5. Label each sample container with a field number and complete a chain of custody.

9.0 GROUNDWATER AND DRINKING WATER SAMPLING

9.1 GROUNDWATER AND DRINKING WATER SAMPLING EQUIPMENT

Equipment type	Purpose	Component(s)	Allowable Parameter Groups
Bailers (disposable and non-disposable)	Purging	Teflon® & SS	All parameter groups
	Sampling	Teflon®	All parameter groups
Peristaltic Pump[1]	Purging[2]	Tygon Tubing	All parameter groups except organics
	Purging	Teflon®	All parameter groups
		Silastic Rubber	All parameter groups except organics
ISCO Bladder Pump[3]	Sampling	Stainless Steel, Teflon®	All parameter groups

[1] New or dedicated tubing must be used at individual monitoring well sites.

[2] If sample is not collected immediately after evacuation, tubing shall be withdrawn from the well prior to pump being turned off to prevent back flowing into the well.

[3] Pump will be cleaned after each use.

9.2 GENERAL GROUNDWATER SAMPLING

Groundwater sampling is necessary for a number of purposes. These include, but are not limited to, evaluating potable or industrial water sources, mapping contaminant plume movement at a land disposal or spill site, RCRA compliance monitoring (landfills), or examining a site where groundwater contamination may have or may be occurring.

Normally, groundwater is sampled from a permanent monitoring well. However, this does not exclude collection of samples from a sinkhole, pit, or other drilling or digging site where groundwater is present.

Monitoring wells are not always at the optimum. In these situations, additional wells may need to be drilled. Experienced, knowledgeable individuals (hydrologists, geologists) are needed to site the well and oversee its installation so that representative samples of groundwater can be collected.

ESC utilizes the procedures being reviewed in this section. Further guidance is available in the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD); ESC field personnel will at a minimum meet, and when possible exceed, the requirements of this document.

9.3 MEASUREMENT OF WELL WATER LEVEL AND STAGNANT WATER VOLUME CALCULATION

The sampling and analysis plan provides for measurement of standing water levels in each well prior to each sampling event. Field measurements will include depth to standing water surface and total depth of the well. This data will then be utilized to calculate the volume of stagnant water in the well and provide a check on the integrity of the well (e.g., silt buildup). The measurement should be taken to 0.01 foot when possible. A battery powered level sensor will be used to measure depth to the surface of the groundwater. Equipment shall be constructed of inert materials and will be cleaned per sample equipment cleaning procedures prior to use at another well. Field data will be recorded on the Monitoring Well Data Sheet (Figure 2).

9.3.1 Procedure For Water Level Measurement

1. Clear debris from area around well (lay plastic sheathing around well pad as an option).
2. Remove protective casing lid.
3. Open monitoring well lid.
4. Lower the clean water level indicator probe down into the well. A beep will sound upon contact with the water surface. False readings can be made from the wetted side of the well so it will be necessary to check the level several times until a consistent reading is achieved. Record the distance (to the nearest 0.01 ft.) from the top of the well casing to the water surface on the Monitoring Well Data Sheet.
5. Continue to lower the probe until it reaches the well bottom. Record the distance (to the nearest 0.01 ft) from the top of the well casing to the bottom of the well on the Monitoring Well Data Sheet.
6. All water level and well depth measurements shall be made from the top of the well casing unless specified otherwise by the project manager or DER.
7. The wetted depth is obtained by subtracting total well depth from the surface level depth.

9.3.2 Calculating Water Volume

Total volume of standing water in a well is calculated by the following formula:

$$V = \pi r^2 h \times 7.48 \text{ gallons/ft}^3$$

where;

V	=	volume of standing water in the well (gallons)
r	=	radius of well (ft)
h	=	depth of water column in the well (ft)
π	=	3.14
7.48	=	conversion factor

9.4 WELL EVACUATION: WELLS WITHOUT IN-PLACE PLUMBING

Water standing in a well may not be representative of actual groundwater conditions. The standing water in a well should be removed to allow representative formation water to supplant the stagnant water. The evacuation method depends on the hydraulic characteristics of the well but the following general rules apply.

The total amount of water purged must be recorded. Therefore, the volume must be measured during the purging operation. This may be determined by:

1. Collecting the water in a graduated or known volume container (i.e., bucket);
2. Calculate the volume based on the pump rate; however pump rate may not be constant and field personnel should be aware of this;
3. Record the time that the actual purging begins in the field record.

Purging is considered complete if any one of the following criteria is satisfied:

1. Three well volumes are purged and field parameters (pH, temperature, conductivity) stabilize within 5% in consecutive readings at least 5 minutes apart. If field parameters have not stabilized after 5 well volumes, the purging is considered complete and sampling can begin.
2. Five well volumes are purged with no monitoring of field parameters.
3. At least one fully dry purge. A second dry purge may be necessary in some situations.

FIGURE 2
MONITORING WELL DATA SHEET

Site location:

ESC Project name/#:

Well Number	Depth to water surface (ft)	Depth to bottom of well (ft)	Length of water column (ft)	Volume of water evacuated (gal)	Time/date

Well Number	Temperature (^{0}F)	pH (S.U.)	Conductivity (Tmho/cm)	Time/Date

Well casing material / diameter:

Sampled by / signature:

NOTES / CALCULATIONS:

Except for low recovery wells, all wells shall be sampled within 6 hours of purging. Low recovery wells may be sampled as soon as sufficient sample matrix is available or up to 10 hours after purging. Wells that do not recover sufficiently within 10 hours should not be sampled.

Purging equipment includes Teflon® or stainless steel bailers or a peristaltic pump. Any fuel-powered pumping units shall be placed downwind of any sampling site. If purging equipment is reused, it shall be cleaned following standard procedures. Disposable latex gloves shall be worn by sampling personnel and changed prior to starting work at each sampling site.

If bailed water is determined to be hazardous, it should be disposed of in an appropriate manner.

The Florida Department of Environmental Regulation requires that during purging of the well, the purging device should be placed just below the surface of the water level and be lowered with the falling water level. For high yield wells, three casing volumes should be evacuated prior to collecting samples. Purging should be conducted at a rate to minimize agitation of the recharge water. Conductivity, pH, and temperature measurement during purging is necessary to monitor variability of the groundwater. **Samples should be collected within 6 hours of purging high yield wells.**

Low-yield wells (incapable of yielding three casing volumes) should be evacuated to dryness at a rate that does not cause turbulence. When the well recovers sufficiently, the first sample should be analyzed for pH, temperature, and conductivity. When recovery exceeds two hours, the sample should be collected as soon as sufficient volume is available. **If recovery is longer than 10 hours, the well should not be tested**. The project manager may wish to review available information to determine if obtaining a representative sample is possible.

9.4.1 Procedure for Well Evacuation: Teflon® Bailer

1. Clear the area around the well pad; cover with plastic if necessary.
2. Slowly lower the bailer to the water surface and remove it when full.
3. Reel or pull bailer to the surface using caution to not allow the lanyard (cable or string) to touch the ground.
4. Use the bailer volume and number of bails removed to determine volume of water removed. Excess hazardous material should be poured into a container for later disposal.
5. Repeat steps 2 and 3 until 1.5 well volumes have been removed.
6. Begin monitoring for pH, temperature, and conductivity. Record on Monitoring Well Data Sheet. Discard the sample into the collection pail. Purge until the change between samples of each parameter is less than 5 percent.
7. Continue until at least three well volumes have been evacuated and the parameters pH, temperature, and conductivity are within 5 percent, or until a low yield well has been evacuated to dryness.
8. Record date and time the well was purged on the Monitoring Well Data Sheet.

NOTE: For wells sampled in the State of Florida, three well volumes will be purged prior to pH, temperature, and conductivity screening. Following evacuation of three well volumes, purge water will be screened for these parameters at regular intervals until two consecutive measurements are within 5 percent. The intervals may be time-based (at least 5 min) or represent a portion of the well volume (at least 0.5 well volume)

Compliance with more stringent local, State, or Regional guidelines will be maintained where required.

9.4.2 Procedure for Well Evacuation: Peristaltic Pump

1. Clean area around the well pad.
2. Install the appropriate length of Tygon® or Teflon® tubing into the pump mechanism.
3. Insert the uncontaminated sampling end of the tubing into the well surface.
4. Connect the pump to the power supply.
5. Operate the pump at a flow rate that does not cause excessive agitation of the replacement water.
6. Determine the pump flow rate.
7. Purge until 1.5 well volumes have been evacuated.
8. Collect samples at a rate of one per well volume evacuated. Monitor these samples for pH, temperature, and conductivity. Record these measurements on the Monitoring Well Data Sheet. Monitor until the difference in each parameter is less than 5 percent.
9. Continue purging until three well volumes have been evacuated and the parameters pH, temperature, and conductivity are within 5 percent, or until a low yield well has been evacuated to dryness.
10. Record the date and time the well was purged on the Well Sampling Field Data Sheet.

9.5 PURGING TECHNIQUES: WELLS WITH IN-PLACE PLUMBING

9.5.1 General

The volume to be purged depends on whether the pumps are running continuously or intermittently and how close to the source samples can be collected. If storage/pressure tanks are present, a volume must be purged to totally exchange the volume of water in the tank.

9.5.2 Continuously Running Pumps

For continuously running pumps, the well should be purged by opening the valve and allowing it to flush for 15 minutes, if the well volume is unknown. If the sample is collected after a holding tank, the volume of the tank should also be purged.

9.5.3 Intermittently Running Pumps

Wells shall be purged at the maximum rate for at least 15 minutes. Monitoring of field parameters will continue until two consecutive measurements within 5% are measured at 5-minute intervals.

9.6 SAMPLE WITHDRAWAL

Technique for withdrawal is dependent on the parameters to be analyzed. To collect a representative sample and minimize the possibility of sample contamination:

- Use Teflon® or stainless steel sampling devices when organics are an analyte of concern.
- Use dedicated tubing or samplers for each well. If a dedicated sampler is not available, clean the sampler between sampling events. Analyze equipment blanks to ensure cross-contamination has not occurred.

The preferred sample collection order is as follows (decreasing volatility):

1. Volatile organic compounds (VOCs)
2. Extractable Organics (includes Total Recoverable Petroleum Hydrocarbons [TRPH], Oil & Grease, Pesticides and Herbicides)
3. Total metals
4. Dissolved metals
5. Microbiological
6. Inorganics (includes Nutrients, demands, and Physical Properties)
7. Radionuclides

The following items are acceptable sampling devices for all parameters:

- A gas-operated, Teflon® or stainless steel squeeze pump (also referred to as a bladder pump with adjustable flow control) should be dedicated or completely cleaned between sampling events. If it is dedicated, the protocols on use, flow rates, and flow controls should be discussed.
- A Teflon® bailer with check valves and a bottom emptying device. Dedicated or disposable bailers should not be cleaned between purging and sampling operations.

ESC generally supplies sampling devices for wells sampled by ESC. However, some clients have wells equipped with dedicated sampling devices. All dedicated equipment will be cleaned between sampling events with the exception of dedicated pump systems or dedicated pipes that are never removed. ESC will evaluate the device and the project manager shall approve/disapprove of the dedicated device prior to sampling.

If sampling includes dissolved parameters, samples shall be filtered in the field in the following manner:

1. Use a one piece, molded, in-line high capacity disposable 1.0 micron filter when collecting samples for dissolved trace metals analysis. Use a 0.45 micron filter when sampling for all other (i.e., orthophosphorous, silica, etc.) dissolved parameters.
2. Filter material should be non-contaminating synthetic fibers.
3. Filter should be placed on the positive pressure side of the peristaltic pump.
4. If well is deeper than 25 feet; a submersible bladder pump may be necessary to bring the sample to the surface. Samples shall not be collected in an intermediate container.
5. At least one filtered equipment blank using deionized water must be collected and analyzed.
6. The sample shall be preserved as required following filtration.
7. Unfiltered samples will be collected in conjunction with filtered samples.

NOTE: Filtered samples will be collected only at the request of DER and will not be collected for turbid samples only.

9.6.1 Sample Removal: With In-Place Plumbing

Samples should be collected following purging from a valve or tap as near to the well as possible, and ahead of all screens, aerators, filters, etc. Samples shall be collected directly into the sampling containers. Flow rate should not exceed 500 mL/min.

9.6.2 Sample Removal: Without In-Place Plumbing

1. Following purging, collect the sample and pour it directly from the bailer into the sample container. If a peristaltic pump is used, pump the sample directly into the container. Collect the samples in order of decreasing volatility.
2. Measure the conductivity, pH, and temperature of the samples and record the results on the Monitoring Well Data Sheet.
3. If a bailer is not dedicated, clean field equipment using standard procedures. Collect blanks at a rate of one per type of equipment cleaned. If a piece of equipment is cleaned more than twenty times, collect blanks at a rate of 10 percent. An equipment blank must be taken and preserved for each analyte method group.
4. If a bailer is used to collect samples, replace the bailer string. Take precautions not to allow the string to touch the ground. Dispose of the used string properly. If Teflon® or stainless steel cable is used, clean according to standard procedures and do not let it touch the ground.
5. Replace the well cap and close and lock the protective casing lid.

9.7 SPLIT AND DUPLICATE SAMPLE COLLECTION

Split samples measure variability between analysts, methods, and laboratories and are taken as subsamples from a single sample. Duplicate samples measure variability inherent in the collection method or waste stream and are obtained in close succession during the same sampling event.

9.7.1 Split Sample Collection

1. Collect sufficient volume in a container constructed of appropriate materials. The volume should be more than twice the volume required for one sample.
2. Preserve as necessary.
3. Mix well.
4. Alternately decant 10% of the sample volume into each container and mix well.
5. Continue until each container is filled with an adequate sample volume.
6. Seal the containers, assign a field number, and complete the chain of custody.

9.7.2 Duplicate Sample Collection

1. Collect two samples in rapid succession into separate containers.
2. Preserve as necessary.
3. Mix well.
4. Seal the containers, assign a field number, and complete the chain of custody.

9.8 DRINKING WATER SAMPLING

9.8.1 General Concerns

Containers and preservatives must be selected prior to sampling.

- Containers and preservatives shall comply with Tables 1 and 2.
- It is recommended that the appropriate preservative be added to the container by the laboratory.

9.8.2 Sampling Drinking Water Wells

1. Purging and sampling should be from a spigot closest to the wellhead.
   - The spigot should be located before the holding tank and filters. If this is not possible, the holding tank must also be purged.
   - All aerators and filters should be removed if possible.
2. Depending on the running schedule of the well and the placement of the pressure tank, the system will be purged as described in Section 9.5.
3. If volume of the pressure tank is not known, the well is purged for at least 15 minutes at maximum rate.
4. The flow is reduced to approximately 500 mL/minute.
5. Sample containers with no preservatives:
   - The interior of the cap or the container should not come in contact with anything.
   - The sample container is rinsed and the water is discarded.
   - Containers are not rinsed if collecting for oil and grease, total recoverable hydrocarbons, volatile organics (including trihalomethanes) or microbiologicals.
   - The container should be tilted to minimize agitation.
6. Sample containers with preservatives:
   - The above protocol is followed but **DO NOT** rinse the container.
   - The open end of the container should be held away from the face while filling.
   - The container should be gently tipped several times to mix the preservatives.
7. Place the bottle in a plastic bag and cool to 4°C.

9.8.3 Sampling Drinking Water Within A Facility/Residence for the Lead/Copper Rule

1. The appropriate sampling point depends on whether the sample is being taken to monitor compliance with Drinking Water Regulations for Lead and Copper. If so, the sample must be taken from a cold water tap in the kitchen or bathroom of residential housing or from an interior tap where water is used for consumption in a non-residential building.
2. Samples must be collected after the water has stood in the pipes for at least six hours.
3. THE SYSTEM SHOULD NOT BE FLUSHED.
4. The first flush should be collected immediately into the sample container. DO NOT RINSE THE CONTAINER PRIOR TO COLLECTING THE SAMPLE.
5. The container should be tilted to minimize agitation.
6. If the container contains preservative, hold the open end away from the face.
7. Add preservative as needed.
8. Replace cap and gently tip the container several times to mix the preservatives.
9. Place in a plastic sample bag.

9.8.4 Sampling a Lead Service Line in a Facility/Residence for the Lead/Copper Rule

1. When sampling for compliance, the sampling point is normally designated by the permit or the municipality.
2. For Lead & Copper samples, each sample shall have stood in the line for at least six hours and shall be collected in one of the following ways:
   a. At the tap, after flushing the volume of water between the tap and the lead service line. The volume of water shall be calculated based upon the inner diameter and length of the pipe between the tap and the service line.
   b. By tapping directly into the service line.
   c. In a single-family residence, allow the water to run until a significant temperature change indicates water standing in the service line is being sampled.
3. The flow shall be reduced to less than 500 mL/min before collecting samples.
4. Test for the presence of residual chlorine using residual chlorine indicator strips or a Hach DR-100 chlorine analyzer.
5. If residual chlorine is present and the parameter being analyzed requires removal of chlorine, collect the sample in the appropriate sample container(s) using the required preservatives.
   a. Add 0.008% $Na_2S_2O_3$ or 100mg of $Na_2S_2O_3$ per 1L of sample water directly into the sample container.
   b. After replacing the cap, tip the container several times to mix the preservative.

10.0 SOIL SAMPLING

Soil samples are preserved as per Section 14. When compositing subsamples, the quantity of each subsample used shall be measured and recorded in the field logbook.

10.1 SAMPLING EQUIPMENT

Type	Use	Materials	Allowable Parameter Groups[1]
Hand Auger (Bucket type)	Sampling	PVC	All parameter groups except VOC's, extractables and organics
Encore™ Sampler	VOC soil subsampling	Teflon®	VOC's only
Split Spoons	Sampling	Carbon Steel	All parameter groups
Trowel, Spatula	Sampling and Compositing*	Chrome-Plated Steel	All parameter groups
Spoons	Sampling and Compositing*	Stainless Steel	All parameter groups
Shovel	Sampling	Carbon Steel	All parameter groups
Mixing Pan	Compositing*	Pyrex & Aluminum	All parameter groups except metals in aluminum pan

[1] Carbon steel & Chrome-plated steel tools may be used for collecting soils where trace metal concentrations are not a concern. When these tools are used, samples should be taken from soils not in contact with the tool surface.

***** Compositing is not suitable for VOC's

10.2 HAND AUGER SAMPLING PROCEDURE

This procedure is used when only relatively shallow samples are required or when the use of heavy equipment is not practical. The hand auger may be used to collect samples of soils or other materials at various depths by adding extensions as necessary.

1. Remove surface debris from the location of the sampling hole using a clean shovel or spoon.
2. Disturbed portions of soil should be discarded and not taken as part of the sample.
3. Using a clean auger, drill to the desired sample depth. Confirm depths using a tape measure or other appropriate device.
4. Use a clean planer auger to clean and level the bottom of the boring.
5. All grab samples should be mixed thoroughly prior to placement in containers (except VOCs).

6. Using a clean auger, extract the desired sample. Subsampling is performed for VOC sample collection using an Encore™ sampling device. Once the core sample is collected, additional samples should be taken using an Encore™ sampler, either 5g or 25g, capped, sealed, and immediately cooled to 4ºC. The holding time for this method is 48 hours. Alternatively, weigh 5g of sample into a pre-weighed vial (with a Teflon® lined screw cap) containing 5mL sodium bisulfate solution and a magnetic stir bar, cap, and then ice to 4ºC. The holding time for this method is 14 days.
7. If less than the collected volume of material is desired or if multiple containers are required, subsampling shall be conducted. The collected material shall be placed in a clean mixing pan and thoroughly mixed using a clean, stainless steel spoon. The mixed material will then be quartered, removed and recombined before samples are collected. For clay soils, representative aliquots of the entire sample should be removed from the auger using stainless steel spoons. Samples for chemical analyses shall not be collected from auger flights or cuttings from hollow stem auger flights. Samples used for vapor meter determinations will not be used for trace contaminant analyses.
8. Samples should then be labeled. The depth range from which the samples were taken should be included in the sample description.
9. Repeat steps (2) through (6) as necessary to obtain samples at all desired depths.
10. When preparing composite samples, the quantity of each subsample shall be measured and recorded in the field logbook.

10.3 SPLIT AND DUPLICATE SAMPLE COLLECTION

Split samples measure variability between analysts, methods, and laboratories and are taken as subsamples from a single sample. This is unlike duplicate samples that measure variability inherent in the collection method or waste stream and are obtained in close succession during the same sampling event. True split samples are difficult to collect for soils, sediment, and sludge under field conditions. Split samples for these materials are therefore considered duplicate samples.

The collection procedure is as follows:

1. Collect the appropriate volume of sample into a clean disk constructed of a non-reactive material.
2. Mix the material with a clean utensil and separate into 4 to 10 equal portions.
3. Alternate placing a portion of the subdivided material into each container.
4. Repeat until each container is filled.
5. Assign each container a field sample number and complete the chain of custody.

11.0 WASTE SAMPLING

11.1 SAMPLING EQUIPMENT

Type	Use	Materials	Allowable Parameter Groups[1]
Shovel	Sampling	Carbon Steel	All parameter groups except metals
Split Spoons	Sampling	Carbon Steel	All parameter groups except metals
Trowel, Spatula	Sampling and Compositing*	Stainless Steel	All parameter groups
Spoon	Sampling and Compositing*	Stainless Steel	All parameter groups
Drum Pump	Sampling	Polypropylene	All parameter groups
Mixing pan	Compositing*	Pyrex or aluminum	All parameter groups except metals in aluminum pan
Coliwasa	Sampling	Glass	All parameter groups

[1]Carbon steel tools may be used for collecting wastes when trace metal concentrations are not a concern.
*Compositing is not suitable for VOC's

11.2 GENERAL

This section discusses the collection of samples from drums, tank trucks, and storage tanks, and samples from waste piles and landfills. All ESC personnel consider sampling from closed containers as a hazardous operation.

11.2.1 Specific Quality Control Procedures for Sampling Equipment

Sampling equipment used during waste sampling must be cleaned as specified in Section 12 of this manual before being returned from the field to minimize contamination.

Contaminated disposable equipment must be disposed of as specified in the sampling plan.

All field equipment shall be cleaned and repaired before being stored at the conclusion of a field study. Special decontamination procedures may be necessary in some instances and will be developed on a case-by-case basis. Any deviation from standard cleaning procedures and all field repairs shall be documented in field logbooks. Equipment that has not been properly cleaned must be tagged and labeled.

11.2.2 Collection of Supplementary Information

The collection of supplementary data is important when collecting waste samples. Any field analyses shall be recorded in field logbooks. Sketches of sampling locations and layout shall be documented in the logbooks. Photographs shall be used extensively.

11.3 OPEN AND CLOSED CONTAINER SAMPLING

11.3.1 General

When sampling containers, open containers should be sampled first since they generally present less of a hazard. Closed containers must be considered as extremely hazardous. Due to the dangers involved with container sampling, the sampling of drums or other containers containing either unknown materials or known hazardous materials shall be considered a hazardous duty assignment.

One problem with container sampling is stratification and/or phase separation. Care must be taken to ensure that the sample collected is representative. If only one layer or phase is sampled, this should be noted when interpreting analytical results.

If no stratification is present, representative samples may be composited by depth. When a drum or cylindrical container is standing vertically, depth compositing provides a good quantitative estimate of the containers contents. In other cases where containers are tipped, horizontal, deformed, etc., and stratification may not be present, vertical compositing will at least provide a qualitative sample.

11.3.2 Sampling Equipment

The following equipment is available for use in collecting waste samples: barrel bung wrenches, adjustable wrenches, etc.; coliwasa samplers for drum sampling; and peristaltic pumps for liquid waste sampling from containers.

11.3.3 Sampling Techniques

Containers containing unknown materials or known hazardous materials shall be opened using only spark proof opening devices from a grounded container.

The coliwasa sampler is a single use glass sampler, consisting of an outer glass tube with one end tapered and a separate inner glass tube with a small bulb on one end. The outer tube is slowly lowered into the drum, tapered end first. Slowly lowering the tube allows the liquid phases in the drum to remain in equilibrium. The inner glass tube is inserted into the outer tube. After both inner and outer tubes are inserted into the drum to be sampled, the inner tube bulb end is pressed gently against the tapered end of the outer tube, forming a seal. Both tubes are withdrawn from the drum and the ends of the tubes are held over the sample container.

Drum samples can also be collected using a length of glass tube (1/2-inch or less inside diameter). The tube is inserted into the drum as far as possible and the open end is sealed to hold the sample in the tube. The sample is then placed in the appropriate container. Sample volumes shall be the absolute minimum required.

Tank truck and storage tank samples may be collected from access ports on top of these tanks or trucks using the above techniques. Tank trucks are often compartmentalized, and each compartment should be sampled. Sampling from discharge valves is not recommended due to stratification possibilities and possibilities of sticking or broken valves. If the investigator must sample from a discharge valve, the valving arrangement of the particular tank truck being sampled must be clearly understood to ensure that the contents of the compartments of interest are sampled. The investigator must realize that samples obtained from valves may not be representative.

If stratification or phase separation of waste samples is suspected, the sample collected should be representative of container contents. Samples should be depth composited when possible and number and types of layers shall be noted when interpreting analytical results.

11.4 WASTE PILES AND LANDFILLS

11.4.1 General

Waste piles consist of sludge and other solid waste, liquid waste mixed with soil, slag, or any type of waste mixed with construction debris, household garbage, etc. The sampling personnel must be aware that landfills were not and are often still not selective in the types of materials accepted. Sampling at landfills could involve sampling operations that are potentially dangerous to sampling personnel.

11.4.2 Sampling Locations

Sampling locations should be selected that will yield a representative sample of the waste. Exceptions are situations in which representative samples cannot be collected safely or when the team is purposely determining worst-case scenarios.

11.4.2.1 Waste Piles

A representative sample from a small waste pile can be obtained by collecting a single sample. Collecting representative samples from large waste piles requires a statistical approach in selecting both the numbers of samples and sample location. A discussion of statistical methods is outlined in the Test Methods for Evaluating Solid Waste (SW-846) issued by the EPA Office of Solid Waste and Emergency Response.

11.4.2.2 Landfills

Representative samples from landfills are difficult to achieve to due to the heterogeneous nature of the wastes. A statistical approach should be used in

selecting both the number of samples and the sample location. Statistical methods are given in Test Methods for Evaluating Solid Waste (SW-846) issued by the EPA Office of Solid Waste and Emergency Response. Landfills often generate leachate at one or more locations downgradient of the fill material that can provide some insight into the materials contained in a landfill that are migrating via groundwater.

11.4.3 Sampling Techniques

All samples collected should be placed into a Pyrex® or aluminum mixing pan and mixed thoroughly. Samples for volatile organic compounds analyses must not be mixed or composited. Stainless steel spoons or scoops should be used to clear away surface materials before samples are collected. Near surface samples can then be collected with a clean stainless steel spoon. Depth samples can be collected by digging to the desired depth with a carbon steel shovel or scoop and removing the sample with a stainless steel spoon.

12.0 STANDARD CLEANING PROCEDURES

12.1 GENERAL

12.1.1 Introduction

ESC personnel use the procedures outlined in this section to clean field equipment prior to use. Ideally, a sufficient amount of clean equipment is carried to the field so that the project can be conducted without the need for field cleaning. This is not always the case. ESC's policy regarding cleaning field equipment is as follows:

1. Equipment used in the field must be thoroughly cleaned in a controlled environment using prescribed procedures. This minimizes the potential for contaminants being transferred to equipment, vehicles, and the laboratory.
2. All equipment will be rinsed immediately with tap water after use, even if it is to be field cleaned for other sites.
3. If equipment is used only once (i.e., not cleaned in the field), it will be labeled as "dirty" or "contaminated equipment" in the field and transported separately from clean equipment.
4. All cleaning procedures shall be documented. Field decontamination shall be documented in the field records. These records will specify the type of equipment cleaned and the specific protocols that are used. In-house cleaning records must identify the type of equipment, date it was cleaned, SOP used, and person that cleaned it.
5. Unless justified through documentation (i.e., company written protocols and analytical records) and historic data (i.e., absence of analytes of interest in equipment blanks), the protocols in Sections 12.1.2 through 12.7.11 shall be followed without modification.
6. All field sampling equipment shall be pre-cleaned in-house.

12.1.2 Cleaning Materials

Use a phosphate-free, laboratory detergent such as Liquinox®. The use of any other detergent is noted in field logbooks and summary reports.

Ten percent nitric acid solution shall be made from reagent-grade nitric acid and deionized water.

The standard cleaning solvent used will be pesticide-grade isopropanol. Other solvents (acetone and/or hexane) may be substituted as necessary. The use of other solvents must be documented in field logbooks and summary reports.

Tap water may be used from any potable water system. Untreated water is not an acceptable substitute for tap water.

Deionized water is tap water that has been passed through a deionizing resin column and should contain no inorganic compounds at or above analytical detection limits. Organic-free water is tap water that has been de-ionized and treated with activated carbon. Organic-free water should contain no detectable levels of organic compounds, and less than 5 ug/L of VOCs.

Analyte-free water is water in which all the analytes of interest and all interferences are below the method detection limits. Analyte-free water is always used for blank preparation and for the final in-house decontamination rinse.

Substitution of a higher grade water (i.e., deionized or organic-free water for tap water) is permitted and need not be recorded. Solvent, nitric acid, detergent, and rinse water used to clean equipment shall not be reused.

12.1.3 Marking Clean Equipment

Equipment that is cleaned by these methods shall be marked with the date and time that the equipment was cleaned.

12.1.4 Marking Contaminated or Damaged Field Equipment

Field equipment that needs repair will be tagged and repairs or symptoms noted on the tag. Field equipment that needs cleaning **will not** be stored with clean equipment. All wrapped equipment not used in the field may be placed back in stock after equipment is inspected to ensure that contamination has not taken place.

12.1.5 Decontamination of Equipment Used With Toxic or Hazardous Waste

Equipment used to collect hazardous or toxic wastes or materials from hazardous waste sites, RCRA facilities, or in-process waste streams shall be decontaminated prior to leaving the site. This decontamination procedure shall consist of washing with laboratory detergent and rinsing with tap water. More stringent procedures may be required depending on the waste sampled.

If equipment is heavily contaminated, an acetone or acetone/hexane/acetone pre-rinse may be necessary prior to regular decontamination procedures. It is not recommended that this type of cleaning be performed in the field.

12.1.6 Disposal of Cleaning Materials

See Section 16.

12.1.7 Safety Procedures For Cleaning Operations

All applicable safety procedures shall be followed during cleaning operations. The following precautions shall be taken during cleaning operations:

- Safety glasses or goggles, gloves, and protective clothing will be worn during all cleaning operations.
- Solvent rinsing operations will be conducted under a hood or in an open, well ventilated area.
- No eating, smoking, drinking, chewing, or hand to mouth contact shall be permitted during cleaning operations.

12.1.8 Storage of Field Equipment

All clean field equipment shall be stored in a designated, contaminant-free area.

12.2 QUALITY CONTROL PROCEDURES FOR CLEANING

12.2.1 General

This section establishes quality control methods to monitor the effectiveness of the equipment cleaning procedures. The results of these methods will be monitored by the ESC Quality Assurance Department. All quality control procedures are recorded in a logbook and maintained in a quality assurance file. If contamination problems are detected, the ESC QA Department shall determine the cause(s) of the problem(s) and take immediate corrective action.

12.2.2 Rinse Water

The quality of water used shall be monitored once per quarter by placing water in standard, precleaned sample containers and submitting them to the ESC laboratory for analysis. Organic-free water will also be submitted for analyses of the various organic compounds.

12.3 PROCEDURES FOR CLEANING TEFLON® OR GLASS EQUIPMENT USED IN THE COLLECTION OF SAMPLES FOR TRACE ORGANIC COMPOUNDS AND/OR METALS ANALYSES

1. Equipment will be washed with laboratory detergent and hot water using a brush to remove any particulate matter or surface film. If oil, grease, or other hard to remove residues are present on the equipment, an acetone/hexane/acetone pre-wash and/or steam cleaning may be necessary.
2. Rinse the equipment with hot tap water.
3. Rinse or soak, if necessary, equipment with a 10% nitric acid solution. If nitrogen-containing compounds are analytes of concern, hydrochloric acid must be used as a substitute or subsequent equipment rinse.
4. Rinse equipment with tap water.
5. Rinse equipment with deionized water.
6. Rinse equipment twice with solvent and allow to dry.
7. If equipment cannot be cleaned effectively, discard properly.
8. Wrap equipment in aluminum foil. Seal in plastic and date.

12.4 PROCEDURES FOR CLEANING STAINLESS STEEL OR METAL SAMPLING EQUIPMENT USED IN TRACE ORGANIC AND/OR METALS SAMPLE COLLECTION

1. Equipment will be washed with laboratory detergent and hot water using a brush to remove any particulate matter or surface film. If oil, grease, or other hard to remove materials are present, a acetone/hexane/acetone pre-wash and/or steam cleaning may be necessary.
2. Rinse equipment with hot tap water.
3. Rinse equipment with deionized water.
4. Rinse equipment twice with solvent and allow to dry.
5. If equipment cannot be cleaned effectively, discard properly.
6. Wrap equipment in aluminum foil. Seal in plastic and date.

12.5 CLEANING PROCEDURES FOR AUTOMATIC SAMPLING EQUIPMENT

12.5.1 General

All automatic wastewater samplers will be cleaned as follows:

- The exterior and accessible interior portions of automatic samplers will be washed with Liquinox and rinsed with tap water.
- The electronics casing will be cleaned with a clean damp cloth.
- All vinyl sample tubing will be discarded after each use.
- Teflon® tubing will be cleaned using procedures found in Section 12.6.2.
- Silastic pump tubing will be cleaned and re-used after each use, if possible. Tubing will be cleaned using cleaning procedures specified in Section 12.6.1 of this document. Tubing shall be checked on a regular basis and will be changed if it has become discolored or loses elasticity.

12.5.2 Reusable Glass Composite Sample Containers

1. If containers are used to collect samples that contain hard to remove materials (i.e., oil and grease) it is rinsed as necessary with reagent grade acetone prior to the detergent wash. If material cannot be removed, the container is discarded.
2. Wash containers thoroughly with hot tap water and Liquinox and rinse thoroughly with hot tap water.
3. If metals are to be sampled, rinse with 10% nitric acid. If nutrients are to be sampled, follow with a 10% hydrochloric acid rinse.
4. Rinse thoroughly with tap water.
5. Rinse thoroughly with DI water.
6. If organics are to be sampled, rinse twice with isopropanol and allow to air dry for 24 hours or more. Cap the container with the decontaminated Teflon® lined lid.
7. After use rinse with tap water in the field and cover to prevent drying of material onto the interior surface.
8. Containers that have a visible scale, film, or discoloration after cleaning or were used at a chemical manufacturing facility should be properly discarded at the conclusion of the sampling activities.

12.5.3 Reusable Plastic Composite Sample Containers

1. Wash containers with hot tap water and laboratory detergent using a bottlebrush to remove particulate matter and surface film.
2. Rinse containers with hot tap water.
3. Rinse containers with 10% nitric acid. If nitrogen containing compounds are analytes of concern, hydrochloric acid must be used as a substitute or subsequent equipment rinse.
4. Rinse containers with tap water.
5. Rinse containers with deionized water.
6. Cap with aluminum foil.
7. Plastic sample containers used at facilities that produce toxic compounds will be properly disposed of at the conclusion of the sampling activities. Containers that have a visible film, scale, or other discoloration remaining after cleaning will be discarded.

12.5.4 Plastic Sequential Sample Bottles for Automatic Sampler Base

1. Rinse bottles in field with potable or de-ionized water when possible.
2. Wash in dishwasher at wash cycle, using laboratory detergent cycle, followed by tap and deionized water rinse cycles. Alternatively, hand wash using the same procedure.
3. Rinse with 10% nitric acid. If nitrogen containing compounds are analytes of concern, hydrochloric acid must be used as a substitute or subsequent equipment rinse.
4. Rinse with tap water.
5. Replace bottles in sampler base; cover with aluminum foil before storing.

12.6 CLEANING PROCEDURES FOR SAMPLING TUBING

12.6.1 Silastic Rubber Pump Tubing Used In Automatic Samplers

Silastic pump tubing used in automatic samplers need not be replaced in pumps where the sample does not contact the tubing, where the sampler is being used solely for purging purposes (i.e., not being used to collect samples). Tubing must be changed on a regular basis, if used for sampling purposes, and should be cleaned in this manner:

1. Flush tubing with laboratory grade detergent and hot tap water
2. Rinse thoroughly with hot tap water
3. Rinse thoroughly with DI water
4. If used to collect metals samples, the tubing shall be flushed with 1+5 nitric acid, followed by a thorough rinsing with DI water
5. Install the tubing in the automatic wastewater sampler
6. Cap both ends with aluminum foil or equivalent

Tubing should always be replaced at automatic sampler manufacturer's recommended frequencies. If tubing cannot be adequately cleaned, it shall be discarded.

12.6.2 Teflon® Tubing

New Teflon® tubing shall be pre-cleaned as follows:

1. Rinse outside of the tubing with pesticide-grade solvent.
2. Flush interior of the tubing with pesticide-grade solvent.
3. Let dry overnight in drying oven or equivalent.
4. Wrap tubing in aluminum foil and seal in plastic.

Reused tubing shall be transported to the field in pre-cut and pre-cleaned sections. Field cleaning of Teflon® is not recommended. The following steps describe in-house cleaning procedures:

1. Exterior of tubing must be cleaned first by soaking in hot, soapy water in a stainless steel or non-contaminating sink. Particulate may be removed with a brush.
2. Clean inside of tubing ends with a small bottlebrush.
3. Rinse surfaces and ends with tap water.
4. Rinse surfaces and ends with nitric acid, tap water, isopropanol, and analyte-free water.
5. Place on fresh aluminum foil, connect all sections with Teflon® couplings.

6. Cleaning configuration:
   a. Cleaning solutions are placed in a clean, 2-liter glass jar.
   b. Place one end of tubing in the solution, the other in the **INFLUENT** end of a peristaltic pump.
   c. Effluent from the pump can be recycled through the glass cleaning solution jar. All cleaning solutions can be recycled EXCEPT the final isopropanol and analyte-free water rinses.
7. The above configuration is used as follows:
   a. Pump generous amounts of hot, soapy water through the tubing.
   b. Follow this with tap water, 10% nitric acid, tap water, isopropanol, and analyte-free water.
   c. The nitric acid and isopropanol rinses should be allowed to remain in the tubing for 15 minutes with the pump shut off then continue with subsequent rinses
   d. Leave any couplings in and connect or cover the remaining ends.
8. After cleaning the interior, rinse the exterior with analyte-free water.
9. The cleaned lengths are wrapped in aluminum foil and stored in a clean, dry area until use.

12.7 FIELD EQUIPMENT CLEANING PROCEDURES

12.7.1 General

It is the responsibility of field personnel to properly clean equipment in the field. The following procedures shall be observed when cleaning equipment in the field.

12.7.2 Conventional Equipment Use

Remove deposits with a brush if necessary. If only inorganic anions are of interest, equipment should be rinsed with analyte-free water and with the sample at the next sampling location prior to collection. Clean equipment for the collection of samples for organic compounds or trace inorganic analyses according to Section 12.7.3.

12.7.3 Equipment Used to Collect Organic Compounds and Trace Metals Samples

1. Clean with tap water and laboratory detergent. If necessary, use a brush to remove particulate and surface films then rinse with tap water.
2. Rinse with 10 to 15% nitric acid solution followed by 10% hydrochloric acid rinse (unless equipment is made of metal) followed by tap water and DI water.
3. Rinse twice with solvent.
4. Rinse with organic-free water and allow to air dry.
5. If organic-free water is unavailable, let air dry. Do not rinse with deionized or distilled water.

6. Wrap with aluminum foil or plastic.

12.7.4 Teflon®, Glass, Stainless Steel or Metal Equipment Used to Collect Samples for Metal Analyses

1. Remove particulate matter and surface films. Clean with laboratory detergent and tap water.
2. Rinse with tap water.
3. Ten percent nitric acid solution (skip 3 and 4 if equipment is made of metal and/or stainless steel).
4. Rinse with tap water.
5. Rinse with deionized water then let air dry.

12.7.5 Instruments Used to Measure Groundwater Levels

1. Wash with laboratory detergent and tap water.
2. Rinse with tap water.
3. Rinse with deionized water.
4. Allow to dry.

12.7.6 Field Filtration Apparatus

1. A new, disposable filtration unit will be used for each site. Filter pore size will be dependent on parameter being monitored as per Section 9.6.
2. The peristaltic pump is cleaned as described in Section 12.7.7.
3. Silastic pump tubing will be cleaned as described in Section 12.6.1.
4. If Teflon® tubing is used, it will be cleaned as described in Section 12.6.2.
5. Other tubing types must be cleaned following the appropriate regimen described in Section 12.6. In general, non-Teflon® type tubing (e.g., HDPE) will not be re-used.

12.7.7 Flow Meters, Above Ground Pumps, Bladder Pumps and Other Field Instrumentation

The exterior of equipment such as flow meters should be washed with a mild detergent and rinsed with tap water before storage. The interior of such equipment may be wiped with a damp cloth.

Other field instrumentation should be wiped with a clean, damp cloth. Meter probes should be rinsed with deionized water before storage.

Equipment desiccant should be checked and replaced as necessary.

Peristaltic pumps used for purging must be free of oil and grease on the exterior. They must be cleaned on the outside with Liquinox and rinsed with tap water followed by DI water.

12.7.8 In-Field Decontamination For Submersible Purging Pump and Tubing

ESC uses the submersible bladder pump listed in Section 9.1 only for purging and not for sample collection. The pump and tubing shall be decontaminated between wells in the following manner:

1. Interior of the pump and tubing shall be thoroughly flushed with a soapy water solution.
2. Wipe or scrub the exterior of the pump and tubing as necessary with the appropriate soap solution.
3. Rinse exterior and interior of pump and tubing thoroughly with tap water followed by a deionized water rinse.
4. Allow remaining water to drain from tubing and pump and allow to air dry as long as possible in a contaminant free area before purging the next well.

12.7.9 Shipping Containers

All reusable shipping containers shall be washed with laboratory detergent, rinsed with tap water, and air dried before storage or re-use. Extremely contaminated shipping containers shall be cleaned as thoroughly as possible and properly disposed.

12.7.10 Analyte Free Water Containers

Analyte-free water containers can be made of glass, Teflon®, polypropylene, or high density polyethylene (HDPE). Inert glass or Teflon® are recommended for holding organic-free sources of water. Polypropylene can be used when organics are not analytes of concern. HDPE is not normally recommended but is acceptable for use. Water should not be stored in these containers for extended periods. Containers of water should only be used for a single event and should be disposed of at the end of the sampling day. The procedure for cleaning analyte-free water containers is as follows:

1. For new containers, follow instructions in Section 12.3 of this manual. Delete the solvent rinse if containers are made of plastic.
2. Cap with Teflon® film, aluminum foil, or the Teflon® lined bottle cap (aluminum foil or Teflon® film may also be used as a cap liner).

If water is being stored in reused containers, the following cleaning procedures should be followed:

1. After emptying, cap the container.
2. Wash exterior of the container with Liquinox and rinse with DI water.
3. Rinse the interior twice with isopropanol unless the container is made of plastic.
4. Rinse the interior thoroughly with analyte-free water.
5. Invert and allow to dry.
6. Fill the container with analyte-free water and cap with aluminum foil, Teflon® film, or a Teflon® lined bottle cap.
7. Water shall not be stored prior to a sampling event for more than 3 days.

12.7.11 Vehicles

Field vehicles used by ESC personnel should be washed at the conclusion of each sampling event. This should reduce the risk of contamination due to transport on a vehicle. When vehicles are used at hazardous waste sites or on studies where pesticides, herbicides, organic compounds, or other toxic materials are known or suspected to be present, a thorough interior and exterior cleaning is mandatory at the conclusion of the site visit.

Vehicles are equipped with trash containers. ESC personnel are responsible for cleanliness of each vehicle.

13.0 SAMPLE HISTORY

Sample chronology is recorded and kept on the ESC chain of custody, field logbooks and laboratory notebooks. These are discussed in detail in Section 9.0.

14.0 SAMPLE CONTAINERS, PRESERVATION METHODS AND HOLDING TIMES

14.1 GENERAL CONSIDERATIONS

The following section contains information regarding sample containers, preservation methods, and holding times. Refer to SW-846, Table II-1 and Chapter 3, Page 3 for solid waste and RCRA projects and 40 CFR Part 136, Table II for water and wastewater projects.

The provisions of 40 CFR Part 136, Table II shall take precedence over requirements given in any approved method when sampling in the State of Florida for water and wastewater.

Proper sample preservation is the responsibility of the sampling team and it is their responsibility to assure that all samples are preserved according to 40 CFR Part 136. For the purposes of this manual, "immediately" will be defined as within 15 minutes.

Sample preservation is accomplished either by obtaining prepreserved containers from an acceptable source or by adding preservatives in the field.

It is the responsibility of the field team accepting prepreserved containers to make sure that the proper preservatives are used and desired results are achieved. The laboratory shall also supply additional preservatives from the same source in suitable containers.

14.2 SAMPLE PRESERVATION

The following protocols apply for sample containers preserved in the field after the sample has been added:

1. Preservatives shall be at least reagent grade or higher. The acid for metals shall be suitable for trace metals analyses.
2. Fresh preservatives shall be obtained prior to each sampling event. Remaining preservatives that are not sealed must be discarded in an acceptable manner.
3. Preservatives are transported in pre-measured glass ampules and added directly to the sample.
4. A corresponding amount of preservative shall be added to associated equipment blanks.
5. The pH is checked on all pH preserved samples with the exception of VOC, oil and grease, and TRPH.

Effectiveness of pH adjustment is made in the following manner:

1. Narrow range pH paper is used to test a small aliquot of the preserved sample.
2. A small portion of sample is placed into a container, checked with pH paper, and compared against the color chart.
3. Discard the aliquot properly, but do not pour back into the sample container.
4. If pH is acceptable, document in field log and prepare for transport to laboratory.

If pH is unacceptable, continue to add additional preservative in measured increments using the methods described above until an acceptable pH has been reached. Record the total amount of preservative used in the field log. Always use additional preservative from the same source as the initial preservation attempt.

In some cases, an extra dummy sample can be used to test pH preservation. Content should be suitably discarded.

If equipment blanks or field blanks are used, the maximum amount of preservative that was used to preserve any single sample in the set shall be added to the equipment or field blank.

Samples requiring temperature preservation shall be cooled to 4°C. The cooler will be checked to ensure that the ice has not melted.

14.3 SAMPLE CONTAINERS

ESC does not clean and re-use sample containers. ESC purchases all sample collection containers precleaned. All used sampling containers are discarded after use. The cleaning criteria of all containers must meet EPA analyte specific requirements.

QEC provides written certification that containers do not contain analytes of concern above method detection levels

ESC maintains records for these containers (lot numbers, certification statements, date of receipt, etc.) and intended uses are documented.

14.4 FIELD REAGENT HANDLING

Reagents, cleaning materials, and preservatives that are maintained by a field team will be stored, transported, and handled in such a way as to prevent and/or minimize contamination. The following storage and use protocols will be observed:

1. Chemicals will be stored in-house and transported to the field segregated by reactivity.
2. Acids are stored in an acid storage cabinet and solvents are stored in a vented, explosion proof solvent storage cabinet.
3. All chemicals transported to the field are stored in bottles and packed to avoid breaks.
4. When reagents are transferred from an original container, the transport container must be pre-cleaned and of compatible material as the original container.
5. Chemicals shall be separated from sample containers and samples to avoid reaction and possible contamination.
6. Analyte free water shall be segregated from solvents to prevent contamination.

14.4.1 Reagent and Standard Storage

Chemical	Method of Storage
Nitric acid	Stored separated from other acids in original container in vented cabinet.
Sulfuric acid	See above
Hydrochloric acid	See above
Isopropanol	Stored in original glass container in vented and explosion proof solvent storage cabinet.
pH calibration buffers, turbidity standards, conductivity standards	Stored in cabinet designated for standard and reagent storage. Stored in temperature-controlled area of laboratory.
Sodium hydroxide	Stored in original container in designated cabinet in laboratory.
Sodium thiosulfate, zinc acetate, ascorbic acid, lead acetate	Stored in original containers in designated area of laboratory. Reagent solutions made fresh prior to use.

14.5 SAMPLE TRANSPORT

In the majority of situations, samples will be delivered directly to the laboratory by the field sampling team or field courier following standard chain of custody protocols. Samples will be preserved immediately (i.e., within 15 minutes) and packed with ice prior to transport. The field team will relinquish custody to the login sample custodian upon arrival at the laboratory.

Certain situations require that the field sampling team ship samples to the laboratory utilizing common carrier (UPS, FEDEX, etc.). If samples are sent by common carrier, all documentation (transmittal form, chain of custody, field data, analyses request, etc.) shall be placed in a ziplock bag and placed inside the sample container. The container is then sealed closed and sent to the laboratory in the required time frame to meet requirements of time-sensitive analyses.

14.6 BIOMONITORING SAMPLING

Preservation and Sample Volume
Aqueous samples collected for Bioassay can be collected in either glass or HDPE plastic. There is no required chemical preservation for this type of sample but the sample must be kept at 4 ± 2°C. The required volume varies independently with each type of analysis but the minimum collected is 250mL. The samples can be held for a maximum of 36 hours from the time of collection until first use.

Sample Collection
Grab sample protocols are utilized for acute bioassay unless otherwise specified in permit requirements. Composite sampling protocols are utilized for chronic bioassays unless otherwise specified in permit requirements. (Actual sampling protocols are discussed in detail throughout this appendix) ESC field collection personnel are required to collect all bioassay samples by completely filling the sample bottle and leaving no headspace. It is important that bottles be filled completely to reduce possible aeration that may reduce the toxic properties of the sample. If a client chooses to collect the samples, a trained ESC field collection person will explain in detail the importance of reducing aeration by filling the sample bottle completely.

14.6.1 Biomonitoring Sampling Containers

All bioassay glassware are cleaned using the following EPA protocol:

- soak for 15 minutes in hot tap water with detergent and scrub
- rinse thoroughly with hot tap water
- rinse thoroughly with dilute nitric acid (10%)
- rinse thoroughly with deionized water
- rinse thoroughly with pesticide grade acetone

- rinse well with deionized water then rinse with dilution water

New glassware will be cleaned according to the same procedure as listed above except the first step will be preceded by soaking the glassware overnight in 10% HNO_3. Sample collection containers used for automatic sampling devices are cleaned according to the same protocol listed above.

ESC does not reuse sample transport containers. All bottles used for sample transport are new.

TABLE 14.6A: PRESERVATION, HOLDING TIME AND SAMPLE CONTAINERS (SOLID WASTE AND SOIL SAMPLES)

PARAMETER	PRESERVATIVE	HOLDING TIME	CONTAINER(S)
Metals	Cool, 4°C	* 6 Months	Plastic, glass
Volatile Organic Compounds in Water, Includes TPH GRO/BTEX	Cool, 4°C	14 Days	Glass, Teflon®-lined septum
Volatile Organic Compounds in Soil/Solid Includes TPH GRO/BTEX	Cool, 4°C (If using vials, then Sodium Bisulfate is used)	48 hours (using Encore™ sampler) 14 Days (using pre-weighed, preserved, vials)	Encore™ Sampler or Pre-weighed glass vials (Teflon®-lined septum) with magnetic stir bar
Semi-volatiles, non-volatile organics Includes TPH DRO	Cool, 4°C	14 Days until extraction, 40 days after extraction	Glass, Teflon®-lined cap
Solids	Cool, 4°C	7 Days	Plastic, glass
Cyanides	Cool, 4°C	14 Days	Glass
Oil and Grease	Cool, 4°C	28 Days	Glass, Teflon®-lined cap

* Maximum holding time for mercury is 28 days.

TABLE 14.6B: WASTEWATER PRESERVATION, HOLDING TIME AND SAMPLE CONTAINERS (OTHER PARAMETERS)

Parameter	Container[1]	Preservation[2,3]	Maximum Holding Time[4]	Required Sample Volume
Biomonitoring				
Biomonitoring Acute and Chronic	P, G	Cool, 4°C	36 hours to first use	Determined by analysis req. Min. 250 mL.
		Bacteriological		
Coliform, Fecal and Total Fecal Streptococci	P, G	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	6 hours	150 mL
Inorganics				
Acidity	P, G	Cool, 4°C	14 days	250 mL
Alkalinity	P, G	Cool, 4°C	14 days	250 mL
Ammonia	P, G	Cool, 4°C, H_2SO_4 to pH <2	28 days	500 mL Distilled-1000 mL
Biochemical Oxygen Demand	P, G	Cool, 4°C	48 hours	2000 mL
Bromide	P, G	None Required	28 days	200 mL

Parameter	Container[1]	Preservation[2,3]	Maximum Holding Time[4]	Required Sample Volume
Biochemical Oxygen Demand, Carbonaceous	P, G	Cool, 4°C	48 hours	2000 mL
Chemical Oxygen Demand	P, G	Cool, 4°C, H_2SO_4 to pH <2	28 days	100 mL
Chloride	P, G	None Required	28 days	200 mL
Chlorine, Total Residual	P, G	None Required	Immediately	200 mL
Color	P, G	Cool, 4°C	48 hours	250 mL
Cyanide, Total and Amenable	P, G	Cool, 4°C, NaOH to pH >12, 0.6 g/l ascorbic acid[5]	14 days[6]	2000 mL
Fluoride	P	None Required	28 days	100 mL
Hardness	P, G	HNO_3 to pH <2, H_2SO_4 to pH <2	6 months	100 mL
Hydrogen Ion (pH)	P, G	None Required	Immediately	100 mL
Kjeldahl and Organic Nitrogen	P, G	Cool, 4°C, H_2SO_4 to pH <2	28 days	500 mL
Chromium VI	P, G	Cool, 4°C	24 hours	500 mL
Mercury[7]	P, G	HNO_3 to pH <2	28 days	500 mL
Metals[7], except Chromium VI and Mercury	P, G	HNO_3 to pH <2	6 months	1000 mL
Nitrate	P, G	Cool, 4°C	48 hours	500 mL
Nitrate-Nitrite	P, G	Cool, 4°C, H_2SO_4 to pH <2	28 days	500 mL
Nitrite	P, G	Cool, 4°C	48 hours	200 mL
Oil and Grease	G	Cool, 4°C, HCl/H_2SO_4 to pH <2	28 days	1000 mL
Organic Carbon	P, G	Cool, 4°C, HCl/H_2SO_4 to pH <2	28 days	100 mL
Orthophosphate	P, G	Filter Immediately, Cool, 4°C	48 hours	200 mL
Oxygen, Dissolved Probe	G Bottle and Top	None Required	Immediately	Not Applicable
Phenols	G only	Cool, 4°C, H_2SO_4 to pH <2	28 days	1000 mL
Phosphorus (elemental)	G	Cool, 4°C	48 hours	2000 mL
Phosphorus, Total	P, G	Cool, 4° C, H_2SO_4 to pH <2	28 days	500 mL
Residue, Total	P, G	Cool, 4°C	7 days	500 mL
Residue, Filterable	P, G	Cool, 4°C	7 days	500 mL
Residue, Nonfilterable (TSS)	P, G	Cool, 4°C	7 days	500 mL
Residue, Settleable	P, G	Cool, 4°C	48 hours	1000 mL
Residue, Volatile	P, G	Cool, 4°C	7 days	500 mL
Specific Conductance	P, G	Cool, 4°C	28 days	500 mL
Sulfate	P, G	Cool, 4°C	28 days	500 mL
Sulfide	P, G	Cool, 4°C, add zinc acetate plus NaOH to pH >9	7 days	300 mL
Sulfite	P, G	None Required	Immediately	250 mL
Surfactants	P, G	Cool, 4°C	48 hours	500 mL
Temperature	P, G	None Required	Immediately	Not Applicable
Turbidity	P, G	Cool, 4°C	48 hours	200 mL
Organics[8]				
Volatile Halocarbons	G, Teflon®-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	14 days	2 x 40 mL
Volatile Aromatic Hydrocarbons	G, Teflon®-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$[5], HCl to pH 2[9]	14 days	2 x 40 mL

Parameter	Container[1]	Preservation[2,3]	Maximum Holding Time[4]	Required Sample Volume
Acrolein and Acrylonitrile	G, Teflon®-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]. Adjust pH to 4-5[10]	14 days	2 x 40 mL
Phenols[11]	G, Teflon®-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	7 days to ext. then 40 days	3000 mL
Benzidines[11]	G, Teflon®-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	7 days to ext.[13]	3000 mL
Phthalate esters[11]	G, Teflon®-lined cap	Cool, 4°C	7 days to ext. then 40 days	3000 mL
Nitrosamines[11, 14]	G, Teflon®-lined cap	Cool, 4°C, store in dark, 0.008% $Na_2S_2O_3$[5].	7 days to ext. then 40 days	3000 mL
PCBs[11], Acrylonitrile	G, Teflon®-lined cap	Cool, 4°C	7 days to ext. then 40 days	3000 mL
Nitroaromatics and Isophorone[11]	G, Teflon®-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5], store in dark	7 days to ext. then 40 days	3000 mL
Polynuclear Aromatic Hydrocarbons[11]	G, Teflon®-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5], store in dark	7 days to ext. then 40 days	3000 mL
Haloethers[11]	G, Teflon®-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	7 days to ext. then 40 days	3000 mL
Chlorinated Hydrocarbons[11]	G, Teflon®-lined cap	Cool, 4°C	7 days to ext. then 40 days	3000 mL
TCDD[11]	G, Teflon®-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	7 days to ext. then 40 days	3000 mL
Pesticides[11]	G, Teflon®-lined cap	Cool, 4°C, pH 5-9[15]	7 days to ext. then 40 days	2000 mL
Radiological Analyses: Alpha, beta and Radium	P, G	HNO_3 to pH <2	6 months	3000 mL

NOTES:

[1] Polyethylene (P) or Glass (G).

[2] Sample preservation should be performed immediately upon sample collection. If using an automatic sampler, preserve by maintaining at 4 deg. C until compositing and sample splitting is completed.

[3] Samples shipped by common carrier or sent through the United States Mail must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). For the preservation requirements of Table II, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

[4] Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid for analytical and regulatory purposes.

[5] Only to be used in the presence of residual chlorine.

[6] Maximum holding time is 24 hours when sulfide is present. Optionally all samples may be tested with lead acetate paper before pH adjustment in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and pH adjusted to 12.

[7] Dissolved metals samples should be filtered immediately on-site before adding preservative.

[8] Applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

[9] Sample receiving no pH adjustment must be analyzed within seven days after collection.

[10] pH adjustment is not required if acrolein will not be measured.

[11] When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for sample integrity. When the analytes of concern fall within two or

more chemical categories, the sample may be preserved by cooling to 4° C, reducing residual chlorine, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction.

[12] 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0 plus or minus 0.2.

[13] Extracts may be stored up to seven days before analysis if stored in an oxidant-free atmosphere.

[14] For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.

[15] The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

14.7 SAMPLE CONTAINER PACKING PROCEDURES

ESC routinely sends sample containers to clients. Standard operating procedure determines the containers needed for the requested analyses. A sample request form is completed to document what is needed, the destination, the date prepared and the initials of the preparer. Containers are prepared, with appropriate preservatives, labels, and custody seals, and organized for the client's convenience in a cooler. The cooler also contains a temperature blank, chain of custody, a return address label, and applicable instructions. The cooler is bound with packaging tape (and a custody seal if requested) and shipped UPS.

15.0 SAMPLE DISPATCH

Samples collected during field investigations or in response to a hazardous materials incident are classified by the project manager, prior to shipping, as either environmental or hazardous material samples. The shipment of samples, designated as environmental samples, is not regulated by the U.S. Department of Transportation.

Samples collected from certain process streams, drums, bulk storage tanks, soil, sediment, or water samples from suspected areas of high contamination may need to be shipped as hazardous. These regulations are promulgated by the US-DOT and described in the Code of Federal Regulations (49 CFR 171 through 177). The guidance for complying with US-DOT regulations in shipping environmental laboratory samples is given in the "National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Environmental Laboratory Samples."

15.1 SHIPMENT OF ENVIRONMENTAL SAMPLES

Shipping receipts are maintained at the ESC laboratory. The shipment of preserved sample containers or bottles of preservatives (i.e., NaOH pellets, HCl, etc.) which are designated as hazardous under the US-DOT, Hazardous Materials Table, 49 CFR 171.101, must be transported pursuant to the appropriate US-DOT regulations.

Samples packaged for shipment by ESC shall be segregated by sample type, preservation requirements, and potential contaminant level. During events in which large numbers of samples will be collected, samples are segregated by analyses required. If multiple sites are sampled, or if specific and separate areas of interest are identified, samples will be further segregated for packaging prior to shipment.

Environmental samples shall be packed prior to shipment using the following procedures:

1. Select a cooler (clean and strong). Line the cooler with a large heavy-duty plastic bag.
2 Allow sufficient headspace (except VOC's or others with zero headspace requirements) to compensate for any pressure and temperature changes.
3. Be sure the lids on all bottles are tight.
4. Place all bottles in appropriately sized polyethylene bags.
5. Place VOC vials in foam material transport sleeves.
6. Place foam padding in the bottom of the cooler and then place the bottles in the cooler with sufficient space to allow for the addition of more foam between the bottles.
7. Put ice on top of and/or between the samples.
8. Place chain of custody in a clean dry bag and into the cooler. Close the cooler and securely tape the cooler shut. The chain of custody seals should be affixed to the top and sides of the cooler so that the cooler cannot be opened without breaking the seal.
9. The shipping containers must be marked "THIS END UP". The name and address of the shipper shall be placed on the outside of the container. Labels used in the shipment of hazardous materials are not permitted to be on the outside of the container used to transport environmental samples and shall not be used.

16.0 INVESTIGATION WASTE

16.1 GENERAL

Field surveys conducted by ESC may generate waste materials. Some of these waste materials may be hazardous requiring proper disposal in accordance with EPA regulations.

16.1.1 Types of Investigation Derived Wastes (IDW)

Materials which may be included in the IDW category are:

- Personnel protective equipment (PPE)
- Disposable sampling equipment (DE)

- Soil cuttings
- Groundwater obtained through well purging
- Spent cleaning and decontamination fluids
- Spent calibration standards

16.1.2 Managing Non-hazardous IDW

Disposal of non-hazardous IDW should be addressed prior to initiating work at a site. Facility personnel should be consulted and wastes handled in an appropriate manner as directed by the client.

For development and purge water generated in the State of Florida, specific disposal requirements apply. The water shall be contained on-site in temporary storage until it is characterized. Appropriate disposal and/or treatment methods will then be determined. Possible disposal options are:

- Direct discharge on-site to infiltrate the same or a more contaminated source
- Transportation to an off-site facility

In no case shall the water be discharged into any surface water unless permitted.

16.1.3 Management of Hazardous IDW

Disposal of hazardous or suspected hazardous IDW (as defined in 40 CFR 261.30-261.33 or displaying the characteristics of ignitability, corrosivity, reactivity, or TC toxicity) must be specified in the sampling plan. Hazardous IDW must be disposed in compliance with USEPA regulations. If appropriate, these wastes may be taken to a facility waste treatment system. These wastes may also be disposed of in the source area from which they originated if state regulations permit.

If on-site disposal is not feasible, appropriate analyses must be conducted to determine if the waste is hazardous. If so, they must be properly contained and labeled. They may be stored on the site for a maximum of 90 days before they must be manifested and shipped to a permitted treatment or disposal facility. Weak acids and bases may be neutralized in lieu of disposal as hazardous wastes. Neutralized wastewaters may be flushed into a sanitary sewer.

If possible, arrangements for proper containment, labeling, transportation, and disposal/treatment of IDW should be anticipated beforehand.

Investigation derived wastes should be kept to a minimum. Most of the routine studies conducted by ESC should not produce any IDW that are hazardous. Many of the above PPE and DE wastes can be deposited in municipal dumpsters if care is taken to keep them segregated from hazardous waste contaminated materials. Disposable equipment can often be cleaned to render it nonhazardous, as can some PPE, such as splash suits. The volume of spent solvent waste produced during equipment decontamination can be reduced or eliminated by applying only the minimum amount of solvent necessary.

17.0 SAMPLING BIBLIOGRAPHY

17.1 Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, February 1, 1991, US EPA Region IV, Environmental Services Division.

17.2 RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (GPO #5500000260-6), US EPA, September 1986.

17.3 Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Office of Solid and Emergency Response, US EPA, November 1986.

17.4 Methods for the Determination of Organic Compounds in Drinking Water, EPA/600/4-88/039, December 1988.

17.5 Florida Department of Environmental Regulation (DER) Quality Assurance Section (QAS) Guidance Documents:
#89-01 - Equipment Material Construction, revised April 7, 1989
#89-02 - Field QC Blanks, revised April 28, 1989
#89-03 - Teflon® /Stainless Steel Bladder Pumps, revised May 10, 1988
#89-04 - Field Cleaning Procedures, revised August 10, 1989

17.6 DER Manual for Preparing Quality Assurance Plans, DER-QA-001/90, revised September 30, 1992.

17.7 NPDES Compliance Inspection Manual, United States Environmental Protection Agency, Enforcement Division, Office of Water Enforcement and Permits, EN-338, 1988.

17.8 Handbook for Monitoring Industrial Wastewater, United States Environmental Protection Agency, Technology Transfer, 1973.

17.9 EPA Primary Drinking Water Regulations, 40 CFR 141.

17.10 Rapid Bioassessment Protocols For Use in Streams and Rivers, United States Environmental Protection Agency, Office of Water, EPA/841/B-99-002.

17.11 Environmental Sampling and Analysis: A Practical Guide. Lawrence H. Keith, Ph.D., 1991. Lewis Publishers.

17.12 Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. Fifth Edition. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA/821/R-02/012

17.13 Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Fourth Edition. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA/821/R-02/013.

1.0 SIGNATORY APPROVALS

WET LAB QUALITY ASSURANCE MANUAL

APPENDIX IV TO THE ESC QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

NOTE: The QAM has been approved by the following people. A signed cover page is available upon request

Judith R. Morgan, M.S., VP of Technical and Regulatory Affairs 615-773-9657

Eric Johnson, B.S., Laboratory Director 615-773-9654

Dixie Marlin, B.S, QC Manager, 615-773-9681

Kenny Buckley, B.S., Organics/Wet Chemistry Department Manager, 615-773-9686

2.0 APPENDIX TABLE OF CONTENTS

3.0 SCOPE AND APPLICATION

This manual discusses specific QA requirements for general analytical protocols to ensure analytical data generated from the Wet Chemistry Laboratory, or Wet Lab, are scientifically valid and are of acceptable quality. Any deviations from these requirements and any deviations that result in nonconforming work must be immediately evaluated and their corrective actions documented.

4.0 LABORATORY ORGANIZATION AND RESPONSIBILITIES

ESC Lab Sciences offers diverse environmental capabilities that enable the laboratory to provide the client with both routine and specialized services, field sampling, and broad laboratory expertise. A brief outline of the organization and responsibilities as they apply to the ESC Quality Assurance Program is presented in *Section 4.0 in the ESC Quality Assurance Manual Version 8.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Kenneth W. Buckley, with a B.S. degree in General Science, is the Department Manager of the Organics and Wet Chemistry laboratories. Mr. Buckley reviews and approves all data reduction associated with analyses in these areas and is responsible for the overall production of these laboratories; including the management of the staff and scheduling. Mr. Buckley has over 9 years of environmental laboratory experience. In his absence, Chad Pfalmer assumes responsibility for departmental decisions in the Wet Lab.

5.2 TRAINING

5.2.1 All new analysts to the laboratory are trained by a primary analyst or Manager according to ESC protocol. Performance is documented using an initial demonstration of capability (IDOCs) and continuing demonstration of capability (CDOC). On-going acceptable capability in Wet Lab analyses is demonstrated by acceptable participation in multiple proficiency testing programs (PTs) and daily Quality Control sample analyses. Documentation of analyst training is maintained on file within the department.

6.0 FACILITIES AND LABORATORY SAFETY

6.1 FACILITIES

The main area of the laboratory has approximately 2800 square feet with roughly 750 square feet of bench area. There is an additional 400 square feet of storage space and the lighting standard is fluorescence. The air system is a 5-ton Trane package unit and a 10-ton Trane package unit with natural gas for heating. The laboratory reagent water is provided through the US Filter deionizer system with a Millipore Milli-Q Academic A-10 system for finished water. Waste disposal containers are located in the laboratory and Clean Harbors serves as ESC's waste disposal contractor. ESC's building information guides and site plan are shown in Appendix I.

6.2 LABORATORY SAFETY

- Laboratory access is limited when work is being performed.
- All procedures where chemicals are prepared or splashes may occur are conducted in laboratory exhaust hoods.
- ESC's laboratory safety guidelines are detailed in the *ESC Chemical Hygiene and Safety Plan.*

7.0 SAMPLING PROCEDURES

7.1 FIELD SAMPLING PROCEDURES, SAMPLE STORAGE, AND HANDLING

- Field Sampling procedure is described in Appendix III of this ESC Quality Assurance Manual. Sample information is recorded and kept on the ESC chain of custody and field logbooks.
- Matrices for Wet Lab environmental analyses include groundwater, wastewater, drinking water, soil, and sludge. The Wet Lab also performs analyses on sorbent media and air filters for Industrial Hygiene monitoring.
- Sample containers, preservation methods and holding times vary depending on analyses requested. Please see the determinative procedures for specific directions.

8.0 EQUIPMENT

8.1 EQUIPMENT LIST

LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Wet Lab
This table is subject to revision without notice

Item	*Manufacturer*	*Model*	*Instrument Name*	*Serial #*	*Location*
Analytical Balance	Mettler	AT200	Balance	m26291	Wet Lab
Analytical Balance	Mettler	AG204 Delta Range	Balance	118420883	Wet Lab
Analytical Balance	Mettler	xs204	OG balance	11619	Wet Lab
Autoanalyzer	Lachat	Quikchem 8000	Lachat 2	1027	Wet Lab
Autoanalyzer	Lachat	Quikchem 8000	Lachat 3	1638	Wet Lab
Autoanalyzer	Lachat	Quikchem 8500	Lachat 4	060900000341	Wet Lab
Autoanalyzer	Lachat	Quikchem 8500	Lachat 5	060900000342	Wet Lab
Autoanalyzer - digestor	Lachat	BD-46	DIG1	1800-772	Wet Lab
Autoanalyzer - digestor	Lachat	BD-46	DIG2	1800-7m21	Wet Lab
Automated distiller	Skalar	SAN++ system	Kelada 1	09719	Wet Lab
Automated titrator	Metrohm	855 titrosampler	Titrando	3256	Wet Lab
Centrifuge	Beckman	Spinchron R	Centrifuge	100515	Wet Lab
Class “I” weights	Troemner	Serial #7944		7944	Wet Lab
COD Reactor	HACH	45600	COD1	22195	Wet Lab
COD Reactor	HACH	45600	COD2	985	Wet Lab
Conductivity Meter	ORION	MODEL 170		32470007	Wet Lab
Distillation Unit - Cyanide	Kontes Glass Co.	Model Cal 3200		501	Wet Lab
Distillation Unit - Cyanide	Kontes Glass Co.	Model Cal 3200		2193	Wet Lab
Distillation Unit - Cyanide	Kontes Glass Co.	Model Cal 3200			Wet Lab
Distillation Unit - Phenol	Westco Scientific	Model EASY-DIST		1062	Wet Lab
Distillation Unit - Phenol	Westco Scientific	Model EASY-DIST		Spare	Wet Lab
Flash Point Tester	Koehler	Pensky-Martens K16200	Manual	13576	Wet Lab
Flash Point Tester	Petrolab	Petrotest	Auto	8851	Wet Lab
Hot Plate	Thermolyne Fisher	Type 2200	Hot	16237	Wet Lab
Hot Plate	Thermolyne Fisher	Type 2200	Hot	16240	Wet Lab
Ion Chromatograph	Dionex	DX1500	IC1	08100010	Wet Lab
Ion Chromatograph	Metrohm	850 Professional	IC2	1860	Wet Lab
Ion Chromatograph	Dionex	ICS 2000	IC3	06050731	Wet Lab
Ion Chromatograph	Dionex	ICS 2000	IC4	08090820	Wet Lab
Ion Chromatograph	Dionex	ICS 1500	IC5	08090871	Wet Lab

LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Wet Lab
This table is subject to revision without notice

Item	*Manufacturer*	*Model*	*Instrument Name*	*Serial #*	*Location*
Muffle Furnace	Thermolyne	(1) 30400		23231	Wet Lab
Oven - Drying	VWR	1305U	#1	202597	Wet Lab
Oven - Drying	Equatherm	D1576	#3	not available	Wet Lab
Oven - Drying	Equatherm	D1576	#4	74845	Wet Lab
Oven - Drying	VWR	1305U	#6	not available	Wet Lab
Oven - Drying	Fisher	Isotemp 655G	OG oven	00127	Wet Lab
pH Meter	Fisher	AB15		AB92322670	Wet Lab
pH Meter	Orion	410A		05074	Wet Lab
Refrigerated Recirculator	VWR	117P		not available	Wet Lab
Refrigerated Recirculator	VWR	117P		not available	Wet Lab
Spectrophotometer (UV/Vis)	Hach	DR 4000U		not available	Wet Lab
Spectrophotometer (UV/Vis)	Hach	DR 4000U		not available	Wet Lab
Total Organic Carbon Analyzer	Shimadzu	Model TOC-VWS	Persulfate	39830872	Wet Lab
Total Organic Carbon Analyzer	Shimadzu	5000A	Combustion	36301649	Wet Lab
Total Organic Halogen Analyzer	Mitsubishi	TOX-100		02909	Wet Lab
Total Organic Halogen Analyzer	Mitsubishi	TOX-100		00247	Wet Lab
Turbidimeter	Hach	2100N		not available	Wet Lab

8.2 EQUIPMENT PREVENTIVE MAINTENANCE, EQUIPMENT CALIBRATION

INSTRUMENT	*P. M. DESCRIPTION*	*FREQUENCY*
Analytical Balances	•Check with Class "I" weights	Daily
Analytical Balances	•Service/Calibration (semi-annual contract maintenance and calibration check)	Tolerance - ±0.1%
Analytical Balances	•Service/Calibration (semiannual contract maintenance and calibration check)	Semi-annually
Refrigerators & Incubators	•Maintenance service	As needed - determined by daily temperature performance checks
Water Bath	•Check thermometer vs. NIST	Once/year
Water Bath	•Remove from service when not maintaining temperature and send off for repair or replace	As needed
Flash Point Tester	•Check thermometer vs. certified traceable	Once/year
Lachat Autoanalyzer	•Check pump tubes, change valve flares	At least 1/month
Pensky Martens	•Check fuel level, refill	As needed
Pensky Martens	•Clean cup thoroughly	Between each test and after use
TOC	•Maintain manufacturer's service contract	Renew each year
Turbidimeter - Hach 2100A	•Illumination lamp or window (alignment and/or replacement)	Erratic or poor response
pH Meters	•Reference junction & electrode replacement	As needed
pH Meters	•Probe stored in KCl	At all times when not in use
pH Meters	•Other	As described in the manufacturer's O & M manual

8.3 STANDARDS AND REAGENTS

Table 8.3A lists standard sources, receipt, and preparation information. Table 8.3B is designed to provide general calibration range information. These ranges may change depending on regulatory requirements, procedural changes, or project needs. Table 8.3C indicates the procedures and frequency for the standardization of laboratory solutions used for titrations.

Table 8.3A: Standard sources, description and calibration information.
This table is subject to revision without notice

Instrument Group	Standard Source	How Received*	Source/ Storage	Preparation from Source	Lab Stock Storage	Preparation Frequency
Alkalinity, Acidity	Lab preparation	Acidity-matrix standard grade KHP	Room temp.	0.0500N	4°± 2°C	6 months
Ammonia-Nitrogen and Total Kjeldahl Nitrogen	Lab preparation	ACS grade NH4Cl	Room temp.	1,000ppm stock standard	Room temp.	Annually or sooner if check samples reveal a problem
Ammonia-Nitrogen and Total Kjeldahl Nitrogen				Working Standards	Not stored	Prepared fresh as needed
BOD	Lab preparation	As dry glucose and glutamic acid	Dessicator	150mg of each/L	4°± 2°C	Made fresh daily
COD	Lab preparation	Acid grade KHP	Dessicator	Stock solution (10,000ppm)	4°± 2°C	When absorbance of curve changes or check samples are out of control
Cyanide (Autoanalyzer)	Lab preparation	KCN	Reagent shelf	Stock solution (1,000ppm)	4°± 2°C	6 months. Working dilutions prepared daily as needed
Fluoride	Inorganic Standard. NSI Lab preparation	ACS grade KF	Room temp.	100ppm stock solution	Room temp.	1 year or as needed when reference standard fails
Fluoride				Dilute standards	Not stored	Prepared fresh daily
Hardness	Lab preparation	Chelometric Std. $CaCO_3$	Room temp.	1mg/mL as CaCO3	Room temp.	Annually or sooner if check samples reveal a problem
IC (Chloride, Nitrate, Nitrite, Bromide, Sulfate, Fluoride)	Commercial source	Varies	4°± 2°C	Working Standards as needed per analyte	4°± 2°C	6 months or sooner if check samples reveal a problem
IC (Chloride, Nitrate, Nitrite, Bromide, Sulfate, Fluoride)	Inorganic Standards	Varies	4°± 2°C	Working Standards as needed per analyte	4°± 2°C	Midpoint standard prepared weekly or sooner if necessary
IC (Chloride, Nitrate, Nitrite, Bromide, Sulfate, Fluoride)	NSI (2nd source)	Varies	4°± 2°C	Working Standards as needed per analyte	4°± 2°C	Prepared weekly or sooner if necessary
MBAS	Lab preparation	LAS Reference Material	4°± 2°C	1,000mg/mL working standards	4°± 2°C Wet Stored	6 months or when check standards are out of control. Prepared fresh.

Table 8.3A: Standard sources, description and calibration information.

This table is subject to revision without notice

Instrument Group	Standard Source	How Received*	Source/ Storage	Preparation from Source	Lab Stock Storage	Preparation Frequency
Nitrite-Nitrate (autoanalyzer)	Lab preparation	ACS grade KNO3	Reagent shelf	Stock solution (1000ppm)	4°± 2°C	When absorbance of curve changes or check samples are out of control
pH Meter	Commercial Source	pH 4.0 Buffer	Room temp.	No prep required	NA	Annual/Expiration Date
pH Meter	Commercial Source	pH 7.0 Buffer	Room temp.	No prep required	NA	Annual/Expiration Date
pH Meter	Commercial Source	pH 10.0 Buffer	Room temp.	No prep required	NA	Annual/Expiration Date
Phenols (autoanalyzer)	Lab preparation	ACS Certified Phenol	Reagent shelf	Stock solution (1000ppm)	4°± 2°C	Every month. Working solutions prepared daily as needed.
Phosphate	(H2O) - Prepared in Lab Total Phos. (soils) RICCA, ERA	KH2PO4	Reagent shelf	Stock solution (50ppm as P)	Room temp.	When absorbance of curve changes or check samples are out of control. Working solutions prepared daily as needed.
Specific Conductivity Meter	NSI-Primary	ACS Certified KCl	Room temp.	Working Standard (0.01M)	Room temp.	As needed
Specific Conductivity Meter	ERA-2nd Source	ACS Certified KCl	Room temp.	Working Standard (0.01M)	Room temp.	As needed
Sulfate	Inorganic Standards, NSF Prepared in Lab	Anhydrous Na2SO4	Reagent shelf	Stock solution (100ppm)	Room temp.	When visible microbiological growth or check samples are out of control
Turbidimeter	Commercial Source Hach	Hach	Room temp.	No prep required	NA	Checked daily against Formazin Standards

TABLE 8.3B: WORKING STANDARD CALIBRATION	
Analysis	**Calibration Standard**
Alkalinity, Acidity- Titrimetric	Primary standard grade Na_2CO_3.
Alkalinity - Methyl orange Autoanalyzer	Primary standard grade Na_2CO_3: 0, 10, 25, 50,100, 250, 375, 500 mg/L
BOD	D.O.-Barometric pressure/temp., Glucose and Glutamic acid reference standard.
Bromate IC	Low Range – 5.0, 10, 20, 30, 50, 100 ug/L
Bromide IC	Range –1.0, 5.0, 10, 50, 100, 150, 200 mg/L
Chlorate IC	Low Range – 5.0, 10, 20, 30, 50, 100 ug/L High Range – 10, 20, 50, 100, 200, 400, 600 ug/L
Chloride IC	Range –1.0, 5.0, 10, 50, 100, 150, 200 mg/L
Conductivity	Standard KCl solution: 1413
Cyanides	Blank, 0.0025 – 0.40ppm. Distill one standard as check with each batch.
COD	KHP (Potassium hydrogen phthalate) standards 20 – 1000 mg/L
Chromium – Hexavalent (Colorimetric)	Blank, 0.0101, 0.0202, 0.0505, 0.1010, 0.2525, 0.5050, 1.010 mg/L
Chromium – Hexavalent (IC)	Blank, 0.5, 1.0, 2.0, 10, 20, 50, 100 ug/L
Fluoride – IC	Range –0.10, 0.50, 1.0, 5.0, 10.0, 15.0, 20.0 mg/L
Hardness	$CaCO_3$, chelometric standard.
Hardness (Colorimetric)	Range – 30, 50, 60, 100, 150, 200, 300 mg/L
MBAS	LAS reference material: 0.0, 0.1, 0. 5, 1.0, 1.5, 2.0 mg/L
Nitrogen-Ammonia – Autoanalyzer	Calibration standards: 0.05, 0.10, 0.50, 1.0, 2.0, 5.0, 10, 20 mg/L
Nitrogen-Nitrate, Nitrite – Autoanalyzer	Blank, 0.1, 0.50, 1.00 5.0, 7.0, 10.0 mg/L
Nitrogen-Nitrate – IC	Range –0.10, 0.50, 1.0, 5.0, 10.0, 15.0, 20.0 mg/L
Nitrogen-Nitrite – IC	Range –0.10, 0.50, 1.0, 5.0, 10.0, 15.0, 20.0 mg/L
Orthophosphate, Total Phosphate	Blank, 0.025, 0.10, 0.25, 0.50, 0.75, 1.0mg/L diluted from standard KH_2PO_4
Perchlorate	Range – 0.5, 1.0, 3.0, 5.0, 10, 20, 25 mg/L
pH	Buffers1.0, 4.0, 7.0, 10, 13
Phosphate, Total	Range – 0.0, 0.1, 0.5, 1.0, 2.5, 5.0 mg/L
Phosphate – IC	Range –0.10, 0.50, 1.0, 5.0, 10.0, 15.0, 20.0 mg/L
Phenols (chloroform ext.)	Blank 0.04, 0.05, 0.10, 0.50, 1.0, 2.0mg/L Distill one standard with each batch
Solids	Gravimetric balance calibrated charts, checked with Class “I” weights in range of sample tare weights.
Sulfate – IC	Range –1.0, 5.0, 10, 50, 100, 150, 200 mg/L
Sulfide (Colormetric)	Range –0.0, 0.05, 0.1, 0.5, 1.0, 1.5, 2.0 mg/L
Sulfite	Titration
TKN	Range – 0.0, 0.1, 0.5, 1.0, 2.5, 5.0, 10, 20 mg/L
Turbidity	Range –0, 20, 200, 1000, 4000NTU
TOC	Range –0, 1.0, 2.5, 5.0, 7.5, 10, 20, 50, 75, 100 mg/L
ToX	Cell checks at 1, 20, 40 ug

TABLE 8.3C: STANDARDIZATION OF TITRATION SOLUTIONS		
Solution	**Primary Standard**	**Frequency**
0.0200 N NaOH	0.050 N KHP	Daily as needed
0.0200 N H_2SO_4	Freshly prepared and standardized NaOH (from KHP standard)	6 months or with each new batch
0.0141 N Hg $(NO_3)_2$	Standard NaCl solution 500 ug Cl/ml	Daily as used
0.0100 M EDTA	Standard $CaCO_3$ solution 1 mg $CaCO_3$/liter	Daily as used

8.4 INSTRUMENT CALIBRATION

Total Organic Carbon Analyzer (TOC) – SOP Number 340356A

The TOC standard curve is prepared using a minimum of five standards. Linear regression is used for quantitation with the correlation coefficient being at least 0.995. The calibration range is 1.0mg/L to 100mg/L. During the analytical sequence, the stability of the initial calibration is verified, following every 10th sample and at the end of the sequence, by the analysis of continuing calibration verification (CCV) standards. The CCV must recovery within 10% of the expected value for each analyte.

A laboratory control standard (LCS) is prepared from a source that is independent from the calibration standards and used to verify that the calibration curve is functioning properly and that the analytical system performs acceptably within a clean matrix. The LCS must recover within ±15% of the expected concentration.

Total Organic Halogen Analyzer (TOX) – SOP Number 340360

The cell performance of the TOX analyzer is verified at the beginning of each analytical sequence in the low, mid and high ranges. The verifications must recover within 3% of the expected target value. The instrument performs a linear regression using the values determined with the required correlation coefficient being at least 0.995. During the analytical sequence, the stability of the initial calibration is verified, following every 10th sample and at the end of the sequence, by the analysis of continuing calibration verification (CCV) standards. The CCV must recovery within 10% of the expected value for each analyte.

A laboratory control standard (LCS) is prepared from a source that is independent from the calibration standards and used to verify that the calibration curve is functioning properly and that the analytical system performs acceptably within a clean matrix. The LCS must recover within ±15% of the expected concentration.

Anions by Ion Chromatography – SOP 340319

Quadratic Fit is the primary method of quantitation; however Linear Regression is required for sample analyzed in conjunction with the Ohio VAP program. When using quadratic fit a minimum of six standards are used. If linear regression is used for quantitation, a minimum of five standards is used and the correlation coefficient must be at least 0.995 for each analyte of interest. The calibration range varies depending upon the analyte(s) to be determined. During the analytical sequence, the stability of the initial calibration is verified, following every 10th sample and at the end of the sequence, by the analysis of continuing calibration verification (CCV) standards. The CCV must recovery within 10% of the expected value for each analyte, except during the analysis of groundwater and soil using EPA Method 9056 that recover within 5%.

A laboratory control standard (LCS) is prepared from a source that is independent from the calibration standards and used to verify that the calibration curve is functioning properly and that the analytical system performs acceptably within a clean matrix. The LCS must recover within ±10% for water samples and 15% of the expected concentration for soil samples.

Auto-Analyzer (Lachat) – Various SOPs

The Autoanalyzer calibration curve is prepared using a minimum of five standards. For most analyses, linear regression is used for quantitation with the correlation coefficient being at least 0.995. The calibration range varies depending upon the analyte to be determined. During the analytical sequence, the stability of the initial calibration is verified, following every 10th sample and at the end of the sequence, by the analysis of continuing calibration verification (CCV) standards. Routinely, the CCV must recovery within 15% of the expected value for each analyte, but is dependent on the analyte of concern, the matrix of the sample and the determinative method.

A laboratory control standard (LCS) is prepared from a source that is independent from the calibration standards and used to verify that the calibration curve is functioning properly and that the analytical system performs acceptably within a clean matrix. The LCS must recover within ±15% of the expected value, except for cyanide where ±10% applies.

Gravimetric Analyses – Various SOPs

Gravimetric analyses are performed using several different published methods, including TDS, TSS, TVDS, TS, TVS, VSS, Settleable Solids, Total Particulates, Respirable Particulates. Calibration for these methods require use of Class I weights and a properly performing and verified balance. Where possible, laboratory control standards are analyzed in conjunction with field sample analysis to verify that the analytical process is performing accurately. Sample duplicate analyses also provide verification that the analytical process is performing as required.

Perchlorate in Drinking Water – ESC SOP 340370

The Ion Chromatograph calibration curve is prepared using a minimum of five standards. The instrument performs a linear regression using the values determined with the required correlation coefficient being at least 0.995. During the analytical sequence, the stability of the initial calibration is verified, following every 10th sample and at the end of the sequence, by the analysis of continuing calibration verification (CCV) standards. The CCV must recovery within 15% of the expected value for each analyte.

A laboratory control standard (LCS) is prepared from a source that is independent from the calibration standards and used to verify that the calibration curve is functioning properly and that the analytical system performs acceptably within a clean matrix. The LCS must recover within ±15% of the expected concentration.

8.5 ACCEPTANCE/REJECTION OF CALIBRATION

The initial calibration curve is compared with previous curves for the same analyte. The curve is checked for linearity and the response must be within 10% of the previous curve. All new standard curves are immediately checked with a laboratory control standard from a separate source than that used for calibration. All curves are visually reviewed to ensure that acceptable correlation represents linearity. Calibration curves may be rejected for nonlinearity, abnormal sensitivity, or poor response of the laboratory control standard. Specific criteria for each instrument are outlined in Table 8.5.

Continuing calibration is performed following every tenth sample. If a check standard does not perform within established criteria then the instrument is evaluated to determine the problem. Once the problem is corrected, all samples between the last “in control” sample and the out of control check are re-analyzed.

TABLE 8.5: INSTRUMENT CALIBRATION

Instrument (Analysis)	Calibration Type	Number of Standards	Type of Curve	Acceptance/Rejection Criteria	Frequency
pH Meter*	Initial	5 (buffers) 1 reference buffer	Log.	Third pH of a different value buffer must read within 0.05 units of true value	Daily as used
	Continuing	1 buffer (may be any certified buffer)		Buffer solution must read within 0.05 units of true value	Every 10th sample; Field**
Conductivity Meter*	Initial	1	1 point	Calculation of cell constant between 0.95 - 1.05	Daily as used
	Continuing	1		Must be within 5% of true value	Every 10th sample; Field**
Turbidimeter *	Initial	5	Linear	Formazin-confirmed Gelex standards in appropriate range. Check with second standard must be within 5%	Daily as used
	Continuing	1 reference of different value, 1 (high-level)		Must be within 5% of true value	Every 10th sample; Field**
UV/VIS Spec.	Initial	At least 5 standards calibration standards 2 laboratory control standard	Linear	Calibration Curve must have a correlation of 0.995 or better Must be within ± 15% of the calibration curve.	Daily as used Daily as used
	Continuing	1 mid-level reference std.		Must be within 90 – 110%	Every 10th sample
Total Organic Halogen Analyzer	Initial	3 calibration standards 1 laboratory control standard	Linear	Calibration Curve must have a correlation of 0.995 or better Laboratory control standard must agree within ± 15% of calibration curve	Daily as used Daily as used
	Continuing	1 mid-level reference std.		Must be within 90 – 110%	Every 10th sample
Total Organic Carbon Analyzer	Initial	5 calibration standards 2 laboratory control standard	Linear	Calibration Curve must have a correlation of 0.995 or better Laboratory control standard must agree within ± 15% of calibration curve	Every 6 months or as needed Daily as used
	Continuing	1 mid-level reference std.		Must be within 90 – 110%	Every 10th sample

Note: ESC defines a "laboratory control standard" as a standard of a different concentration and source than those stock standards used for calibration.
*This equipment is also calibrated and used in the field.
**Field equipment must be checked every 4 hours and at the end of the day.

9.0 LABORATORY PRACTICES

9.1 REAGENT GRADE WATER

Reagent grade water is obtained from either a Barnstead NANOpure Diamond system or the Millipore Milli-Q Academic A-10 system.

9.2 GLASSWARE WASHING AND STERILIZATION PROCEDURES

General

Routine laboratory glassware is washed in a non-phosphate detergent and warm tap water. Before washing all labeling and large deposits of grease are removed with acetone. Glassware is then rinsed with: tap water, "No Chromix" solution, tap water, and deionized (DI) water. Glassware is stored in designated drawers or on shelves, inverted when possible. All glassware is rinsed with the required solvent, prior to use. DI water is then used as a precaution against airborne contamination

Phosphate Glassware

Glassware involved in phosphate analysis is marked and segregated. All labels and markings are removed from the glassware prior to washing. The glassware is then washed using hot water and a non-phosphorus detergent. It is then rinsed thoroughly in hot water followed by a rinse in DI water. It is rinsed in 1:1 HCl followed by a final rinse of DI water. If the phosphate glassware has not been used recently, it is the responsibility of the analyst to rinse the glassware with warm 1+9 hydrochloric acid prior to use.

Nutrients and Minerals Glassware

All labels and markings are removed from the glassware prior to washing. The glassware is then washed using hot water and detergent. It is then rinsed thoroughly in hot water followed by a rinse in DI water. It is rinsed in 1:1 HCl followed by a final rinse of DI water. Immediately prior to use, the ammonia glassware is rinsed in DI water. Routine blanks are run on ammonia glassware to ensure that the detergent is contaminant free.

Non-Metals (CN, BOD, COD) Glassware

All labels and markings are removed prior to washing. The glassware is soaked in hot soapy water followed by a thorough rinse with hot tap water. A final rinse of DI water is then performed.

BOD analysis is performed in disposable, pre-sterilized bottles. In the event that glass bottles must be used, the BOD glassware is washed in a commercial laboratory dishwasher using a phosphate free detergent, followed by a nitric acid rinse, with a final rinse of laboratory DI water.

10.0 ANALYTICAL PROCEDURES

10.1 A list of laboratory SOP's associated with the Wet Lab can be found in the following table:

TABLE 10.1: WET LAB DEPARTMENT SOP'S

This table is subject to revision without notice

SOP #	Title
340300	Acidity
340301	Alkalinity (Titrimetric)
340302	Alkalinity - Lachat
340303	Biochemical Oxygen Demand
340305	Chlorine, Total Residual
340306	Corrosivity
340307	Cyanide- All Forms (Colorimetric Automated UV) - Lachat
340309	Chemical Oxygen Demand
340310	Color by Visual Comparison
340313	Density (Specific Gravity)
340317	Total Hardness by Lachat
340317	Total Hardness (mg/l as CaCO3) - (Titrimetric)
340318	Hexavalent Chromium (Colorimetric) Water/Soil
340319	Ion Chromatography - Anions
340325	MBAS (Methylene Blue Active Substances)
340327	Ammonia, Phenolate (Lachat)
340328	Organic Nitrogen
340331	Threshold Odor Test
340333	Nitrate/Nitrite (Lachat Autoanalyzer)
340334	Paint Filter Test
340335	pH
340336	Phenol - 4AAP (Lachat Autoanalyzer)
340338	Orthophosphate Colorimetric
340338	Total Phos. Colorimetric
340339	Reactivity
340340	Reactive Cyanide/Sulfide Distillation
340342	Specific Conductance

SOP #	Title
340344	Sulfide (Colorimetric Methylene Blue)
340344	Sulfide Acid-soluble,and acid-insoluble
340345	Sulfite
340346	Settleable Solids
340347	Total Dissolved Solids
340348	Total Suspended Solids (Non-Filterable Residue)
340349	Total Solids/Percent Moisture
340350	Total Volatile Solids
340352	Total Kjeldahl Nitrogen
340356	Total Organic Carbon In Soils (loss of weight on ignit.)
340356	TOC for Drinking Water only
340356	Total Organic Carbon (TOC) and Total Inorganic Carbon (TIC)
340357	Ignitability
340357	Ignitability
340359	UV254
340360	TOX (total organic halides)
340361	Ferrous Iron
340362	Heat of Combustion
340365	Particles Not Otherwise Regulated, Total (PNOR)
340366	Oxidation Reduction Potential
340367	Extractable Organic Halides
340368	TOC in Soil (Walkley-Black)
340369	Carbon Dioxide by Calculation
340370	Perchlorate in DW
340371	Chlorine in Oil
340372	Hexavalent Chromium in Water by IC
340373	Organic Matter (FOM) and Fractional Organic Carbon (FOC)
340374	Total Volatile Dissolved Solids (TVDS)
340375	Hexavalent Chromium in Air by IC
340376	Total Organic Halides in Oil
340377	Manual Nitrocellulose Analysis
340378	Volatile Suspended Solids
340379	Guanidine Nitrate by IC

11.0 QUALITY CONTROL CHECKS

NOTE: For specific guidance on each determinative method, including required quality control and specific state requirements/modifications, refer to the relevant laboratory standard operating procedure(s).

11.1 ESC participates in proficiency testing (PT's) in support of various laboratory accreditations/recognitions. Environmental samples are purchased from Environmental Resource Associates (ERA). The WS, WP and solid matrix studies are completed every 6 months.

11.2 Initial Demonstrations of Capability (IDOC's) are performed during new analyst training and/or prior to acceptance and use of any new method/instrumentation. Continuing Demonstration of Capability (CDOC's) must be updated at least annually. The associated data is filed within the department and available for review.

11.3 Where appropriate, Matrix Spike and Matrix Spike Duplicates are performed on each batch of samples analyzed, depending on analytical method requested.

11.4 A Laboratory Control Sample (LCS) is analyzed once per batch of samples. Where appropriate, an LCS Duplicate may also be analyzed.

11.5 Where appropriate, a method preparation blank is performed per batch of samples processed. If one-half the reporting limit [RL] is exceeded, the laboratory shall evaluate whether reprocessing of the samples is necessary, based on the following criteria:

- The blank contamination exceeds a concentration greater than 1/10 of the measured concentration of any sample in the associated preparation batch or
- The blank contamination is greater than 1/10 of the specified regulatory limit.

The concentrations of common laboratory contaminants shall not exceed the reporting limit. Any samples associated with a blank that fail these criteria shall be reprocessed in a subsequent preparation batch, except when the sample analysis resulted in non-detected results for the failing analytes.

12.0 DATA REDUCTION, VALIDATION AND REPORTING

12.1 DATA REDUCTION

The analyst performs the data calculation functions and is responsible for the initial examination of the finished data. Data reduction steps applied to the raw data are outlined in ESC SOP #030201, *Data Handling and Reporting.* The Quality Control Department performs the secondary review of the data package using the ESC SOP #030227, *Data Review*. The QC Reviewer verifies that the analysis has performed as required and meets method criteria, all associate data is present and complete, and also ensures that any additional documentation is completed as required (i.e. Ohio VAP checklists, required flags on test reports, etc.)

TABLE 12.1: Data Reduction Formulas

PARAMETER	FORMULA
Acidity, Alkalinity	mL titrant x normality titrant x 50,000 / mL sample
BOD, 5-day	Initial D.O. - Final D.O. - CF / % Dilution Sample *Calculations are performed by computer software*
Boron, COD, Sulfate	Concentration from curve x dilution factor
Nitrogen-Nitrate, Nitrite, Nitrogen-Nitrite, Ortho and Total Phosphate, Phenols, Chloride	Calculated by computer software as provided by Lachat Corp.
Fluoride**, Nitrogen-Ammonia**, Nitrogen-Total Kjeldahl**	Calculated by computer software as provided by Lachat Corp.
Anions	Calculated by computer software as provided by Dionex
Conductivity*, pH, Turbidity,	Directly read from instrument
Cyanide, Total and Amenable	µg from standard curve x mL total volume absorbing solution / mL volume sample x mL volume of absorbing solution colored *Calculated by software as provided by Lachat Corp.*
Solids, Total and Total Dissolved	((mg wt of dried residue + dish) - mg wt of dish) x 1000 / mL sample
Solids, Total Suspended	((mg wt of dried residue + filter) - mg wt of filter) x 1000 / mL sample

12.2 VALIDATION

The validation process consists of data generation, reduction review, and reporting results. Once data reduction is complete, validation is conducted by verification that the QC samples are within acceptable QC limits and that all documentation is complete, including the analytical report and associated QC. See Table 12.3 by method for current QC targets, controls and current reporting limits.

12.3 REPORTING

Reporting procedures are documented in *SOP 030201 Data Handling and Reporting.*

Inorganic Control Limits: Inorganic QC targets are statutory. The laboratory calculated limits verify the validity of the regulatory limits. The Wet Lab QC targets for all inorganic analyses are within the range of $\pm$ 5 to 15% for accuracy, depending on determinative method requirements, and, where applicable, $\leq$20 RPD for precision, unless laboratory-generated data indicate that tighter control limits can be routinely maintained. When using a certified reference material for QC sample analysis, the acceptance limits used in the laboratory will conform to the provider's certified ranges for accuracy and precision.

Table 12.3: QC Targets for Wet Lab Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Analyte	Analysis Method	Matrix	Accuracy Range (%)	Precision (RPD)	RL (ppb)
Acidity	SM 2310B	w	85 - 115	<20	1000
Alkalinity	SM 2320	w	85 - 115	<20	10000
Ammonia	350.1, SM 4500-NH3-H	w	85 - 115	<20	100
Ammonia	350.1 (mod.)	s	Certified Values	<20	500
Bromide	300.0/9056/9056A	w	90 - 110	<20	1000
Bromide	SM 4110B	w	90 - 110	<20	1000
Bromide	300.0	s	Certified Values	<20	10000
Chloride	300.0/9056/9056A	w	90 - 110	<20	1000
Chloride	SM 4110B	w	90 - 110	<20	1000
Chloride	300.0	s	Certified Values	<20	10000
Color	SM 2120-E	w	n/a	<20	1 pCu
Conductivity	120.1/9050A, 2510	w	85 - 115	<20	1000
Cyanide	335.3, 335.4, 335.2 (CLP-M), 9012A	w	90 - 110	<20	5
Cyanide	SM 4500-CN-E	w	90 - 110	<20	5
Cyanide	EPA 9012A	s	Certified Values	<20	250
Ferrous Iron	3500FE B	w	85 - 115	<20	50
Fluoride	300.0/9056/9056A	w	90 - 110	<20	100
Fluoride	SM 4110B	w	90 - 110	<20	100
Fluoride	9056A	s	Certified Values	<20	1000
Hardness	130.1	w	85 - 115	<20	30000
Hardness	SM 2340	w	85 - 115	<20	1000
Hexavalent Chromium	SM3500 CrD/7196A	w	85 - 115	<20	10
Hexavalent Chromium	7196A	s	Certified Values	<20	2000
Ignitability	1010	ws	$\pm$3 degrees C	<20	n/a
Methylene Blue Active Substances	5540C SM20th	w	85 - 115	<20	100
Nitrate-Nitrite	300	w	90 - 110	<20	100
Nitrate-Nitrite	SM 4110B	w	85 - 115	<21	100
Nitrate-Nitrite	9056/9056A	w	90-110	<20	100
Nitrate-Nitrite	9056/9056A	s	Certified Values	<20	1000
Nitrite	300.0/9056/9056A	w	90 - 110	<20	100
Nitrite	SM 4110B	w	90 - 110	<21	100
Nitrite	300.0/9056/9056A	s	Certified Values	<20	1000
Nitrate	300.0/9056/9056A	w	90 - 110	<20	100
Nitrate	SM 4110B	w	90 - 110	<20	100
Nitrate	300.0/9056/9056A	s	Certified Values	<20	1000
Moisture	Karl Fisher	ws	n/a	<20	n/a
pH	SM 4500-H, 9040B	w	n/a	<1	n/a
pH	9045C	s	n/a	<1	n/a

Table 12.3: QC Targets for Wet Lab Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Analyte	Analysis Method	Matrix	Accuracy Range (%)	Precision (RPD)	RL (ppb)
Phosphate (ortho)	SM 4500-P	w	85 - 115	<20	25
Phosphorous/Total	365.4, SM 4500-P	w	85 - 115	<20	25
Phosphorous/Total	365.4	s	Certified Values	<20	1000
Phosphorous/Total	9056/9056A	s	Certified Values	<20	1000
Residual Chlorine	SM 4500Cl G 20th	w	90 - 110	<20	100
Residue, Total (TS)	SM 2540-B, SM2540-G	w	85 - 115	<20	1000
Residue, Filterable (TDS)	SM 2540-C	w	95 - 105	<20	1000
Residue Non-Filterable (TSS)	SM 2540-D	w	95 - 105	<20	1000
Residue, Total Volatile (TVS)	160.4, SM 2540-E, SM2540-G	w,s	80 - 120	<20	1000
Sulfate	300.0/9056/9056A	w	90 - 110	<20	5000
Sulfate	SM 4110-B	w	90 -110	<20	5000
Sulfate	300.0/9056/9056A	s	Certified Values	<20	50000
Sulfide	SM 4500S2 D 20th	w	85 - 115	<20	100
Sulfite	SM 4500-SO3	w	85 - 115	<20	500
Total Kjeldahl Nitrogen	351.2	w	85 - 115	<20	500
Total Kjeldahl Nitrogen	351.2	s	Certified Values	<20	50000
Total Organic Carbon	415.1, SM 5310B&C, 9060	w	85 - 115	<20	1000
Total Organic Carbon	LOI	s	Certified Values	<20	10000
Dissolved Organic Carbon	415.1, SM 5310B&C, 9060	w	85 - 115	<20	1000
Total Inorganic Carbon	415.1, SM 5310B&C, 9060	w	85 - 115	<20	1000
Total Organic Halogens	9020A, SM 5320B	w	85 - 115	<20	10
EOX	9023	s	85 - 115	<20	20000
Total Phenol	420.2	w	85 - 115	<20	50
Total Phenol	9066	s, ws	Certified Values	<20	50
Turbidity	180.1, SM 2130	w	n/a	<20	1 NTU

13.0 CORRECTIVE ACTIONS

13.1 In the event that a nonconformance occurs in conjunction with the analytical batch, a corrective action response (CAR) form must be completed. The reason for the nonconformance is stated on the form and the measures taken to correct the nonconformance clearly defined. The effectiveness of the corrective action must be assessed and noted. The CAR is kept on file by the QA department. Corrective action procedures are documented in SOP 030208, *Corrective and Preventive Action*

13.2 Required Corrective Action

Control limits have been established for each type of analysis. When these control limits are exceeded, corrective action must be taken. Calculated sample spike control limits are also used.

All samples and procedures are governed by ESC's quality assurance program. General corrective actions are as follows; however additional and more specific direction is provided in the specific determinative procedure. For more information, see the appropriate determinative SOP.

13.2.1 Laboratory QC Criteria and Appropriate Corrective Actions

If the analytical method contains acceptance/rejection criteria and it is more stringent than those controls generated by the laboratory the method criteria take precedence.

13.2.2 Calibration Verification Criteria Are Not Met: Inorganic Analysis

Rejection Criteria - See Table 8.5.

Corrective Action - If a standard curve linearity is not acceptable and/or the absorbance for specific standard(s) is not analogous to historic data, the instrument settings, etc. are examined to ensure that nothing has been altered, clogged, etc. Check the standard curve for linearity and re-analyze the standards once. If the failure persists, the working standards will be made fresh, intermediate dilutions will be re-checked and the instrument will be re-calibrated. If a problem persists, the group supervisor or QA Department is notified for further action.

If the initial reference check sample is out of control, the instrument is re-calibrated and the check sample is re-analyzed. If the problem continues the check sample is re-prepared. If the problem still exists then the standards and reagent blank are re-prepared. If the problem persists, the group supervisor or QA Department is notified for further action.

13.2.3 Out Of Control Blanks: Applies to Method, Trip, Rinsate & Instrument Blanks

Rejection Criteria - Blank reading is more than twice the background absorbance or more than 1/2 RL.

Corrective Action - Blanks are re-analyzed and the response is assessed. Standard curves and samples are evaluated for any obvious contamination that may be isolated or uniform throughout the run. If necessary, reagents are re-prepared. Field sample analyses are not started until the problem is identified and solved. If samples have already been partially prepared or analyzed, the group leader or QA Department will be consulted to determine if data needs to be rejected or if samples need to be re-prepped.

13.2.4 Out Of Control Laboratory Control Standards (LCS)

Rejection Criteria - If the performance of associated laboratory control sample(s) is outside of lab-generated control limits calculated as the mean of at least 20 data points $\pm$ 3 times the standard deviation of those points. (Listed in Section 12).

Corrective Action - Instrument settings are checked, LCS standard is re-analyzed. If the LCS is still out of control, re-calibration is performed, and samples affected since the last "in control" reference standard are re-analyzed. The group leader, lab supervisor, or QA Department will be consulted for further action.

13.2.5 Out Of Control Matrix Spike Samples

Rejection Criteria - If either the MS or MSD sample is outside the established control limits from accuracy charts on matrix spike samples of a similar matrix (i.e., water, solid, etc). Limits are calculated as the mean ± three times the standard deviations.

Corrective Action - Spiking technique is assessed to ascertain if the sample has been spiked correctly. The spiked sample should be 1 – 5 times the concentration of the client sample; otherwise, the percent recovery (%R) or relative percent difference (RPD) of the MS/MSD should be flagged as not meaningful or usable The sample is re-spiked and re-analyzed, along with several other similar samples in subset. If an "out of control" situation persists, sample matrix interference is indicated. Samples to be analyzed by standard additions are prepared (where appropriate), and the group leader, lab supervisor, or QA Department is notified.

13.2.6 Out Of Control Duplicate Samples

Rejection Criteria - Lab-generated maximum RPD limit (as listed under precision in Section 12)

Corrective Action - Instrument and samples checked to see if precision variance is likely (i.e., high suspended solids content, high viscosity, etc.). They are re-analyzed in duplicate and samples just preceding and following the duplicated sample are re-analyzed. If problem still exists, lab supervisor or QA Department is notified to review the analytical techniques.

13.2.7 Out Of Control Matrix Spike Duplicates

These QC samples can be out of control for accuracy, precision, or both. The appropriate corrective actions listed for either matrix spikes, duplicate samples, or both are followed.

Analysis-specific corrective action lists are available for each type of analysis performed by ESC.

13.2.8 Out Of Control Calibration Standards: ICV, CCV, SSCV

Rejection Criteria - If the performance is outside of method requirements.

Corrective Action - Instrument settings are checked, calibration verification standard is reanalyzed. If the standard is still out of control, re-calibration is performed, and samples affected since the last "in control" reference standard are re-analyzed. The group leader, lab supervisor, or QA Department will be consulted for further action.

14.0 RECORD KEEPING

Record keeping is outlined in SOP *#010103 Document Control and Distribution,* SOP *#030203 Reagent Logs and Records* and SOP *#030201 Data Handling and Reporting*

All calibration data and graphs generated for wet chemistry are kept in a calibration notebook with the following information: date prepared, calibration concentrations, correlation, and analyst initials. The analyst reviews the calibration and evaluates it against acceptance criteria before placing it in the calibration notebook. Data on initial and continuing reference standards, as well as matrix spikes and duplicates, are entered in the QC box generated on each analysis page. If a test allows the use of a previously established calibration curve then the calibration check standard is reviewed against acceptance criteria and if acceptable, analysis can proceed. In this situation the calibration date is referenced so that the curve can be easily reviewed, if necessary.

15.0 QUALITY AUDITS

System and data quality audits are outlined in the ESC Quality Assurance Manual *Version 8*.0.

1.0 SIGNATORY APPROVALS

Metals Department
QUALITY ASSURANCE MANUAL

APPENDIX V TO THE ESC
QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

NOTE: The QAM has been approved by the following people. A signed cover page is available upon request

Judith R. Morgan, M.S., VP of Technical and Regulatory Affairs 615-773-9657

Eric Johnson, B.S., Laboratory Director 615-773-9654

Dixie Marlin, B.S, QC Manager, 615-773-9681

James Burns, B.S., Metals Department Manager 615-773-9685

2.0 APPENDIX TABLE OF CONTENTS

3.0 SCOPE AND APPLICATION

This appendix discusses specific QA requirements for general analytical protocols to ensure that data generated from the Metals Laboratory is scientifically valid and is of acceptable quality. Any deviations from these requirements and any deviations that result in nonconforming work must be immediately evaluated and their corrective actions documented.

4.0 LABORATORY ORGANIZATION AND RESPONSIBILITIES

ESC Lab Sciences offers diverse environmental capabilities that enable the laboratory to provide the client with both routine and specialized services, field sampling and broad laboratory expertise. A brief outline of the organization and responsibilities as they apply to the ESC Quality Assurance Program is presented in *Section 4.0 in the ESC Quality Assurance Manual Version 8.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

James Burns, with a B.S. degree in Medical Technology, is the Department Manager of the Metals Laboratory. Mr. Burns reviews and approves all data reduction associated with metals analysis. Scheduling for analyses and personnel are his responsibility and is paramount to achieving success and quality analyses of samples. His responsibilities also include the coordination with clients' analytical needs regarding regulatory compliance. Mr. Burns has previous experience with numerous regulatory agencies including: USACE, DOD, DOE, NAVY, AFCEE and CLP. Additionally, he has also been involved in waste management/disposal and has held the position of Radiation Safety Officer. In his absence, Lisa Taylor or Lakeia Layne assume responsibility for departmental decisions.

5.2 TRAINING

The primary analyst or Manager trains all new analysts to the laboratory according to ESC protocol. Performance is documented using an initial demonstration of capability (IDOCs) and continuing demonstration of capability (CDOC). On-going acceptable capability in metals analysis and preparation is also demonstrated by acceptable participation in multiple proficiency testing programs (PTs) and daily Quality Control sample analyses. Documentation of analyst training is maintained on file within the department.

6.0 FACILITIES AND LABORATORY SAFETY

6.1 FACILITIES

The main area of the analysis laboratory has approximately1200 square feet with roughly 90 square feet of bench area. The main area of the metals prep laboratory has approximately 1200 square feet with 232 square feet of bench area. The main area of the mercury/TCLP laboratory has approximately 1272 square feet with 136 square feet of bench area. The lighting standard in all three labs is fluorescence. The air system is a 15-ton make-up unit plus 15-ton HVAC with electric heat. The laboratory reagent water is provided through the US Filter deionizer system. Waste disposal containers are located in the laboratory and Clean Harbors serves as ESC's waste disposal company. ESC's building information guides and site plan are shown in Appendix I.

6.2 LABORATORY SAFETY

- Laboratory access is limited when work is being performed.
- All procedures where chemicals are prepared or splashes may occur are conducted in laboratory exhaust hoods.
- ESC's laboratory safety guidelines are detailed in *the ESC Chemical Hygiene and Safety Plan.*

7.0 SAMPLING PROCEDURES

7.1 FIELD SAMPLING PROCEDURES, SAMPLE STORAGE, AND HANDLING

- Field Sampling procedure is described in Appendix III of this ESC Quality Assurance Manual. Sample information is recorded and kept on the ESC chain of custody and field logbooks.
- Matrices for metals analysis are as follows: groundwater, wastewater, drinking water, soil, sludge, paint chips, wipes, filters, and leachates.
- Sample containers, preservation methods and holding times:
  - Glass and plastic containers are acceptable for all elements except Boron and Silicon. Plastic must be used for Boron and Silicon.
  - Water Samples that are analyzed for dissolved metals must be filtered using a 0.45µm pore membrane. Water samples for total metals are not filtered. All water samples are acidified with 1+1 nitric acid to a pH<2. Filtered water samples (dissolved metals) are preserved immediately after filtration. All other water samples are preserved immediately after sampling. Water samples are not refrigerated prior to analysis.
  - Paint chips, dust wipes and filters do not require preservation.
  - Soil samples are stored at 4 ± 2^{o}C and do not require acid preservation.
  - Hold times for all metals, except Mercury, are 180 days. Mercury has a hold time of 28 days.

8.0 EQUIPMENT

Instrument Software

- PE ELAN ICPMS - PE - ICP Winlab - Used for calibration, calculation, QC review, diagnostics, data storage
- Perkin Elmer ICP Optima DV - PE - ICP Winlab - Used for calibration, calculation, qc review, diagnostics, data storage

NOTE: All purchased software that is used in conjunction with software specific instruments is guaranteed by the supplier to function as required. The supplier of the software performs all troubleshooting or software upgrades and revisions.

8.1 EQUIPMENT LIST

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Metals Analysis and Preparation *This table is subject to revision without notice*						
Item	***Manufacturer***	***Model***	***Name***	***#***	***Serial number***	***Location***
Balance - Top Loading	Mettler Toledo	PB3002-5		1	1119070828	Metals Prep Lab
Balance - Top Loading	Mettler Toledo	PB3002-5		1	71242213216	Mercury Lab
Hot Block	CPI	Mod Block	A	1	NA	Metals Prep Lab
Hot Block	Env. Express	SC154	C	1	3994CEC1880	Metals Prep Lab
ICPMS with autosampler	Perkin Elmer	ELAN DRC-e SC Fast	ICPMS4	1	AH13650804	Metals Lab
ICPMS with autosampler	Perkin Elmer	ELAN DRC-e ASX-510	ICPMS3	1	AH00110504H	Metals Lab
ICPMS with autosampler	Perkin Elmer	ELAN 9000	ICPMS5	1	AJ12270805	Metals Lab
ICPMS with autosampler	Perkin Elmer	ELAN DRC II	ICPMS6	1	AI13820805H	Metals Lab
ICP - Simultaneous with autosampler	Perkin Elmer	Optima 4300DV AS 93 Plus	ICP3	1	077NO110301	Metals Lab
ICP - Simultaneous with autosampler	Perkin Elmer	Optima 4300DV ASX-510	ICP4	1	077N2100201	Metals Lab
ICP - Simultaneous with autosampler	Perkin Elmer	Optima 5300DV ASX-510	ICP5	1	077N5041802	Metals Lab
ICP - Simultaneous with autosampler	Perkin Elmer	Optima 5300DV ASX-510	ICP6	1	077N5091002	Metals Lab
ICP - Simultaneous with autosampler	Perkin Elmer	Optima 5300DV ASX-510	ICP7	1	077C6110602	Metals Lab
Hot Block	CPI	Mod Block	NA	1	3256	Mercury Lab
Hot Block	CPI	Mod Block	NA	1	3356	Mercury Lab
Mercury Auto Analyzer	Perkin Elmer	(2) FIMS 400	I	1	4545	Mercury Lab
Mercury Auto Analyzer	Perkin Elmer	(2) FIMS 400	II	1	401S3060101	Mercury Lab
Mercury Auto Analyzer	Perkin Elmer	(1) FIMS 100	III	1	110156051101	Mercury Lab
Mercury Auto Sampler	Perkin Elmer	(2) AS-91, (1) AS-93	NA	3	NA	Mercury Lab

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Metals Analysis and Preparation ***This table is subject to revision without notice***						
Item	***Manufacturer***	***Model***	***Name***	***#***	***Serial number***	***Location***
Microwave	CEM	MARS 5	NA	1	DS-9071	Metals Prep Lab
Microwave	CEM	MARS 5	NA	1	DS-8025	Metals Prep Lab
Microwave	CEM	MARS 5	NA	1	DS-8177	Metals Prep Lab
Microwave	CEM	MARS Xpress	NA	1	MD-2861	Metals Prep Lab
Microwave	CEM	MARS Xpress	NA	1	MD-9972	Metals Prep Lab
Microwave	CEM	MARS Xpress	NA	1	MD-9640	Metals Prep Lab
Prep Station	Env. Express	Automated prep station	Autoblock 1	1	1243	Metals Prep Lab
Prep Station	Env. Express	Automated prep station	Autoblock 2	2	1783	Metals Prep Lab
TCLP Extraction Unit	Env. Express	6 Position	NA	1	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	NA	5	4809-12-542	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	NA	5	1918-12-415	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	NA	5	1918-12-414	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	NA	5	5152-12-548	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	NA	5	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	10 Position	NA	1	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	Teflon Vessels	NA	12	NA	TCLP Lab
TCLP Zero Headspace Extractor	Env. Express	Vessels	NA	20	NA	TCLP Lab
Turbidimeter	HACH	2100N		1	05090C020685	Metals Prep Lab
Water Purification - Nanopure	Barnstead	D11911		1	1372051120948	Metals Prep Lab
PH Meter	Orion	410A	NA	1	015683	TCLP Lab
Auto Block	Env. Express		NA	1	1783	Metals Prep Lab
Auto pipetters 1000µl to 20 µl	Oxford	Varies	NA		NA	Metals Lab
Auto pipetters	Eppendorf, Oxford	Varies	NA		NA	Metals Prep Lab
MAX/MIN Thermometer	VWR	MAX/MIN	TCLP #1		NA	TCLP Lab
MAX/MIN Thermometer		MAX/MIN	TCLP #2		NA	TCLP Lab

8.2 EQUIPMENT PREVENTIVE MAINTENANCE, EQUIPMENT CALIBRATION

INSTRUMENT	P. M. DESCRIPTION	FREQUENCY
ICP	•Maintain manufacturer's service contract	Renew annually
ICP and ICPMS	•Pump tubing, torch alignment, o-ring, injector tip and torch	Check daily and adjust/change as needed
ICPMS	•Sampler and Skimmer cones	Clean or replace when needed
ICP and ICPMS	•Pump rollers	Clean and lubricate when needed

INSTRUMENT	P. M. DESCRIPTION	FREQUENCY
ICP and ICPMS	•Nebulizer	As needed
Mercury Analyzer	•Calibrate and check sensitivity with previous data	Daily with use
Mercury Analyzer	•Response factor problems, check tubing for leaks, particularly in pump head, and check cell for fogging	As needed
Mercury Analyzer	•Replace desiccant in tube	With each use
Mercury Analyzer	•Check rotometer for airflow, if inadequate, replace flex tubing in pump lead	As needed
TCLP Apparatus (ZHE)	•Change O-rings	As needed
Thermometer	•All working thermometers are compared to a NIST thermometer.	Semi-annually
pH Meter	•Calibrated according to manufacturers instructions. •The slope is documented and acceptable range 95-105%	Daily
Analytical Balance	•Analytical balances are checked and calibrated by a certified technician semi-annually. •Calibration is checked daily with class S weights. Must be within 0.1% S class weights calibrated annually	Semi-annually Daily
TCLP Tumblers	•Visually timed and confirmed to be 30±2 rpm.	Monthly
Microwaves	•Checked and calibrated by a certified technician	Semi-annually, calibrated weekly by staff
Microwaves	Check cap membranes for leaks	As needed

8.3 STANDARDS AND REAGENTS

All reagents and standards must meet the requirements listed in the analytical methods.

Table 8.3A: Stock Standard sources, receipt, and preparation information.
(subject to revision as needed)

STOCK STANDARD SOURCES
****ICP metals used – Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Sn, Sr, Ti, Tl, V, Zn (Sulfur is analyzed individually)***
****ICP/MS metals used – Ag, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, Sb, Se, Sn, Tl, V, Zn***

Instrument Group/Standard	*Standard Source**	*How Received**	*Source/ Storage*	*Lab Stock Storage*	*Receipt Frequency*
ICP (single element standards)	Env. Express or High Purity	1000ppm	Room temp.		Annual/Expiration Date
ICP/ICV	High Purity	500ppm – Al. Ca, Fe, Mg, Na, K 5ppm – Ag 50ppm – All others	Room temp.	5% HNO3 w/ Tr HF	As needed
ICP/Calibration Standard and CCV	Env. Express	1000ppm – Al, Ca, Fe, K, Mg, Na 10ppm – Ag 100ppm – All others	Room temp.	5% HNO3 w/ Tr HF	As needed
ICP/LCS water	Ultra Scientific	1000ppm – Ca, Mg, K, Na 100ppm – all others except Li (spiked separately)	Room temp.	5% HNO3	As needed

Table 8.3A: Stock Standard sources, receipt, and preparation information.
(subject to revision as needed)

STOCK STANDARD SOURCES
****ICP metals used – Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Sn, Sr, Ti, Tl, V, Zn (Sulfur is analyzed individually)***
****ICP/MS metals used – Ag, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, Sb, Se, Sn, Tl, V, Zn***

Instrument Group/Standard	*Standard Source**	*How Received**	*Source/ Storage*	*Lab Stock Storage*	*Receipt Frequency*
ICP/LCS soil	ERA	Varies with Lot #	Room temp.	none	As needed
ICP/ICSA	Env. Express	5000ppm – Al, Ca, Mg, Na 2000ppm – Fe 100ppm – K	Room temp.	10% HNO3	As needed
ICP/ICSB	Env. Express	100ppm – B, Cd, Pb, Ag, Ni, Si, Zn, 50ppm – all others except Sr, Li	Room temp.	4% HNO3 w/ Tr HF	As needed
ICP/Yttrium	Env. Express	10,000 ppm	Room temp.	4% HNO3	As needed
ICPMS/ICV	High Purity	5 ppm	Room temp.	5% HNO3 w/ Tr HF	As needed
ICPMS/ Calibration Standard and CCV	Env. Express	100 ppm	Room temp.	5% HNO3 w/ Tr HF	As needed
ICPMS/LCS water	Ultra Scientific	1000ppm – Ca, Mg, K, Na 100ppm – all others except Li (spiked separately)	Room temp.	5% HNO3	As needed
ICPMS/LCS soil	ERA	Varies with Lot #	Room temp.	none	As needed
ICPMS/ICSA	Env. Express	10000ppm – Cl 2000ppm – C 1000ppm – Al, Ca, Fe, Mg, P, K, Na, S 20ppm – Mo, Ti	Room temp.	10% HNO3	As needed
ICP/ICSB	Env. Express	2ppm – Sb, As, Be, Ca, Cr, Co, Cu, Pb, Ni, Se, Ag, Tl, Sn, Zn	Room temp.	4% HNO3 w/ Tr HF	As needed
Hg/ICV and LCS	Inorganic Ventures	1000ppm – Hg	Room temp.	2% HNO3	As needed
Hg/Calibration Standard and CCV	Env. Express	1000ppm – Hg	Room temp.	2% HNO3	As needed

**Equivalent Providers may be utilized.*

Table 8.3B: Working standard concentration, storage and preparation information.
(subject to revision as needed)

WORKING STANDARD PREPARATION
****ICP metals used – Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Sn, Sr, Ti, Tl, V, Zn (Sulfur is analyzed individually)***
****ICP/MS metals used – Ag, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, Sb, Se, Sn, Tl, V, Zn***

Instrument Group/Standard	*How Prepared*	*Final Concentration*	*Source/ Storage*	*Expiration*
ICP/ICV	10mL Custom Stock ICV A and B, 0.1 mL stock Sc adjusted to 100mL with 5% HNO3	50ppm – Al, Ca, Fe, K, Mg, Na 0.5ppm – Ag 2ppm - Sr 5ppm – All others	Room temp.	1 month

Table 8.3B: Working standard concentration, storage and preparation information.
(subject to revision as needed)

WORKING STANDARD PREPARATION
****ICP metals used – Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Sn, Sr, Ti, Tl, V, Zn (Sulfur is analyzed individually)***
****ICP/MS metals used – Ag, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, Sb, Se, Sn, Tl, V, Zn***

Instrument Group/Standard	*How Prepared*	*Final Concentration*	*Source/ Storage*	*Expiration*
ICP/Calibration Standard	Std 6 – 10mL Stock Cal. Std. Std 5 – 1mL Stock Cal. Std. Std 4 – 1mL Std. 6 Std 3 – 1mL Std. 5 Std 2 – 0.5mL Std. 5 Std 1 – 2mL Std. 4 All adjusted to 100 mL with 5%HNO3	Std 6 – 1/10/1000ppm Std 5 – 0.1/1/10ppm Std 4 – 0.01/0.1/1ppm Std 3 – 0.01/0.1ppm Std 2 – 0.005ppm Std 1 – 0.002ppm	Room temp.	1 month
ICP/CCV	50mL Custom Stock CCV adjusted to 1000mL with 5% HNO3	50ppm – Al, Ca, Fe, K, Mg, Na 0.5ppm – Ag 5ppm – All others	Room temp.	1 month
ICP/ICSA	100mL Custom Stock ICSA adjusted to 1000mL with 5% HNO3	500ppm – Al, Ca, Mg, Na 200ppm – Fe 10ppm – K	Room temp.	1 month
ICP/ICSAB	100mL Custom Stock ICSA, 10mL Stock ICSAB adjusted to 1000mL with 5% HNO3	500ppm – Al, Ca, Mg, Na 200ppm – Fe 10ppm – K 1ppm – B, Cd, Pb, Ag, Ni, Si, Zn, 0.5ppm – all others except Sr, Li	Room temp.	1 month
ICP/Yttrium	5mL Stock Yttrium adjusted to 10L with 5% HNO3	5 ppm	Room temp.	1 month
ICPMS/ICV	1.0mL Stock ICV adjusted to 100mL with 5% HNO3	0.05 ppm	Room temp.	1 month
ICPMS/ Calibration Standard	0.1 Stock Cal Std adjusted to 100mL with 5%HNO3. Serial Dilutions are done each calibration from 0.1ppm Std.	Cal 5 – 0.1ppm Cal 4 – 0.05ppm Cal 3 – 0.01ppm Cal 2 – 0.001ppm Cal 1 – 0.0005ppm	Room temp.	1 month
ICPMS/CCV	0.05mL Stock CCV adjusted to 100mL with 5% HNO3.	0.050 ppm	Room temp.	1 month
ICPMS/ICSA	10mL Stock ICSA adjusted to 100mL with 5% HNO3	1000ppm – Cl 200ppm – C 100ppm – Al, Ca, Fe, Mg, P, K, Na, S 2ppm – Mo, Ti	Room temp.	1 month
ICPMS/ICSAB	10mL Stock ICSA, 1mL Stock ICSAB adjusted to 100mL with 5% HNO3	1000ppm – Cl 200ppm – C 100ppm – Al, Ca, Fe, Mg, P, K, Na, S 2ppm – Mo, Ti 0.02ppm – Sb, As, Be, Ca, Cr, Co, Cu, Pb, Ni, Se, Ag, Tl, Sn, Zn	Room temp.	1 Month
Hg/ICV	30µL of 3ppm Intermediate	0.003ppm – Hg	Room temp.	1 Month

Table 8.3B: Working standard concentration, storage and preparation information.
(subject to revision as needed)

WORKING STANDARD PREPARATION
****ICP metals used – Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Sn, Sr, Ti, Tl, V, Zn (Sulfur is analyzed individually)***
****ICP/MS metals used – Ag, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, Sb, Se, Sn, Tl, V, Zn***

Instrument Group/Standard	*How Prepared*	*Final Concentration*	*Source/ Storage*	*Expiration*
Hg/Calibration Standard	Std 6 - 100µL of 3ppm Intermediate Std 5 - 50µL of 3ppm Intermediate Std 4 - 200µL of 300ppb Intermediate Std 3 - 100µL of 300ppb Intermediate Std 2 - 40µL of 300ppb Intermediate Std 1 - 20µL of 300ppb Intermediate	Std 6 – 0.01ppm Std 5 – 0.005ppm Std 4 – 0.002ppm Std 3 – 0.001ppm Std 2 – 0.0004ppm Std 1 – 0.0002ppm	Room temp.	4 days
Hg/CCV	2.5ppb CCV - 25µL of 3ppm Intermediate	0.0025ppm	Room temp.	1 Month
Hg/LCS	30µL of 3ppm Intermediate	0.003ppm – Hg	Room temp.	1 Month

8.4 INSTRUMENT CALIBRATION

Mercury Analyzer - SOP Numbers 340384A & 340384B

Calibration of the mercury analyzer is achieved using 5 standards. Acceptable calibration is achieved when the correlation coefficient $\geq$0.998. All results are calculated using software based on the peak area of the sample. A second source ICV is analyzed initially and must recover within $\pm$10% for Methods 7470A/7471A/7471B and within $\pm$5% for method 245.1. A primary source CCV is analyzed after every tenth sample and at the conclusion of the analytical sequence. The CCV must recovery within $\pm$10% for all analyses. Duplicate and spike analyses are performed on 5% of the samples analyzed using EPA Method 7470A/7471A/7471B and on 10% of the samples analyzed using EPA Method 245.1.

Inductively Coupled Plasma - SOP Numbers 340386 & 340390

The PE ICP Optima 4300DV, 5300DV and PE ELAN 6100 and DRC-e ICPMS are calibrated using at least 3 standards. A new calibration curve is analyzed daily. All calculations are performed by software using computerized linear regression. The linear regression correlation coefficient for the each analyte in the calibration curve lines must be 0.998 or better for all methods, except methods 6010C and 6020A that must be 0.998 or better. A second source ICV is run initially and a primary source CCV is run after every tenth sample. For method 200.7, the ICV must recover within 5% of the true value and for all other methods, the ICV must recover within 10%. The CCV for all methods must recover within 10% of the true value. Duplicate and spike analyses are performed on 5% of the samples for EPA Methods 6010B, 6010C, 6020, 6020A and on 10% of the samples analyzed using EPA Methods 200.7 & 200.8.

TABLE 8.4: CALIBRATION STANDARD CONCENTRATIONS
This table is subject to revision without notice

HIGH LEVEL	ICP (mg/L)	ICP/MS (mg/L)
Aluminum	0.10 - 100	----------
Antimony	0.01 - 10	0.0005 – 0.05
Arsenic	0.01 - 10	0.0005 – 0.10
Barium	0.005 - 10	0.0005 – 0.10
Beryllium	0.002 – 10	0.0005 – 0.01
Boron	0.10 – 10	----------
Cadmium	0.005 - 10	0.0005 – 0.10
Calcium	0.10 - 100	----------
Chromium	0.01 - 10	0.0005 – 0.10
Cobalt	0.01 - 10	0.0005 – 0.10
Copper	0.01 - 10	0.0005 – 0.10
Iron	0.10- 100	----------
Lead	0.005 - 10	0.0005 – 0.10
Lithium	0.005 - 10	----------
Magnesium	0.10 - 100	----------
Manganese	0.010 - 10	0.0005 – 0.10
Molybdenum	0.002 - 10	0.0005 – 0.10
Nickel	0.01 - 10	0.0005 – 0.10
Potassium	0.50 - 100	----------
Selenium	0.01 - 10	0.0005 – 0.10
Silicon	0.10 - 10	----------
Silver	0.01 – 1.0	0.0005 – 0.05
Sodium	0.50 - 100	----------
Strontium	0.002 – 10	----------
Sulfur	10 - 100	----------
Thallium	0.01 - 10	0.0005 – 0.05
Tin	0.01 - 10	0.0005 – 0.10

TABLE 8.4: CALIBRATION STANDARD CONCENTRATIONS *This table is subject to revision without notice*		
HIGH LEVEL	ICP (mg/L)	ICP/MS (mg/L)
Titanium	0.01 – 10	----------
Vanadium	0.01 - 10	0.0005 – 0.10
Zinc	0.010 - 10	0.001 – 0.10
MERCURY		
Mercury	Blank, 0.2 - 0.010 µg/L	

8.5 ACCEPTANCE/REJECTION OF CALIBRATION

The initial calibration curve is compared with previous curves for the same analyte. All new standard curves are immediately checked with a secondary source or laboratory control standard prepared from a separate source than those used for calibration. All curves are visually reviewed to ensure that acceptable correlation represents linearity. Calibration curves may be rejected for nonlinearity, abnormal sensitivity, or poor response of the laboratory control standard. Specific criteria for each instrument are outlined in Table 8.5.

Continuing calibration verification is performed on each day that initial calibration is not performed and following every tenth sample. If a check standard does not perform within established criteria then the instrument is evaluated to determine the problem. Once the problem is corrected, all samples between the last in control sample and the first out of control check are re-analyzed.

TABLE 8.5 INSTRUMENT CALIBRATION & QC

Instrument (Analysis)	Calibration Type	Number of Standards	Acceptance/ Rejection Criteria	Frequency
ICP & ICPMS	Linear/ Initial	3 - 5	6010B, 6020, 200.7 200.8: Must have a correlation coefficient of at least 0.998 6010C, 6020A: Must have a correlation coefficient of at least 0.998	Daily
ICP & ICPMS	Initial	Secondary source (ICV)	6010B, 6010C, 6020, 6020A, 200.8: ICV must be within +/-10%; 200.7: ICV must be within +/-5%	After initial calibration
ICP & ICPMS	Initial	1 Initial Calibration Blank	< ½ RL, concentrations of common laboratory contaminants shall not exceed the RL	After initial calibration
ICP, ICPMS, Mercury	Continuing	1 mid-level ref. std. (CCV)	Must be within ±10%	Every 10th sample
ICP & ICPMS	Continuing	1 Continuing Calibration Blank	< ½ RL, concentrations of common laboratory contaminants must not exceed the RL	Every 10th sample
ICP & ICPMS	Continuing	1 ICSA 1 ICSAB	Must be within ±20% for ICP, No criteria for ICPMS	After initial calibration, at end and every 8 hours of run time.
ICP, ICPMS, Mercury	Continuing	1 Method Blank	< ½ RL, concentrations of common laboratory contaminants must not exceed the RL	1 per batch
ICP, ICPMS, Mercury	Continuing	1 Laboratory Control Standard	Liquid Samples (all methods) - LCS must be within ±15%. Solid Samples (all methods) - LCS must be within the certified standard value determined by the provider.	1 per batch
ICP, ICPMS, Mercury	Continuing	1 Sample Duplicate	Sample and Duplicate must have an RPD ≤20%	1 per batch
ICP & ICPMS	Continuing	1 Matrix Spike (MS), 1 Matrix Spike Duplicate (MSD)	Spike must be within ±25%, MS and MSD must have an RPD ≤20%	1 of each per batch
Mercury	Linear/ Initial	3 - 5	Must have a correlation coefficient of at least 0.998	Daily
Mercury	Initial	Secondary source (ICV)	7470A, 7471: ICV must be within ±10% 245.1: ICV must be within ±5%	After initial calibration
Mercury	Initial	1 Initial Calibration Blank	< ½ RL	After initial calibration
Mercury	Continuing	1 Continuing Calibration Blank	< ½ RL	Every 10th sample
Mercury	Continuing	1 Matrix Spike (MS), 1 Matrix Spike Duplicate (MSD)	Spike must be within ±30%, MS and MSD must have an RPD ≤20%	1 of each per batch

9.0 LABORATORY PRACTICES

9.1 REAGENT GRADE WATER

ASTM Type I grade water.

9.2 GLASSWARE WASHING AND STERILIZATION PROCEDURES

Glassware involved in metals preparation is washed with soap and water, rinsed in 1+1 nitric acid, and rinsed in DI water. Through digestion blanks, it has been determined that chromic acid washing is unnecessary. Glassware with visible gummy deposits remaining after washing is disposed of properly. All metals glassware is given another DI water rinse immediately prior to use. Metals glassware is segregated from all other glassware.

10.0 ANALYTICAL PROCEDURES

10.1 A list of laboratory SOP's associated with the metals laboratory can be found in the following table.

TABLE 10.1: METALS DEPARTMENT SOP'S

This table is subject to revision without notice

SOP #	Title
TCLP SOP's	
340358	TCLP
340362	SPLP
340363	EP TOX
340364	MEP
340705	California Waste Extraction Test
Mercury SOP's	
340384A	Mercury in Liquid Waste (Cold-Vapor Technique) 7470A/245.1
340384B	Mercury in Solid Waste (Cold-Vapor Technique) 7471A
Metals Prep SOP's	
340389	Acid Digestion of Aqueous Samples and Extracts Method 3005A/3010A/3015/3030C
340380	Digestion of Metals and Trace Elements in DW and Wastes Method 200.2
340388	Acid Digestion of Sediments, Sludge, Soils and Oils Method 3050B/3051
340701	Metals Digestion of personal cassettes Method 7300, 3051
340702	Metals Digestion for Sediments, Soils, and Sludge NIOSH 7300, Method 3051 for ELLAP Paint chips and ELLAP soils
340703	Metals Digestion of Hi-Vol filters and Environmental Lead Wipes 3050B and 3051
340391	Silver (Photographic Waste) Method 7760 and 272.1
340392	Sodium Adsorption Ratio
Metals Analysis SOP's	
340386	Metals by ICP Method 6010, 200.7
340390	Metals by ICP-MS Method 6020, 200.8

11.0 QUALITY CONTROL CHECKS

NOTE: For specific guidance on each determinative method, including required quality control and specific state requirements/modifications, refer to the relevant laboratory standard operating procedure(s).

11.1 ESC participates in proficiency testing (PT's) in support of various laboratory accreditations/recognitions. Environmental samples are purchased from Environmental Resource Associates (ERA). The WS, WP and solid matrix studies are completed every 6 months. For industrial hygiene and environmental lead accreditation, PTs are administered by AIHA. IHPAT samples for metals analysis, including lead in air, by NIOSH 7300 is completed every quarter. Soil, wipes and paint PTs are also completed in conjunction with the AIHA Environmental Lead Laboratory Accreditation Program (ELLAP). AIHA PT samples are received and analyzed by method according to the vendor's instructions and according to ESC SOP.

11.2 Initial Demonstrations of Capability (IDOC's) are performed during new analyst training and/or prior to acceptance and use of any new method/instrumentation. Continuing Demonstration of Capability (CDOC's) must be updated at least annually. The associated data is filed within the department and available for review.

11.3 Sample Duplicates, Matrix Spike and Matrix Spike Duplicates are performed on 5–10% of samples analyzed depending on analytical method requested. For methods 6010, 6020, 7470A and 7471A duplicates, matrix spikes and matrix spike duplicates are performed on 5% of samples. For methods 200.7, 200.8 and 245.1, the same QC is performed on 10% of samples. The RPD must not exceed 20%.

11.4 A laboratory control sample (LCS) is analyzed one per batch of samples. The acceptance criteria for all water samples is ±15%. See certificate of analysis for soil true values. For Industrial Hygiene samples, the LCS is analyzed in duplicate per batch.

11.5 A method preparation blank is performed per batch of samples processed. If one-half the reporting limit [RL] is exceeded, the laboratory evaluates whether reprocessing of the samples is necessary, based on the following criteria:

- The blank contamination exceeds a concentration greater than 1/10 of the measured concentration of any sample in the associated preparation batch or
- The blank contamination is greater than 1/10 of the specified regulatory limit.

The concentrations of common laboratory contaminants must not exceed the reporting limit. Any samples associated with a blank that fail these criteria is re-processed in a subsequent preparation batch, except when the sample analysis resulted in non-detected results for the failing analytes.

12.0 DATA REDUCTION, VALIDATION, AND REPORTING

12.1 DATA REDUCTION

The analyst performs the data calculation and is responsible for the initial examination of the finished data. Data reduction steps applied to the raw data are outlined in ESC SOP #030201, *Data Handling and Reporting.* The Quality Control Department performs the secondary review of the data package using the ESC SOP #030227, *Data Review*. The QC Reviewer verifies that the analysis has performed as required and meets method criteria, all associate data is present and complete, and also ensures that any additional documentation is completed as required (i.e. Ohio VAP checklists, required flags on test reports, etc.)

12.2 VALIDATION

The validation process consists of data generation, reduction review, and reporting results. Once data reduction is complete, validation is conducted by verification that the QC samples are within acceptable QC limits and that all documentation is complete, including the analytical report and associated QC. See Table 12.1 for current QC targets and controls and current reporting limits.

12.3 REPORTING

Reporting procedures are documented in SOP #030201, *Data Handling and Reporting.*

Table 12.3A: QC Targets for Environmental Metals Accuracy (LCS), Precision and RL's
(subject to revision without notice)

Class	Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range (%)	Precision (RPD)	RL (ppb)
(ICP-AES)	Aluminum	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	5000
(ICP-AES)	Aluminum	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	5000
(ICP-AES)	Aluminum	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	100
(ICP-AES)	Aluminum	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	100
(ICP-MS)	Antimony	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	50
(ICP-AES)	Antimony	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-AES)	Antimony	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-MS)	Antimony	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	1
(ICP-MS)	Antimony	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	1
(ICP-AES)	Antimony	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	20
(ICP-AES)	Antimony	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	20

Table 12.3A: QC Targets for Environmental Metals Accuracy (LCS), Precision and RL's

(subject to revision without notice)

Class	Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range (%)	Precision (RPD)	RL (ppb)
(ICP-MS)	Arsenic	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	50
(ICP-AES)	Arsenic	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-AES)	Arsenic	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-AES)	Arsenic	1311, 1312	6010B/C	Leachate	85 - 115	<20	50
(ICP-MS)	Arsenic	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	1
(ICP-MS)	Arsenic	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	1
(ICP-AES)	Arsenic	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	20
(ICP-AES)	Arsenic	NPDES	200.7	Liquid/Aqueous	85 - 115	<20	20
(ICP-MS)	Barium	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	100
(ICP-AES)	Barium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	250
(ICP-AES)	Barium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	250
(ICP-AES)	Barium	1311-12	6010B/C	Leachate	85 - 115	<20	50
(ICP-AES)	Barium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	5
(ICP-MS)	Barium	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	2
(ICP-MS)	Barium	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	2
(ICP-AES)	Barium	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	5
(ICP-MS)	Beryllium	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	50
(ICP-MS)	Beryllium	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	1
(ICP-MS)	Beryllium	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	1
(ICP-AES)	Beryllium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	100
(ICP-AES)	Beryllium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	100
(ICP-AES)	Beryllium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	2
(ICP-AES)	Beryllium	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	2
(ICP-AES)	Boron	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	10000
(ICP-AES)	Boron	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	10000
(ICP-AES)	Boron	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	200
(ICP-AES	Boron	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	200
(ICP-MS)	Cadmium	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	25
(ICP-AES)	Cadmium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	250
(ICP-AES)	Cadmium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	250
(ICP-AES)	Cadmium	1311-1312	6010B/C	Leachate	85 - 115	<20	50

Table 12.3A: QC Targets for Environmental Metals Accuracy (LCS), Precision and RL's

(subject to revision without notice)

Class	Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range (%)	Precision (RPD)	RL (ppb)
(ICP-MS)	Cadmium	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	0.5
(ICP-MS)	Cadmium	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	0.5
(ICP-AES)	Cadmium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	5
(ICP-AES)	Cadmium	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	5
(ICP-AES)	Calcium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	25000
(ICP-AES)	Calcium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	25000
(ICP-AES)	Calcium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	500
(ICP-AES)	Calcium	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	500
(ICP-MS)	Chromium	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	50
(ICP-AES)	Chromium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-AES)	Chromium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-AES)	Chromium	1311-12	6010B/C	Leachate	85 - 115	<20	50
(ICP-MS)	Chromium	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	1
(ICP-MS)	Chromium	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	1
(ICP-AES)	Chromium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	10
(ICP-AES)	Chromium	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	10
(ICP-MS)	Cobalt	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	50
(ICP-AES)	Cobalt	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-AES)	Cobalt	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-MS)	Cobalt	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	1
(ICP-MS)	Cobalt	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	1
(ICP-AES)	Cobalt	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	10
(ICP-AES)	Cobalt	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	10
(ICP-MS)	Copper	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	50
(ICP-AES)	Copper	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-AES)	Copper	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-AES)	Copper	1311-12	6010B/C	Leachate	85 - 115	<20	50
(ICP-MS)	Copper	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	1
(ICP-MS)	Copper	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	1
(ICP-AES)	Copper	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	20

Table 12.3A: QC Targets for Environmental Metals Accuracy (LCS), Precision and RL's

(subject to revision without notice)

Class	Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range (%)	Precision (RPD)	RL (ppb)
(ICP-AES)	Copper	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	20
(ICP-AES)	Iron	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	5000
(ICP-AES)	Iron	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	5000
(ICP-AES)	Iron	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	100
(ICP-AES)	Iron	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	100
(ICP-MS)	Lead	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	50
(ICP-AES)	Lead	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	250
(ICP-AES)	Lead	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	250
(ICP-AES)	Lead	1311-12	6010B/C	Leachate	85 - 115	<20	50
(ICP-MS)	Lead	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	1
(ICP-MS)	Lead	200.2 (mod.)	200.8	Liquid/Aqueous	85 - 115	<20	1
(ICP-AES)	Lead	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	5
(ICP-AES)	Lead	NPDES	200.7	Liquid/Aqueous	85 - 115	<20	5
(ICP-AES)	Lithium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	750
(ICP-AES)	Lithium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	750
(ICP-AES)	Lithium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	15
(ICP-AES)	Lithium	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	15
(ICP-AES)	Magnesium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	5000
(ICP-AES)	Magnesium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	5000
(ICP-AES)	Magnesium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	100
(ICP-AES)	Magnesium	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	100
(ICP-MS)	Manganese	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	100
(ICP-AES)	Manganese	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-AES)	Manganese	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-MS)	Manganese	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	2
(ICP-MS)	Manganese	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	2
(ICP-AES)	Manganese	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	10
(ICP-AES)	Manganese	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	10
(CVAA)	Mercury	7471 (mod.)	7471	Solid	Certified Standard Values	<20	20
(CVAA)	Mercury	1311-12	7470A	Leachate	85 - 115	<20	1
(CVAA)	Mercury	245.1 (mod.)/7470A	245.1/7470A	Liquid/Aqueous	85 - 115	<20	0.2

Table 12.3A: QC Targets for Environmental Metals Accuracy (LCS), Precision and RL's

(subject to revision without notice)

Class	Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range (%)	Precision (RPD)	RL (ppb)
(ICP-MS)	Molybdenum	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	100
(ICP-AES)	Molybdenum	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	250
(ICP-AES)	Molybdenum	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	250
(ICP-MS)	Molybdenum	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	2
(ICP-MS)	Molybdenum	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	2
(ICP-AES)	Molybdenum	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	5
(ICP-AES)	Molybdenum	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	5
(ICP-MS)	Nickel	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	50
(ICP-AES)	Nickel	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-AES)	Nickel	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-AES)	Nickel	1311-12	6010B/C	Leachate	85 - 115	<20	50
(ICP-AES)	Nickel	3015/3010 (mod)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	1
(ICP-MS)	Nickel	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	1
(ICP-AES)	Nickel	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	20
(ICP-AES)	Nickel	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	20
(ICP-AES)	Potassium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	25000
(ICP-AES)	Potassium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	25000
(ICP-AES)	Potassium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	500
(ICP-AES)	Potassium	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	500
(ICP-MS)	Selenium	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	50
(ICP-AES)	Selenium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-AES)	Selenium	3051 (mod.),	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-AES)	Selenium	1311-12	6010B/C	Leachate	85 - 115	<20	50
(ICP-MS)	Selenium	3015/3010 (mod.)	6020/A	Liquid/Aqueous	85 - 115	<20	1
(ICP-MS)	Selenium	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	1
(ICP-AES)	Selenium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	20
(ICP-AES)	Selenium	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	20
(ICP-AES)	Silicon	3050B (mod.)	6010B/C	Solid	85-115	<20	10000
(ICP-AES)	Silicon	3051 (mod.)	6010B/C	Solid	85-115	<20	10000
(ICP-AES)	Silicon	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	200
(ICP-AES)	Silicon	200.2 (mod.) NPDES	200.7	Liquid/Aqueous	85 - 115	<20	200

Table 12.3A: QC Targets for Environmental Metals Accuracy (LCS), Precision and RL's

(subject to revision without notice)

Class	Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range (%)	Precision (RPD)	RL (ppb)
(ICP-MS)	Silver	3050B (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	25
(ICP-AES)	Silver	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-AES)	Silver	1311-12	6010B/C	Leachate	85 - 115	<20	50
(ICP-MS)	Silver	3015/3010 (mod.)	6020/A	Liquid/Aqueous	85 - 115	<20	0.5
(ICP-MS)	Silver	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	0.5
(ICP-AES)	Silver	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	10
(ICP-AES)	Silver	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	10
(ICP-AES)	Sodium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	25000
(ICP-AES)	Sodium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	25000
(ICP-AES)	Sodium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	500
(ICP-AES)	Sodium	200.2 (mod.) NPDES	200.7	Liquid/Aqueous	85 - 115	<20	500
(ICP-AES)	Strontium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-AES)	Strontium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-AES)	Strontium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	10
(ICP-AES)	Strontium	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	10
(ICP-AES)	Sulfur	3050B (mod.)	6010B/C	Solid	85-115	<20	50000
(ICP-AES)	Sulfur	3051 (mod.)	6010B/C	Solid	85-115	<20	50000
(ICP-AES)	Sulfur	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	1000
(ICP-AES)	Sulfur	200.2 (mod.) NPDES	200.7	Liquid/Aqueous	85 - 115	<20	1000
(ICP-MS)	Thallium	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	50
(ICP-AES)	Thallium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-AES)	Thallium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-AES)	Thallium	3015/3010 (mod.)	6020/A	Liquid/Aqueous	85 - 115	<20	1
(ICP-MS)	Thallium	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	1
(ICP-AES)	Thallium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	20
(ICP-AES)	Thallium	NPDES	200.7	Liquid/Aqueous	85 - 115	<20	20
(ICP-MS)	Tin	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	50
(ICP-AES)	Tin	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-AES)	Tin	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	1000
(ICP-MS)	Tin	3015/3010 (mod.)	6020/A	Liquid/Aqueous	85 - 115	<20	1
(ICP-MS)	Tin	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	1

Table 12.3A: QC Targets for Environmental Metals Accuracy (LCS), Precision and RL's

(subject to revision without notice)

Class	Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range (%)	Precision (RPD)	RL (ppb)
(ICP-AES)	Tin	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	20
(ICP-AES)	Tin	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	20
(ICP-AES)	Titanium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-AES)	Titanium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-AES)	Titanium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	10
(ICP-AES)	Titanium	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	10
(ICP-MS)	Vanadium	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	100
(ICP-AES)	Vanadium	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-AES)	Vanadium	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	500
(ICP-MS)	Vanadium	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	2
(ICP-MS)	Vanadium	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	2
(ICP-AES)	Vanadium	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	10
(ICP-AES)	Vanadium	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	10
(ICP-MS)	Zinc	3051 (mod.)	6020/A (mod.)	Solid	Certified Standard Values	<20	500
(ICP-AES)	Zinc	3050B (mod.)	6010B/C	Solid	Certified Standard Values	<20	1500
(ICP-AES)	Zinc	3051 (mod.)	6010B/C	Solid	Certified Standard Values	<20	1500
(ICP-AES)	Zinc	1311-12	6010B/C	Leachate	85 - 115	<20	50
(ICP-MS)	Zinc	3015/3010 (mod.)	6020/A (mod.)	Liquid/Aqueous	85 - 115	<20	10
(ICP-MS)	Zinc	200.2 (mod.), NPDES	200.8	Liquid/Aqueous	85 - 115	<20	10
(ICP-AES)	Zinc	3015/3010 (mod.)	6010B/C	Liquid/Aqueous	85 - 115	<20	30
(ICP-AES)	Zinc	200.2 (mod.), NPDES	200.7	Liquid/Aqueous	85 - 115	<20	30

Table 12.3B: QC Targets for IH Metals Accuracy (LCS), Precision and RL's

(subject to revision without notice)

Class	Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range (%)	Precision (% RPD)	RL
(ICP-AES)	Lead	3050B (mod.)	6010B/C	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Lead	3050B (mod.)	6010B/C	Paint Chips	80-120	<20	50. mg/kg
(ICP-AES)	Lead	3050B (mod.)	6010B/C	Wipes	80-120	<20	2.0 ug/sample

13.0 CORRECTIVE ACTIONS

13.1 In the event that a nonconformance occurs in conjunction with the analytical batch, a corrective action response (CAR) form must be completed. The reason for the nonconformance is stated on the form and the measures taken to correct the nonconformance clearly defined. The effectiveness of the corrective action must be assessed and noted. The CAR is kept on file by the QA department. Corrective action procedures are documented in SOP #030208, *Corrective and Preventive Action*

13.2 Required Corrective Action

Control limits have been established for each type of analysis. When these control limits are exceeded, corrective action must be taken. Calculated sample spike control limits are also used.

All samples and procedures are governed by ESC's quality assurance program. General corrective actions are as follows; however additional and more specific direction is provided in the specific determinative procedure. For more information, see the appropriate determinative SOP

13.2.1 Laboratory QC Criteria and Appropriate Corrective Actions

If the analytical method contains acceptance/rejection criteria and it is more stringent than those controls generated by the laboratory the method criteria takes precedence.

13.2.2 Calibration Verification Criteria Are Not Met: Inorganic Analysis

Rejection Criteria - See Table 8.5.

Corrective Action - If a standard curve linearity is not acceptable and/or the absorbance for specific standard(s) is not analogous to historic data, the instrument settings, nebulizer, etc. are examined to ensure that nothing has been altered, clogged, etc. The working standards are made fresh, intermediate dilutions are re-checked and the instrument is re-calibrated. If a problem persists, the Department Manager or QA department is notified for further action.

If the initial reference check sample is out of control, the instrument is re-calibrated and the check sample is rerun. If the problem continues the check sample is re-prepared. If the problem still exists then the standards and reagent blank are re-prepared. If the problem persists, the Department Manager or QA department is notified for further action.

13.2.3 Out Of Control Blanks: Applies to Method, Trip, Rinsate & Instrument Blanks

Rejection Criteria - Blank reading is more than ½ the RL for Method Blanks and/or Instrument Blanks.

Corrective Action - Standard curves and samples are evaluated for any obvious contamination that may be isolated or uniform throughout the sequence. If necessary, reagents, QC samples and field samples are re-prepared and re-analyzed. Re-analyses are not initiated until the cause of the contamination is identified and resolved. If samples have already been partially prepared or analyzed, the group leader or QA department is consulted to determine if data needs to be rejected or if samples need to be reprepped.

13.2.4 Out Of Control Laboratory Control Standards (LCS)

Rejection Criteria - If the performance is outside of lab-generated control (Listed in Table 12.3).

Corrective Action - Instrument settings are checked. The LCS standard is re-analyzed. If the LCS is still out of control, re-calibration is performed, and samples affected since the last in control reference standard are re-analyzed. If the LCS fails again after re-calibration, the entire workgroup must be re-prepped. The group leader, Department Manager, or QA department is consulted for further action.

13.2.5 Out Of Control Matrix Spike Samples

Rejection Criteria - If spike recovery is outside of lab-generated control limits determined from accuracy charts on matrix spike samples from a similar matrix (i.e., water, solid, etc).

Corrective Action - Spiking technique is assessed to ascertain if the sample has been spiked correctly. The spiked sample should be 1 – 5 times the client sample concentration; otherwise, the percent recovery (%R) or relative percent difference (%RPD) of the MS/MSD is flagged as not meaningful or usable per the EPA method. The sample is re-analyzed. If an out of control situation persists, sample matrix interference is suspected and flagged.

13.2.6 Out Of Control Duplicate Samples

Rejection Criteria - Lab-generated maximum RPD limit (as listed under precision in Table 12.3)

Corrective Action - Instrument and samples checked to see if precision variance is likely (i.e., high suspended solids content, high viscosity, etc.). The duplicates are re-analyzed along with the parent sample. If problem persists, matrix interference is suspected and flagged

13.2.7 Out Of Control Matrix Spike Duplicates

These QC samples can be out of control for either accuracy, precision, or both. The appropriate corrective actions listed for either matrix spikes, duplicate samples, or both are followed.

NOTE: Some samples cannot be duplicated. This is the case for wipe samples, filters, and some water samples. When possible, sampling personnel should collect duplicate samples.

Analysis-specific corrective action lists are available for each type of analysis performed by ESC.

13.2.8 Out Of Control Calibration Standards: ICV, CCV, SSCV

Rejection Criteria - If the performance is outside of method requirements.

Corrective Action - Instrument settings are checked, calibration verification standard is rerun. If the standard is still out of control, re-calibration is performed, and samples affected since the last in control reference standard are rerun. The group leader, Department Manager, or QA department is consulted for further action.

13.3 Responsibility - It is the Department Manager's responsibility to evaluate the validity of the corrective action response and submit it to QA department for processing. In addition, the manager is responsible for appointing the appropriate person within the department to be responsible for correcting the nonconformance. When a corrective action warrants a cessation of analysis, the following personnel are responsible for executing the "stop work" order:

- Laboratory Manager
- QA Department
- Department Manager
- Technical Service Representative

14.0 RECORD KEEPING

Record keeping is outlined in SOP #010103, *Document Control and Distribution*, SOP #030203, *Reagent Logs and Records* and SOP #030201, *Data Handling and Reporting*

15.0 QUALITY AUDITS

System and data quality audits are outlined in the ESC Quality Assurance Manual Version 8.0

1.0 SIGNATORY APPROVALS

VOLATILES QUALITY ASSURANCE MANUAL

APPENDIX VI TO THE ESC QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

NOTE: The QAM has been approved by the following people. A signed cover page is available upon request

Judith R. Morgan, M.S., VP of Technical and Regulatory Affairs 615-773-9657

Eric Johnson, B.S., Laboratory Director 615-773-9654

Dixie Marlin, B.S, QC Manager, 615-773-9681

Kenny Buckley, B.S., Organics/Wet Chemistry Department Manager, 615-773-9686

2.0 APPENDIX TABLE OF CONTENTS

3.0 SCOPE AND APPLICATION

This appendix discusses specific QA requirements for general analytical protocols to ensure analytical data generated from the Volatiles (VOC) laboratory are scientifically valid and are of acceptable quality. Any deviations from these requirements and any deviations that result in non-conforming work must be immediately evaluated and their corrective actions documented.

4.0 LABORATORY ORGANIZATION AND RESPONSIBILITIES

ESC Lab Sciences offers diverse environmental capabilities that enable the laboratory to provide the client with both routine and specialized services, field sampling and broad laboratory expertise. A brief outline of the organization and responsibilities as they apply to the ESC Quality Assurance Program is presented in *Section 4.0 in the ESC Quality Assurance Manual Version 8.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Kenneth W. Buckley, with a B.S. degree in General Science, is the Department Manager of Organics and Wet Chemistry laboratories. Mr. Buckley reviews and approves all data reduction associated with analyses in these areas and is responsible for the overall production of these laboratories; including the management of the staff and scheduling. Mr. Buckley has over 9 years of environmental laboratory experience. In his absence, J. D. Gentry, with a B.S. degree in Chemistry and over 9 years of environmental laboratory experience, assumes responsibility for Volatiles Department decisions.

5.2 TRAINING

5.2.1 All new analysts to the laboratory are trained by a primary analyst or Manager according to ESC protocol. Performance is documented using an initial demonstration of capability (IDOCs) and continuing demonstration of capability (CDOC). On-going acceptable capability in VOC analyses is demonstrated by acceptable participation in multiple proficiency testing programs (PTs) and daily Quality Control sample analyses. Documentation of analyst training is maintained on file within the department.

6.0 FACILITIES AND LABORATORY SAFETY

6.1 FACILITIES

The main area of the instrumentation laboratory in Building #2 has approximately 7000 square feet with 700 square feet of bench area and 300 square feet of preparatory area. The lighting standard is fluorescence. The air handling systems are (1) 60-ton units with gas heating and (1) 25-ton unit. The physical and air-handling separations, between this laboratory and other ESC sections, prevent potential cross-contamination between solvent vapor generation and incompatible analytical processes. The laboratory reagent water is created by reverse osmosis/DI filtration and evaluated to 0.055uS/cm to ensure purity. Waste disposal containers are located in the laboratory and Clean Harbors serves as ESC's waste disposal carrier. Waste handling is discussed in detail in Section 6.0 of the ESC Quality Assurance Manual. ESC's building information guides and site plan are shown in Appendix I.

6.2 LABORATORY SAFETY

- Laboratory access is limited when work is being performed.
- All procedures where chemicals are prepared or splashes may occur are conducted in laboratory exhaust hoods.
- ESC's laboratory safety guidelines are detailed in the *ESC Chemical Hygiene and Safety Plan.*

7.0 SAMPLING PROCEDURES

7.1 FIELD SAMPLING PROCEDURES, SAMPLE STORAGE, AND HANDLING

- Field Sampling procedure is described in Appendix III of this ESC Quality Assurance Manual. Sample information is recorded and kept on the ESC chain of custody and field logbooks.
- Matrices for VOC environmental analyses include groundwater, wastewater, drinking water, soil, and sludge.
- Sample containers, preservation methods and holding times vary depending on analyses requested. Please see determinative procedures for specific directions.
- Plastic containers or lids may NOT be used for the storage of samples due to sample contamination from the phthalate esters and other hydrocarbons in the plastic.
- Environmental sample containers should be filled carefully to prevent any portion of the sample from coming into contact with the sampler's gloves causing possible contamination.
- Containers for VOC samples should be selected carefully to minimize headspace that could lead to a low bias in the analytical results. Headspace is monitored during sample login and is documented on the Sample Receipt Corrective Action form when observed.

8.0 EQUIPMENT

8.1 EQUIPMENT LIST

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Volatiles Analysis
This table is subject to revision without notice

Item	*Manufacturer*	*Model*	*Instrument Name*	*#*	*Serial #*	*Location*
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	1	3333A31215	Volatiles
Gas Chromatograph	Agilent	6890	VOCGC	2	cn10609095	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	3	2950A26786	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	4	3336A50614	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	5	3027A29678	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	6	2950A27895	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	7	3313A37610	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	8	3033A31856	Volatiles
Gas Chromatograph	Hewlett Packard	5890 Series II	VOCGC	13	2921A23548	Volatiles
Gas Chromatograph	Agilent	6890	VOCGC	10	US00022519	Volatiles
Gas Chromatograph	Agilent	6890	VOCGC	12	US00000410	Volatiles
Gas Chromatograph	Agilent	6890	VOCGC	14	CN10408054	Volatiles
Gas Chromatograph/ Mass Spectrometer	Hewlett Packard	5890 GC/ 5972 MSD	VOCMS	1	GC336A50093 MS3329A00703	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5975 MSD	VOCMS	2	GCCN10641044 MSUS63234371	Volatiles
Gas Chromatograph/ Mass Spectrometer	Hewlett Packard	5890 GC/ 5972 MSD	VOCMS	3	GC3310A48625 MS3435A01982	Volatiles
Gas Chromatograph/ Mass Spectrometer	Hewlett Packard	5890 GC/ 5972 MSD	VOCMS	5	GC3310A48625 MS3341A01200	Volatiles
Gas Chromatograph/ Mass Spectrometer	Hewlett Packard	6890 GC/ 5973 MSD	VOCMS	6	CN10343037 US44647141	Volatiles
Gas Chromatograph/ Mass Spectrometer	Hewlett Packard	5890 GC/ 5972 MSD	VOCMS	9	GC3308A46997 MS3609A03629	Volatiles
Gas Chromatograph/ Mass Spectrometer	Hewlett Packard	5890 GC/ 5972 MSD	VOCMS	10	GC2921A22675 MS3329A00524	Volatiles
Gas Chromatograph/ Mass Spectrometer	Hewlett Packard	5890 GC/ 5972 MSD	VOCMS	12	GC3336A51994 MS3549A03312	Volatiles
Gas Chromatograph/ Mass Spectrometer	Hewlett Packard	5890 GC/ 5971 MSD	VOCMS	11	GC3336A61599 MS3306A04478	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	4	GCUS00003465 MSUS82311257	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	7	GCUS00040221 MS05040022	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	8	GCUS00040221 MS03940725	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	13	GCCN103390006 MSUS91911078	Volatiles

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Volatiles Analysis
This table is subject to revision without notice

Item	*Manufacturer*	*Model*	*Instrument Name*	*#*	*Serial #*	*Location*
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	14	GCUS00009794 MSUS63810153	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	16	GCUS00006479 MSUS82321899	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	17	GCUS10232130 MSUS03940744	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	18	GC CN10517046 MSUS03340424	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	19	GCCN10611062 MSUS60542638	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5975MSD	VOCMS	20	GCCN621S4367 MSUS469A4832	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5975MSD	VOCMS	21	GCCN621S4368 MSUS469A4833	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	22	GCCN10728074 MSUS71236615	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5975MSD	VOCMS	23	GCCN10728068 MS71236616	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	24	GCCN10151020 MSUS10223406	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	25	GCCN99205324 MSUS98003634	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	26	GCCN10301152 MSUS10313616	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	7890 GC/ 5975MSD	VOCMS	27	GCCN10301155 MSUS10313619	Volatiles
Centurion Autosampler	(8) PTS/EST	Centurion				Volatiles
Autosampler	(27) Varian	Archon				Volatiles
Purge and Trap	(16) OI Analytical	Eclipse				Volatiles
Purge and Trap	(14) PTS/EST	Encon				Volatiles

8.2 EQUIPMENT PREVENTIVE MAINTENANCE, EQUIPMENT CALIBRATION

INSTRUMENT	P. M. DESCRIPTION	FREQUENCY
Analytical Balances	•Check with Class "I" weights	Daily; tolerance ±0.1%
Analytical Balances	•Service/Calibration (semiannual contract maintenance and calibration check)	Semiannually
Refrigerators & Incubators	•Maintenance service	As needed - determined by daily temperature performance checks
Gas Chromatograph Detectors: FID	Change Quartz jet; clean; replace flame tip	As needed - when deterioration is noticeable
Gas Chromatograph Detectors: PID	Change or clean lamp	As needed - when deterioration is noticeable
Gas Chromatograph/Mass Spectrometer	•Autotune Report	Inspected daily

8.2 EQUIPMENT PREVENTIVE MAINTENANCE, EQUIPMENT CALIBRATION		
INSTRUMENT	P. M. DESCRIPTION	FREQUENCY
Gas Chromatograph/Mass Spectrometer	•Clean ion source	As needed to maintain high mass resolution
Gas Chromatograph/Mass Spectrometer & Gas Chromatographs	•Replace septum and liner	As needed to maintain injection port inert
Gas Chromatograph/Mass Spectrometer	•Replace vacuum pump oil	Every 6 months
Gas Chromatograph/Mass Spectrometer & Gas Chromatographs	•Replace column	When separation begins to degrade
Archon/ Centurion Autosampler	•Monitor the Daily QC, including internal standards for changes or failure.	Daily with use

8.3 STANDARDS AND REAGENTS

Table 8.3A: Standard stock sources, description and calibration information.
This table is subject to revision without notice

Method	Vendor*	Description	Calibration	Storage Req.	Expiration
8260	NSI	Gases Mix	Primary	-10°C to –20°C	1 week
	NSI	Custom VOC Mix1	Primary	-10°C to –20°C	6 months
	NSI	Mix 2	Primary	4° ± 2°C	6 months
	Absolute Stds	n-Hexane	Primary	-10°C to –20°C	6 months
	Restek	TX TPH Mix (GRO)	Primary	4° ± 2°C	6 months
	Ultra	CUS-5661	Primary	-10°C to –20°C	6 months
	NSI	Custom Std	Primary	4° ± 2°C	6 months
	Absolute Std	Acrolein	Primary	4° ± 2°C	3 months
	NSI	2-CEVE	Secondary	4° ± 2°C	6 months
	Restek	Vinyl Acetate	Secondary	-10°C to –20°C	6 months
	Restek	Custom LCS Additions	Secondary	-10°C to –20°C	6 months
	Restek	Custome Voa LCS Mix 1	Secondary	-10°C to –20°C	6 months
	Absolute Stds	n-Hexane	Secondary	-10°C to –20°C	6 months
	Restek	Acrolein	Secondary	4° ± 2°C	3 months
8015 (GRO)	Restek	Certified BTEX in Unleaded Gas Composite Standard	Primary	4° ± 2°C	6 months
	NSI	Gas Composite	Secondary	4° ± 2°C	6 months
8021	Restek	WISC PVOC/GRO Mix	Primary	-10°C to –20°C	6 months
	NSI	PVOC/GRO Mix	Secondary	4° ± 2°C	6 months
VPH	NSI	VPH ICV MIX	Primary	4° ± 2°C	6 months
	NSI	VPH LSC MIX	Secondary	4° ± 2°C	6 months

Equivalent Providers may be utilized.

TABLE 8.3B: Working Standard Concentrations
This table is subject to revision without notice

ORGANIC COMPOUNDS	Method #	GC/MS	GC
VOC's by GC/MS	524.2, 624, SM6200B 20th, 8260B	GW/WW 0.5, 1, 2, 5, 10, 25, 40, 50, 100 µg/L DW 0.5, 1, 2, 5, 10, 25, 50, 100, 150 µg/L GRO 0.4, 1, 2, 4, 5, 7, 10, 20ug/mL	
BTEX/GRO, 8015MOD, WI GRO, LA TPH G, OHIO GRO, WI PVOC	BTEX 8021 GRO 8015 or state specific		BTEX 0.5, 1, 5,10, 25,50,100,150,200, 250ug/L (m,p-Xylene is doubled) GRO 0.055, 0.11, 0.55, 1.1. 2.75, 5.5, 11

TABLE 8.3B: Working Standard Concentrations
This table is subject to revision without notice

ORGANIC COMPOUNDS	Method #	GC/MS	GC
			mg/L
MADEP VPH	MADEP VPH		Aromatic C9-C10: 0.001, 0.002, 0.01, 0.02, 0.05, 0.1, 0.2, 0.4, 1.0, 2.0 mg/L Aliphatic C5-C8: 0.006, 0.012, 0.06, 0.12, 0.3, 0.6, 1.2, 2.4, 6.0, 12.0 mg/L Aliphatic C9-C12: 0.007, 0.014, 0.07, 0.14, 0.36, 0.7, 1.4, 2.8, 7.0, 14.0 mg/L
BTEX/OA1	BTEX OA1		BTEX 0.5, 1, 5,10, 25,50,100,150,200, 250ug/L (m,p-Xylene is doubled) GRO 0.055, 0.11, 0.55, 1.1. 2.75, 5.5, 11 mg/L

8.4 INSTRUMENT CALIBRATION

602 - BTEX - SOP Number 330351

The gas chromatograph is calibrated using the internal standard procedure. A standard curve is prepared using a minimum of three concentration levels for each compound of interest. The calibration standards are tabulated according to peak height or area responses against concentration for each compound and response factors are calculated. If the response factors are <10 % RSD over the working range, the average RF can be used for calculations. Alternatively, when the response factor criteria is exceeded, the analyst may utilize a linear calibration model of response ratios (i.e. Area/Ref. Area or Amt./Ref Amt.) for quantitation providing that the correlation coefficient is at least 0.990 (0.995 for USACE DOD Projects). An independent, or second source, calibration verification standard (SSCV) is analyzed after each initial calibration and should recover within ±20% of the expected concentration for each analyte.

During the analytical sequence, the stability of the initial calibration is verified, following every 10th sample and at the end of the sequence, by the analysis of continuing calibration verification (CCV) standards. The CCV must recovery within 15% of the expected concentration for each analyte.

At daily instrument startup and in lieu of performing an entire initial calibration, the working calibration curve or response factors are verified on each working day by the analysis of a Quality Control Check Standard. The responses must meet the criteria found in Table 2 of the 602 Method. If the responses do not meet these criteria, the analysis must be repeated. If the standard still does not meet the criteria, a new calibration curve is prepared.

8021B - BTEX - SOP Number 330351

The gas chromatograph is calibrated using the internal standard procedure. A standard curve is prepared using a minimum of five concentration levels for each compound of interest.

The calibration standards are tabulated according to peak height or area responses against concentration for each compound and response factors are calculated. If the response factors are <20 % RSD over the working range, the average RF can be used for calculations. Alternatively, the results can be used to plot a calibration curve of response ratios (Area/Ref. Area) vs (Amt./Ref Amt). If the response factors of the initial calibration are <20 % RSD over the calibration range, the average RF can be used for calculations. Alternatively, when the response factor criteria is exceeded, the analyst may utilize a linear calibration model of response ratios (i.e. Area/Ref. Area or Amt./Ref Amt.) for quantitation providing that the correlation coefficient is at least 0.990 (0.995 for USACE DOD Projects). An independent, or second source, calibration verification standard (SSCV) is analyzed after each initial calibration and should recover within ±20% of the expected concentration for each analyte.

At daily instrument startup and in lieu of performing an entire initial calibration, the most recent calibration curve may be verified by the analysis of check calibration verification standard (CCV). If the response for any analyte in this check varies from the predicted response by more than ±15%, the analysis must be repeated using fresh standard. If the standard still does not meet the acceptance criteria, a new initial calibration curve must be generated.

8015B/C/D & State Methods - Gasoline Range Organics - SOP Number 330351

Certain state accreditation/registration programs may have specific requirements for calibration and analysis that must be met. Those requirements supersede the general guidance provided in this section and are addressed in the determinative SOP. 8015GRO analysis, the gas chromatograph is calibrated using the internal standard procedure. A standard curve is prepared using a minimum of five concentration levels for each analyte of interest. The calibration range must represent the typical environmental sample concentration and include the RL as the lowest calibration point. The linear range of the instrument must also be monitored to ensure that the maximum calibration point is within detection range. The calibration standards are tabulated according to peak height or area responses against concentration for each compound and response factors are calculated. If the response factors of the initial calibration are <20 % RSD over the calibration range, the average RF can be used for calculations. Alternatively, when the response factor criteria is exceeded, the analyst may utilize a linear calibration model of response ratios (i.e. Area/Ref. Area or Amt./Ref Amt.) for quantitation providing that the correlation coefficient is at least 0.990 (0.995 for USACE DOD Projects). An independent, or second source, calibration verification standard (SSCV) is analyzed after each initial calibration and should meet criteria of ±20% of the expected concentration for each analyte.

The working calibration curve or response factors are verified on each working day by the analysis of one or more calibration standards. If the response of any analyte varies from the predicted response by more than 15% RSD, the analysis must be repeated using a new calibration standard. If the standard still does not meet the criteria, a new calibration curve is prepared.

8260B/C, 624, SM6200B, 524.2 - Gas Chromatography/Mass Spectrometry (GC/MS): Volatile Organics - SOP Numbers 330363 & 330364

Detector mass calibration is performed daily using the autotune function of the GC/MS analytical system and PFTBA (Perfluorotributylamine). Following verification of the appropriate masses, the instrument sensitivity is verified by injecting a tuning solution containing Bromofluorobenzene (BFB). The BFB spectra must meet the following ion abundance criteria:

Mass	Ion Abundance Criteria
50	15 to 40% of mass 95
75	30 to 60% of mass 95
95	base peak, 100% relative abundance
96	5 to 9% of mass 95
173	0% to less than 2% of mass 174
174	greater than 50% of mass 95
175	5 to 9% of mass 174
176	greater than 95% but less than 101% of mass 174
177	5 to 9% of mass 176

Successful tuning must occur every 12 hours for method 524.2, 8260B/C & SM6200B and every 24 hours for method 624.

Following successful tuning, the GC/MS is calibrated using the internal standard procedure. A standard curve is prepared using a minimum of three standards for method 624, 524.2 and five standards for method 8260B and SM6200B. The calibration standards are tabulated according to peak height or area against concentration and the concentrations and responses of the internal standard analytes. The results are used to determine a response factor for each analyte in each standard injected. A calibration curve is constructed and is determined to be acceptable if each target analyte is found to be constant over the working range as defined as:

≤15% RSD for methods 8260B/C and SM6200B,
≤20% RSD for method 524.2, and
≤35% RSD for method 624.

The calibration checks compounds (CCCs) for method 8260 must be ≤30% RSD. When these conditions are met, linearity through the origin can be assumed and the average RF can be used in place of a calibration curve. Per the analytical method, specific target analytes are defined as calibration check compounds (CCCs) or system performance check compounds (SPCCs).

Linear regression can be used for any target compound exceeding the 15% RSD criteria but less than 40% (poor performers <50%), if the correlation coefficient is 0.990 or better. For USACE projects the correlation coefficient must meet 0.995 or better. The same is true for the CCC's as long as the RSD does not exceed 30%. A second source calibration verification standard is analyzed after each calibration and should meet the criteria of ± 20%. For 524.2 the second source calibration verification standard must be within ± 30%.

SPCCs:	
Analyte	**Minimum Average Response Factor**
Chloromethane	0.10
1,1-Dichloroethane	0.10
Bromoform	0.10
Chlorobenzene	0.30
1,1,2,2-Tetrachloroethane	0.30

CCCs:	
1,1-Dicholoethene	Toluene
Chloroform	Ethylbenzene
1,2-Dichloropropane	Vinyl Chloride

The initial calibration range must represent the typical environmental sample and include the RL as the lowest calibration point. The linear range of the instrument must be monitored to ensure that the maximum calibration point is within the range. A second source calibration verification standard is analyzed after each calibration. The second source should recover within 20% for all CCC compounds and within 40% for other analytes of interest, with the exception of analytes known to perform poorly (i.e. low purging efficiency, etc.) that will meet historical limits. Following successful calibration, the analysis of field and QC samples may begin. Analysis may be performed only during the timeframe of a valid tuning cycle (12 hours for 8260B, 524.2 & SM6200B and 24 hours for 624). Following the expiration of the tuning clock, the instrument must be retuned and either recalibrated or existing calibration may be re-verified.

For 8260B, 524.2 & SM6200B analyses, daily calibration verification includes successful demonstration of BFB sensitivity and the injection of a mid-level CCV standard containing all the target analytes of interest, the CCC, and SPCC compounds. The BFB tune must meet the ion abundance criteria (see table above). Each SPCC in the calibration verification standard must meet the minimum response factors listed above. The CCC must achieve the criteria of +/- 20% RSD. Each internal standard in the CCV must recover between -50% to + 100%, when compared to the same internal standard compound in the mid-point standard of the initial calibration curve. Additionally, if the retention time of an internal standard changes by more than 30 seconds from the retention time of the same internal standard in the mid-level standard of the most recent initial calibration, the system must be evaluated, corrected, and possibly re-calibrated.

Daily calibration is accomplished for method 624 by a BFB tuning and analysis of a QC check standard. The BFB tune must meet EPA ion abundance criteria. The QC check standard must meet the criteria found in table 5 of the method.

Poor performing compounds for 8260B/524.2/SM6200B/624:

Dichlorofluoromethane	Vinyl acetate
Bromomethane	trans-1,4-Dichloro-2-butene
Chloroethane.	Alcohols (Ethanol, TBA, TAA, ETBA, TBF, Butanol)
2,2-Dichloropropane.	Iodomethane.
1,2-Dibromo-3-chloropropane	Naphthalene
2-Chloroethylvinylether (2-CEVE)	2- Methylnaphthalene
Acrolein	1- Methylnaphthalene
Acetone	4-Methyl-2-pentanone
2-Butanone	2-Hexanone

8.5 ACCEPTANCE/REJECTION OF CALIBRATION

Organic Chemistry

The initial calibration curve is compared with previous curves for the same analyte. All new standard curves are immediately checked with a secondary source or laboratory control standard prepared from a separate source than those used for calibration. All curves are visually reviewed to ensure that acceptable correlation represents linearity. Calibration curves may be rejected for nonlinearity, abnormal sensitivity, or poor response of the laboratory control standard.

Continuing calibration verification is performed on each day that initial calibration is not performed and following every tenth sample for GC analyses and once per 12 hour shift for GCMS analyses. If a check standard does not perform within established criteria, the instrument is evaluated to determine the cause. Once the issue is corrected, all samples between the last in control sample and the first out of control check is re-analyzed.

TABLE 8.5: INSTRUMENT CALIBRATION

Instrument (Analysis)	Calibration Type	Minimum Number of Standards	Type of Curve	Acceptance/ Rejection Criteria	Frequency
GC (VOC)	Initial	3 –600 series 5 –All others	Avg. RF	Must be ≤10% RSD for 601/602, ≤20%RSD for 8021B, and ≤20% difference for 8015B	As needed
	Second Source	1 Second Source		+/- 20% of true value	With each calibration
	Daily / Cont.	1/10	External	Must be within 15% of the initial calibration curve	Beginning, every 10 and ending
		1	Internal	Must be within 15% of the initial calibration curve	Every 12 hours
GC/MS VOC 8260	Initial	5 –8000 series	Avg. RF	8260B - Must be ≤15 %RSD for all target analytes and ≤30% for CCC's	As needed
	Second Source	1 Second Source		Should recover within 20% for all CCC compounds and within 40% for other analytes of interest, with the exception of analytes known to perform poorly	With each calibration
	Daily / Cont.	Tune & CCV every 12 hours		Must pass established method tuning criteria; 8260B - CCV must be ≤20% difference for CCC compounds, RF criteria for SPCC compounds must meet method criteria. Targets must meet ESC %drift criteria.	Every 12 hours
GC/MS VOC 624	Initial	3 –600 series	Avg. RF	624 - Must be ≤35 %RSD for all target analytes and ≤30% for CCC's	As needed
	Second Source	1 Second Source		Should recover within 20% for all CCC compounds and within 40% for other analytes of interest, with the exception of analytes known to perform poorly	With each calibration
	Daily / Cont.	Tune & CCV every 12 hours		Must pass established method tuning criteria; 624 - CCV must be ≤20% difference for CCC, RF for SPCC compounds must meet method criteria. Targets must meet ESC %drift criteria.	Every 12 hours

9.0 LABORATORY PRACTICES

9.1 REAGENT GRADE WATER

ASTM Type I grade water.

9.2 GLASSWARE WASHING PROCEDURE

All VOA sampling vials are purchased specifically for volatiles analysis and only used once. They are stored in a contaminant-free environment in the original carton with screw cap lids tightly fastened. All glassware used for volatiles analysis (volumetric flasks, syringes, etc.) is segregated from other laboratory glassware. Standard cleaning procedures involve rinsing three times with methanol. Volatiles spargers are kept on the autosampler at all times. Between runs, spargers are cleaned with a distilled water rinse. When a highly contaminated sample is purged, a blank is analyzed in the sparger before another sample can be purged in it. If the sparger is contaminated, it is removed from the autosampler and cleaned with soap and water then a methanol rinse followed by heating to drive off any remaining volatile contaminants. The sparger is then returned to its position and a blank analysis is performed. If the blank proves to be contaminant free, the system is then ready for further field sample analysis.

10.0 ANALYTICAL PROCEDURES

10.1 A list of laboratory SOP's associated with the volatiles laboratory can be found in the following table:

TABLE 10.1: VOLATILE DEPARTMENT SOP'S

This table is subject to revision without notice

SOP #	Title
330351	BTEX and Gasoline Range Organics by Gas Chromatography (8015B)
330351A	TNGRO
330351B	BTEXM (8021B)
330354	NC - Volatile Petroleum Hydrocarbons
330357	Volatile Organic Compounds (GRO by GCMS)
330362	8021B (601/602) Volatile Organic Compounds by Gas Chromatography
330363	Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry
330364	DW Volatile Organic Compounds by GC/MS (524.2)
330365	VOC Screen using RAE Systems PID ppbRAE
330751	5035 Closed System Purge and Trap and Extraction for VOC's in Soil and Waste
330752	5030B Purge and Trap for Aqueos Samples

11.0 QUALITY CONTROL CHECKS

NOTE: For specific guidance on each determinative method, including required quality control and specific state requirements/modifications, refer to the relevant laboratory standard operating procedure(s).

11.1 ESC participates in proficiency testing (PT's) in support of various laboratory accreditations/recognitions. Environmental samples are purchased from Environmental Resource Associates (ERA). The WS, WP and solid matrix studies are completed every 6 months. PT samples are received and analyzed by method according to the vendor's instructions and according to ESC SOP.

11.2 Initial Demonstrations of Capability (IDOC's) are performed during new analyst training and/or prior to acceptance and use of any new method/instrumentation. Continuing Demonstration of Capability (CDOC's) must be updated at least annually. The associated data is filed within the department and available for review.

11.3 Matrix Spike and Matrix Spike Duplicates are performed on each batch of samples analyzed depending on analytical method requested.

11.4 A Laboratory Control Sample (LCS) and LCS Duplicate are analyzed one per batch of samples.

11.5 A method preparation blank is performed per batch of samples processed. If one-half the reporting limit [RL] is exceeded, the laboratory shall evaluate whether reprocessing of the samples is necessary, based on the following criteria:

- The blank contamination exceeds a concentration greater than 1/10 of the measured concentration of any sample in the associated preparation batch or
- The blank contamination is greater than 1/10 of the specified regulatory limit. The concentrations of common laboratory contaminants shall not exceed the reporting limit. Any samples associated with a blank that fail these criteria shall be reprocessed in a subsequent preparation batch, except where the sample analysis resulted in non-detected results for the failing analytes.

12.0 DATA REDUCTION, VALIDATION AND REPORTING

12.1 DATA REDUCTION

The analyst performs the data calculation functions and is responsible for the initial examination of the finished data. Data reduction steps applied to the raw data are outlined in SOP #030201, *Data Handling and Reporting.* The Quality Control Department performs the secondary review of the data package using the ESC SOP #030227, *Data Review*. The QC Reviewer verifies that the analysis has performed as required and meets method criteria, all associate data is present and complete, and also ensures that any additional documentation is completed as required (i.e. Ohio VAP checklists, required flags on test reports, etc.)

TABLE 12.1 Data Reduction Formulas

PARAMETER	FORMULA
GC	response of sample analyte {*area*} x final extract volume {*mL*} x dilution response factor {*area/(mg/L)*} x initial extract volume-mass {*mL or g*} *Calculations performed by HP Enviroquant Software*
GC/MS	response of analyte {*area*} x extract volume {*mL*} x dilution x int. std amt. {*area*} response factor {*area/(mg/mL)*} x initial volume-mass {*mL or g*} x int. std cal. {area} *Calculations performed by HP Enviroquant Software*

12.2 VALIDATION

The validation process consists of data generation, reduction review, and reporting results. Once data reduction is complete, validation is conducted by verification that the QC samples are within acceptable QC limits and that all documentation is complete, including the analytical report and associated QC. See Table 12.3 by method for current QC targets and controls and current reporting limits.

Marginal Excedence – When a large number of analytes exist in the LCS, it is statistically possible for a few analytes to be outside established control limits while the analytical system remains in control. These excursions must be random in nature and, if not, a review of the control limits or analytical process is necessary.

Upper and lower marginal excedence (ME) limits are established as the mean of at least 20 data points ± four times their standard deviations. The number of allowable marginal excedences per event is based on the number of analytes spiked in the LCS.

Allowable Marginal Excedence per Event	
Analytes in LCS:	**ME Allowable**
>90	5
71-90	4
51-70	3
31-50	2
11-30	1
<11	0

Organic Control Limits - The organic QC targets are statutory in nature; warning and control limits for organic analyses are initially set for groups of compounds based on preliminary method validation data. When additional data becomes available, the QC targets are reviewed. All QC targets are routinely re-evaluated at least annually (and updated, if necessary) against laboratory historical data to insure that the limits continue to reflect realistic, method achievable goals.

12.3 REPORTING

Reporting procedures are documented in SOP #030201, *Data Handling and Reporting.*

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	Dichlorodifluoromethane	8260B/C, 624, 6200B	GW, WW	39-189	24	0.001	mg/L
Volatiles	Chloromethane	8260B/C, 624, 6200B	GW, WW	45-152	20	0.001	mg/L
Volatiles	Vinyl Chloride	8260B/C, 624, 6200B	GW, WW	55-153	20	0.001	mg/L
Volatiles	Bromomethane	8260B/C, 624, 6200B	GW, WW	45-175	20	0.001	mg/L
Volatiles	Chloroethane	8260B/C, 624, 6200B	GW, WW	49-155	20	0.001	mg/L
Volatiles	Trichlorofluoromethane	8260B/C, 624, 6200B	GW, WW	54-156	20	0.001	mg/L
Volatiles	Ethyl Ether	8260B/C, 624, 6200B	GW, WW	60-142	20	0.001	mg/L
Volatiles	Acrolein	8260B/C, 624, 6200B	GW, WW	6-182	39	0.050	mg/L
Volatiles	1,1-Dichloroethene	8260B/C, 624, 6200B	GW, WW	60-130	20	0.001	mg/L
Volatiles	1,1,2-Trichloro-1,2,2-trifluoroethane	8260B/C, 624, 6200B	GW, WW	51-149	20	0.001	mg/L
Volatiles	Acetone	8260B/C, 624, 6200B	GW, WW	48-134	20	0.050	mg/L
Volatiles	Iodomethane	8260B/C, 624, 6200B	GW, WW	61-148	20	0.050	mg/L
Volatiles	Carbon Disulfide	8260B/C, 624, 6200B	GW, WW	41-148	20	0.001	mg/L
Volatiles	Methylene Chloride	8260B/C, 624, 6200B	GW, WW	64-125	20	0.005	mg/L
Volatiles	Acrylonitrile	8260B/C, 624, 6200B	GW, WW	60-140	20	0.050	mg/L
Volatiles	trans-1,2-Dichloroethene	8260B/C, 624, 6200B	GW, WW	67-129	20	0.001	mg/L
Volatiles	Methyl Tert Butyl Ether	8260B/C, 624, 6200B	GW, WW	51-142	20	0.001	mg/L

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	1,1-Dichloroethane	8260B/C, 624, 6200B	GW, WW	67-133	20	0.001	mg/L
Volatiles	Vinyl Acetate	8260B/C, 624, 6200B	GW, WW	34-178	26	0.050	mg/L
Volatiles	Di Isopropyl Ether	8260B/C, 624, 6200B	GW, WW	63-139	20	0.001	mg/L
Volatiles	2,2-Dichloropropane	8260B/C, 624, 6200B	GW, WW	46-151	20	0.001	mg/L
Volatiles	cis-1,2-Dichloroethene	8260B/C, 624, 6200B	GW, WW	72-128	20	0.001	mg/L
Volatiles	2-Butanone (MEK)	8260B/C, 624, 6200B	GW, WW	53-132	20	0.050	mg/L
Volatiles	Bromochloromethane	8260B/C, 624, 6200B	GW, WW	75-128	20	0.001	mg/L
Volatiles	Tetrahydrofuran	8260B/C, 624, 6200B	GW, WW	50-140	20	0.001	mg/L
Volatiles	Chloroform	8260B/C, 624, 6200B	GW, WW	66-126	20	0.005	mg/L
Volatiles	1,1,1-Trichloroethane	8260B/C, 624, 6200B	GW, WW	67-137	20	0.001	mg/kg
Volatiles	Carbon Tetrachloride	8260B/C, 624, 6200B	GW, WW	64-141	20	0.001	mg/kg
Volatiles	1,1-Dichloropropene	8260B/C, 624, 6200B	GW, WW	68-132	20	0.001	mg/kg
Volatiles	Benzene	8260B/C, 624, 6200B	GW, WW	67-126	20	0.001	mg/kg
Volatiles	1,2-Dichloroethane	8260B/C, 624, 6200B	GW, WW	67-133	20	0.001	mg/kg
Volatiles	Trichloroethene	8260B/C, 624, 6200B	GW, WW	74-126	20	0.001	mg/kg
Volatiles	1,2-Dichloropropane	8260B/C, 624, 6200B	GW, WW	74-122	20	0.001	mg/kg
Volatiles	Dibromomethane	8260B/C, 624, 6200B	GW, WW	73-125	20	0.001	mg/kg
Volatiles	Bromodichloromethane	8260B/C, 624, 6200B	GW, WW	68-133	20	0.001	mg/kg
Volatiles	2-Chloroethylvinyl Ether	8260B/C, 624, 6200B	GW, WW	0-171	27	0.050	mg/kg
Volatiles	cis-1,3-Dichloropropene	8260B/C, 624, 6200B	GW, WW	73-131	20	0.001	mg/kg
Volatiles	4-Methyl-2-Pentanone (MIBK)	8260B/C, 624, 6200B	GW, WW	60-142	20	0.050	mg/kg
Volatiles	Toluene	8260B/C, 624, 6200B	GW, WW	72-122	20	0.005	mg/kg
Volatiles	trans-1,3-Dichloropropene	8260B/C, 624, 6200B	GW, WW	66-137	20	0.001	mg/kg
Volatiles	1,1,2-Trichloroethane	8260B/C, 624, 6200B	GW, WW	79-123	20	0.001	mg/kg
Volatiles	Tetrachloroethene	8260B/C, 624, 6200B	GW, WW	67-135	20	0.001	mg/kg
Volatiles	1,3-Dichloropropane	8260B/C, 624, 6200B	GW, WW	77-119	20	0.001	mg/kg
Volatiles	2-Hexanone	8260B/C, 624, 6200B	GW, WW	56-147	20	0.050	mg/kg
Volatiles	Chlorodibromomethane	8260B/C, 624, 6200B	GW, WW	73-138	20	0.001	mg/kg
Volatiles	1,2-Dibromoethane	8260B/C, 624, 6200B	GW, WW	75-126	20	0.001	mg/kg
Volatiles	Chlorobenzene	8260B/C, 624, 6200B	GW, WW	77-125	20	0.001	mg/kg
Volatiles	1,1,1,2-Tetrachloroethane	8260B/C, 624, 6200B	GW, WW	75-134	20	0.001	mg/kg
Volatiles	Ethylbenzene	8260B/C, 624, 6200B	GW, WW	76-129	20	0.001	mg/kg
Volatiles	Total-Xylene	8260B/C, 624, 6200B	GW, WW	75-128	20	0.003	mg/kg
Volatiles	Styrene	8260B/C, 624, 6200B	GW, WW	78-130	20	0.001	mg/kg
Volatiles	Bromoform	8260B/C, 624, 6200B	GW, WW	60-139	20	0.001	mg/L
Volatiles	Isopropylbenzene	8260B/C, 624, 6200B	GW, WW	73-132	20	0.001	mg/L

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	Bromobenzene	8260B/C, 624, 6200B	GW, WW	76-123	20	0.001	mg/L
Volatiles	1,1,2,2-Tetrachloroethane	8260B/C, 624, 6200B	GW, WW	72-128	20	0.001	mg/L
Volatiles	1,2,3-Trichloropropane	8260B/C, 624, 6200B	GW, WW	68-130	20	0.001	mg/L
Volatiles	trans-1,4-Dichloro-2-Butene	8260B/C, 624, 6200B	GW, WW	48-139	20	0.001	mg/L
Volatiles	n-Propylbenzene	8260B/C, 624, 6200B	GW, WW	71-132	20	0.001	mg/L
Volatiles	2-Chlorotoluene	8260B/C, 624, 6200B	GW, WW	74-128	20	0.001	mg/L
Volatiles	4-Chlorotoluene	8260B/C, 624, 6200B	GW, WW	74-130	20	0.001	mg/L
Volatiles	1,3,5-Trimethylbenzene	8260B/C, 624, 6200B	GW, WW	73-134	20	0.001	mg/L
Volatiles	tert-Butylbenzene	8260B/C, 624, 6200B	GW, WW	72-134	20	0.001	mg/L
Volatiles	1,2,4-Trimethylbenzene	8260B/C, 624, 6200B	GW, WW	72-135	20	0.001	mg/L
Volatiles	sec-Butylbenzene	8260B/C, 624, 6200B	GW, WW	70-135	20	0.001	mg/L
Volatiles	1,3-Dichlorobenzene	8260B/C, 624, 6200B	GW, WW	70-121	20	0.001	mg/L
Volatiles	p-Isopropyltoluene	8260B/C, 624, 6200B	GW, WW	68-138	20	0.001	mg/L
Volatiles	1,4-Dichlorobenzene	8260B/C, 624, 6200B	GW, WW	70-121	20	0.001	mg/L
Volatiles	1,2,3-Trimethylbenzene	8260B/C, 624, 6200B	GW, WW	70-127	20	0.001	mg/L
Volatiles	1,2-Dichlorobenzene	8260B/C, 624, 6200B	GW, WW	75-122	20	0.001	mg/L
Volatiles	n-Butylbenzene	8260B/C, 624, 6200B	GW, WW	63-142	20	0.001	mg/L
Volatiles	1,2-Dibromo-3-Chloropropane	8260B/C, 624, 6200B	GW, WW	55-134	20	0.001	mg/L
Volatiles	1,2,4-Trichlorobenzene	8260B/C, 624, 6200B	GW, WW	65-137	20	0.001	mg/L
Volatiles	Hexachlorobutadiene	8260B/C, 624, 6200B	GW, WW	67-135	20	0.001	mg/L
Volatiles	Naphthalene	8260B/C, 624, 6200B	GW, WW	56-145	20	0.005	mg/L
Volatiles	1,2,3-Trichlorobenzene	8260B/C, 624, 6200B	GW, WW	63-138	20	0.001	mg/L
Volatiles	Hexane	8260B/C, 624, 6200B	GW, WW	33-167	20	0.010	mg/L
Volatiles	Acetonitrile	8260B/C, 624, 6200B	GW, WW	61.3-134-.7	25	0.050	mg/L
Volatiles	Allyl Chloride	8260B/C, 624, 6200B	GW, WW	77.9-127-.7	25	0.005	mg/L
Volatiles	Chloroprene	8260B/C, 624, 6200B	GW, WW	49.4-142.3	25	0.050	mg/L
Volatiles	Isobutanol	8260B/C, 624, 6200B	GW, WW	59.3-137.6	25	0.100	mg/L
Volatiles	1,4-Dioxane	8260B/C, 624, 6200B	GW, WW	76.2-132.3	25	0.100	mg/L
Volatiles	Methacrylonitrile	8260B/C, 624, 6200B	GW, WW	74.7-126.1	25	0.050	mg/L
Volatiles	Methyl Methacrylate	8260B/C, 624, 6200B	GW, WW	62-142.2	25	0.005	mg/L
Volatiles	Ethyl methacrylate	8260B/C, 624, 6200B	GW, WW	55.4-126.3	25	0.005	mg/L
Volatiles	Propionitrile	8260B/C, 624, 6200B	GW, WW	53.7-143.7	25	0.050	mg/L
Volatiles	Pentachloroethane	8260B/C, 624, 6200B	GW, WW	10-200	25	0.005	mg/L
Volatiles	Cyclohexanone	8260B/C, 624, 6200B	GW, WW	36.5-138.1	25	0.010	mg/L
Volatiles	Bromoethane	8260B/C, 624, 6200B	GW, WW	74.3-136.2	25	0.001	mg/L

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	2Butanol	8260B/C, 624, 6200B	GW, WW	64.8-140.6	25	0.050	mg/L
Volatiles	Ethanol	8260B/C, 624, 6200B	GW, WW	51.8-153.6	25	0.050	mg/L
Volatiles	Di-isopropyl ether	8260B/C, 624, 6200B	GW, WW	63-139	20	0.001	mg/L
Volatiles	Ethyl tert-butyl ether	8260B/C, 624, 6200B	GW, WW	63.5-131.4	25	0.001	mg/L
Volatiles	Methyl-tert-butyl ether	8260B/C, 624, 6200B	GW, WW	51-142	20	0.001	mg/L
Volatiles	Tert-Butyl alcohol	8260B/C, 624, 6200B	GW, WW	44.2-173.9	25	0.050	mg/L
Volatiles	Tert-Amyl Methyl Ether	8260B/C, 624, 6200B	GW, WW	69.3-125.1	25	0.001	mg/L
Volatiles	Dichlorodifluoromethane	8260B/C	Solid	26-186	22	0.001	mg/kg
Volatiles	Chloromethane	8260B/C	Solid	42-149	20	0.001	mg/kg
Volatiles	Vinyl Chloride	8260B/C	Solid	50-151	20	0.001	mg/kg
Volatiles	Bromomethane	8260B/C	Solid	41-175	20	0.001	mg/kg
Volatiles	Chloroethane	8260B/C	Solid	44-159	20	0.001	mg/kg
Volatiles	Trichlorofluoromethane	8260B/C	Solid	52-147	20	0.001	mg/kg
Volatiles	Ethyl Ether	8260B/C	Solid	56-147	20	0.001	mg/kg
Volatiles	Acrolein	8260B/C	Solid	3-181	31	0.050	mg/kg
Volatiles	1,1-Dichloroethene	8260B/C	Solid	53-136	20	0.001	mg/kg
Volatiles	1,1,2-Trichloro-1,2,2-trifluoroethane	8260B/C	Solid	49-155	20	0.001	mg/kg
Volatiles	Acetone	8260B/C	Solid	44-140	25	0.050	mg/kg
Volatiles	Iodomethane	8260B/C	Solid	55-156	20	0.050	mg/kg
Volatiles	Carbon Disulfide	8260B/C	Solid	36-161	20	0.001	mg/kg
Volatiles	Methylene Chloride	8260B/C	Solid	57-129	20	0.005	mg/kg
Volatiles	Acrylonitrile	8260B/C	Solid	55-143	20	0.050	mg/kg
Volatiles	trans-1,2-Dichloroethene	8260B/C	Solid	61-133	20	0.001	mg/kg
Volatiles	Methyl Tert Butyl Ether	8260B/C	Solid	44-148	20	0.001	mg/kg
Volatiles	1,1-Dichloroethane	8260B/C	Solid	61-134	20	0.001	mg/kg
Volatiles	Vinyl Acetate	8260B/C	Solid	45-163	20	0.050	mg/kg
Volatiles	Di Isopropyl Ether	8260B/C	Solid	59-143	20	0.001	mg/kg
Volatiles	2,2-Dichloropropane	8260B/C	Solid	50-147	20	0.001	mg/kg
Volatiles	cis-1,2-Dichloroethene	8260B/C	Solid	71-129	20	0.001	mg/kg
Volatiles	2-Butanone (MEK)	8260B/C	Solid	51-131	25	0.050	mg/kg
Volatiles	Bromochloromethane	8260B/C	Solid	73-130	20	0.001	mg/kg
Volatiles	Tetrahydrofuran	8260B/C	Solid	44-144	25	0.001	mg/kg
Volatiles	Chloroform	8260B/C	Solid	63-123	20	0.005	mg/kg
Volatiles	1,1,1-Trichloroethane	8260B/C	Solid	62-135	20	0.001	mg/kg
Volatiles	Carbon Tetrachloride	8260B/C	Solid	60-140	20	0.001	mg/kg
Volatiles	1,1-Dichloropropene	8260B/C	Solid	63-132	20	0.001	mg/kg

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	Benzene	8260B/C	Solid	65-128	20	0.001	mg/kg
Volatiles	1,2-Dichloroethane	8260B/C	Solid	58-141	20	0.001	mg/kg
Volatiles	Trichloroethene	8260B/C	Solid	71-126	20	0.001	mg/kg
Volatiles	1,2-Dichloropropane	8260B/C	Solid	71-128	20	0.001	mg/kg
Volatiles	Dibromomethane	8260B/C	Solid	70-130	20	0.001	mg/kg
Volatiles	Bromodichloromethane	8260B/C	Solid	66-126	20	0.001	mg/kg
Volatiles	2-Chloroethylvinyl Ether	8260B/C	Solid	0-188	39	0.050	mg/kg
Volatiles	cis-1,3-Dichloropropene	8260B/C	Solid	73-132	20	0.001	mg/kg
Volatiles	4-Methyl-2-Pentanone (MIBK)	8260B/C	Solid	61-143	23	0.050	mg/kg
Volatiles	Toluene	8260B/C	Solid	70-120	20	0.005	mg/kg
Volatiles	trans-1,3-Dichloropropene	8260B/C	Solid	70-135	20	0.001	mg/kg
Volatiles	1,1,2-Trichloroethane	8260B/C	Solid	77-124	20	0.001	mg/kg
Volatiles	Tetrachloroethene	8260B/C	Solid	65-135	20	0.001	mg/kg
Volatiles	1,3-Dichloropropane	8260B/C	Solid	76-120	20	0.001	mg/kg
Volatiles	2-Hexanone	8260B/C	Solid	62-145	23	0.050	mg/kg
Volatiles	Chlorodibromomethane	8260B/C	Solid	72-137	20	0.001	mg/kg
Volatiles	1,2-Dibromoethane	8260B/C	Solid	76-127	20	0.001	mg/kg
Volatiles	Chlorobenzene	8260B/C	Solid	75-125	20	0.001	mg/kg
Volatiles	1,1,1,2-Tetrachloroethane	8260B/C	Solid	73-134	20	0.001	mg/kg
Volatiles	Ethylbenzene	8260B/C	Solid	74-128	20	0.001	mg/kg
Volatiles	Total-Xylene	8260B/C	Solid	74-127	20	0.003	mg/kg
Volatiles	Styrene	8260B/C	Solid	76-133	20	0.001	mg/kg
Volatiles	Bromoform	8260B/C	Solid	64-139	20	0.001	mg/kg
Volatiles	Isopropylbenzene	8260B/C	Solid	73-130	20	0.001	mg/kg
Volatiles	Bromobenzene	8260B/C	Solid	75-123	20	0.001	mg/kg
Volatiles	1,1,2,2-Tetrachloroethane	8260B/C	Solid	74-129	20	0.001	mg/kg
Volatiles	1,2,3-Trichloropropane	8260B/C	Solid	70-133	20	0.001	mg/kg
Volatiles	trans-1,4-Dichloro-2-Butene	8260B/C	Solid	52-143	20	0.001	mg/kg
Volatiles	n-Propylbenzene	8260B/C	Solid	71-132	20	0.001	mg/kg
Volatiles	2-Chlorotoluene	8260B/C	Solid	73-128	20	0.001	mg/kg
Volatiles	4-Chlorotoluene	8260B/C	Solid	72-129	20	0.001	mg/kg
Volatiles	1,3,5-Trimethylbenzene	8260B/C	Solid	71-133	20	0.001	mg/kg
Volatiles	tert-Butylbenzene	8260B/C	Solid	72-132	20	0.001	mg/kg
Volatiles	1,2,4-Trimethylbenzene	8260B/C	Solid	68-135	20	0.001	mg/kg
Volatiles	sec-Butylbenzene	8260B/C	Solid	71-134	20	0.001	mg/kg
Volatiles	1,3-Dichlorobenzene	8260B/C	Solid	71-132	20	0.001	mg/kg

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RL's
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Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	p-Isopropyltoluene	8260B/C	Solid	67-138	20	0.001	mg/kg
Volatiles	1,4-Dichlorobenzene	8260B/C	Solid	72-123	20	0.001	mg/kg
Volatiles	1,2,3-Trimethylbenzene	8260B/C	Solid	73-126	20	0.001	mg/kg
Volatiles	1,2-Dichlorobenzene	8260B/C	Solid	77-123	20	0.001	mg/kg
Volatiles	n-Butylbenzene	8260B/C	Solid	60-145	20	0.001	mg/kg
Volatiles	1,2-Dibromo-3-Chloropropane	8260B/C	Solid	61-134	21	0.001	mg/kg
Volatiles	1,2,4-Trichlorobenzene	8260B/C	Solid	61-148	20	0.001	mg/kg
Volatiles	Hexachlorobutadiene	8260B/C	Solid	65-137	20	0.001	mg/kg
Volatiles	Naphthalene	8260B/C	Solid	61-142	20	0.005	mg/kg
Volatiles	1,2,3-Trichlorobenzene	8260B/C	Solid	62-146	20	0.001	mg/kg
Volatiles	Hexane	8260B/C	Solid	28-169	20	0.010	mg/kg
Volatiles	Acetonitrile	8260B/C	Solid	59.6-170.4	25	0.050	mg/kg
Volatiles	Allyl Chloride	8260B/C	Solid	66.7-106.4	25	0.005	mg/kg
Volatiles	Chloroprene	8260B/C	Solid	61-114.3	25	0.050	mg/kg
Volatiles	Isobutanol	8260B/C	Solid	80.4-130.2	25	0.100	mg/kg
Volatiles	1,4-Dioxane	8260B/C	Solid	78.4-148.5	25	0.100	mg/kg
Volatiles	Methacrylonitrile	8260B/C	Solid	87.1-108.6	25	0.050	mg/kg
Volatiles	Methyl Methacrylate	8260B/C	Solid	90.4-141.9	25	0.005	mg/kg
Volatiles	Ethyl methacrylate	8260B/C	Solid	41.6-159	25	0.005	mg/kg
Volatiles	Propionitrile	8260B/C	Solid	77.8-136	25	0.050	mg/kg
Volatiles	Pentachloroethane	8260B/C	Solid	63.5-179.2	25	0.005	mg/kg
Volatiles	Cyclohexanone	8260B/C	Solid	21.3-170	25	0.010	mg/kg
Volatiles	Bromoethane	8260B/C	Solid	61.7-123.8	25	0.001	mg/kg
Volatiles	2Butanol	8260B/C	Solid	82.5-138.5	25	0.050	mg/kg
Volatiles	Ethanol	8260B/C	Solid	65.6-136.3	25	0.050	mg/kg
Volatiles	Di-isopropyl ether	8260B/C	Solid	59-143	20	0.001	mg/kg
Volatiles	Ethyl tert-butyl ether	8260B/C	Solid	81.4-110.9	25	0.001	mg/kg
Volatiles	Methyl-tert-butyl ether	8260B/C	Solid	44-148	20	0.001	mg/kg
Volatiles	Tert-Butyl alcohol	8260B/C	Solid	59.5-170.4	25	0.050	mg/kg
Volatiles	Tert-Amyl Methyl Ether	8260B/C	Solid	82-115.5	25	0.001	mg/kg
Volatiles	GRO	8015B/C/D	GW, WW	70-124	20	0.100	mg/L
Volatiles	Benzene	8021B, 602, 6200C	GW, WW	79 - 131	20	0.0005	mg/L
Volatiles	Toluene	8021B, 602, 6200C	GW, WW	68 - 114	20	0.005	mg/L
Volatiles	Ethylbenzene	8021B, 602, 6200C	GW, WW	68 - 125	20	0.0005	mg/L
Volatiles	m&p-Xylene	8021B, 602, 6200C	GW, WW	67 - 113	20	0.001	mg/L

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	o-Xylene	8021B, 602, 6200C	GW, WW	72 - 114	20	0.0005	mg/L
Volatiles	MTBE	8021B, 602, 6200C	GW, WW	60 - 133	20	0.001	mg/L
Volatiles	Benzene	502.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Toluene	502.2	DW	70 - 130	25	0.005	mg/L
Volatiles	Ethylbenzene	502.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	m&p-Xylene	502.2	DW	70 - 130	25	0.001	mg/L
Volatiles	o-Xylene	502.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	MTBE	502.2	DW	70 - 130	25	0.001	mg/L
Volatiles	GRO	8015B	Solid	67 - 135	20	0.500	mg/kg
Volatiles	Benzene	8021B	Solid	78 - 141	20	0.0025	mg/kg
Volatiles	Toluene	8021B	Solid	65 - 117	20	0.025	mg/kg
Volatiles	Ethylbenzene	8021B	Solid	69 - 133	20	0.0025	mg/kg
Volatiles	m&p-Xylene	8021B	Solid	61 - 121	20	0.005	mg/kg
Volatiles	o-Xylene	8021B	Solid	71 - 121	20	0.0025	mg/kg
Volatiles	MTBE	8021B	Solid	54 - 129	20	0.005	mg/kg
Volatiles	1,1,1,2-Tetrachloroethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,1,1-Trichloroethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,1,2,2-Tetrachloroethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,1,2-Trichloroethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,1-Dichloroethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,1-Dichloroethene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,1-Dichloropropanone	524.2	DW	70 - 130	25		mg/L
Volatiles	1,1-Dichloropropene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,2,3-Trichlorobenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,2,3-Trichloropropane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,2,4-Trichlorobenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,2,4-Trimethylbenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,2-Dibromo-3-chloropropane	524.2	DW	70 - 130	25	0.0010	mg/L
Volatiles	1,2-Dibromoethane	524.2	DW	70 - 130	25	0.0010	mg/L
Volatiles	1,2-Dichlorobenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,2-Dichloroethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,2-Dichloropropane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,3,5-Trimethylbenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,3-Dichlorobenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1,3-Dichloropropane	524.2	DW	70 - 130	25	0.0005	mg/L

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	1,4-Dichlorobenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	1-Chlorobutane	524.2	DW	70 - 130	25		mg/L
Volatiles	2,2-Dichloropropane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	2-Butanone	524.2	DW	70 - 130	25		mg/L
Volatiles	2-Chlorotoluene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	2-Hexanone	524.2	DW	70 - 130	25		mg/L
Volatiles	2-Nitropropane	524.2	DW	70 - 130	25		mg/L
Volatiles	4-Chlorotoluene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	4-Isopropyltoluene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	4-Methyl-2-pentanone	524.2	DW	70 - 130	25		mg/L
Volatiles	Acetone	524.2	DW	70 - 130	25	0.01	mg/L
Volatiles	Acrylonitrile	524.2	DW	70 - 130	25		mg/L
Volatiles	Allyl Chloride	524.2	DW	70 - 130	25		mg/L
Volatiles	Benzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Bromobenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Bromochloromethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Bromodichloromethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Bromoform	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Bromomethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Carbon Disulfide	524.2	DW	70 - 130	25		mg/L
Volatiles	Carbon Tetrachloride	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Chloroacetonitrile	524.2	DW	70 - 130	25		mg/L
Volatiles	THMs	524.2	DW	70 - 130	25		mg/L
Volatiles	Chlorobenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Chloroethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Chloroform	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Chloromethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Cis-1,2-dichloroethene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Cis-1,3-dichloropropene	524.2	DW	70 - 130	25	0.0010	mg/L
Volatiles	Dibromochloromethane	524.2	DW	70 - 130	25		mg/L
Volatiles	Dibromomethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Dichlorodifluoromethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Diethyl ether	524.2	DW	70 - 130	25		mg/L
Volatiles	Ethyl Methacrylate	524.2	DW	70 - 130	25		mg/L
Volatiles	Ethylbenzene	524.2	DW	70 - 130	25	0.0005	mg/L

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	Hexachlorobutadiene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Hexachloroethane	524.2	DW	70 - 130	25		mg/L
Volatiles	Isopropylbenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Meta-xylene	524.2	DW	70 - 130	25		mg/L
Volatiles	Methacrylonitrile	524.2	DW	70 - 130	25		mg/L
Volatiles	Methyl Iodide	524.2	DW	70 - 130	25		mg/L
Volatiles	Methylacrylate	524.2	DW	70 - 130	25		mg/L
Volatiles	Methylene Chloride	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Methylmethacrylate	524.2	DW	70 - 130	25		mg/L
Volatiles	Methyl-t-butyl ether	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Naphthalene	524.2	DW	70 - 130	25	0.0050	mg/L
Volatiles	N-butylbenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Nitrobenzene	524.2	DW	70 - 130	25		mg/L
Volatiles	N-propylbenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Ortho-xylene	524.2	DW	70 - 130	25		mg/L
Volatiles	Para-xylene	524.2	DW	70 - 130	25		mg/L
Volatiles	Pentachloroethane	524.2	DW	70 - 130	25		mg/L
Volatiles	Propionitrile	524.2	DW	70 - 130	25		mg/L
Volatiles	Sec-butylbenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Styrene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Tert-butylbenzene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Tetrachloroethene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Tetrahydrofuran	524.2	DW	70 - 130	25		mg/L
Volatiles	Toluene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Trans-1,2-dichloroethene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Trans-1,3-dichloropropene	524.2	DW	70 - 130	25	0.0010	mg/L
Volatiles	Trans-1,4-dichloro-2-butene	524.2	DW	70 - 130	25		mg/L
Volatiles	Trichloroethene	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Trichlorofluoromethane	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Vinyl Chloride	524.2	DW	70 - 130	25	0.0005	mg/L
Volatiles	Xylenes – total	524.2	DW	70 - 130	25		mg/L

*** Specific organizations may require limits that supersede values listed.*

13.0 CORRECTIVE ACTION

13.1 In the event that a nonconformance occurs in conjunction with the analytical batch, a corrective action response (CAR) form must be completed. The cause of the event is stated on the form and the measures taken to correct the nonconformance clearly defined. The effectiveness of the corrective action must be assessed and noted. The CAR are kept on file by the QA Department. Corrective action procedures are documented in SOP #030208, *Corrective and Preventive Action*

13.2 Required Corrective Action

Control limits have been established for each type of analysis. When these limits are exceeded, corrective action must be taken. Calculated sample spike control limits are also used.

All samples and procedures are governed by ESC's quality assurance program. General corrective actions are as follows; however additional and more specific direction is provided in the specific determinative procedure. For more information, see the appropriate determinative SOP.

13.2.1 Laboratory QC Criteria and Appropriate Corrective Actions

If the analytical method contains acceptance/rejection criteria and it is more stringent than those controls generated by the laboratory the method criteria take precedence.

13.2.2 Out Of Control Blanks: Applies to Method, Trip, Rinsate & Instrument Blanks

Rejection Criteria - Blank reading is more than twice the background absorbance or more than 1/2 RL.

Corrective Action - Blanks are reanalyzed and the response is assessed. Standard curves and samples are evaluated for any obvious contamination that is isolated or uniform throughout the run. If necessary, reagents are re-prepared. Analyses are not initiated until the problem is identified and solved. If samples have already been prepared or analyzed, the Department Manager or QA Department is consulted to determine if data needs to be rejected or if samples need to be re-prepared.

13.2.3 Out Of Control Laboratory Control Standards (LCS & LCSD)

Rejection Criteria - If the performance is outside of lab-generated control limits which are calculated as the mean of at least 20 data points +/- 3 times the standard deviation of those points (Listed in Section 12) and the marginal excedence allowance is surpassed (see section 12.2).

Corrective Action - Instrument settings are checked and the LCS standard is re-analyzed. If the LCS is still out of control, instrumentation is checked for systemic problems and repaired (if necessary). Re-calibration is performed and the samples affected since the last in control reference standard are rerun. The group leader, Department Manager, or QA Department is consulted for further action.

13.2.4 Out Of Control Matrix Spike Samples

Rejection Criteria - If sample is outside of lab-generated control limits from accuracy charts on matrix spike samples from a similar matrix (i.e., water, solid, etc). Limits are calculated as the mean of at least 20 data points +/- 3 times the standard deviation of those points.

Corrective Action - Spiking technique is assessed to ascertain if the sample has been spiked correctly. The spiked sample should be 1 – 5 times the client sample concentration; otherwise, the percent recovery (%R) or relative percent difference (%RPD) of the MS/MSD is flagged as not meaningful or usable. The sample is re-spiked and re-analyzed, along with several other similar samples in subset. If an out of control situation persists, sample matrix interference is indicated. Samples to be analyzed by standard additions are prepared (where appropriate), and the group leader, Department Manager, or QA Department is notified.

13.2.5 Out Of Control Duplicate Samples

Rejection Criteria - Lab-generated maximum RPD limit (as listed under precision in Section 12)

Corrective Action - Instrument and samples are checked to see if precision variance is likely (i.e., high suspended solids content, high viscosity, etc.). They are re-analyzed in duplicate and samples just before and just after the duplicated sample are re-checked. If problem still exists, Department Manager, or QA Department is notified to review the analytical techniques.

13.2.6 Out Of Control Matrix Spike Duplicates

Rejection Criteria - These QC samples can be out of control for accuracy, precision, or both.

Corrective Action - The appropriate corrective actions listed for either matrix spikes, duplicate samples, or both are followed.

NOTE: Some samples cannot be duplicated. This is the case for wipe samples, filters, and some water samples. When possible, sampling personnel should collect duplicate samples.

13.2.7 Out Of Control Calibration Standards: ICV, CCV, SSCV

Rejection Criteria - If the performance is outside of method requirements.

Corrective Action - Instrument settings are checked, calibration verification standard is re-analyzed. If the standard is still out of control, re-calibration is performed, and samples affected since the last in control reference standard are rerun. The group leader, Department Manager, or QA Department is consulted for further action.

14.0 RECORD KEEPING

Record keeping is outlined in SOP #010103, *Document Control and Distribution*, SOP #030203, *Reagent Logs and Records* and SOP #030201, *Data Handling and Reporting.* Volatile organics calibration data are recorded and integrated using HP Enviroquant software. Calibration data from the volatile analyses, in addition to the initial and daily calibration, includes GC/MS autotunes, DFTPP reports and surrogate recovery reports. Hard copy records of initial calibration and daily calibration are stored with chromatograms and integrated with sample data by date analyzed.

15.0 QUALITY AUDITS

System and data quality audits are outlined in the ESC Quality Assurance Manual Version 8.0.

1.0 SIGNATORY APPROVALS

Semi-Volatile
QUALITY ASSURANCE MANUAL

APPENDIX VII TO THE ESC
QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

NOTE: The QAM has been approved by the following people. A signed cover page is available upon request

Judith R. Morgan, M.S., VP of Technical and Regulatory Affairs 615-773-9657

Eric Johnson, B.S., Laboratory Director 615-773-9654

Dixie Marlin, B.S, QC Manager, 615-773-9681

Kenny Buckley, B.S., Organics/Wet Chemistry Department Manager, 615-773-9686

2.0 APPENDIX TABLE OF CONTENTS

3.0 SCOPE AND APPLICATION

This appendix discusses specific QA requirements for general analytical protocols to ensure that analytical data generated from the Semi-Volatile (SVOC) laboratory are scientifically valid and are of acceptable quality. Any deviations from these requirements and any deviations that result in non-conforming work must be immediately evaluated and their corrective actions documented.

4.0 LABORATORY ORGANIZATION AND RESPONSIBILITIES

ESC Lab Sciences offers diverse environmental capabilities that enable the laboratory to provide the client with both routine and specialized services, field sampling and broad laboratory expertise. A brief outline of the organization and responsibilities as they apply to the ESC Quality Assurance Program is presented in *Section 4.0 in the ESC Quality Assurance Manual Version 8.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Kenneth W. Buckley, with a B.S. degree in General Science, is the Department Manager of Organics and Wet Chemistry laboratories. Mr. Buckley reviews and approves all data reduction associated with analyses in these areas and is responsible for the overall production of these laboratories; including the management of the staff and scheduling. Mr. Buckley has over 9 years of environmental laboratory experience. In his absence, Chris Johnson assumes responsibility for departmental decisions. Mr. Johnson has a B.S. degree in Biology and over 9 years of environmental laboratory experience.

5.2 TRAINING

5.2.1 All new analysts to the laboratory are trained by the primary analyst or Manager according to ESC protocol. Performance is documented using an initial demonstration of capability (IDOCs) and continuing demonstration of capability (CDOC). On-going acceptable capability in SVOC analyses and preparation is also demonstrated by acceptable participation in multiple proficiency testing programs (PTs) and daily Quality Control sample analyses. Documentation of analyst training is maintained on file within the department.

6.0 FACILITIES AND LABORATORY SAFETY

6.1 FACILITIES

The main area of the instrumentation laboratory in Building #1 has nearly 4500 square feet with approximately 220 square feet of bench area and an additional storage area of 210 square feet. The air handling system in this area is a 100-ton Trane split unit with natural gas for heating. The 4000 square feet of area in the extraction laboratory, contained in Building 5, includes roughly 330 square feet of bench area with 245 square feet of hood space. There is an additional 2000 square feet of storage for this laboratory. The air system is a 15-ton make-up unit plus 15-ton HVAC with electric heat. The physical and air-handling separations, between this laboratory and other ESC sections, prevent potential cross-contamination between solvent vapor generation and incompatible analytical processes. The laboratory reagent water is provided through the US Filter deionizer system. Waste disposal containers are located in the laboratory and Clean Harbors serves as ESC's waste disposal carrier as discussed in detail in Section 6.0 of the ESC Quality Assurance Manual. ESC's building information guides and site plan are shown in Appendix I.

6.2 LABORATORY SAFETY

- Laboratory access is limited when work is being performed.
- All procedures where chemicals are prepared or splashes may occur are conducted in laboratory exhaust hoods.
- ESC's laboratory safety guidelines are detailed in the *ESC Chemical Hygiene and Safety Plan.*

7.0 SAMPLING PROCEDURES

7.1 FIELD SAMPLING PROCEDURES, SAMPLE STORAGE, AND HANDLING

- Field Sampling procedure is described in Appendix III of this ESC Quality Assurance Manual. Sample information is recorded and kept on the ESC chain of custody and field logbooks.
- Matrices for SVOC environmental analyses include groundwater, wastewater, drinking water, soil, and sludge. Matrices for Industrial Hygiene analyses include: sorbent tubes, filters, or Organic Vapor Monitor (OVM) Badges.
- Sample containers, preservation methods and holding times vary depending on analyses requested. Please see determinative procedures for specific directions.
- Plastic containers or lids may NOT be used for the storage of samples due to possible contamination from the phthalate esters and other hydrocarbons.
- Environmental sample containers should be filled carefully to prevent any portion of the sample from coming into contact with the sampler's gloves causing possible phthalate contamination.

8.0 EQUIPMENT

8.1 EQUIPMENT LIST

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Semi-Volatiles Analysis
This table is subject to revision without notice

Item	*Manufacturer*	*Model*	*Instrument Name*	*#*	*Serial #*	*Location*
Gas Chromatograph 2	HP	6890	svcompa	2	US00004397	SVOC
Gas Chromatograph 7	Agilent	6890	svcompe	7	US10350064	SVOC
Gas Chromatograph 8	Agilent	6890	svcompp	8	DE00022534	SVOC
Gas Chromatograph 9	HP	6890	svcompj	9	US00029095	SVOC
Gas Chromatograph 10	Agilent	6890	svcompk	10	US00039655	SVOC
Gas Chromatograph 11	Agilent	6890	svcompn	11	US00040550	SVOC
Gas Chromatograph 12	Agilent	6890	svcompo	12	US00034155	SVOC
Gas Chromatograph 13	HP	6890	svcomps	13	US00010364	SVOC
Gas Chromatograph 14	HP	6890	svcompt	14	US00020581	SVOC
Gas Chromatograph 16	Agilent	6890	svcompv	16	US10212071	SVOC
Gas Chromatograph 17	Agilent	6890	svcompw	17	US10344078	SVOC
Gas Chromatograph 18	Agilent	6890	svcompd	18	US10351038	SVOC
Gas Chromatograph 19	Agilent	6890	svcompaa	19	CN10516070	SVOC
Gas Chromatograph 20	Agilent	6890	svcompab	20	CN10543031	SVOC
Gas Chromatograph 21	Agilent	7890	svcompae	21	CN 10730070	SVOC
Gas Chromatograph 22	Agilent	7890	svcompaf	22	CN 10730081	SVOC
Gas Chromatograph 23	Agilent	6890	svcompag	23	CN 92174366	SVOC
Gas Chromatograph 24	Agilent	6890	svcompah	24	CN 92174369	SVOC
Gas Chromatograph 25	Agilent	7890	svcompaj	25	CN 10091009	SVOC
Gas Chromatograph Detectors 3	Detectors	NPD/NPD	svcompo	3	N/A	SVOC
Gas Chromatograph Detectors 7	Detectors	FID	svcompe	7	N/A	SVOC
Gas Chromatograph Detectors 8	Detectors	FID	svcompp	8	N/A	SVOC
Gas Chromatograph Detectors 9	Detectors	FID	svcompj	9	N/A	SVOC
Gas Chromatograph Detectors 10	Detectors	ECD/ECD	svcompk	10	F) U11751 B) U11135	SVOC
Gas Chromatograph Detectors 11	Detectors	ECD/ECD	svcompn	11	F) U12482 B) U12481	SVOC
Gas Chromatograph Detectors 12	Detectors	FPD/FPD	svcompo	12	N/A	SVOC
Gas Chromatograph Detectors 13	Detectors	FID	svcomps	13	N/A	SVOC
Gas Chromatograph Detectors 14	Detectors	ECD/ECD	svcompt	14	F) U0418 B) U6632	SVOC

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Semi-Volatiles Analysis
This table is subject to revision without notice

Item	*Manufacturer*	*Model*	*Instrument Name*	*#*	*Serial #*	*Location*
Gas Chromatograph Detectors 16	Detectors	FID	svcompu	16	N/A	SVOC
Gas Chromatograph Detectors 17	Detectors	FID	svcompv	17	N/A	SVOC
Gas Chromatograph Detectors 18	Detectors	ECD/ECD	svcompd	18	F) U8422 B) U11613	SVOC
Gas Chromatograph Detectors 19	Detectors	ECD/ECD	svcompaa	19	F) U2620 B) U11614	SVOC
Gas Chromatograph Detectors 20	Detectors	ECD/ECD	svcompab	20	F) U8422 B) U8423	SVOC
Gas Chromatograph Detectors 21	Detectors	FID	svcompae	21	N/A	SVOC
Gas Chromatograph Detectors 22	Detectors	ECD/ECD	svcompaf	22	N/A	SVOC
Gas Chromatograph Detectors 23	Detectors	ECD/ECD	svcompag	23	F) U11733 B) U11734	SVOC
Gas Chromatograph Detectors 24	Detectors	ECD/ECD	svcompah	24	F) U13989 B) U13988	SVOC
Gas Chromatograph/Mass Spectrometer 1	Agilent	6890 GC/5973MSD	svcompf	1	GC CN10335001 MS US33220022	SVOC
Gas Chromatograph/Mass Spectrometer 2	Agilent	6890 GC/5973MSD	svcompc	2	GC US10409048 MS US35120400	SVOC
Gas Chromatograph/Mass Spectrometer 3	Agilent	6890 GC/5973MSD	svcompz	3	GC US00039611 MS US03940681	SVOC
Gas Chromatograph/Mass Spectrometer 4	Agilent	6890 GC/5973MSD	svcomph	4	GC CN10403067 MS US35120308	SVOC
Gas Chromatograph/Mass Spectrometer 5	Agilent	6890 GC/5973MSD	svcompi	5	GC US00024766 MS US91911297	SVOC
Gas Chromatograph/Mass Spectrometer 6	Agilent	6890 GC/5973MSD	svcompl	6	GC US00039647 MS US05040021	SVOC
Gas Chromatograph/Mass Spectrometer 7	Agilent	6890 GC/5973MSD	svcompm	7	GC ---------- MS US03940745	SVOC
Gas Chromatograph/Mass Spectrometer 9	Agilent	6890 GC/5973MSD	svcompx	9	GC CN10344042 MS US33220158	SVOC
Gas Chromatograph/Mass Spectrometer 10	Agilent	6890 GC/5973MSD	svcompy	10	GC CN10340045 MS US33220183	SVOC
Gas Chromatograph/Mass Spectrometer 11	Agilent	6890 GC/5975MSD		11	GC CN10509031 MS US60532657	SVOC
Gas Chromatograph/Mass Spectrometer 12	Agilent	7890 GC/5975MSD	svcompai	12	GC CN10728074/ MS 12-0706-1325	SVOC
Gas Chromatograph/Mass Spectrometer 13	Agilent	7890 GC/5975MSD	svcompak	13	GC CN10301081/ MS US10313621	SVOC
High Performance Liquid Chromatography	Agilent	1100 Series DAD/FLD	hplc1	1	DAD de01608402 FLD de23094489	SVOC
High Performance Liquid Chromatography	Agilent	1100 Series DAD/FLD	hplc2	2	DAD de30518420 FLD de11103457	SVOC
High Performance Liquid Chromatography	Agilent	1100 Series DAD	hplc3	3	DAD us64400711	SVOC
High Performance Liquid Chromatography	Agilent	1100 Series DAD/FLD	hplc4	4	DAD de43623013 FLD de92001880	SVOC

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Semi-Volatiles Analysis
This table is subject to revision without notice

Item	*Manufacturer*	*Model*	*Instrument Name*	*#*	*Serial #*	*Location*
Analytical Balance	Mettler Toledo	XS204			1122411619	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	3	1461	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	7	1462	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	6	1463	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	8	1464	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	10	1466	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	02	1468	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	04	1469	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	9	416870050003	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	5	406583020005	Ext. Lab
Capping station	Horizon	MARS X			snxc2225	Ext. Lab
Capping station	Horizon	MARS X			snxc2215	Ext. Lab
Centrifuge	Labnet	Z-400			2158	Ext. Lab
Concentration Chiller	Lauda	WKL 3200			2031	Ext. Lab
Concentration Chiller	Lauda	WKL 3200			2039	Ext. Lab
Furnace	Thermo Scientific				1882	Ext. Lab
HAA Shaker	Eberbach	6010-04			1834	Ext. Lab
HAA water Bath	Thermo Scientific	280 series			2033602-102	Ext. Lab
High Intensity Ultrasonic Processor	Misonix				1379	Ext. Lab
High Intensity Ultrasonic Processor	Misonix				1382	Ext. Lab
High Intensity Ultrasonic Processor	Misonix				1888	Ext. Lab
High Intensity Ultrasonic Processor	Misonix				1381	Ext. Lab
High Intensity Ultrasonic Processor	Misonix				1640	Ext. Lab
Microwave	CEM	MARS X			1507	Ext. Lab
Microwave	CEM	MARS X			1518	Ext. Lab
OG concentrator	Horizon	SpeedVap III			1534	Ext. Lab
OG concentrator	Horizon	SpeedVap III			SN04-2020	Ext. Lab
OG SPE extractor	Horizon	SPE-DEX 3000			1481	Ext. Lab
OG SPE extractor	Horizon	SPE-DEX 3000			1482	Ext. Lab
OG SPE extractor	Horizon	SPE-DEX 3000			1483	Ext. Lab
OG SPE extractor	Horizon	SPE-DEX 3000			1484	Ext. Lab
Separatory funnel rotators	ATR				1510	Ext. Lab
Separatory funnel rotators	ATR				1511	Ext. Lab
Separatory funnel rotators	ATR				1512	Ext. Lab
Separatory funnel rotators	ATR				1513	Ext. Lab
Separatory funnel rotators	ATR				1514	Ext. Lab

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Semi-Volatiles Analysis ***This table is subject to revision without notice***						
Item	***Manufacturer***	***Model***	***Instrument Name***	***#***	***Serial #***	***Location***
Separatory funnel rotators	ATR				1515	Ext. Lab
Separatory funnel rotators	ATR				1516	Ext. Lab
Separatory funnel rotators	ATR				2055	Ext. Lab
Separatory funnel rotators	ATR				2056	Ext. Lab
Separatory funnel rotators	ATR				2057	Ext. Lab
SPE Water Extractor	UCT				1944	Ext. Lab
SPE Water Extractor	UCT				1945	Ext. Lab
Water Bath Sonicator	Branson	8510			RPA040384175E	Ext. Lab
Vacuum Pump	Gast				0908605639	Ext. Lab
Vacuum Pump	Gast				0908605639	Ext. Lab

8.2 EQUIPMENT PREVENTIVE MAINTENANCE, EQUIPMENT CALIBRATION

INSTRUMENT	**P. M. DESCRIPTION**	**FREQUENCY**
Analytical Balances	•Check with Class "I" weights	Daily-tolerance $\pm$0.1%
Analytical Balances	•Service/Calibration (semiannual contract maintenance and calibration check)	Semiannually
Refrigerators & Incubators	•Maintenance service	As needed - determined by daily temperature performance checks
Gas Chromatograph Detectors: ECD	•Bake off or Replace •Perform wipe leakage test	As needed - when deterioration is noticeable Annually
Gas Chromatograph Detectors: FID	•Change Quartz jet; clean; replace flame tip	As needed - when deterioration is noticeable
Gas Chromatograph/Mass Spectrometer	•Autotune Report	Inspected daily
Gas Chromatograph/Mass Spectrometer	•Clean ion source	As needed to maintain high mass resolution
Gas Chromatograph/Mass Spectrometer	•Replace vacuum pump oil	Every 6 months
Gas Chromatographs/Mass Spectrometer & Gas Chromatographs	•Replace septa and liner	As needed to maintain injection port inert
Gas Chromatographs/Mass Spectrometer & Gas Chromatographs	•Replace column	When separation begins to degrade
High Intensity Ultrasonic Processor - Misonix	•Check tuning criteria	Daily with use
Infrared Spectrophotometer - Foxboro Miran 1A	•Optics alignment or replacement	As needed when response begins to deteriorate

8.3 STANDARDS AND REAGENTS

Table 8.3A: Standard stock sources, description and calibration information.
This table is subject to revision without notice

Method	Vendor*	Description	Calibration	Storage Req.	Expiration
8310	Ultra	Aromatic Hydrocarbon	Primary	4° ± 2°C	6 months
	NSI	8310/610 Spike	Second Source	4° ± 2°C	6 months
DRO	NSI	DRO #2 Cal Mix	Primary	-10°C to –20°C	6 months
	NSI	DRO #2 Spike	Second Source	-10°C to –20°C	6 months
EPH TN DRO	NSI	TN-EPH Calibration Mix	Primary	-10°C to –20°C	6 months
	NSI	EPH-TN Spike	Second Source	-10°C to –20°C	6 months
RRO	NSI	30W Oil	Primary	-10°C to –20°C	6 months
PCB	Accustd	Aroclor PCB Kit	Primary	4° ± 2°C	6 months
	NSI	1260 Spike	Second Source	4° ± 2°C	6 months
Chlordane	Restek	Chlordane Mix	Primary	4° ± 2°C	6 months
Toxaphene	Restek	Toxaphene	Primary	4° ± 2°C	6 months
Pesticides	Ultra	Pest Mix	Primary	4° ± 2°C	6 months
	NSI	Pest Spike Mix	Second Source	4° ± 2°C	6 months
Herbicides	NSI	Custom Herbicide Mis	Primary	4° ± 2°C	6 months
	NSI	Herb Spike Mix	Second Source	4° ± 2°C	6 months
	Ultra/NSI	OP Cal Mix A, B	Primary	4° ± 2°C	6 months
	NSI	OP Spike Mix A, B	Second Source	4° ± 2°C	6 months
507 NP Pest	Ultra/NSI	507 Cal Mix	Primary	4° ± 2°C	2 months
	NSI	NP Pest Spike	Second Source	4° ± 2°C	2 months
THAA	Ultra/Accustd	HAA Cal Mix	Primary	-10°C to –20°C	6 months
	Accustd/NSI	HAA Spike	Second Source	-10°C to –20°C	6 months
8270	Ultra	Custom Std Mega Mix	Primary	4° ± 2°C	6 months
	Restek	Spike Mix	Second Source	4° ± 2°C	6 months
8330	Restek	Mix1, Mix2, PETN	Primary	4° ± 2°C	6 months
	Ultra, Chemservice	Mix1, Mix2, PETN	Second Source	4° ± 2°C	6 months
8011, 504.1	Accustd	504.1 Cal Mix	Primary	4° ± 2°C	1 month
	NSI	Spike Mix	Second Source	4° ± 2°C	1 month
Industrial Hygiene	Chemservice	Neat	Primary & Secondary	4° ± 2°C	6 months

**Equivalent Providers may be utilized.*

TABLE 8.3B: Working Standard Concentrations

This table is subject to revision without notice

Organic Compounds	Method #	Standard Concentrations	Storage Requirements	Expiration
Semi-Volatiles	625, SM6410B 20th, 8270C	1,2,4,8,12,16,20,30,40,50,80 (low level and regular)	4° ± 2°C	6 months
PCB's	608, SM6431B 20th, 8082	0.05, 0.1, 0.25, 0.5, 0.75, 1.0 µg/mL	4° ± 2°C	6 months
Pesticides	608, SM 6630C, 8081A, 508	0.05, 0.10, 0.20, 0.40, 0.60, 0.80 µg/mL	4° ± 2°C	6 months
Chlordane and/or Toxaphene	608, SM 6630C, 8081A, 508	0.1, 0.5, 1.0, 2.5, 5.0, 10.0 µg/mL	4° ± 2°C	6 months
PCB Arochlor 1016/1260	8082	0.05, 0.10, 0.25, 0.50, 0.75, 1.0, µg/mL	4° ± 2°C	6 months
PCB Arochlor's 1221, 1232, 1242, 1248, 1254	8082	0.5 µg/mL	4° ± 2°C	6 months
Herbicides	515.2, 8151A, SM6640C 20th	0.02, 0.05, 0.1, 0.2, 0.5, 1.0 mg/L	4° ± 2°C	6 months
OP and NP Pesticides	507 by dual-NPD, 1657A, 8141A by dual-FPD	1.0, 2.0, 5.0, 10.0, 15.0, 20.0 ug/L	4° ± 2°C	6 months
PAHs	8310, 610, SM6440B 20th 8270C SIM	0.04, 0.20,1.0,5.0,8.0,20.0,30.0,40.0 ug/L 0.025, 0.05, 0.10, 0.50, 2.0, 4.0, 10.0, 20.0 ug/L	4° ± 2°C	6 months
Nitroaromatics & Nitramines	8330	.05, 0.1, 0.25, 0.5, 2.0, 5.0, 10.0, 25.0 mg/L	NA*	NA*
EPHTN	EPH TN	10000, 6000, 4000, 2000, 1000, 400, 200, 100 mg/L	NA*	NA*
DRO	OA2 , 8015Mod, LA TPH D, LA TPH O, OHIO DRO	10000, 5000, 3000, 2000, 1000, 400, 200, 100 mg/L	NA*	NA*
MADEP EPH	MADEP EPH	Aromatics C11-C22: 17, 85, 425, 850, 1700, 3400, 6800 mg/L Aliphatic C9 - C18: 6, 30, 150, 300, 600, 1200, 2400 mg/L Aliphatic C19 - C36: 8, 40, 200, 800, 1600, 3200 mg/L	NA*	NA*
EDB, DBCP, TCP	8011, 504.1	0.01, 0.02, 0.05, 0.10, 0.25, 0.5 ug/L	NA*	NA*
THAA's	552.2	1, 2, 4, 10, 20, 30, 40, 50 ug/L	NA*	NA*
FL PRO	FL PRO	85, 850, 2550, 4250, 5950, 8500 mg/l	NA*	NA*
TX TPH	TX1005	Individual Ranges- 4.5, 10, 25, 50, 125, 250, 500, 1250, 2500 ppm. Total Range- 9.0, 20, 50, 100, 250, 500, 1000, 2500, 5000 ppm.	NA*	NA*
IH - Aromatics	NIOSH/OSHA.	10-10000 ug/sample	NA*	NA*
DROMO PAHMO	MO DRO/PAH by 8270	300, 500, 1000, 2000, 4000, 6000, 8000, 10000 mg/L 1.0, 5.0, 10, 20, 40, 60, 80, 100 ug/L	4° ± 2°C	6 months

* indicates solutions are prepared fresh daily as needed.

8.4 INSTRUMENT CALIBRATION

608/8081A or B/SM6630C - Chlorinated Pesticides – SOP Number 330344

The gas chromatograph is calibrated using either the internal or external standard calibration model. A standard curve is prepared using a minimum of three concentration levels for each compound of interest for method 608. A minimum of five concentration levels is necessary for methods 8081A/B and SM6630C. The calibration range must represent the typical environmental sample concentration and include the RL as the lowest calibration point. The linear range of the instrument must also be monitored to ensure that the maximum calibration point is within detection range. The calibration standards are tabulated according to peak height or area responses against concentration or ISTD response for each compound and calibration/response factors are calculated. If performing analysis by method 608 and the response factors of the initial calibration are < 10 % RSD for method 608 and 20% RSD for methods 8081A/B and 6630C over the calibration range, the average RF can be used for calculations. Alternatively, when the response factor criteria is exceeded, the analyst may utilize a linear calibration model of response ratios (i.e. Area/Ref. Area or Amt./Ref Amt.) for quantitation providing that the correlation coefficient is at least 0.990.

During the analytical sequence, the stability of the initial calibration curve is verified, following every 20th sample, by the analysis of a continuing calibration verification (CCV) standard. The CCV must recover within 15% of the expected concentration for each analyte. The concentration of the continuing check standard must be routinely varied to verify the entire calibration range.

At daily instrument startup and in lieu of performing an entire initial calibration, the most recent calibration curve may be verified by the analysis of initial calibration verification standard (ICV). If the response for any analyte in this check varies from the predicted response by more than $\pm$15%, the analysis must be repeated using fresh standard. If the standard still does not meet the acceptance criteria, a new initial calibration curve must be generated.

An independent, or second source, calibration verification standard (SSCV) is analyzed after each initial calibration and should recover within $\pm$20% of the expected concentration for each analyte. When analyte responses in field samples exceed the calibration range, the sample is diluted and re-analyzed.

507 - Nitrogen/Phosphorus Pesticides - SOP Number 330348

The gas chromatograph is calibrated using the external standard procedure. A standard curve is prepared using a minimum of three concentration levels for each compound of interest for method 507. The calibration range must represent the typical environmental sample concentration and include the RL as the lowest calibration point. The linear range of the instrument must also be monitored to ensure that the maximum calibration point is within detection range. The calibration standards are tabulated according to peak height or area responses against concentration for each compound and response factors are calculated. If the response factors of the initial calibration are ≤20 % RSD over the calibration range, the average RF can be used for calculations. Alternatively, when the response factor criteria is exceeded, the analyst may utilize a linear calibration model of response ratios (i.e. Area/Ref. Area or Amt./Ref Amt.) for quantitation providing that the correlation coefficient is at least 0.990.

During the analytical sequence the stability of the initial calibration is verified, following every 10th sample and at the end of the sequence, by the analysis of a continuing calibration verification (CCV) standard. The CCV must recovery within 20% of the expected concentration for each analyte. The concentration of the continuing check standard must be routinely varied to verify the entire calibration range.

At daily instrument startup and in lieu of performing an entire initial calibration, the most recent calibration curve may be verified by the analysis of check calibration verification standard (CCV). If the response for any analyte in this check varies by more than ±20% from the initial calibration, the analysis must be repeated using fresh standard. If the standard still does not meet the criteria, a new initial calibration curve must be generated.

A Quality Control Sample (QCS) is analyzed at minimum quarterly to verify calibration standards.

552.2 - HAA - SOP Number 330319

The gas chromatograph is calibrated using the internal standard procedure. A standard curve is prepared using a minimum of five concentration levels for each compound of interest. The calibration range must represent the typical environmental sample concentration and include the RL as the lowest calibration point. The linear range of the instrument must also be monitored to ensure that the maximum calibration point is within detection range. The calibration standards are tabulated according to peak height or area responses against concentration for each compound and response factors are calculated. If the response factors of the initial calibration are ≤20 % RSD over the calibration range, the average RF can be used for calculations. Alternatively, when the response factor criteria is exceeded, the analyst may utilize a linear calibration model of response ratios (i.e. Area/Ref. Area or Amt./Ref Amt.) for quantitation providing that the correlation coefficient is at least 0.990.

During the analytical sequence the stability of the initial calibration is verified, following every 10th sample and at the end of the sequence, by the analysis of a continuing calibration verification (CCV) standard. The response of the analytes in the CCV must not vary more than 30% from the initial calibration.

At daily instrument startup and in lieu of performing an entire initial calibration, the most recent calibration curve may be verified by the analysis of check calibration verification standard (CCV). If the response for any analyte in this check varies by more than ±30% from the initial calibration, the analysis must be repeated using fresh standard. If the standard still does not meet the criteria, a new initial calibration curve must be analyzed.

A Quality Control Sample (QCS) is analyzed at minimum quarterly to verify calibration standards.

515.1, 8151A, SM6640B – Herbicides - SOP Number 330320

The gas chromatograph is calibrated using the external standard procedure. A standard curve is prepared using a minimum of five concentration levels for each analyte of interest. The calibration range must represent the typical environmental sample concentration and include the RL as the lowest calibration point. The linear range of the instrument must also be monitored to ensure that the maximum calibration point is within detection range. The calibration standards are tabulated according to peak height or area responses against concentration for each compound and response factors are calculated. If the response factors of the initial calibration are ≤20 % RSD over the calibration range, the average RF can be used for calculations. Alternatively, when the response factor criteria is exceeded, the analyst may utilize a linear calibration model of response ratios (i.e. Area/Ref. Area or Amt./Ref Amt.) for quantitation providing that the correlation coefficient is at least 0.990.

During the analytical sequence, the stability of the initial calibration is verified following every 10th sample and at the end of the sequence by the analysis of a continuing calibration verification (CCV) standard. The CCV must recovery within 15% of the expected concentration for each analyte for method 8151A and within 20% for method 6640C. The value of the CCV can exceed the criteria for a single compound provided that all samples in the analytical batch are BDL (below detection limit). The concentration of the continuing check standard must be routinely varied to verify the entire calibration range.

At daily instrument startup and in lieu of performing an entire initial calibration, the most recent calibration curve may be verified by the analysis of check calibration verification standard (CCV). If the response for any analyte in this check varies from the predicted response by more than ±15%, the analysis must be repeated using fresh standard. If the standard still does not meet the criteria, a new initial calibration curve must be generated.

An independent, or second source, calibration verification standard (SSCV) is analyzed after each initial calibration and should recover within ±20% of the expected concentration for each analyte. When sample responses exceed the calibration range, the sample is diluted and re-analyzed.

8141A, 1657A – Organophosphorus Pesticides - SOP Number 330318

The gas chromatograph is calibrated using the external standard procedure. A standard curve is prepared using a minimum of five concentration levels for each analyte of interest. The calibration range must represent the typical environmental sample concentration and include the RL as the lowest calibration point. The linear range of the instrument must also be monitored to ensure that the maximum calibration point is within detection range. The calibration standards are tabulated according to peak height or area responses against concentration for each compound and response factors are calculated. If the response factors of the initial calibration are ≤20 % RSD over the calibration range, the average RF can be used for calculations. Alternatively, when the response factor criteria is exceeded, the analyst may utilize a linear calibration model of response ratios (i.e. Area/Ref. Area or Amt./Ref Amt.) for quantitation providing that the correlation coefficient is at least 0.990.

During the analytical sequence, the stability of the initial calibration is verified following every 10^{th} sample and at the end of the sequence by the analysis of a continuing calibration verification (CCV) standard. The CCV must recovery within 15% of the expected concentration for each analyte. The concentration of the continuing check standard must be routinely varied to verify the entire calibration range.

At daily instrument startup and in lieu of performing an entire initial calibration, the most recent calibration curve may be verified by the analysis of check calibration verification standard (CCV). If the response for any analyte in this check varies from the predicted response by more than ±15%, the analysis must be repeated using fresh standard. If the standard still does not meet the criteria, a new initial calibration curve must be generated.

An independent, or second source, calibration verification standard (SSCV) is analyzed after each initial calibration and should recover within ±20% of the expected concentration for each analyte. When sample responses exceed the calibration range, the sample is diluted and re-analyzed.

625, 8270C or D, SM6410B - Base/Neutrals/Acids by GC/MS: Semivolatile Organics – SOP Number 330345

Detector mass calibration is performed using the autotune function of the GC/MS analytical system and PFTBA (Perfluorotributylamine). Following verification of the appropriate masses, the instrument sensitivity is verified by injecting a tuning solution containing decafluorotriphenylphosphine (DFTPP), benzidine, pentachlorophenol and DDT. The DFTPP must meet the ion abundance criteria specified by the EPA published method.

Benzidine and pentachlorophenol are reviewed for tailing and DDT is reviewed for breakdown to DDE and DDD. Successful tuning must occur every 12 hours for method 8270C/D and every 24 hours for method 625, except where noted in the determinative SOP.

Following successful tuning, the GC/MS is calibrated using the internal standard procedure. A standard curve is prepared using a minimum of three standards for method 625 and five standards for method 8270C/D and SM6410B. The calibration standards are tabulated according to peak height or area against concentration and the concentrations and responses of the internal standard analytes. The results are used to determine a response factor for each analyte in each standard injected. A calibration curve is the constructed and is determined to be acceptable if each analyte meets the criteria specified in the determinative method. When this condition is met, linearity through the origin can be assumed and the average RF can be used in place of a calibration curve. Initial calibration that does not meet these requirements will not be accepted and recalibration must be performed. Linear regression can be used for target compounds exceeding the 15% criteria, providing that the correlation coefficient is 0.990 or better. USACE projects must meet a correlation coefficient of 0.995 or better. The initial calibration range must represent the typical environmental sample and include the RL as the lowest calibration point. The linear range of the instrument must be monitored to ensure that the maximum calibration point is within the range.

A second source calibration verification standard is analyzed after each calibration and should recover within 20% for all CCC compounds and within 40% for other analytes of interest, with the exception of analytes known to perform poorly that will meet historical limits. Following successful calibration, the analysis of field and QC samples may begin. Analysis may be performed only during the timeframe of a valid tuning cycle (12 hours for 8270C/D and 24 hours for 625). Following the expiration of the tuning clock, the instrument must be retuned and either re-calibrated or existing calibration may be re-verified.

For 8270C/D analyses, daily calibration verification includes successful demonstration of DFTPP sensitivity and the injection of a mid-level CCV standard containing all the target analytes of interest. The DFTPP tune must meet the ion abundance criteria specified within the published method. The CCC must achieve the criteria of ±20% RSD. Each internal standard in the CCV must recover between -50% to + 100%, when compared to the same internal standard compound in the mid-point standard of the initial calibration curve. Additionally, if the retention time of an internal standard changes by more than 30 seconds from the retention time of the same internal standard in the mid-level standard of the most recent initial calibration, the system must be evaluated, corrected, and possibly re-calibrated.

For 625 analyses, daily calibration verification is accomplished by a successful demonstration of DFTPP sensitivity and the injection of a mid-level CCV standard containing all the target analytes of interest. The DFTPP tune must meet the same ion abundance criteria as the 8270C analysis and the CCV standard must recover within 20 % of predicted response for all analytes of interest.

8310, 610, SM6640B - PAH's by HPLC - SOP Number 330322

610: A standard curve is prepared using a minimum of three concentration levels for each compound of interest. If the response factors are < 10 % RSD over the working range, the average RF can be used for calculations

8310 & SM6640B: Perform calibration using a minimum of 5 points. If the response factors are < 20 % RSD over the working range, the average RF can be used for calculations or linear regression may be used providing that the correlation coefficient for each analyte of interest is 0.990 or better. USACE projects must meet a correlation coefficient of 0.995 or better. The regression line must never be forced through the origin.

The initial calibration standards are tabulated according to peak height or area responses against concentration for each compound and response factors are calculated. Alternatively, the results can be used to plot a calibration curve of response ratios (Area/Ref. Area) vs (Amt./Ref Amt.). The calibration range must represent the typical environmental sample and include the RL as the lowest calibration point. The linear range of the instrument must be monitored to ensure that the maximum calibration point is within the range. A second source calibration verification standard is analyzed after each calibration and should meet criteria of ±20%.

A continuing calibration verification (CCV) must be run at the beginning of each run and every 10 samples thereafter. The continuing calibration standard is prepared from the same source as the calibration curve and must perform within ±15% of the actual value. The CCV must represent the midpoint of the calibration range.

8330A/B/C – Nitroaromatics/Nitrosamines - SOP Number 330323

A standard curve is prepared using a minimum of five concentration levels for each compound of interest. Experience indicates that a linear calibration curve with zero intercept is appropriate for each analyte. Therefore, a response factor for each analyte can be taken as the slope of the best-fit regression line. The correlation coefficient for each analyte of interest is 0.990 or better. The calibration range must represent the typical environmental sample and include the RL as the lowest calibration point. The linear range of the instrument must be monitored to ensure that the maximum calibration point is within the range. A second source calibration verification standard is analyzed after each calibration and should meet the criteria of $\pm$20%.

Daily calibration is accomplished through the analysis of midpoint calibration standards, at a minimum, at the beginning of the day, and singly after the last sample of the day (assuming a sample group of 10 samples or less). Obtain the response factor for each analyte from the mean peak heights or peak areas and compare it with the response factor obtained for the initial calibration. The mean response factor for the daily calibration must agree within ±20% of the response factor of the initial calibration. If this requirement is not met, a new initial calibration must be obtained.

8015B/C/D or State Specific Method - DRO/RRO - Various SOPs

Certain state accreditation/registration programs may have specific requirements for calibration and analysis that must be met. Those requirements supersede the general guidance provided in this section and are addressed in the determinative SOP. Generally, for 8015B/C/D analysis, the gas chromatograph is calibrated using the external standard procedure. A standard curve is prepared using a minimum of five concentration levels for each analyte of interest. The calibration range must represent the typical environmental sample concentration and include the RL as the lowest calibration point. The linear range of the instrument must also be monitored to ensure that the maximum calibration point is within detection range. The calibration standards are tabulated according to peak height or area responses against concentration for each compound and response factors are calculated. If the response factors of the initial calibration are $\leq$20 % RSD over the calibration range, the average RF can be used for calculations. Alternatively, when the response factor criteria is exceeded, the analyst may utilize a linear calibration model of response ratios (i.e. Area/Ref. Area or Amt./Ref Amt.) for quantitation providing that the correlation coefficient is at least 0.990. USACE projects must meet a correlation coefficient of 0.995 or better.

During the analytical sequence, the stability of the initial calibration is verified following every 10th sample and at the end of the sequence by the analysis of a continuing calibration verification (CCV) standard. Typically, the CCV must recovery within 15% of the expected concentration for each analyte for method 8015B/C/D; however state specific limits for the CCV may vary. See the specific SOP or published method for more guidance. The concentration of the continuing check standard must be routinely varied to verify the entire calibration range.

At daily instrument startup and in lieu of performing an entire initial calibration, the most recent calibration curve may be verified by the analysis of check calibration verification standard (CCV). If the response for any analyte in this check varies from the predicted response by more than ±15% of the expected concentration for each analyte for method 8015B/C/D or more than state specified limits, the analysis must be repeated using fresh standard. If the standard still does not meet the criteria, a new initial calibration curve must be generated.

An independent, or second source, calibration verification standard (SSCV) is analyzed after each initial calibration and should meet criteria of ±20% of the expected concentration for each analyte. When sample responses exceed the range of the standard curve, the sample is diluted to a concentration suspected to be within the calibration range and re-analyzed.

NIOSH 1501 modified – Aromatic Hydrocarbons in Air - SOP Number 330303

The gas chromatograph is calibrated using the external standard procedure. A standard curve is prepared using a minimum of six concentration levels for each analyte of interest. The calibration range must represent the typical sample concentration. The linear range of the instrument must be monitored to ensure that the maximum calibration point is within detection range. The calibration standards are tabulated according to peak height or area responses against concentration for each compound and response factors are calculated. If the response factors of the initial calibration are ≤15% RSD over the calibration range, the average RF can be used for calculations. Alternatively, when the response factor criteria is exceeded, the analyst may utilize a linear calibration model of response ratios (i.e. Area/Ref. Area or Amt./Ref Amt.) for quantitation providing that the correlation coefficient is at least 0.990. When sample responses exceed the range of the standard curve, the sample is diluted and re-analyzed. A mid-level independently prepared calibration verification standard (ICV) is analyzed following each initial calibration and should meet criteria of ±15% of the expected concentration for each analyte. Following each 10 samples and at the end of the analytical sequence, a continuing calibration verification standard is analyzed to demonstrate the continued stability of the analytical sequence. This standard should meet criteria of ±15% of the expected concentration for each analyte.

An independent, or second source, calibration verification standard (SSCV) is analyzed after each initial calibration and should meet criteria of ±20% of the expected concentration for each analyte. When sample responses exceed the range of the standard curve, the sample is diluted to a concentration suspected to be within the calibration range and re-analyzed.

Desorption Efficiency for each lot of sorbent media is determined for each analyte of interest. Desorption Efficiency for analytes on badges has been determined and is available from the manufacturer. The reporting limit from media must be verified with each batch of samples analyzed. Additionally, a Laboratory Control Sample pair (LCS & LCSD) is prepared on media for each batch of samples analyzed.

8.5 ACCEPTANCE/REJECTION OF CALIBRATION

Organic Chemistry

The initial calibration curve is compared with previous curves for the same analyte. All new standard curves are immediately checked with a secondary source or laboratory control standard prepared from a separate source than those used for calibration. All curves are visually reviewed to ensure that acceptable correlation represents linearity. Calibration curves may be rejected for nonlinearity, abnormal sensitivity, or poor response of the laboratory control standard.

Continuing calibration verification is performed on each day that initial calibration is not performed and following every tenth sample. If a check standard does not perform within established criteria then the instrument will undergo an evaluation to determine the cause. Once the issue is corrected, all samples between the last in control standard and the first out of control check will be re-analyzed.

TABLE 8.5: INSTRUMENT CALIBRATION

Instrument (Analysis)	Calibration Type	Minimum Number of Standards	Type of Curve	Acceptance/ Rejection Criteria	Frequency
Gas Chromatography	Initial	3 (600 series methods) - 5 (other) cal.stds	Avg. RF or Linear	8081A, 8151A, 6640C, 8141A, 657A: Must be ≤20% RSD 608 - ≤10% RSD	As needed
(Pest/PCB, Herbicides, Organophos/ Organonitrogen Pesticides)	Second Source	1 Second Source		+/- 20% of true value	With each calibration
	Daily / Continuing	1/10		Must be within 15% of the initial calibration curve, 20% for 6640C.	Beginning, every 10 and ending
HPLC (PAH and Explosive)	Initial	3 (600 series methods) 5 (other) cal.stds	Avg. RF or Linear	8310, 8330: Must be ≤20% RSD 610 - ≤10% RSD	As needed
	Second Source	1 Second Source		+/- 20% of true value	With each calibration
	Daily / Continuing	1/10		Must be within 15% of the initial calibration curve.	Beginning, every 10 and ending.
GC/MS Semi-volatiles 8270C/D	Initial	At least 5 cal. stds	Avg. RF or Linear	8270C - Must be ≤15% RSD, CCCs must be ≤ 30% RSD, Linear regression: 0.990 per method or 0.995 for USACE 8270D - Must be ≤20% RSD for target analytes, Linear regression: 0.990 per method or 0.995 for USACE	As needed
	Second Source	1 Second Source		Should recover within 20% for all CCC compounds and within 40% for other analytes of interest, with the exception of analytes known to perform poorly	With each calibration
	Daily / Continuing	Tune & CCV		Must pass established method criteria. See SOP.	Every 12 hours per method
GC/MS Semi-volatiles 625	Initial	3 cal.stds	Avg. RF or Linear	625 - ≤35% RSD all compounds	As needed
	Second Source	1 Second Source		Should recover within 20% for all CCC compounds and within 40% for other analytes of interest, with the exception of analytes known to perform poorly	With each calibration
	Daily / Continuing	Tune & CCV every 24 hours		Must pass established method tuning criteria; 625: CCV must be ≤20% difference for all compounds,	Every 24 hours
HAA 552.2	Initial	5 cal.stds	Avg. RF or Linear	≤30% RSD all compounds	As needed
	Second Source(QCS)	1 Second Source		±30% of true value	Quarterly
	Daily / Continuing	1/10		CCV must be ≤30% difference for all compounds,	Beginning, every 10 and ending

TABLE 8.5: INSTRUMENT CALIBRATION					
Instrument (Analysis)	**Calibration Type**	**Minimum Number of Standards**	**Type of Curve**	**Acceptance/ Rejection Criteria**	**Frequency**
Pesticides 507	Initial Second Source(QCS) Daily / Continuing	5 cal.stds 1 Second Source 1/10	Avg. RF or Linear	≤20% RSD all compounds ±20% of true value CCV must be ≤20% difference for all compounds,	As needed Quarterly Beginning, every 10 and ending
DRO –8015, State Programs* * Or per state requirement	Initial Second Source Daily / Continuing	5 cal.stds 1 Second Source 1/10	Avg. RF or Linear	8015B/C/D - ≤20% RSD all compounds ±20% of true value CCV must be ≤15% difference for all compounds,	As needed With each calibration Beginning, every 10 and ending
NIOSH 1501 mod.	Initial ICV Continuing	6 cal.stds 1 Independent Prep. 1/10	Avg. RF or Linear	≤15% RSD all compounds ±15% of true value ±15% of true value	Daily With each calibration Beginning, every 10 and ending

9.0 LABORATORY PRACTICES

9.1 REAGENT GRADE WATER

ASTM Type I grade water.

9.2 GLASSWARE WASHING AND STERILIZATION PROCEDURES

Organic laboratory glassware is washed in a non-phosphate detergent and warm tap water. Before washing, all writing and large deposits of grease are removed with acetone. Glassware is then rinsed with: tap water, "No Chromix" solution, tap water, and deionized (DI) water. It is then solvent rinsed in the following order: methanol, acetone, and then methylene chloride. Glassware is stored in designated drawers or on shelves, inverted if possible. All glassware is rinsed with the required solvent for the particular extraction protocol prior to use.

10.0 ANALYTICAL PROCEDURES

10.1 A list of laboratory SOP's associated with the semi-volatile laboratory can be found in the following table:

TABLE 10.1: SEMI-VOLATILE DEPARTMENT SOP'S

This table is subject to revision without notice

SOP #	Title
	Preparatory SOP's
330702	Separatory Funnel Liquid-Liquid Extraction 3510C
330702A	Separatory Funnel Liquid-Liquid Extraction 3510C for Minnesota Samples
330705	Ultrasonic Extraction 3550B
330707	Microwave Extraction 3546
330708	Buchi Syncore Concentration System
330743	Solid Phase Extraction
330754	Waste Dilution for SVOC's 3580A
330755	PCB in Oil Waste Dilution
	Extract Cleanup SOP's
330739	Silica Gel Cleanup 3630C
330740	Acid Cleanup 3665A
330741	Sulfur Cleanup 3660C
330742	Florisil Cleanup 3620B
	Semi-Volatiles Analysis SOPs
330303	Organics on Charcoal Tubes (includes badges)
330318	Organophosphorus Pesticides 8141A/ 1657A/ 614/ 622
330319	THAA's 552.2
330320	Chlorinated Herbicides by Gas Chromatography 8151A/ SM6640B
330322	PAH's by HPLC 8310/ 610/ SM6440B
330323	Explosives by HPLC 8330
330324	Carbamates by HPLC 531.1/ SM6610B
330343	PCB's 8082 & A
330344	Pesticides and PCBS by Gas Chromatography 8081A&B/ 608/ SM6630C
330345	Semi-volatile Organics by GC/MS using Capillary Column 8270C & D/ 625/ SM6410B
330346	EDB in Drinking Water by GC ECD 8011/ 504.1
330348	NP Pesticides in Drinking Water by GC NPD 507
330349	Chlorinated Pesticides in Drinking Water by GC ECD 508
330352	Method for Determination of Extractable Petroleum Hydrocarbons by GC/FID – DRO-KY, TN EPH, TPH-AZ, DRO CA and OH by Modified Method 8015. Includes Wyoming LAUST Requirements
330353	NC - Extractable Petroleum Hydrocarbons
330355	Florida PRO, WI DRO and CT ETPH
330356	TX TPH 1005/1006
330358	OA2 & NWTPH-Dx
330359	AK 102/103
330360	DRO Wisconsin/Minnesota

11.0 QUALITY CONTROL CHECKS

NOTE: For specific guidance on each determinative method, including required quality control and specific state requirements/modifications, refer to the relevant laboratory standard operating procedure(s).

11.1 ESC participates in proficiency testing (PT's) in support of various laboratory accreditations/recognitions. Environmental samples are purchased from Environmental Resource Associates (ERA). The WS, WP and solid matrix studies are completed every 6 months. For industrial hygiene accreditation, PTs are administered by AIHA. PT samples are received and analyzed by method according to the vendor's instructions and according to ESC SOP.

11.2 Initial Demonstrations of Capability (IDOC's) are performed during new analyst training and/or prior to acceptance and use of any new method/instrumentation. Continuing Demonstration of Capability (CDOC's) must be updated at least annually. The associated data is filed within the department and available for review.

11.3 Matrix Spike and Matrix Spike Duplicates are performed on each batch of samples analyzed depending on analytical method requested.

11.4 A Laboratory Control Sample (LCS) and LCS Duplicate are analyzed one per batch of samples.

11.5 A method preparation blank is performed per batch of samples processed. If one-half the reporting limit [RL] is exceeded, the laboratory shall evaluate whether re-processing of the samples is necessary, based on the following criteria:

- The blank contamination exceeds a concentration greater than 1/10 of the measured concentration of any sample in the associated preparation batch or
- The blank contamination is greater than 1/10 of the specified regulatory limit.

The concentrations of common laboratory contaminants shall not exceed the reporting limit. Any samples associated with a blank that fail these criteria shall be reprocessed in a subsequent preparation batch, except when the sample analysis resulted in non-detected results for the failing analytes.

11.6 For Industrial Hygiene analyses (sorbent tubes and badges), a media blank will be prepared with each batch of samples. In addition, a media reporting limit verification will be prepared with each batch of samples. For accuracy and precision determinations, a LCS/LCSD pair will be spiked on media then desorbed and analyzed concurrently with every batch of field samples.

12.0 DATA REDUCTION, VALIDATION AND REPORTING

12.1 DATA REDUCTION

The analyst performs the data calculation functions and is responsible for the initial examination of the finished data. Data reduction steps applied to the raw data are outlined in *SOP 030201 Data Handling and Reporting.* The Quality Control Department performs the secondary review of the data package using the ESC SOP #030227, *Data Review*. The QC Reviewer verifies that the analysis has performed as required and meets method criteria, all associate data is present and complete, and also ensures that any additional documentation is completed as required (i.e. Ohio VAP checklists, required flags on test reports, etc.)

TABLE 12.1 Data Reduction Formulas

PARAMETER	FORMULA
GC and HPLC	response of sample analyte {*area*} x final extract volume {*mL*} x dilution response factor {*area/(mg/mL)*} x initial extract volume-mass {*mL or g*} *Calculations performed by HP Enviroquant Software*
GC/MS	response of analyte {*area*} x extract volume {*mL*} x dilution x int. std amt. {*area*} response factor {*area/(mg/mL)*} x initial volume-mass {*mL or g*} x int. std cal. {area} *Calculations performed by HP Enviroquant Software*
GC - IH	Sample conc. (front tube + back tube) (*ug*) – blank conc. (front tube + back tube) (*ug*) Volume of air sampled (*L*)

12.2 VALIDATION

The validation process consists of data generation, reduction review, and reporting results. Once data reduction is complete, validation is conducted by verification that the QC samples are within acceptable QC limits and that all documentation is complete, including the analytical report and associated QC. See Table 12.3 by method for current QC targets and controls and current reporting limits.

Marginal Excedence – When a large number of analytes exist in the LCS, it is statistically possible for a few analytes to be outside established control limits while the analytical system remains in control. These excursions must be random in nature and, if not, a review of the control limits or analytical process is necessary.

Upper and lower marginal excedence (ME) limits are established as the mean of at least 20 data points ± four times their standard deviations. The number of allowable marginal excedences per event is based on the number of analytes spiked in the LCS.

Allowable Marginal Excedence per Event	
Analytes in LCS:	**ME Allowable**
>90	5
71-90	4
51-70	3
31-50	2
11-30	1
<11	0

Organic Control Limits - The organic QC targets are statutory in nature; warning and control limits for organic analyses are initially set for groups of compounds based on preliminary method validation data. When additional data becomes available, the QC targets are reviewed. All QC targets are routinely re-evaluated at least annually (and updated, if necessary) against laboratory historical data to insure that the limits continue to reflect realistic, method achievable goals.

12.3 REPORTING

Reporting procedures are documented in *SOP 030201 Data Handling and Reporting.*

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
Pesticides	Azinphos-Methyl	8141A, 1657A	GW	31-146	31	0.001	mg/L
Pesticides	Bolstar (Sulprofos)	8141A, 1657A	GW	46-126	27	0.001	mg/L
Pesticides	Chlorpyrifos	8141A, 1657A	GW	48-123	28	0.001	mg/L
Pesticides	Coumaphos	8141A, 1657A	GW	37-142	31	0.001	mg/L
Pesticides	Demeton,-O And -S	8141A, 1657A	GW	35-119	27	0.002	mg/L
Pesticides	Diazinon	8141A, 1657A	GW	49-118	26	0.001	mg/L
Pesticides	Dichlorvos	8141A, 1657A	GW	22-106	39	0.002	mg/L
Pesticides	Dimethoate	8141A, 1657A	GW	10-130	25	0.001	mg/L
Pesticides	Disulfoton	8141A, 1657A	GW	34-122	28	0.001	mg/L
Pesticides	Epn	8141A, 1657A	GW	36-134	29	0.001	mg/L
Pesticides	Ethoprop	8141A, 1657A	GW	44-114	28	0.001	mg/L
Pesticides	Ethyl Parathion	8141A, 1657A	GW	41-128	28	0.001	mg/L
Pesticides	Fensulfothion	8141A, 1657A	GW	40-131	28	0.001	mg/L
Pesticides	Fenthion	8141A, 1657A	GW	40-127	26	0.001	mg/L
Pesticides	Malathion	8141A, 1657A	GW	40-129	28	0.001	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
Pesticides	Merphos	8141A, 1657A	GW	51-147	28	0.001	mg/L
Pesticides	Methyl Parathion	8141A, 1657A	GW	46-117	28	0.001	mg/L
Pesticides	Mevinphos	8141A, 1657A	GW	37-109	32	0.001	mg/L
Pesticides	Naled	8141A, 1657A	GW	13-97	32	0.001	mg/L
Pesticides	Phorate	8141A, 1657A	GW	31-125	27	0.001	mg/L
Pesticides	Ronnel	8141A, 1657A	GW	34-118	26	0.001	mg/L
Pesticides	Stirophos	8141A, 1657A	GW	45-130	28	0.001	mg/L
Pesticides	Sulfotep	8141A, 1657A	GW	33-124	31	0.001	mg/L
Pesticides	Tepp	8141A, 1657A	GW	10-107	64	0.0083	mg/L
Pesticides	Tokuthion (Prothiofos)	8141A, 1657A	GW	47-122	28	0.001	mg/L
Pesticides	Trichloronate	8141A, 1657A	GW	45-125	28	0.001	mg/L
Pesticides	Azinphos-Methyl	8141A	SS	56-123	30	0.1	mg/Kg
Pesticides	Bolstar (Sulprofos)	8141A	SS	58-113	23	0.1	mg/Kg
Pesticides	Chlorpyrifos	8141A	SS	59-106	24	0.1	mg/Kg
Pesticides	Coumaphos	8141A	SS	54-124	32	0.1	mg/Kg
Pesticides	Demeton,-O And -S	8141A	SS	50-104	24	0.1	mg/Kg
Pesticides	Diazinon	8141A	SS	55-104	20	0.1	mg/Kg
Pesticides	Dichlorvos	8141A	SS	27-90	34	0.1	mg/Kg
Pesticides	Dimethoate	8141A	SS	37-114	30	0.1	mg/Kg
Pesticides	Disulfoton	8141A	SS	50-100	22	0.1	mg/Kg
Pesticides	Epn	8141A	SS	55-116	27	0.1	mg/Kg
Pesticides	Ethoprop	8141A	SS	53-97	26	0.1	mg/Kg
Pesticides	Ethyl Parathion	8141A	SS	57-110	21	0.1	mg/Kg
Pesticides	Fensulfothion	8141A	SS	23-170	28	0.1	mg/Kg
Pesticides	Fenthion	8141A	SS	58-105	22	0.1	mg/Kg
Pesticides	Malathion	8141A	SS	57-108	21	0.1	mg/Kg
Pesticides	Merphos	8141A	SS	61-133	23	0.1	mg/Kg
Pesticides	Methyl Parathion	8141A	SS	58-106	22	0.1	mg/Kg
Pesticides	Mevinphos	8141A	SS	37-102	29	0.1	mg/Kg
Pesticides	Naled	8141A	SS	14-85	41	0.1	mg/Kg
Pesticides	Phorate	8141A	SS	46-105	24	0.1	mg/Kg
Pesticides	Ronnel	8141A	SS	44-99	26	0.1	mg/Kg
Pesticides	Stirophos	8141A	SS	58-114	22	0.1	mg/Kg
Pesticides	Sulfotep	8141A	SS	51-102	24	0.1	mg/Kg
Pesticides	Tepp	8141A	SS	10-96	41	0.1	mg/Kg
Pesticides	Tokuthion (Prothiofos)	8141A	SS	60-109	23	0.1	mg/Kg
Pesticides	Trichloronate	8141A	SS	58-105	23	0.1	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
Pesticides	Alachlor	507	DW	70-130	25	0.0002	mg/L
Pesticides	Atrazine	507	DW	70-130	25	0.0001	mg/L
Pesticides	Butachlor	507	DW	70-130	25	0.0001	mg/L
Pesticides	Metolachlor	507	DW	70-130	25	0.0002	mg/L
Pesticides	Metribuzin	507	DW	70-130	25	0.0002	mg/L
Pesticides	Simazine	507	DW	70-130	25	7.00E-05	mg/L
Pesticides	Aldrin	508	DW	70-130	25	0.0005	mg/L
Pesticides	Dieldrin	508	DW	70-130	25	0.0005	mg/L
Pesticides	Endrin	508	DW	70-130	25	0.0005	mg/L
Pesticides	Gamma BHC	508	DW	70-130	25	0.0005	mg/L
Pesticides	Heptachlor	508	DW	70-130	25	0.0005	mg/L
Pesticides	Heptachlor Epoxide	508	DW	70-130	25	0.0005	mg/L
Pesticides	Hexachlorobenzene	508	DW	70-130	25	0.0005	mg/L
Pesticides	Methoxychlor	508	DW	70-130	25	0.0005	mg/L
Pesticides	4,4-DDD	608/8081A/B, 6630C	GW, WW	37-142	39	0.00005	mg/L
Pesticides	4,4-DDE	608/8081A/B, 6630C	GW, WW	33-124	37	0.00005	mg/L
Pesticides	4,4-DDT	608/8081A/B, 6630C	GW, WW	32-143	42	0.00005	mg/L
Pesticides	Aldrin	608/8081A/B, 6630C	GW, WW	25-115	45	0.00005	mg/L
Pesticides	Alpha BHC	608/8081A/B, 6630C	GW, WW	38-119	30	0.00005	mg/L
Pesticides	Beta BHC	608/8081A/B, 6630C	GW, WW	42-126	31	0.00005	mg/L
Pesticides	Chlordane	608/8081A/B, 6630C	GW, WW	-	-	0.005	mg/L
Pesticides	Delta BHC	608/8081A/B, 6630C	GW, WW	24-141	41	0.00005	mg/L
Pesticides	Dieldrin	608/8081A/B, 6630C	GW, WW	37-130	36	0.00005	mg/L
Pesticides	Endosulfan I	608/8081A/B, 6630C	GW, WW	37-125	35	0.00005	mg/L
Pesticides	Endosulfan II	608/8081A/B, 6630C	GW, WW	38-131	36	0.00005	mg/L
Pesticides	Endosulfan Sulfate	608/8081A/B, 6630C	GW, WW	38-131	37	0.00005	mg/L
Pesticides	Endrin	608/8081A/B, 6630C	GW, WW	37-126	37	0.00005	mg/L
Pesticides	Endrin Aldehyde	608/8081A/B, 6630C	GW, WW	24-154	36	0.00005	mg/L
Pesticides	Endrin Ketone	608/8081A/B, 6630C	GW, WW	37-139	36	0.00005	mg/L
Pesticides	Gamma BHC	608/8081A/B, 6630C	GW, WW	35-114	30	0.00005	mg/L
Pesticides	Heptachlor	608/8081A/B, 6630C	GW, WW	21-123	38	0.00005	mg/L
Pesticides	Heptachlor Epoxide	608/8081A/B, 6630C	GW, WW	38-121	33	0.00005	mg/L
Pesticides	Hexachlorobenzene	608/8081A/B, 6630C	GW, WW	28-115	29	0.00005	mg/L
Pesticides	Methoxychlor	608/8081A/B, 6630C	GW, WW	55-150	40	0.00005	mg/L
Pesticides	Toxaphene	608/8081A/B, 6630C	GW, WW	-	-	0.0005	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
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Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
PCBs	PCB 1016	608, 6431B, 8082/A	GW, WW	46-126	34	0.0005	mg/L
PCBs	PCB 1221	608, 6431B, 8082/A	GW, WW	-	-	0.0005	mg/L
PCBs	PCB 1232	608, 6431B, 8082/A	GW, WW	-	-	0.0005	mg/L
PCBs	PCB 1242	608, 6431B, 8082/A	GW, WW	-	-	0.0005	mg/L
PCBs	PCB 1248	608, 6431B, 8082/A	GW, WW	-	-	0.0005	mg/L
PCBs	PCB 1254	608, 6431B, 8082/A	GW, WW	-	-	0.0005	mg/L
PCBs	PCB 1260	608, 6431B, 8082/A	GW, WW	46-126	34	0.0005	mg/L
PCBs	PCB 1016	8082/A	SS	62-131	22	0.017	mg/Kg
PCBs	PCB 1221	8082/A	SS	-	-	0.017	mg/Kg
PCBs	PCB 1232	8082/A	SS	-	-	0.017	mg/Kg
PCBs	PCB 1242	8082/A	SS	-	-	0.017	mg/Kg
PCBs	PCB 1248	8082/A	SS	-	-	0.017	mg/Kg
PCBs	PCB 1254	8082/A	SS	-	-	0.017	mg/Kg
PCBs	PCB 1260	8082/A	SS	62-131	22	0.017	mg/Kg
PCBs	PCB 1260	8082/A	SS	-	-	0.017	mg/Kg
Pesticides	4,4-DDD	8081A/B	SS	62-133	28	0.02	mg/Kg
Pesticides	4,4-DDE	8081A/B	SS	61-122	28	0.02	mg/Kg
Pesticides	4,4-DDT	8081A/B	SS	54-138	31	0.02	mg/Kg
Pesticides	Aldrin	8081A/B	SS	57-114	27	0.02	mg/Kg
Pesticides	Alpha BHC	8081A/B	SS	56-122	30	0.02	mg/Kg
Pesticides	Beta BHC	8081A/B	SS	67-122	23	0.02	mg/Kg
Pesticides	Delta BHC	8081A/B	SS	63-120	26	0.02	mg/Kg
Pesticides	Dieldrin	8081A/B	SS	63-124	26	0.02	mg/Kg
Pesticides	Endosulfan I	8081A/B	SS	63-119	26	0.02	mg/Kg
Pesticides	Endosulfan II	8081A/B	SS	63-123	28	0.02	mg/Kg
Pesticides	Endosulfan Sulfate	8081A/B	SS	60-124	30	0.02	mg/Kg
Pesticides	Endrin	8081A/B	SS	58-118	27	0.02	mg/Kg
Pesticides	Endrin Aldehyde	8081A/B	SS	50-136	32	0.02	mg/Kg
Pesticides	Endrin Ketone	8081A/B	SS	57-127	30	0.02	mg/Kg
Pesticides	Gamma BHC	8081A/B	SS	58-113	27	0.02	mg/Kg
Pesticides	Heptachlor	8081A/B	SS	56-116	29	0.02	mg/Kg
Pesticides	Heptachlor Epoxide	8081A/B	SS	63-118	26	0.02	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
Pesticides	Hexachlorobenzene	8081A/B	SS	51-118	30	0.02	mg/Kg
Pesticides	Methoxychlor	8081A/B	SS	50-152	32	0.02	mg/Kg
Pesticides	Chlordane	8081A/B	SS	-	-	0.2	mg/Kg
Pesticides	Toxaphene	8081A/B	SS	-	-	0.4	mg/Kg
Herbicides	2,4,5-TP (SILVEX)	515.1	DW	70-130	25	0.0001	mg/L
Herbicides	2,4-D	515.1	DW	70-130	25	0.0001	mg/L
Herbicides	Dalapon	515.1	DW	70-130	25	0.001	mg/L
Herbicides	Dicamba	515.1	DW	70-130	25	0.0001	mg/L
Herbicides	Dinoseb	515.1	DW	70-130	25	0.0001	mg/L
Herbicides	Pentachlorophenol	515.1	DW	70-130	25	0.00004	mg/L
Herbicides	Picloram	515.1	DW	70-130	25	0.0001	mg/L
Herbicides	2,4,5-T	1658, 8151A, 6640C	GW, WW	30-136	31	0.002	mg/L
Herbicides	2,4,5-TP (SILVEX)	1658, 8151A, 6640C	GW, WW	33-134	30	0.002	mg/L
Herbicides	2,4-D	1658, 8151A, 6640C	GW, WW	24-127	27	0.002	mg/L
Herbicides	2,4-DB	1658, 8151A, 6640C	GW, WW	22-198	33	0.002	mg/L
Herbicides	Dalapon	1658, 8151A, 6640C	GW, WW	14-121	31	0.002	mg/L
Herbicides	Dicamba	1658, 8151A, 6640C	GW, WW	31-135	25	0.002	mg/L
Herbicides	Dichloroprop	1658, 8151A, 6640C	GW, WW	30-122	26	0.002	mg/L
Herbicides	Dinoseb	1658, 8151A, 6640C	GW, WW	28-183	38	0.002	mg/L
Herbicides	MCPA	1658, 8151A, 6640C	GW, WW	32-153	31	0.1	mg/L
Herbicides	MCPP	1658, 8151A, 6640C	GW, WW	42-133	29	0.1	mg/L
Herbicides	2,4,5-T	8151A	SS	40-122	27	0.07	mg/Kg
Herbicides	2,4,5-TP (SILVEX)	8151A	SS	36-125	26	0.07	mg/Kg
Herbicides	2,4-D	8151A	SS	33-119	28	0.07	mg/Kg
Herbicides	2,4-DB	8151A	SS	20-155	28	0.07	mg/Kg
Herbicides	Dalapon	8151A	SS	10-127	44	0.07	mg/Kg
Herbicides	Dicamba	8151A	SS	37-122	25	0.07	mg/Kg
Herbicides	Dichloroprop	8151A	SS	40-110	23	0.07	mg/Kg
Herbicides	Dinoseb	8151A	SS	10-155	50	0.07	mg/Kg
Herbicides	MCPA	8151A	SS	23-161	27	6.5	mg/Kg
Herbicides	MCPP	8151A	SS	30-148	24	6.5	mg/Kg
PAH	1-Methylnaphthalene	8310, 610, 6440B	GW, WW	31-95	32	0.0001	mg/L
PAH	2-Methylnaphthalene	8310, 610, 6440B	GW, WW	30-97	34	0.0001	mg/L
PAH	Acenaphthene	8310, 610, 6440B	GW, WW	32-120	29	0.0001	mg/L
PAH	Acenaphthylene	8310, 610, 6440B	GW, WW	41-112	30	0.0001	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
PAH	Anthracene	8310, 610, 6440B	GW, WW	48-122	26	0.0001	mg/L
PAH	Benzo(a)Anthracene	8310, 610, 6440B	GW, WW	52-122	22	0.0001	mg/L
PAH	Benzo(a)Pyrene	8310, 610, 6440B	GW, WW	45-120	24	0.0001	mg/L
PAH	Benzo(b)Fluoranthene	8310, 610, 6440B	GW, WW	46-118	24	0.0001	mg/L
PAH	Benzo(g,h,i)Perylene	8310, 610, 6440B	GW, WW	31-110	31	0.0001	mg/L
PAH	Benzo(k)Fluoranthene	8310, 610, 6440B	GW, WW	45-112	24	0.0001	mg/L
PAH	Chrysene	8310, 610, 6440B	GW, WW	53-126	23	0.0001	mg/L
PAH	Dibenz(a,h)Anthracene	8310, 610, 6440B	GW, WW	26-113	35	0.0001	mg/L
PAH	Fluoranthene	8310, 610, 6440B	GW, WW	52-125	23	0.0001	mg/L
PAH	Fluorene	8310, 610, 6440B	GW, WW	45-117	27	0.0001	mg/L
PAH	Indeno(1,2,3-cd)Pyrene	8310, 610, 6440B	GW, WW	40-113	29	0.0001	mg/L
PAH	Naphthalene	8310, 610, 6440B	GW, WW	22-105	37	0.0001	mg/L
PAH	Phenanthrene	8310, 610, 6440B	GW, WW	48-122	26	0.0001	mg/L
PAH	Pyrene	8310, 610, 6440B	GW, WW	53-128	24	0.0001	mg/L
PAH	1-Methylnaphthalene	8310	SS	18-102	42	0.02	mg/Kg
PAH	2-Methylnaphthalene	8310	SS	18-107	43	0.02	mg/Kg
PAH	Acenaphthene	8310	SS	22-139	36	0.02	mg/Kg
PAH	Acenaphthylene	8310	SS	33-118	35	0.02	mg/Kg
PAH	Anthracene	8310	SS	65-119	20	0.02	mg/Kg
PAH	Benzo(a)Anthracene	8310	SS	77-123	20	0.02	mg/Kg
PAH	Benzo(a)Pyrene	8310	SS	68-118	20	0.02	mg/Kg
PAH	Benzo(b)Fluoranthene	8310	SS	68-110	20	0.02	mg/Kg
PAH	Benzo(g,h,i)Perylene	8310	SS	57-118	28	0.02	mg/Kg
PAH	Benzo(k)Fluoranthene	8310	SS	70-124	20	0.02	mg/Kg
PAH	Chrysene	8310	SS	79-125	20	0.02	mg/Kg
PAH	Dibenz(a,h)Anthracene	8310	SS	64-121	25	0.02	mg/Kg
PAH	Fluoranthene	8310	SS	76-121	20	0.02	mg/Kg
PAH	Fluorene	8310	SS	47-126	28	0.02	mg/Kg
PAH	Indeno(1,2,3-cd)Pyrene	8310	SS	62-121	26	0.02	mg/Kg
PAH	Naphthalene	8310	SS	11-104	49	0.02	mg/Kg
PAH	Phenanthrene	8310	SS	63-118	20	0.02	mg/Kg
PAH	Pyrene	8310	SS	77-125	20	0.02	mg/Kg
BNA	1,2,4,5-Tetrachlorobenzene	8270C/D	GW,WW	39-116	33	0.01	mg/L
BNA	1,2,4-Trichlorobenzene	8270C/D, 625, SM6410B	GW,WW	26-103	38	0.01	mg/L
BNA	1,4-Naphthoquinone	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	1-Naphthylamine	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	2,3,4,6-Tetrachlorophenol	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	2,4,5-Trichlorophenol	8270C/D	GW,WW	48-120	29	0.01	mg/L
BNA	2,4,6-Trichlorophenol	8270C/D, 625, SM6410B	GW,WW	49-118	28	0.01	mg/L
BNA	2,4-Dichlorophenol	8270C/D, 625, SM6410B	GW,WW	46-115	28	0.01	mg/L
BNA	2,4-Dimethylphenol	8270C/D, 625, SM6410B	GW,WW	40-124	36	0.01	mg/L
BNA	2,4-Dinitrophenol	8270C/D, 625, SM6410B	GW,WW	10-125	50	0.01	mg/L
BNA	2,4-Dinitrotoluene	8270C/D, 625, SM6410B	GW,WW	56-128	24	0.01	mg/L
BNA	2,6-Dichlorophenol	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	2,6-Dinitrotoluene	8270C/D, 625, SM6410B	GW,WW	56-121	23	0.01	mg/L
BNA	2-Acetylaminofluorene	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	2-Chloronaphthalene	8270C/D, 625, SM6410B	GW,WW	44-110	30	0.001	mg/L
BNA	2-Chlorophenol	8270C/D, 625, SM6410B	GW,WW	38-114	36	0.01	mg/L
BNA	2-Methylnaphthalene	8270C/D	GW,WW	28-122	36	0.001	mg/L
BNA	2-Methylphenol	8270C/D	GW,WW	42-99	26	0.01	mg/L
BNA	2-Naphthylamine	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	2-Nitroaniline	8270C/D	GW,WW	55-124	22	0.01	mg/L
BNA	2-Nitrophenol	8270C/D, 625, SM6410B	GW,WW	35-118	35	0.01	mg/L
BNA	3,3-Dichlorobenzidine	8270C/D, 625, SM6410B	GW,WW	46-145	31	0.01	mg/L
BNA	3,3-Dimethylbenzidine	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	3-Methylcholanthrene	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	3-Nitroaniline	8270C/D	GW,WW	39-141	32	0.01	mg/L
BNA	4,6-Dinitro-2-Methylphenol	8270C/D, 625, SM6410B	GW,WW	24-119	50	0.01	mg/L
BNA	4-Aminobiphenyl	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	4-Bromophenyl-Phenylether	8270C/D, 625, SM6410B	GW,WW	45-105	26	0.01	mg/L
BNA	4-Chloro-3-Methylphenol	8270C/D, 625, SM6410B	GW,WW	47-116	22	0.01	mg/L
BNA	4-Chloroaniline	8270C/D	GW,WW	27-151	36	0.01	mg/L
BNA	4-Chlorophenyl-Phenylether	8270C/D, 625, SM6410B	GW,WW	49-116	26	0.01	mg/L
BNA	4-Nitroaniline	8270C/D	GW,WW	43-144	34	0.01	mg/L
BNA	4-Nitrophenol	8270C/D, 625, SM6410B	GW,WW	10-66	37	0.01	mg/L
BNA	5-Nitro-O-Toluidine	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Acenaphthene	8270C/D, 625, SM6410B	GW,WW	48-110	26	0.001	mg/L
BNA	Acenaphthylene	8270C/D, 625, SM6410B	GW,WW	48-113	28	0.001	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	Acetophenone	8270C/D	GW,WW	35-98	38	0.01	mg/L
BNA	Aniline	8270C/D	GW,WW	0-159	50	0.01	mg/L
BNA	Anthracene	8270C/D, 625, SM6410B	GW,WW	55-127	24	0.001	mg/L
BNA	Azobenzene	8270C/D	GW,WW	50-129	28	0.01	mg/L
BNA	Benzo(a)Anthracene	8270C/D, 625, SM6410B	GW,WW	57-115	20	0.001	mg/L
BNA	Benzo(a)Pyrene	8270C/D, 625, SM6410B	GW,WW	63-125	22	0.001	mg/L
BNA	Benzo(b)Fluoranthene	8270C/D, 625, SM6410B	GW,WW	50-123	32	0.001	mg/L
BNA	Benzo(g,h,i)Perylene	8270C/D, 625, SM6410B	GW,WW	39-143	31	0.001	mg/L
BNA	Benzo(k)Fluoranthene	8270C/D, 625, SM6410B	GW,WW	45-126	37	0.001	mg/L
BNA	Benzyl Alcohol	8270C/D	GW,WW	33-104	32	0.01	mg/L
BNA	Benzylbutyl Phthalate	8270C/D, 625, SM6410B	GW,WW	22-154	29	0.01	mg/L
BNA	Bis(2-Chlorethoxy)Methane	8270C/D, 625, SM6410B	GW,WW	42-116	38	0.01	mg/L
BNA	Bis(2-Chloroethyl)Ether	8270C/D, 625, SM6410B	GW,WW	26-115	50	0.01	mg/L
BNA	Bis(2-Chloroisopropyl)Ether	8270C/D, 625, SM6410B	GW,WW	32-115	47	0.01	mg/L
BNA	Bis(2-Ethylhexyl)Phthalate	8270C/D, 625, SM6410B	GW,WW	47-143	24	0.001	mg/L
BNA	Chlorobenzilate	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Chrysene	8270C/D, 625, SM6410B	GW,WW	58-113	21	0.001	mg/L
BNA	Diallate	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Dibenz(a,h)Anthracene	8270C/D, 625, SM6410B	GW,WW	39-144	30	0.001	mg/L
BNA	Dibenzofuran	8270C/D	GW,WW	50-121	26	0.01	mg/L
BNA	Diethyl Phthalate	8270C/D, 625, SM6410B	GW,WW	36-128	27	0.001	mg/L
BNA	Dimethoate	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Dimethyl Phthalate	8270C/D, 625, SM6410B	GW,WW	10-135	33	0.001	mg/L
BNA	Dimethylbenz (a) Anthracene	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Di-N-Butyl Phthalate	8270C/D, 625, SM6410B	GW,WW	51-131	22	0.001	mg/L
BNA	Di-N-Octyl Phthalate	8270C/D, 625, SM6410B	GW,WW	51-138	22	0.001	mg/L
BNA	Dinoseb	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Diphenylamine	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Disulfoton	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Ethyl Methanesulfonate	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Famphur	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Fluoranthene	8270C/D, 625, SM6410B	GW,WW	53-119	28	0.001	mg/L
BNA	Fluorene	8270C/D, 625, SM6410B	GW,WW	49-116	25	0.01	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	Hexachloro-1,3-Butadiene	8270C/D, 625, SM6410B	GW,WW	21-116	50	0.01	mg/L
BNA	Hexachlorobenzene	8270C/D, 625, SM6410B	GW,WW	51-121	23	0.001	mg/L
BNA	Hexachlorocyclopentadiene	8270C/D, 625, SM6410B	GW,WW	4-126	50	0.01	mg/L
BNA	Hexachloroethane	8270C/D, 625, SM6410B	GW,WW	15-109	50	0.01	mg/L
BNA	Hexachloropropene	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Indeno(1,2,3-cd)Pyrene	8270C/D, 625, SM6410B	GW,WW	40-143	30	0.001	mg/L
BNA	Isodrin	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Isophorone	8270C/D, 625, SM6410B	GW,WW	48-126	31	0.01	mg/L
BNA	Isosafrole	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Kepone	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	m&p-Cresol	8270C/D	GW,WW	36-102	31	0.01	mg/L
BNA	M-Dinitrobenzene	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Methapyrilene	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Methyl Methanesulfonate	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Methyl Parathion	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Naphthalene	8270C/D, 625, SM6410B	GW,WW	29-103	45	0.001	mg/L
BNA	Nitrobenzene	8270C/D, 625, SM6410B	GW,WW	31-105	43	0.01	mg/L
BNA	N-Nitrosodiethylamine	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	N-Nitrosodimethylamine	8270C/D, 625, SM6410B	GW,WW	Nov-69	50	0.01	mg/L
BNA	N-Nitrosodi-N-Butylamine	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	N-Nitrosodi-N-Propylamine	8270C/D, 625, SM6410B	GW,WW	47-122	33	0.01	mg/L
BNA	N-Nitrosodiphenylamine	8270C/D, 625, SM6410B	GW,WW	59-143	23	0.01	mg/L
BNA	N-Nitrosomethylethylamine	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	N-Nitrosopiperidine	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	N-Nitrosopyrrolidine	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	O,O,O-Triethyl Phosphorothioate	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	O-Toluidine	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	P-(Dimethylamino) Azobenzene	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Parathion	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Pentachlorobenzene	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Pentachloronitrobenzene	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Pentachlorophenol	8270C/D, 625, SM6410B	GW,WW	20-122	50	0.001	mg/L
BNA	Phenacetin	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Phenanthrene	8270C/D, 625, SM6410B	GW,WW	54-112	22	0.001	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	Phenol	8270C/D, 625, SM6410B	GW,WW	17-56	33	0.01	mg/L
BNA	Phorate	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	P-Phenylenediamine	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Pronamide	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Pyrene	8270C/D, 625, SM6410B	GW,WW	46-130	28	0.001	mg/L
BNA	Pyridine	8270C/D	GW,WW	7-48	50	0.01	mg/L
BNA	Safrole	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Sym-Trinitrobenzene	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Thionazin	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	Triethyl Phosphorothioate	8270C/D	GW,WW	50 - 150*	25*	0.01	mg/L
BNA	1,2,4,5-Tetrachlorobenzene	8270C/D	SS	51-112	21	0.33	mg/Kg
BNA	1,2,4-Trichlorobenzene	8270C/D, 625, SM6410B	SS	46-99	24	0.33	mg/Kg
BNA	1,4-Naphthoquinone	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	1-Naphthylamine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	2,3,4,6-Tetrachlorophenol	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	2,4,5-Trichlorophenol	8270C/D	SS	53-110	21	0.33	mg/Kg
BNA	2,4,6-Trichlorophenol	8270C/D, 625, SM6410B	SS	56-109	24	0.33	mg/Kg
BNA	2,4-Dichlorophenol	8270C/D, 625, SM6410B	SS	54-107	21	0.33	mg/Kg
BNA	2,4-Dimethylphenol	8270C/D, 625, SM6410B	SS	58-119	23	0.33	mg/Kg
BNA	2,4-Dinitrophenol	8270C/D, 625, SM6410B	SS	16-130	45	0.33	mg/Kg
BNA	2,4-Dinitrotoluene	8270C/D, 625, SM6410B	SS	53-120	23	0.33	mg/Kg
BNA	2,6-Dichlorophenol	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	2,6-Dinitrotoluene	8270C/D, 625, SM6410B	SS	56-113	22	0.33	mg/Kg
BNA	2-Acetylaminofluorene	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	2-Chloronaphthalene	8270C/D, 625, SM6410B	SS	55-103	20	0.033	mg/Kg
BNA	2-Chlorophenol	8270C/D, 625, SM6410B	SS	52-108	24	0.33	mg/Kg
BNA	2-Methylnaphthalene	8270C/D	SS	52-107	21	0.033	mg/Kg
BNA	2-Methylphenol	8270C/D	SS	58-116	22	0.33	mg/Kg
BNA	2-Naphthylamine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	2-Nitroaniline	8270C/D	SS	54-116	24	0.33	mg/Kg
BNA	2-Nitrophenol	8270C/D, 625, SM6410B	SS	38-110	24	0.33	mg/Kg
BNA	2-Picoline	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	3,3-Dichlorobenzidine	8270C/D, 625, SM6410B	SS	24-123	35	0.33	mg/Kg
BNA	3,3-Dimethylbenzidine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
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Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	3-Methylcholanthrene	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	3-Nitroaniline	8270C/D	SS	17-135	33	0.33	mg/Kg
BNA	4,6-Dinitro-2-Methylphenol	8270C/D, 625, SM6410B	SS	34-111	33	0.33	mg/Kg
BNA	4-Aminobiphenyl	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	4-Bromophenyl-Phenylether	8270C/D, 625, SM6410B	SS	47-98	23	0.33	mg/Kg
BNA	4-Chloro-3-Methylphenol	8270C/D, 625, SM6410B	SS	54-116	23	0.33	mg/Kg
BNA	4-Chloroaniline	8270C/D	SS	18-130	31	0.33	mg/Kg
BNA	4-Chlorophenyl-Phenylether	8270C/D, 625, SM6410B	SS	55-106	22	0.33	mg/Kg
BNA	4-Nitroaniline	8270C/D	SS	16-133	37	0.33	mg/Kg
BNA	4-Nitrophenol	8270C/D, 625, SM6410B	SS	34-123	36	0.33	mg/Kg
BNA	4-Nitroquinoline 1-Oxide	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	5-Nitro-O-Toluidine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	A,A-Dimethylphenethylamine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Acenaphthene	8270C/D, 625, SM6410B	SS	54-102	20	0.033	mg/Kg
BNA	Acenaphthylene	8270C/D, 625, SM6410B	SS	56-104	20	0.033	mg/Kg
BNA	Acetochlor	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Acetophenone	8270C/D	SS	42-92	22	0.33	mg/Kg
BNA	Alachlor	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Ametryn	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Aniline	8270C/D	SS	0-157	33	0.33	mg/Kg
BNA	Anthracene	8270C/D, 625, SM6410B	SS	57-112	21	0.033	mg/Kg
BNA	Aramite	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Atraton	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Atrazine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Azobenzene	8270C/D	SS	55-118	24	0.33	mg/Kg
BNA	Benfluralin	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Benzidine	8270C/D, 625, SM6410B	SS	0-13	50	0.33	mg/Kg
BNA	Benzo(a)Anthracene	8270C/D, 625, SM6410B	SS	55-105	21	0.033	mg/Kg
BNA	Benzo(a)Pyrene	8270C/D, 625, SM6410B	SS	59-114	22	0.033	mg/Kg
BNA	Benzo(b)Fluoranthene	8270C/D, 625, SM6410B	SS	44-116	33	0.033	mg/Kg
BNA	Benzo(g,h,i)Perylene	8270C/D, 625, SM6410B	SS	41-127	29	0.033	mg/Kg
BNA	Benzo(k)Fluoranthene	8270C/D, 625, SM6410B	SS	36-119	37	0.033	mg/Kg
BNA	Benzyl Alcohol	8270C/D	SS	53-115	23	0.33	mg/Kg
BNA	Benzylbutyl Phthalate	8270C/D, 625, SM6410B	SS	57-130	27	0.33	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	Bis(2-Chlorethoxy)Methane	8270C/D, 625, SM6410B	SS	52-107	21	0.33	mg/Kg
BNA	Bis(2-Chloroethyl)Ether	8270C/D, 625, SM6410B	SS	38-115	28	0.33	mg/Kg
BNA	Bis(2-Chloroisopropyl)Ether	8270C/D, 625, SM6410B	SS	49-106	25	0.33	mg/Kg
BNA	Bis(2-Ethylhexyl)Phthalate	8270C/D, 625, SM6410B	SS	50-130	29	0.33	mg/Kg
BNA	Bromacil	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Chlorobenzilate	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Chlorpropham	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Chrysene	8270C/D, 625, SM6410B	SS	54-103	23	0.033	mg/Kg
BNA	Cyanazine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Dacthal	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Diallate	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Dibenz(a,h)Anthracene	8270C/D, 625, SM6410B	SS	42-128	28	0.033	mg/Kg
BNA	Dibenzofuran	8270C/D	SS	56-111	21	0.33	mg/Kg
BNA	Dichlobenil	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Diethyl Phthalate	8270C/D, 625, SM6410B	SS	57-110	20	0.33	mg/Kg
BNA	Dimethenamid	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Dimethoate	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Dimethyl Phthalate	8270C/D, 625, SM6410B	SS	57-108	20	0.33	mg/Kg
BNA	Dimethylbenz (a) Anthracene	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Di-N-Butyl Phthalate	8270C/D, 625, SM6410B	SS	56-121	22	0.33	mg/Kg
BNA	Di-N-Octyl Phthalate	8270C/D, 625, SM6410B	SS	50-128	26	0.33	mg/Kg
BNA	Dinoseb	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Diphenylamine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Disulfoton	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Eptc	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Ethalfluralin	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Ethofumesate	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Ethyl Methanesulfonate	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Ethyl Parathion	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Famphur	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Fluoranthene	8270C/D, 625, SM6410B	SS	51-109	26	0.033	mg/Kg
BNA	Fluorene	8270C/D, 625, SM6410B	SS	53-106	20	0.033	mg/Kg
BNA	Hexachloro-1,3-Butadiene	8270C/D, 625, SM6410B	SS	46-110	25	0.33	mg/Kg
BNA	Hexachlorobenzene	8270C/D, 625, SM6410B	SS	51-117	24	0.33	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	Hexachlorocyclopentadiene	8270C/D, 625, SM6410B	SS	21-127	40	0.33	mg/Kg
BNA	Hexachloroethane	8270C/D, 625, SM6410B	SS	43-104	27	0.33	mg/Kg
BNA	Hexachlorophene	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Hexachloropropene	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Hexazinone	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Indeno(1,2,3-cd)Pyrene	8270C/D, 625, SM6410B	SS	42-127	28	0.033	mg/Kg
BNA	Isodrin	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Isophorone	8270C/D, 625, SM6410B	SS	56-116	21	0.33	mg/Kg
BNA	Isosafrole	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Kepone	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	m&p-Cresol	8270C/D	SS	60-136	29	0.33	mg/Kg
BNA	M-Dinitrobenzene	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Methapyrilene	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Methyl Methanesulfonate	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Methyl Parathion	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Metolachlor	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Metribuzin	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Naphthalene	8270C/D, 625, SM6410B	SS	46-97	23	0.033	mg/Kg
BNA	Napropamide	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Nitrobenzene	8270C/D, 625, SM6410B	SS	46-102	23	0.33	mg/Kg
BNA	N-Nitrosodiethylamine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	N-Nitrosodimethylamine	8270C/D, 625, SM6410B	SS	35-111	35	0.33	mg/Kg
BNA	N-Nitrosodi-N-Butylamine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	N-Nitrosodi-N-Propylamine	8270C/D, 625, SM6410B	SS	54-113	21	0.33	mg/Kg
BNA	N-Nitrosodiphenylamine	8270C/D, 625, SM6410B	SS	66-126	22	0.33	mg/Kg
BNA	N-Nitrosomethylethylamine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	N-Nitrosomorpholine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	N-Nitrosopiperidine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	N-Nitrosopyrrolidine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Norflurazon	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	O,O,O-Triethyl Phosphorothioate	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	O-Toluidine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Oxadiazon	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Oxyfluorfen	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	P-(Dimethylamino) Azobenzene	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	Parathion	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Pendimethalin	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Pentachlorobenzene	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Pentachloroethane	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Pentachloronitrobenzene	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Pentachlorophenol	8270C/D, 625, SM6410B	SS	37-118	28	0.33	mg/Kg
BNA	Phenacetin	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Phenanthrene	8270C/D, 625, SM6410B	SS	56-102	20	0.033	mg/Kg
BNA	Phenol	8270C/D, 625, SM6410B	SS	55-115	22	0.33	mg/Kg
BNA	Phorate	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	P-Phenylenediamine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Prometon	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Prometryn	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Pronamide	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Pronamide	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Propachlor	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Propazine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Pyrene	8270C/D, 625, SM6410B	SS	53-111	26	0.033	mg/Kg
BNA	Pyridine	8270C/D	SS	22-86	41	0.33	mg/Kg
BNA	Safrole	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Simazine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Sulfotep	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Sym-Trinitrobenzene	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Terbacil	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Terbuthylazine	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Terbutryn	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Thionazin	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Triallate	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Triethyl Phosphorothioate	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
BNA	Trifluralin	8270C/D	SS	50 - 150*	25*	0.33	mg/Kg
Explosives	1,3,5-Trinitrobenzene	8330A/B	SS	83-126	20	0.5	mg/Kg
Explosives	1,3-Dinitrobenzene	8330A/B	SS	75-111	20	0.5	mg/Kg
Explosives	2,4,6-Trinitrotoluene	8330A/B	SS	34-186	20	0.5	mg/Kg
Explosives	2,4-Dinitrotoluene	8330A/B	SS	75-111	20	0.5	mg/Kg
Explosives	2,6-Dinitrotoluene	8330A/B	SS	80-118	20	0.5	mg/Kg
Explosives	2-Nitrotoluene	8330A/B	SS	76-127	20	0.5	mg/Kg
Explosives	3-Nitrotoluene	8330A/B	SS	77-113	20	0.5	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
Explosives	4-Nitrotoluene (4-NT)	8330A/B	SS	70-119	20	0.5	mg/Kg
Explosives	Hexahydro-1,3,5-Trinitro-1,3,5-Triazine	8330A/B	SS	74-115	20	0.5	mg/Kg
Explosives	Methyl-2,4,6-Trinitrophenylnitramine	8330A/B	SS	28-157	37	0.5	mg/Kg
Explosives	Nitrobenzene	8330A/B	SS	80-109	20	0.5	mg/Kg
Explosives	Octahydro - 1,3,5,7 -tetranitro-1,3,5,7-tetrazocine (HMX)	8330A/B	SS	77-122	20	0.0005	mg/Kg
Explosives	Pentaerythritol Tetranitrate (PETN)	8330A/B	SS	50-150	20	2	mg/Kg
Explosives	Nitroglycerine	8330A/B	SS	50-150	20	2	mg/Kg
Explosives	Nitroguanidine	8330A/B	SS	50-150	20	8	mg/Kg
Explosives	1,3,5-Trinitrobenzene	8330A/B	GW	72-105	20	0.0005	mg/L
Explosives	1,3-Dinitrobenzene	8330A/B	GW	56-97	20	0.0005	mg/L
Explosives	2,4,6-Trinitrotoluene	8330A/B	GW	60-95	20	0.0005	mg/L
Explosives	2,4-Dinitrotoluene	8330A/B	GW	39-92	20	0.0005	mg/L
Explosives	2,6-Dinitrotoluene	8330A/B	GW	34-101	20	0.0005	mg/L
Explosives	2-Nitrotoluene	8330A/B	GW	44-90	20	0.0005	mg/L
Explosives	3-Nitrotoluene	8330A/B	GW	37-91	20	0.0005	mg/L
Explosives	4-Nitrotoluene (4-NT)	8330A/B	GW	37-92	20	0.0005	mg/L
Explosives	Hexahydro-1,3,5-Trinitro-1,3,5-Triazine	8330A/B	GW	46-90	20	0.0005	mg/L
Explosives	Methyl-2,4,6-Trinitrophenylnitramine	8330A/B	GW	47-92	20	0.0005	mg/L
Explosives	Nitrobenzene	8330A/B	GW	61-97	20	0.0005	mg/L
Explosives	Octahydro - 1,3,5,7 -tetranitro-1,3,5,7-tetrazocine (HMX)	8330A/B	GW	37-94	20	0.0005	mg/L
Explosives	Pentaerythritol Tetranitrate (PETN)	8330A/B	GW	57-94	20	0.0005	mg/L
Explosives	Nitroglycerine	8330A/B	GW	34-140	20	0.0005	mg/L
Explosives	Nitroguanidine	8330A/B	GW	50-150	20	0.0005	mg/L
GC	1, 2 Dibromoethane (EDB)	504/8011	DW,GW, WW	70 - 130	<30	0.00002	mg/L
GC	1, 2 Dibromo-3-chloropropane	504/8011	DW,GW, WW	70 - 130	<30	0.00002	mg/L
GC	1,2,3-Trichloropropane	504/8011	DW,GW, WW	70 - 130	<30	0.0005	mg/L
THAA	Bromoacetic Acid	552.2	DW	70 - 130	<30	0.001	mg/L
THAA	Chloroacetic Acid	552.2	DW	70 - 130	<30	0.002	mg/L
THAA	Dibromoacetic Acid	552.2	DW	70 - 130	<30	0.001	mg/L
THAA	Dichloroacetic Acid	552.2	DW	70 - 130	<30	0.001	mg/L
THAA	Trichloroacetic Acid	552.2	DW	70 - 130	<30	0.001	mg/L
TPH	Petroleum Range Organics (TRPH)	FL-PRO	GW,	50 - 150	<20	0.1	mg/L
TPH	Petroleum Range Organics (TRPH)	FL-PRO	SS	50 - 150	<20	4.0	mg/Kg
TPH	Petroleum Range Organics (TRPH)	EPH TN	GW	50 - 150	<20	0.1	mg/L
TPH	Petroleum Range Organics (TRPH)	EPH TN	SS	50 - 150	<20	4.0	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
TPH	Petroleum Range Organics (TRPH) - C9-C18, C19-C36, C11-C22	MADEP EPH	GW, WW	50 - 150	<20	0.1	mg/L
TPH	Petroleum Range Organics (TRPH) - C9-C18, C19-C36, C11-C22	MADEP EPH	SS	50 - 150	<20	5.5	mg/Kg
TPH	Petroleum Range Organics (TRPH) - C10-C28	DRO, 8015Mod	GW, WW	50 - 150	<20	0.1	mg/L
TPH	Petroleum Range Organics (TRPH) - C10-C28	DRO, 8015Mod	SS	50 - 150	<20	4.0	mg/Kg
TPH	Petroleum Range Organics (TRPH) – C10-C20, C20-C34	OHIO DRO	GW, WW	50 - 150	<20	0.1	mg/L
TPH	Petroleum Range Organics (TRPH) – C10-C20, C20-C34	OHIO DRO	SS	50 - 150	<20	4.0	mg/Kg
TPH	Petroleum Range Organics (TRPH) – gas, diesel, motor oil, etc.	OA2	GW, WW	50 - 150	<20	0.1	mg/L
TPH	Petroleum Range Organics (TRPH) – gas, diesel, motor oil, etc.	OA2	SS	50 - 150	<20	4.0	mg/Kg
TPH	Petroleum Range Organics - C10-C28, C28-C40	DRORLA	GW, WW	50 - 150	<20	0.1	mg/L
TPH	Petroleum Range Organics - C10-C28, C28-C40	DRORLA	SS	50 - 150	<20	4.0	mg/Kg
TPH	Petroleum Range Organics – C10-C32	DROWY	GW, WW	50 - 150	<20	0.1	mg/L
TPH	Petroleum Range Organics – C10-C32	DROWY	SS	50 - 150	<20	4.0	mg/Kg
TPH	Petroleum Range Organics – gas, diesel, motor oil, etc.	NWTPH-Dx	GW, WW	50 - 150	<20	0.25	mg/L
TPH	Petroleum Range Organics – gas, diesel, motor oil, etc.	NWTPH-Dx	SS	50 - 150	<20	25	mg/Kg
TPH	Petroleum Range Organics – C10-C28	DROWM	GW, WW	75 - 115	<20	0.1	mg/L
TPH	Petroleum Range Organics – C10-C28	DROWM	SS	70 - 120	<20	10	mg/Kg
TPH	Petroleum Range Organics – C10-C22	TPHAZ	SS	70-130	<20	30	mg/Kg
TPH	Petroleum Range Organics – C22-C32	TPHAZ	SS	70-130	<20	100.	mg/Kg
TPH	Petroleum Range Organics – C10-C32	TPHAZ	SS	70-130	<20	130.	mg/Kg
TPH	Petroleum Range Organics - C6-C12, C12-C28, C28-C35, C6-C35	TX TPH	SS	75 - 125	<20	50	mg/Kg
TPH	Petroleum Range Organics - C10-C21, C21-C35	DROMO	GW, WW	75 - 125	<20	1.0	mg/L
TPH	Petroleum Range Organics - C10-C21, C21-C35	DROMO	SS	75 - 125	<20	20	mg/Kg
IH	Aromatic Hydrocarbons	NIOSH 1501	Air	85-115	<20	10	ug/sample

13.0 CORRECTIVE ACTION

13.1 In the event that a nonconformance occurs in conjunction with the analytical batch, a corrective action response (CAR) form must be completed. The cause of the event is stated on the form and the measures taken to correct the nonconformance clearly defined. The effectiveness of the corrective action must be assessed and noted. The CAR is kept on file by the QA Department. Corrective action procedures are documented in SOP #030208, *Corrective and Preventive Action*

13.2 Required Corrective Action

Control limits have been established for each type of analysis. When these limits are exceeded, corrective action must be taken. Calculated sample spike control limits are also used.

All samples and procedures are governed by ESC's quality assurance program. General corrective actions are as follows; however additional and more specific direction is provided in the specific determinative procedure. For more information, see the appropriate determinative SOP.

13.2.1 Laboratory QC Criteria and Appropriate Corrective Actions

If the analytical method contains acceptance/rejection criteria and it is more stringent than those controls generated by the laboratory the method criteria will take precedence.

13.2.2 Out Of Control Blanks: Applies to Method, Trip, Rinsate & Instrument Blanks

Rejection Criteria - Blank reading is more than twice the background absorbance or more than 1/2 RL.

Corrective Action - Blanks are re-analyzed and the response is assessed. Standard curves and samples are evaluated for any obvious contamination that is isolated or uniform throughout the run. If necessary, reagents are re-prepared. Analyses are not initiated until the problem is identified and solved. If samples have already been prepared or analyzed, the Department Manager or QA Department is consulted to determine if data needs to be rejected or if samples need to be re-prepared.

13.2.3 Out Of Control Laboratory Control Standards (LCS & LCSD)

Rejection Criteria - If the performance is outside of lab-generated control limits which are calculated as the mean of at least 20 data points ±3 times the standard deviation of those points (Listed in Section 12) and the marginal excedence allowance is surpassed (see section 12.2).

Corrective Action - Instrument settings are checked and the LCS standard is reanalyzed. If the LCS is still out of control, instrumentation is checked for systemic problems and repaired (if necessary). Re-calibration is performed and the samples affected since the last in control reference standard are rerun. The group leader, Department Manager, or QA Department is consulted for further action.

13.2.4 Out Of Control Matrix Spike Samples

Rejection Criteria - If sample is outside of lab-generated control limits from accuracy charts on matrix spike samples from a similar matrix (i.e., water, solid, etc). Limits are calculated as the mean of at least 20 data points ±3 times the standard deviation of those points.

Corrective Action - Spiking technique is assessed to ascertain if the sample has been spiked correctly. The spiked sample should be 1 – 5 times the client sample concentration; otherwise, the percent recovery (%R) or relative percent difference (%RPD) of the MS/MSD is flagged as not meaningful or usable. The sample is re-spiked and re-analyzed, along with several other similar samples in subset. If an out of control situation persists, sample matrix interference is indicated. Samples to be analyzed by standard additions are prepared (where appropriate), and the group leader, Department Manager, or QA Department is notified.

13.2.5 Out Of Control Duplicate Samples

Rejection Criteria - Lab-generated maximum RPD limit (as listed under precision in Section 12)

Corrective Action - Instrument and samples are checked to see if precision variance is likely (i.e., high suspended solids content, high viscosity, etc.). They are re-analyzed in duplicate and samples just before and just after the duplicated sample are re-checked. If problem still exists, Department Manager, or QA Department is notified to review the analytical techniques.

13.2.6 Out Of Control Matrix Spike Duplicates

Rejection Criteria - These QC samples can be out of control for accuracy, precision, or both.

Corrective Action - The appropriate corrective actions listed for either matrix spikes, duplicate samples, or both are followed.

NOTE: Some samples cannot be duplicated. This is the case for wipe samples, filters, and some water samples. When possible, sampling personnel should collect duplicate samples.

13.2.7 Out Of Control Calibration Standards: ICV, CCV, SSCV

Rejection Criteria - If the performance is outside of method requirements.

Corrective Action - Instrument settings are checked, calibration verification standard is reanalyzed. If the standard is still out of control, recalibration is performed, and samples affected since the last in control reference standard are rerun. The group leader, Department Manager, or QA Department will be consulted for further action.

14.0 RECORD KEEPING

Record keeping is outlined in SOP #010103, *Document Control and Distribution*, SOP #030203, *Reagent Logs and Records* and SOP #030201, *Data Handling and Reporting.* Semi-Volatile organics calibration data are recorded and integrated using HP Enviroquant software. Calibration data from the semi-volatile analyses, in addition to the initial and daily calibration, includes GC/MS autotunes, DFTPP reports and surrogate recovery reports. Hard copy records of initial calibration and daily calibration are stored with chromatograms and integrated with sample data by date analyzed.

15.0 QUALITY AUDITS

System and data quality audits are outlined in the ESC Quality Assurance Manual Version 8.0.

1.0 SIGNATORY APPROVALS

Air Laboratory
QUALITY ASSURANCE MANUAL

APPENDIX VIII TO THE ESC QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

NOTE: The QAM has been approved by the following people. A signed cover page is available upon request

Judith R. Morgan, M.S., VP of Technical and Regulatory Affairs 615-773-9657

Eric Johnson, B.S., Laboratory Director 615-773-9654

Dixie Marlin, B.S, QC Manager, 615-773-9681

Kenny Buckley, B.S., Organics/Wet Chemistry Department Manager, 615-773-9686

2.0 APPENDIX TABLE OF CONTENTS

3.0 SCOPE AND APPLICATION

This appendix discusses specific QA requirements for general analytical protocols to ensure that analytical data generated from the Air Laboratory are scientifically valid and are of acceptable quality. Any deviations from these requirements and any deviations that result in nonconforming work must be immediately evaluated and their corrective actions documented.

4.0 LABORATORY ORGANIZATION AND RESPONSIBILITIES

ESC Lab Sciences offers diverse environmental capabilities that enable the laboratory to provide the client with both routine and specialized services, field sampling and broad laboratory expertise. A brief outline of the organization and responsibilities as they apply to the ESC Quality Assurance Program is presented in *Section 4.0 in the ESC Quality Assurance Manual Version 8.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Kenneth W. Buckley, with a B.S. degree in General Science, is the Department Manager of Organics and Wet Chemistry laboratories. Mr. Buckley reviews and approves all data reduction associated with analyses in these areas and is responsible for the overall production of these laboratories; including the management of the staff and scheduling. Mr. Buckley has over 9 years of environmental laboratory experience. In his absence, J. D. Gentry, with a B.S. degree in Chemistry and over 9 years of environmental laboratory experience, assumes responsibility for Air Department decisions.

5.2 TRAINING

The primary analyst or Manager trains new laboratory analysts according to ESC protocol. ESC's training program is outlined in *SOP 030205 Technical Training and Personnel Qualifications.* Performance is documented using an initial demonstration of capability (IDOCs) and continuing demonstration of capability (CDOC). Documentation of analyst training is maintained on file within the department.

6.0 FACILITIES AND LABORATORY SAFETY

6.1 FACILITIES

The main area of the laboratory has approximately 670 square feet of area with roughly 150 square feet of bench area. There are 670 square feet of additional storage and the lighting is fluorescence. The air system is a ten-ton Trane split unit with natural gas for heating. The laboratory reagent water is provided through the US Filter deionizer system. Waste disposal containers are located in the laboratory and Clean Harbors serves as ESC's hazardous waste disposal company. ESC's building information guides and site plan are shown in Appendix I.

6.2 LABORATORY SAFETY

- Laboratory access is limited when work is being performed.
- All procedures where chemicals are prepared or splashes may occur are conducted in laboratory exhaust hoods.

ESC's laboratory safety guidelines are detailed in the *ESC Chemical Hygiene and Safety Plan.*

7.0 SAMPLING PROCEDURES

7.1 FIELD SAMPLING PROCEDURES, SAMPLE STORAGE, AND HANDLING

- Field Sampling procedure is described in Appendix III of this ESC Quality Assurance Manual. Sample information is recorded and kept on the ESC chain of custody and field logbooks.
- Samples for air analysis are collected in four ways:
  - Samples may be collected directly in evacuated Summa canisters fit with the appropriately adjusted regulator that controls sampling flow to fill the canister over a given time period.
  - Summa canisters may also be collected as "grab" samples by simply opening the canister without the aid of a flow regulator and allowing the canister to fill quickly by virtue of the canister vacuum.
  - The third method entails collection of field samples using various sized bags specifically designed for air sampling (i.e. Tedlar). This type of sampling allows a pump connected to the bag to sample the air over the appropriate timeframe needed by the client.
  - The headspace of containers housing water samples may also be analyzed for specific volatile components.

- Air samples taken in summa canisters should be shipped in bubble wrapped boxes. Tedlar bags and water samples can be shipped in a container or cooler that is sufficiently rigid and protects the samples from damage that may be incurred in shipping. The chain of custody is also placed in the container. The shipping label containing the name and address of the shipper is affixed to the outside of the cooler.
- Samples are received in the laboratory login area and are tracked using LIMS (Laboratory Information Management System). A Chain of Custody Form accompanies all samples received by the lab. This is necessary to prove the traceability of the samples and to document the change in possession from sampling to delivery to receipt by the laboratory. Prior to analysis samples are checked for integrity. Sample handling, tracking and acceptance procedures are outlined in *SOP #060105, Sample Receiving.*

8.0 EQUIPMENT

8.1 EQUIPMENT LIST

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Air Analysis
This table is subject to revision without notice

Item	*Manufacturer*	*Model*	*Instrument Name*	*#*	*Serial #*	*Location*
Gas Chromatograph	HP	6890N TCD	AIRGC1	1	US10726007	Air Lab
Gas Chromatograph/Mass Spectrometer	HP	6890 GC/5973MSD	AIRMS1	1	GCUS00024616 MSUS63810244	Air Lab
Gas Chromatograph/Mass Spectrometer	Agilent	6890N/5975	AIRMS2	2	CN10551083	Air Lab
Gas Chromatograph/Mass Spectrometer	Agilent	6890/5973	AIRMS3	3	US000011333 US91911078	Air Lab
Preconcentrator	Entech	7100A			1089	Air Lab
Canister Autosampler	Entech	7016CA			1039	Air Lab
Tedlar Autosampler	Entech	7032A-L			1019	Air Lab
Dynamic Diluter	Entech	Model 4600A			1086	Air Lab
Canister Cleaner	Entech	Model 3100A			1045	Air Lab
Canister Cleaner	Entech	Model 3100A			1178	Air Lab
Canister cleaner	Entech	Model 3100A			B33-02663	Air Lab
Preconcentrator	Entech	7100A			1137	Air Lab
Canister Autosampler	Entech	7016CA			1137	Air Lab
Tedlar Autosampler	Entech	7032A-L			1017	Air Lab
GC/FID	Agilent	6890N	AIRGC2	2	US10137006	Air Lab
Headspace Autosampler	Tekmar	7000			9507018	Air Lab
TO Canister	Restek/Entech	TO-Can/ SiloniteCan	860 cans owned		N/A	Air Lab
Passive Sampling Kit	Restek		380 owned		N/A	Air Lab

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Air Analysis ***This table is subject to revision without notice***						
Item	***Manufacturer***	***Model***	***Instrument Name***	***#***	***Serial #***	***Location***
Field hand held PID	RAE Systems	MiniRae2000			110-012980	Air Lab
Field hand held PID	RAE Systems	MiniRAE2000				Air Lab

8.2 EQUIPMENT PREVENTIVE MAINTENANCE, EQUIPMENT CALIBRATION

INSTRUMENT	***P. M. DESCRIPTION***	***FREQUENCY***
Gas Chromatograph Detectors: FID	Change Quartz jet; clean; replace flame tip	As needed - when deterioration is noticeable
Gas Chromatograph/Mass Spectrometer	•Autotune Report	Inspected daily
Gas Chromatograph/Mass Spectrometer	•Clean ion source	As needed to maintain high mass resolution
Gas Chromatograph/Mass Spectrometer	•Replace vacuum pump oil	Every 6 months
Gas Chromatographs/Mass Spectrometer & Gas Chromatographs	•Replace column	When separation begins to degrade

8.3 STANDARDS AND REAGENTS

Table 8.3A: Standard stock sources, description and calibration information. ***This table is subject to revision without notice***					
Method	**Vendor**	**Description**	**Conc.**	**Storage Req.**	**Expiration**
TO-15/8260B (VAP)/Method 8-mod. ISTD Stock Standard	Spectra Gases	ISTD and Tuning Mixture	1 ppmv	3395 L (2A) cylinder	1 year
TO-15/ 8260B(VAP)/ Method 18-mod. Stock Standard*	Spectra Gases	Target Analytes except Bromoform at 3 ppmv, m&p Xylene at 2 ppmv and GRO at 40 ppmv	100 ppbv	3395 L (2A) cylinder	1 year
TO-15/ 8260B(VAP)/ Method 18-mod. Laboratory Control Stock Standard*	Spectra Gases	Target Analytes – Second Source	100 ppbv	3395 L (2A) cylinder	1 year
Landfill Gases Stock (CO_2, CO, CH_6, N_2, O_2, He)	Spectra Gases	Target Analytes	3 Levels	3395 L (2A) cylinder	1 year
Landfill Gases Laboratory Control Stock Standard	Spectra Gases	Target Analytes – Second Source	20%	3395 L (2A) cylinder	1 year
RSK-175 (Methane, Ethane, Ethene) Stock Standard	Scotty Gases	Target Analytes	1000 ppmv	3395 L (2A) cylinder	1 year
RSK-175 Laboratory Control Stock Standard	Scotty Gases	Target Analytes – Second Source	1000 ppmv	3395 L (2A) cylinder	1 year

TABLE 8.3B: Intermediate/Working Standard Concentrations ***This table is subject to revision without notice***					
Organic Compounds	**Method #**	**Working Standard Concentrations**	**Volume of Stock Used**	**Final Volume**	**Expiration**
ISTD and Tuning Intermediate Standard	TO-15/8260B (VAP)/Method 18.	20 ppbv	900 cc	45L in 15L Canister	1 year

TABLE 8.3B: Intermediate/Working Standard Concentrations *This table is subject to revision without notice*					
Organic Compounds	**Method #**	**Working Standard Concentrations**	**Volume of Stock Used**	**Final Volume**	**Expiration**
Target Analytes* Intermediate Standard	TO-15/8260B (VAP)/Method 18	5 ppbv except Bromoform at 5ppbv, m&p Xylene at 10 ppbv and GRO at 200 ppbv	225 cc	45L in 15L Canister	1 year
TO-15/ 8260B(VAP)/ Method 18-mod. Laboratory Control* Intermediate Standard	TO-15/8260B (VAP)/Method 18	Second Source: 5 ppbv except Bromoform at 15ppbv, m&p Xylene at 10 ppbv and GRO at 200 ppbv	225 cc	45L in 15L Canister	1 year

** see analytes listed in Table 12.3.*

8.4 INSTRUMENT CALIBRATION

TO-15, 8260B(Ohio VAP Air), Gasoline Range Components (Method 18) – Volatiles in Air by GC/MS – SOP Numbers 330367, 330368, & 330369

Detector mass calibration is performed daily using the autotune function of the GC/MS analytical system and PFTBA (Perfluorotributylamine). Following verification of the appropriate masses, the instrument sensitivity is verified by injecting a tuning solution containing Bromofluorobenzene (BFB). The BFB must meet the following ion abundance criteria:

Mass	Ion Abundance Criteria
50	15.0-40.0% of mass 95
75	30.0-60.0% of mass 95
95	base peak, 100% relative abundance
96	5.0-9.0% of mass 95
173	< 2.0% of mass 174
174	> 50.0% of mass 95
175	5.0-9.0% of mass 174
176	> 95.0%, but less than 101% of mass 174
177	5.0-9.0% of mass 176

Successful tuning must occur every 24 hours for method TO-15 and Method 18 and every 12 hours for method 8260B.

Following successful tuning, the GC/MS is calibrated using the internal standard procedure. A standard curve is prepared using a minimum of five standards. The calibration standards are tabulated according to peak height or area against concentration and the concentrations and responses of the internal standard analytes. The results are used to determine a response factor for each analyte in each standard injected.

A TO-15 or Method 18 calibration curve is constructed and determined to be acceptable if each analyte is found to be constant over the working range (<30 % RSD with no more than 2 compounds being between 30 and 40 % RSD). When this condition is met, linearity through the origin can be assumed and the average RF can be used in place of a calibration curve.

When analyzing air by method 8260B, specific target analytes in the calibration standards are defined as calibration check compounds (CCCs) or system performance check compounds (SPCCs).

SPCCs:	
Analyte	Minimum Relative Response Factor
Chloromethane	0.10
1,1-Dichloroethane	0.10
Bromoform	0.10
Chlorobenzene	0.30
1,1,2,2-Tetrachloroethane	0.30

CCCs:	
1,1-Dichloroethene	Toluene
Chloroform	Ethylbenzene
1,2-Dichloropropane	Vinyl Chloride

Analytes identified by the method as SPCCs must meet the minimum average response factors listed above for successful initial calibration. Compounds identified as CCCs must have a %RSD of less than 30% in the initial calibration curve. The remaining target analytes in the calibration standards must be <15% RSD. Initial 8260B calibration that does not meet these requirements is not accepted and re-calibration must be performed. Linear regression can be used for any target compound exceeding the 15% RSD criteria providing that the correlation coefficient is 0.990 or better.

For all methods, the initial calibration range must represent the typical air sample and include the lowest standard at or below the RL. The linear range of the instrument must be monitored to ensure that the maximum calibration point is within the range. Following successful calibration, the analysis of field and QC samples may begin. Analysis may be performed only during the timeframe of a valid tuning cycle (12 hours for 8260B and 24 hours for TO-15 and Method 18). Following the expiration of the tuning clock, the instrument must be retuned and either recalibrated or the existing calibration may be verified prior to further sample analysis.

For 8260B analyses, daily continuing calibration verification (CCV) includes successful demonstration of BFB sensitivity and the injection of a mid-level CCV standard

containing all the target analytes of interest, the CCC, and SPCC compounds. The BFB tune must meet the ion abundance criteria (see table above). Each SPCC in the calibration verification standard must meet a minimum response factors listed above. The CCCs must achieve the criteria of +/- 20% RSD. Each internal standard in the CCV must recover between -50% to + 100%, when compared to the same internal standard compound in the mid-point standard of the initial calibration curve. Additionally, if the retention time of an internal standard changes by more than 30 seconds from the retention time of the same internal standard in the mid-level standard of the most recent initial calibration, the system must be evaluated, corrected, and possibly re-calibrated.

For TO-15 and Method 18 analyses, daily calibration verification is accomplished by a successful demonstration of BFB sensitivity and the injection of a mid-level CCV standard containing all the target analytes of interest. The BFB tune must meet the same ion abundance criteria as previously listed and the CCV standard must recover within 30% of predicted response for all analytes of interest.

Landfill Gases (Carbon Dioxide, Carbon Monoxide, Methane, Nitrogen, Oxygen) – SOP Number 330366

Optimize the conditions of the Gas Chromatograph with Thermal Conductivity Detection according to the manufacturer's specification to provide good resolution and sensitivity. Verify that the gas flows and column and detector temperatures are at optimum levels for analysis, based on peak resolution and chromatograph performance. Allow sufficient time between each temperature adjustment to attain a stable reading (typically one hour). Standards are injected at a minimum of three concentration levels from purchased certified standards. Generation of the initial calibration is performed using Chrom-Perfect Spirit software and a linear regression model. The correlation coefficient must be at least 0.990. Instrument calibration must be verified initially on days when a full calibration curve is not analyzed, following every 10 injections during the analytical sequence, and at the end of each sequence by the analysis of a check standard. These standards must recover within 30% of the expected concentration. Each sample is analyzed in triplicate and the average sample area for each compound is calculated. The sample results are considered acceptable when the injections agree within 5% of their average. If this criteria is not met, additional injections are analyzed until consistent area data is obtained.

Methane, Ethane, Ethene based on RSK-175 – SOP Number 330370

Optimize the conditions of the Gas Chromatograph with Thermal Conductivity Detection according to the manufacturer's specification to provide good resolution and sensitivity. Verify that the gas flows and column and detector temperatures are at optimum levels for analysis, based on peak resolution and chromatograph performance. Allow sufficient time between each temperature adjustment to attain a stable reading (typically one hour). Standards are injected at a minimum of three concentration levels. The target analytes in the calibration standards must be <15% RSD. Linear regression can be used for any

target compound exceeding the 15% RSD criteria providing that the correlation coefficient is 0.990 or better. Headspace is created in each field sample by forcing 20cc of helium into each sample vial. Following sufficient time for the sample and headspace to reach equilibrium, 100 uL of air is removed from each vial and injected into the GC. Instrument calibration must be verified initially on days when a full calibration curve is not analyzed, following every 10 injections during the analytical sequence, and at the end of each sequence by the analysis of a check standard. These standards must recover within 15% of the expected concentration.

8.5 ACCEPTANCE/REJECTION OF CALIBRATION

The initial calibration curve is compared with previous curves for the same analyte. All new standard curves are immediately checked with a secondary source or laboratory control standard prepared from a separate source than those used for calibration. All curves are visually reviewed to ensure that acceptable correlation represents linearity. Calibration curves may be rejected for nonlinearity, abnormal sensitivity, or poor response of the laboratory control standard.

Continuing calibration verification is performed on each day that initial calibration is not performed and following every tenth sample. If a check standard does not perform within established criteria then the instrument will undergo evaluation to determine the problem. Once the problem is corrected, all samples between the last in control sample and the first out of control check will be re-analyzed.

TABLE 8.5: INSTRUMENT CALIBRATION & QC

Analysis/ Instrument	Calibration Type	Number of Standards	Acceptance/ Rejection Criteria	Frequency
TO-15 & Method 18/ GC/MS	Initial/ Continuing	1 - Tuning Solution	Mass m/z Abundance Criteria 50 8-40% of mass 95 75 30-66% of mass 95 95 Base peak, 100% 96 5-9% of mass 95 173 <2% of mass 174 174 >50% of mass 95 175 4-9% of mass 174 176 >93% but <101% of mass 174 177 5-9% of mass 176	TO-15/ M-18: Every 24 hours 8260 VAP: Every 12 hours
TO-15 & Method 18/ GC/MS	Initial	5 minimum	Average Response Factor: <30 % RSD with no more than 2 compounds being between 30 and 40 % RSD	As needed
8260B VAP/ GC/MS	Initial	5	Average Response Factor: Target analytes in the calibration standards must be <15% RSD, CCCs must have a %RSD of less than 30% & SPCCs must meet the minimum	As needed

TABLE 8.5: INSTRUMENT CALIBRATION & QC

Analysis/ Instrument	Calibration Type	Number of Standards	Acceptance/ Rejection Criteria	Frequency
			average response factors. Linear regression can be used for any target compound exceeding the 15% RSD	
TO-15 & Method 18/ GC/MS	Continuing	1 cal. check verification (CCV)	Percent Difference for all compounds <30%	Daily, when init. calibration is not required.
TO-15 VAP/ GC/MS	Continuing	1 cal. check verification (CCV)	Average Response Factor: Target analytes in the calibration standards must be <15% RSD, CCCs must have a %RSD of less than 20% & SPCCs must meet the minimum average response factors.	Daily, when init. calibration is not required.
TO-15 & Method 18	Initial/ Continuing	1 - Blank	< ½ RL, concentrations of common laboratory contaminants shall not exceed the reporting limit	Following init. calibration or daily cal. verification
TO-15 & Method 18	Initial/ Continuing	2 – Second source (LCS/LCSD)	Must be within +/-30% with an RPD of <25.	Following initial calibration or daily cal. Verification
Landfill Gas	Initial	3	Average Response Factor: Target analytes in the calibration standards must be <15% RSD. Linear regression can be used for any target compound exceeding the 15% RSD	As needed
Landfill Gas	Continuing	1 - cal. check verification (CCV)	Target analytes in the calibration standards must be <15% RSD.	Daily, when init. calibration is not required, following every 10th injection, and the end of the sequence.
Landfill Gas	Initial/ Continuing	1 - Blank	< ½ RL, concentrations of common laboratory contaminants shall not exceed the reporting limit	Following init. calibration or daily cal. verification
Landfill Gas	Initial/ Continuing	2 – Second source (LCS/LCSD)	Must be within +/-30% with an RPD of <25.	Following initial calibration or daily cal. verification
RSK-175	Initial	3	Average Response Factor: Target analytes in the calibration standards must be <15% RSD. Linear regression can be used for any target compound exceeding the 15% RSD	As needed
RSK-175	Continuing	1 - cal. check verification (CCV)	Target analytes in the calibration standards must be <15% RSD.	Daily, when init. calibration is not required, following every 10th injection, and the end of the sequence.
RSK-175	Initial/ Continuing	1 - Blank	< ½ RL, concentrations of common laboratory contaminants shall not exceed the reporting limit	Following init. calibration or daily cal. verification
RSK-175	Initial/	2 – Second source	Must be within +/-30% with an RPD of <25.	Following initial

TABLE 8.5: INSTRUMENT CALIBRATION & QC				
Analysis/ Instrument	**Calibration Type**	**Number of Standards**	**Acceptance/ Rejection Criteria**	**Frequency**
	Continuing	(LCS/LCSD)		calibration or daily cal. verification

9.0 LABORATORY PRACTICES

9.1 REAGENT GRADE WATER

Reagent Grade water –Type II used in the Microbiology Laboratory is periodically checked for contamination. Type II water is checked annually for single and total heavy metals. Monthly checks for total organic carbon, ammonia and organic nitrogen, total residual chlorine and a heterotrophic plate count are also conducted. Conductivity and pH are checked continuously or with each use.

9.2 SAMPLER CLEANING AND CERTIFICATION PROCEDURE

Canisters are cleaned in the laboratory using the Entech 3100 4-Position Canister Cleaner. Canisters are cleaned in batches of 4 to 8 per cleaning cycle. Prior to cleaning, canisters are inspected for integrity, damage and visible contamination. Acceptable canisters are connected to the manifold on the Entech cleaner and the cleaning cycle is controlled using Entech SmartLab software. Programmable cleaning cycles include: light, medium and heavy-duty and the cycle selected depends on the previous use of the dirtiest canister being cleaned. The cleaner automatically performs a leak check for the canisters and the manifold prior to the initial evacuation cycle. Heating bands are placed on each canister to elevate the temperature of the metallic canister to a level that provides for efficient cleaning. The typical cleaning cycle parameters are:

	Operating temperature = 120°C
1	Initial evacuation of canister to 1000 mtorr
2	Refill canister to 20psi
3	Evacuate the canister to 50 mtorr
4	Repeat items 2 & 3 for 8 total cycles
5	Final zero air pressure in clean canister is 50 mtorr.

Following cleaning, a single canister is selected as a QC sample for the entire batch and the sample is filled with zero air or nitrogen and analyzed to verify that successful cleaning has occurred. If the analysis indicates that the batch is clean (i.e. <0.2 ppbv for target analytes and free of additional contamination), the QC sample is returned to the cleaner manifold. The entire batch is evacuated to less than 50 mtorr and clearly labeled as clean and ready for sample collection. If the QC sample indicates that canister contamination is still present, the batch may be recycled through the cleaning process until residual contamination is no longer present. If following repeated cleaning cycles,

residual contamination is still observed, canisters may be permanently removed from service and clearly identified as unusable.

Tedlar bags and vials, as used for headspace analyses, are purchased as certified pre-cleaned from approved providers.

9.3 TYPICAL ENTECH AUTOSAMPLER OPERATING PARAMETERS

These parameters are provided as an example and may be modified to improve analytical system performance or better address project needs.

Line Temp = 100°C	Module 2 Desorb = 180°C
Bulk Head 1 = 30°C	Module 2 Bake = 190°C
Bulk Head 2 = 30°C	Module 2 Desorb Time = 3.5 min
Module 1 Trap = -150°C	Module 3 Trap = -180°C
Module 1 Preheat = 20°C	Module 3 Inject = 2 min
Module 1 Desorb = 20°C	Module 3 Bake Time = 2 min
Module 1 Bake = 130°C	Module 3 Event = 3
Module 1 Bake Time = 5 min	Module 3 Wait Time = 25 min.
Module 2 Trap = -30°C	Pressure Comp Factor = 14
Module 2 Preheat = off	Loop Flush = 30 seconds

10.0 ANALYTICAL PROCEDURES

10.1 A list of laboratory SOP's associated with the air laboratory can be found in the following table:

TABLE 10.1: AIR DEPARTMENT SOP'S

This Table is subject to revision without notice

SOP #	Title/Description
330366	Determination of Carbon Dioxide, Carbon Monoxide, Methane, Nitrogen and Oxygen in Air Samples.
330367	Measurement of Volatile Organic Compound in Ambient Air by GC/MS (EPA TO-15)
330368	Gasoline Range Organics in Ambient Air by GC/MS – Method 18 Modified
330369	Volatile Organic Compounds in Air by GC/MS 8260B for the Ohio VAP Program (with provisions for GRO determination based on 8015B)
330370	Method for Determination of Methane, Ethane, and Ethene (Based on RSK-175)

10.2 Sample Dilutions:

Dilutions for air samples from summa canisters and Tedlar bags may take three forms depending on the level of dilution required. These dilution techniques are demonstrated below:

Autosampler Dilution:

- First, a smaller sample volume can be analyzed using the capabilities of the Entech autosampler. For example, for a standard sample volume of 400cc, if 40cc were analyzed, that would be equivalent to a 10-fold dilution.
- The smallest sample volume that can be accurately analyzed using the autosampler method is l0cc (or a 40x).

Pressurized Manual Dilution:

- Sometimes, a 40X dilution is not sufficient to bring the concentration of a target analyte within the calibration range. In those cases, the sample canister is pressurized resulting in a dilution of the target analytes present.
- The act of introducing more pure air into the canister performs a dilution.
- The canister can then be analyzed at 400cc or diluted using a lesser autosampler volume, if necessary.

Secondary Manual Dilution:

- In extreme cases, the canister may need to be diluted into a second evacuated canister.
- This is accomplished by using a gas tight syringe to remove an aliquot of sample (1-l0mL) from the initial canister then injecting it into a clean evacuated second canister.
- The second canister is then analyzed and quantified taking into account the dilution based on the amount of sample injected and the total volume of the canister utilized.

Tedlar Bag Dilutions:

- Dilutions on Tedlar bags can be performed in much the same manner as summa canisters using either the autosampler dilution or the secondary manual dilution using a second Tedlar bag and filling it with pure air then adding an aliquot of field sample using a gas tight syringe.

11.0 QUALITY CONTROL CHECKS

NOTE: For specific guidance on each determinative method, including required quality control and specific state requirements/modifications, refer to the relevant laboratory standard operating procedure(s).

11.1 Initial Demonstrations of Capability (IDOC's) are performed during new analyst training and/or prior to acceptance and use of any new method/instrumentation. Continuing Demonstration of Capability (CDOC's) must be updated at least annually. The associated data is filed within the department and available for review.

11.2 A Laboratory Control Sample (LCS) and LCS Duplicate are analyzed per batch of samples and must yield recoveries within 70-130% of the expected concentration for all analytes and this pair must not exceed and RPD of 25%. LCS stock standards are prepared from sources independent of the calibration standards and also serve to verify the original calibration curve.

11.3 A method preparation blank is performed per batch of samples processed. If one-half the reporting limit [RL] is exceeded, the laboratory shall evaluate whether reprocessing of the samples is necessary, based on the following criteria:

- The blank contamination exceeds a concentration greater than 1/10 of the measured concentration of any sample in the associated preparation batch or
- The blank contamination is greater than 1/10 of the specified regulatory limit.

The concentrations of common laboratory contaminants shall not exceed the reporting limit. Any samples associated with a blank that fail these criteria shall be reprocessed in a subsequent preparation batch, except when the sample analysis resulted in non-detected results for the failing analytes.

12.0 DATA REDUCTION, VALIDATION AND REPORTING

12.1 DATA REDUCTION

The analyst performs the data calculation functions and is responsible for the initial examination of the finished data. Data reduction steps applied to the raw data are outlined in SOP #030201, *Data Handling and Reporting.* The Quality Control Department performs the secondary review of the data package using the ESC SOP #030227, *Data Review*. The QC Reviewer verifies that the analysis has performed as required and meets method criteria, all associate data is present and complete, and also ensures that any additional documentation is completed as required (i.e. Ohio VAP checklists, required flags on test reports, etc.)

TABLE 12.1 Data Reduction Formulas	
PARAMETER	**FORMULA**
GC/MS – Analyte Response Factor	response of analyte primary ion {*area*} x concentration of analyte (ug/L) response of ISTD primary ion {*area*} x concentration of ISTD (ug/L) *Calculations performed by HP Enviroquant Software*
GC/MS – Sample Analyte Concentration	response of primary ion in analyte x int. std concentration. {*ppbv*} x dilution factor response factor {*area/(mg/ml)*} x initial volume-mass {*ml or g*} x int. std cal. {area} *Calculations performed by HP Enviroquant Software*

12.2 VALIDATION

The validation process consists of data generation, reduction review, and reporting results. Once data reduction is complete, validation is conducted by verification that the QC samples are within acceptable QC limits and that all documentation is complete, including the analytical report and associated QC. See Table 12.3 by method for current QC targets and controls and current reporting limits.

Organic Control Limits - The organic QC targets are statutory in nature; warning and control limits for organic analyses are initially set for groups of compounds based on preliminary method validation data. When additional data becomes available, the QC targets are reviewed. All QC targets are routinely re-evaluated at least annually (and updated, if necessary) against laboratory historical data to insure that the limits continue to reflect realistic, method achievable goals.

12.3 REPORTING

Reporting procedures are documented in SOP #030201, *Data Handling and Reporting.*

Table 12.3: QC Targets for Air Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Analyte	Method	Matrix	Accuracy (%)	Prec. (% RPD)	RL	Unit
1,1,1-Trichloroethane	TO-15	Air	70-130	25	0.2	ppbv
1,1,2,2-Tetrachloroethane	TO-15	Air	70-130	25	0.2	ppbv
1,1,2,2-Tetrachloroethane	TO-15	Air	70-130	25	0.2	ppbv
1,1,2-Trichloroethane	TO-15	Air	70-130	25	0.2	ppbv
1,1-Dichloroethane	TO-15	Air	70-130	25	0.2	ppbv
1,1-Dichloroethene	TO-15	Air	70-130	25	0.2	ppbv
1,2,4-Trichlorobenzene	TO-15	Air	70-130	25	0.63	ppbv

Table 12.3: QC Targets for Air Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Analyte	Method	Matrix	Accuracy (%)	Prec. (% RPD)	RL	Unit
1,2,4-Trimethylbenzene	TO-15	Air	70-130	25	0.2	ppbv
1,2-Dibromoethane	TO-15	Air	70-130	25	0.2	ppbv
1,2-Dichlorobenzene	TO-15	Air	70-130	25	0.2	ppbv
1,2-Dichloroethane	TO-15	Air	70-130	25	0.2	ppbv
1,2-Dichloropropane	TO-15	Air	70-130	25	0.2	ppbv
1,3,5-Trimethylbenzene	TO-15	Air	70-130	25	0.2	ppbv
1,3-Butadiene	TO-15	Air	70-130	25	0.2	ppbv
1,3-Dichlorobenzene	TO-15	Air	70-130	25	0.2	ppbv
1,4-Dichlorobenzene	TO-15	Air	70-130	25	0.2	ppbv
1,4-Dioxane	TO-15	Air	70-130	25	0.2	ppbv
1,1,1-Trichloroethane	TO-15	Air	70-130	25	0.2	ppbv
2,2,4-Trimethylpentane	TO-15	Air	70-130	25	0.2	ppbv
2-Chlorotoluene	TO-15	Air	70-130	25	0.2	ppbv
2-Propanol	TO-15	Air	70-130	25	0.2	ppbv
4-Ethyltoluene	TO-15	Air	70-130	25	0.2	ppbv
Acetone	TO-15	Air	70-130	25	1.25	ppbv
Allyl Chloride	TO-15	Air	70-130	25	0.2	ppbv
Benzene	TO-15	Air	70-130	25	0.2	ppbv
Benzyl Chloride	TO-15	Air	70-130	25	0.2	ppbv
Bromomethane	TO-15	Air	70-130	25	0.2	ppbv
Bromodichloromethane	TO-15	Air	70-130	25	0.2	ppbv
Bromoform	TO-15	Air	70-130	25	0.6	ppbv
Carbon Disulfide	TO-15	Air	70-130	25	0.2	ppbv
Carbon Tetrachloride	TO-15	Air	70-130	25	0.2	ppbv
Chlorobenzene	TO-15	Air	70-130	25	0.2	ppbv
Chloroethane	TO-15	Air	70-130	25	0.2	ppbv
Chloroform	TO-15	Air	70-130	25	0.2	ppbv
Chloromethane	TO-15	Air	70-130	25	0.2	ppbv
Cis-1,2-Dichloroethene	TO-15	Air	70-130	25	0.2	ppbv
Cis-1,3-Dichloropropene	TO-15	Air	70-130	25	0.2	ppbv
Cyclohexane	TO-15	Air	70-130	25	0.2	ppbv
Dibromochloromethane	TO-15	Air	70-130	25	0.2	ppbv
Ethanol	TO-15	Air	70-130	25	0.63	ppbv
Ethyl Acetate	TO-15	Air	70-130	25	0.2	ppbv
Ethylbenzene	TO-15	Air	70-130	25	0.2	ppbv

Table 12.3: QC Targets for Air Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Analyte	Method	Matrix	Accuracy (%)	Prec. (% RPD)	RL	Unit
Freon-11	TO-15	Air	70-130	25	0.2	ppbv
Freon-12	TO-15	Air	70-130	25	0.2	ppbv
Freon-113	TO-15	Air	70-130	25	0.2	ppbv
Freon-114	TO-15	Air	70-130	25	0.2	ppbv
Gasoline Range Organics	TO-15	Air	70-130	25	50	ppbv
Heptane	TO-15	Air	70-130	25	0.2	ppbv
Hexachloro-1,3-Butadiene	TO-15	Air	70-130	25	0.63	ppbv
Hexane	TO-15	Air	70-130	25	0.2	ppbv
Isopropylbenzene	TO-15	Air	70-130	25	0.2	ppbv
M&P-Xylene	TO-15	Air	70-130	25	0.4	ppbv
Methyl Butyl Ketone	TO-15	Air	70-130	25	1.25	ppbv
Methyl Ethyl Ketone	TO-15	Air	70-130	25	1.25	ppbv
Methyl Isobutyl Ketone	TO-15	Air	70-130	25	1.25	ppbv
Methyl Methacrylate	TO-15	Air	70-130	25	0.2	ppbv
Methyl tert Butyl Ether	TO-15	Air	70-130	25	0.31	ppbv
Methylene Chloride	TO-15	Air	70-130	25	0.63	ppbv
Naphthalene	TO-15	Air	70-130	25	0.63	ppbv
o-Xylene	TO-15	Air	70-130	25	0.2	ppbv
Propene	TO-15	Air	70-130	25	0.4	ppbv
Styrene	TO-15	Air	70-130	25	0.2	ppbv
t-Butyl Alcohol	TO-15	Air	70-130	25	0.2	ppbv
Tetrachloroethylene	TO-15	Air	70-130	25	0.2	ppbv
Tetrahydrofuran	TO-15	Air	70-130	25	0.2	ppbv
Toluene	TO-15	Air	70-130	25	0.2	ppbv
Trans-1,3-Dichloropropene	TO-15	Air	70-130	25	0.2	ppbv
Trans-1,2-Dichloroethene	TO-15	Air	70-130	25	0.2	ppbv
Trichloroethylene	TO-15	Air	70-130	25	0.2	ppbv
Vinyl Acetate	TO-15	Air	70-130	25	0.2	ppbv
Vinyl Bromide	TO-15	Air	70-130	25	0.2	ppbv
Vinyl Chloride	TO-15	Air	70-130	25	0.2	ppbv
Methane	RSK-175	Air/ Headspace	70-130	25	0.01	ppmv
Ethane	RSK-175	Air/ Headspace	70-130	25	0.129	ppbmv
Ethene	RSK-175	Air/ Headspace	70-130	25	0.127	ppmv
Carbon Dioxide	Method 3C	Air	70-130	25	0.50 / 200	% / ppmv

Table 12.3: QC Targets for Air Accuracy (LCS), Precision and RL's
This table is subject to revision without notice

Analyte	Method	Matrix	Accuracy (%)	Prec. (% RPD)	RL	Unit
Carbon Monoxide	Method 3C	Air	70-130	25	0.50 / 200	% / ppmv
Methane	Method 3C	Air	70-130	25	0.50 / 200	% / ppmv
Nitrogen	Method 3C	Air	70-130	25	0.50 / 200	% / ppmv
Oxygen	Method 3C	Air	70-130	25	0.50 / 200	% / ppmv

13.0 CORRECTIVE ACTION

13.1 In the event that a nonconformance occurs in conjunction with the analytical batch, a corrective action response (CAR) form must be completed. The reason for the nonconformance is stated on the form and the measures taken to correct the nonconformance clearly defined. The effectiveness of the corrective action must be assessed and noted. The CAR is kept on file by the QA department. Corrective action procedures are documented in SOP #030208, *Corrective and Preventive Action*

13.2 Required Corrective Action

All samples and procedures are governed by ESC's quality assurance program. Designated corrective actions are as follows.

All samples and procedures are governed by ESC's quality assurance program. General corrective actions are as follows; however additional and more specific direction is provided in the specific determinative procedure. For more information, see the appropriate determinative SOP

13.2.1 Laboratory QC Criteria and Appropriate Corrective Actions

If the analytical method contains acceptance/rejection criteria and it is more stringent than those controls generated by the laboratory the method criteria will take precedence.

13.2.2 Calibration Verification Criteria Are Not Met.

Rejection Criteria – See Table 8.5.

Corrective Action – Instrument settings are checked. The standard is reviewed for obvious cause. The standard may require re-analysis or the instrument may require recalibration.

13.2.3 Out Of Control Blanks:

Rejection Criteria - Blank reading is more than ½ the RL.

Corrective Action - Instrument settings are checked. The Blank is re-analyzed. If the blank is still out of control, bakeout of the system is performed and the blank is re-analyzed.

13.2.4 Out Of Control Laboratory Control Standards (LCS)

Rejection Criteria - If the performance is outside of lab-generated control (Listed in Table 12.3).

Corrective Action - Instrument settings are checked. The LCS standard is re-analyzed. If the LCS is still out of control, re-calibration is performed, and samples affected since the last in control reference standard are re-analyzed.

14.0 RECORD KEEPING

Record keeping is outlined in SOP #010103, *Document Control and Distribution*, SOP #030203, *Reagent Logs and Records* and SOP #030201, *Data Handling and Reporting*

15.0 QUALITY AUDITS

System and data quality audits are outlined in the ESC Quality Assurance Manual Version 8.0.

1.0 SIGNATORY APPROVALS

Aquatic Toxicity Laboratory QUALITY ASSURANCE MANUAL

APPENDIX IX TO THE ESC QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

NOTE: The QAM has been approved by the following people. A signed cover page is available upon request

Judith R. Morgan, M.S., VP, Technical and Regulatory Affairs, 615-773-9657

Eric Johnson, B.S., Laboratory Director, 615-773-9654

Dixie Marlin, B.S., QC Manager, 615-773-9681

Kim Johnson, B.S., Aquatic Toxicity Department Manager, 615-773-9687

2.0 APPENDIX TABLE OF CONTENTS

3.0 SCOPE AND APPLICATION

This appendix discusses specific QA requirements for general analytical protocols to ensure that analytical data generated from the Aquatic Toxicity laboratory are scientifically valid and are of acceptable quality. Any deviations from these requirements and any deviations that result in non-conforming work must be immediately evaluated and their corrective actions documented.

4.0 LABORATORY ORGANIZATION AND RESPONSIBILITIES

ESC Lab Sciences offers diverse environmental capabilities that enable the laboratory to provide the client with both routine and specialized services, field sampling and broad laboratory expertise. A brief outline of the organization and responsibilities as they apply to the ESC Quality Assurance Program is presented in *Section 4.0 in the ESC Quality Assurance Manual Version 8.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Kim Johnson, with a B.S. degree in Biological Sciences, is the Department Manager of the Aquatic Toxicity laboratory. Ms. Johnson reviews and approves all data reduction associated with Aquatic Toxicity analysis. Her responsibilities include the coordination with clients regarding sample analysis for regulatory compliance, scheduling of testing and personnel, and data reduction, interpretation and validation for Toxicity analyses. Ms. Johnson is also involved in microbiological assessments of wastewater, sludges and drinking water and oversees the Protozoan laboratory. She is also a certified mold analyst. In her absence, Shain Schmitt assumes responsibility for departmental decisions.

5.2 TRAINING

All new analysts to the laboratory will be trained by the primary analyst or Manager according to ESC protocol. ESC's training program is outlined in *SOP 350355 Technical Training and Personnel Qualification for Biology.*

6.0 FACILITIES AND LABORATORY SAFETY

6.1 FACILITIES

The main area of the laboratory has approximately 1440 square feet of area with roughly 280 square feet of bench area. There are 300 square feet of additional storage and the lighting is fluorescence. The air system is a five-ton Trane split unit with natural gas for heating. The laboratory reagent water is provided through the Siemans Elga UltraPure deionizer system. Waste disposal containers are located in the laboratory and Clean Harbors serves as ESC's hazardous waste disposal company. Biohazard containers are located in the laboratory and Stericycle Waste Removal serves as ESC'S biological waste disposal contractor. ESC's building information guides and site plan are shown in Appendix I.

6.2 LABORATORY SAFETY

- Laboratory access is limited when work is being performed.
- All procedures where chemicals are prepared or splashes may occur are conducted in laboratory exhaust hoods, where applicable.

ESC's laboratory safety guidelines are detailed in *the ESC Chemical Hygiene and Safety Plan.*

7.0 SAMPLING PROCEDURES

7.1 FIELD SAMPLING PROCEDURES, SAMPLE STORAGE, AND HANDLING

- Field Sampling procedure is described in Appendix III of this ESC Quality Assurance Manual. Sample information is recorded and kept on the ESC chain of custody and field logbooks.
- Samples are received in the laboratory login area and are tracked using LIMS (Laboratory Information Management System). A Chain of Custody Form accompanies all samples received by the lab. This is necessary to prove the traceability of the samples and to document the change in possession from sampling to delivery to receipt by the laboratory. Prior to analysis samples are checked for integrity. Once samples are checked to confirm integrity, the samples are logged with unique sample identification information and a label is affixed to each container. Chronic Toxicity samples are uniquely identified with "sample 1, sample 2 and sample 3". A sample custodian then transports samples to the laboratory. Sample handling and tracking procedures are outlined in *SOP 060105, Sample Receiving.*

- Requirements for sample acceptance is located in *SOP 060105, Sample Receiving.* At a minimum, the following physical and chemical parameters are analyzed for each sample received:

  - Temperature - recorded up to twice daily.
  - pH - initial and final measurements recorded
  - D.O. - initial and final measurements recorded
  - Specific Conductance
  - Alkalinity
  - Hardness
  - Total Residual Chlorine
- Samples must be immediately cooled and maintained at 0-6^{o}C during shipment and prior to testing.

Residual Chlorine Treatment

- Residual chlorine in biomonitoring samples are monitored using a pocket colorimeter and these checks are documented. Chlorine removal is not performed.

Dissolved Oxygen

- For acute tests, samples that are $\leq$ 4.0mg/L are aerated until the sample reaches 90% saturation. For chronic tests, samples that are $\leq$ 4.0 mg/L are aerated until the sample reaches 90% saturation.

8.0 EQUIPMENT

8.1 EQUIPMENT LIST

LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Aquatic Toxicity Lab ***This table is subject to revision without notice.***			
Item	***Manufacturer***	***Model***	***Location***
Analytical Balance	Mettler	AT261 Delta Range	Aquatic Tox Lab
Class "I" weights (2)	Troemner		Aquatic Tox Lab
Conductivity Meter	Orion	150 A+	Aquatic Tox Lab
Dissolved Oxygen Meter	YSI	Model 50	Aquatic Tox Lab
Stereoscope	Olympus	SZX-IllK100	Aquatic Tox Lab
Oven	Fisher	655F	Aquatic Tox Lab
Incubator	Thermo-Kool	Environmental chamber	Aquatic Tox Lab
Incubator	Percival Scientific	1-37 VL	Aquatic Tox Lab
Incubator	Precision Sci.	818	Aquatic Tox Lab
Incubator (2)	Precision Sci.	818	Aquatic Tox Lab
Microscope	Olympus	CHT	Aquatic Tox Lab
pH Meter	Beckman	pH/Temp/mV/ISE	Aquatic Tox Lab
Refrigerator (2)	Beverage Air	E Series	Aquatic Tox Lab
Stereoscope	Olympus	SZH-ILLD	Aquatic Tox Lab
Stereoscope	Olympus	SZH-ILLD	Aquatic Tox Lab
Refrigerator	Frigidaire	FRC445GB	Aquatic Tox Lab
Refrigerator	True	T-49	Aquatic Tox Lab
Water Purifier	Siemans	Elga Purelab	Aquatic Tox Lab
Refrigerator	Fridgidaire	FRC 445GB	Aquatic Tox Lab
Freezer	Kenmore	198130582	Aquatic Tox Lab

8.2 EQUIPMENT PREVENTIVE MAINTENANCE, EQUIPMENT CALIBRATION

PREVENTATIVE MAINTENANCE FOR LABORATORY EQUIPMENT		
INSTRUMENT	***P. M. DESCRIPTION***	***FREQUENCY***
Analytical Balances	•Check with Class "I" weights	Daily-tolerance 1 gm - ±0.0001 gm
Analytical Balances	•Service/Calibration (semiannual contract maintenance and calibration check)	10 gm - ±0.01 gm
Analytical Balances	•Service/Calibration (semiannual contract maintenance and calibration check)	Semi-annually
Refrigerators & Incubators	•Maintenance service	As needed - determined by twice daily temperature performance checks @ least 4 hours apart
Dissolved oxygen meter	•Calibrate with each use	Daily
Dissolved oxygen meter	•Change probe membrane	Every two to four weeks
Conductivity Meter	•Check probe cables	As needed
Conductivity Meter	•Clean probe	Daily
Conductivity Meter	•Replace or replatinize probe	Poor response not corrected by above
Conductivity Meter	•Calibrate with each use	Daily (or prior to each use)
Microscope/Stereoscope	•Service/calibration of each ocular micrometer	Annually
Microscope/Stereoscope	• Clean optics and stage	Each Use
pH Meters	•Reference junction & electrode replacement	As needed
pH Meters	•Probe stored in pH standard 4	At all times when not in use
pH Meters	•Other	As described in the manufacturer's manual
pH Meters	•Calibrate with each use	Daily (or prior to each use)
Bottle top dispenser/repipettor	•Calibrate	Quarterly
Bottle top dispenser/repipettor	•Clean to prevent residue buildup	As needed
Water Purifier	Tank Exchange, UV bulb and sleeve replacement (service contract maintenance and check	As needed and annually
Water Purifier	•Replace cartridge and filter	As needed and semi-annual

8.3 STANDARDS , REAGENTS AND ORGANISM CULTURES

All reagents and standards must meet the requirements listed in the analytical methods.

Table 8.3A: Stock solution sources, description and related information.
(subject to revision as needed)

Description	Vendor	Storage Req.	Expiration
Conductivity standard 100	Fisher	Ambient	1 yr
Conductivity standard 1000	Fisher	Ambient	1 yr
pH buffer 7	Fisher	Ambient	1 yr
pH buffer 10	Fisher	Ambient	1 yr
Bromothymol blue solution	Fisher	Ambient	1 yr
Potassium phosphate monobasic	Fisher	Ambient	1 yr
Magnesium chloride	JT Baker	Ambient in dessicator	1 yr
Potassium Chloride	EMD	Ambient in dessicator	1 yr
Brine shrimp eggs	Argentemia	Ambient, tightly sealed.	1 yr
Calcium sulfate	EM	Ambient in dessicator	1 yr
EDTA	Fisher	Ambient in dessicator	1 yr
Sodium thiosulfate	JT Baker	Ambient in dessicator	1 yr
pH buffer 4	Fisher	Ambient.	1yr
YCT	Made in-house	-10 to -20^{o}C	14 days after thawing
Selenastrum capricornatum	Aq. Biosystems	1-6^{o}C	NA
Vitamin B12	Fisher	1-6^{o}C	NA

TABLE 8.3B: Working Solution Descriptions and Related Information.
(subject to change)

Solution	Concentrations	Storage Requirements	Expiration
KCl stock solution	31.237g KCl to 2L of 20% DMW	1-4^{o}C	14 days
B12 Solution	0.01125g to 1L of DI Water	1-4^{o}C	NA

Source and Maintenance of in-house cultures:

Source of Biological Organisms (subject to change):
The primary source for all fathead minnows is:
Aquatic Biosystems Inc.
2821 Remington Street
Fort Collins, CO 80525

The source for their organisms is documented on each packing slip received. ESC accepts the packing slip as documentation and verification by the supplier with regards to the taxonomic identification of the bioassay species. The packing slips for bioassay test organisms are kept on file.

The amount of food added to culture vessels will depend upon the number of organisms within a given culture. As standard procedure, *Ceriodaphnia dubia* batch cultures are fed 4.5mL of YCT and algal suspension on the day of initiation. Batches are fed daily as needed. The date, time and the amount the organisms are fed are documented. All brewers yeast purchased is at least food grade and has passed FDA standards. All yeast trout chow is made in-house. New lots are tested for pesticides, metals, and PCB's.

Ceriodaphnia dubia, fresh batch cultures are set up on Monday, Wednesday and Friday using newly hatched neonates less than 24 hours old. In addition, a minimum of 4 brood trays are set up daily in order to guarantee organisms of the right age to use in bioassays. Condition of cultures is monitored daily and documented in the daily log. The *C. dubia* brood trays are fed daily. The *C. dubia* are transferred into fresh water daily after their first brood of neonates is born. Third generation neonates, less than 24 hours old, are used for batch cultures and brood trays. Third generation neonates, less than 24 hours old and hatched within 8 hours of each other, are used for tests. Adults are used as sources for neonates until 14 days of age.

C.dubia are taxonomically identified to species on a quarterly basis. All taxonomy information is documented and kept on file for a year.

Pimephales promelas batch cultures are cleaned as needed by siphoning off the excess food and waste from the bottom of the culture vessel and renewing the water. Cultures are aerated as needed to maintain adequate dissolved oxygen.

The water used for culturing is dilute mineral water prepared by diluting (6) 750mL bottles of Perrier to 20 Liters with deionized water and aerating for 24 hours. The physical and chemical parameters for each new tank of water prepared are recorded and should fall within the following acceptable range:

1. pH - 7.9 to 8.3 units
2. D.O. - greater than 80% saturation in mg/L
3. Specific Conductance - ~215 micromhos/cm
4. Alkalinity - 57 to 64 mg $CaCO_3$/L
5. Hardness - 80 to 100 mg $CaCO_3$/L
6. Total Residual Chlorine - <0.1 mg/L

Pimephales promelas are taxonomically identified to species on a quarterly basis. All taxonomy information is documented and kept on file for a year.

8.4 INSTRUMENT CALIBRATION

Lighting

All testing and culturing is maintained in incubators in which temperature is constant and the photoperiod is on a 16-hour light/8-hour dark cycle. The photoperiod is verified and documented quarterly. The light intensity must be within 50 – 100 foot candles and is verified and documented semi-annually. All incubators are monitored at least weekly for proper light intensity.

pH Meter

With each use of pH meters, calibrate the instrument according to manufacturer's instructions. The slope is documented on a daily basis. Acceptable pH slope range is 95-105%. All calibration information is documented.

Volumetric Equipment

Equipment such as filter funnels, bottles, pipettes non-Class A and other containers with graduations are calibrated once per lot prior to first use. Volumetric equipment that is not disposed of after use is calibrated on an annual basis. The error of calibration must not exceed 2.5%.

Analytical Balance

Analytical balances are checked and calibrated semi-annually by a certified technician. Calibration is checked before each use with Class I weights. Class I weights are calibrated annually.

Stereoscope

All glass surfaces are kept clean using a 3:7 mixture of alcohol and ether or a small amount of xylene. Maintenance is performed by a trained technician on an annual basis.

Conductivity Meter

With each use of conductivity meters, calibrate the instrument according to manufacturer's instructions.

Dissolved Oxygen Meter

With each use of the DO meter, calibrated according to manufacturer's instructions. The probe membrane is changed every two to four weeks to maintain accurate readings.

Test Chambers

Each test chamber is rinsed with DI water prior to introducing the test organisms.

Bottle Top Dispenser/Repipettor

Repipettors are calibrated quarterly to ensure the instrument is dispensing the correct amount. Periodic cleaning is performed to maintain the accuracy and to prevent buildup of residue.

Colorimeter Chlorine tester

The colorimeter is calibrated before each use using standards to verify the instrument is accurate.

9.0 LABORATORY PRACTICES

9.1 REAGENT GRADE WATER

Deionized water or reverse-osmosis produces water free from bactericidal and inhibitory substances and shall be used in the preparation of media, solutions and buffers. The quality of the water shall be monitored for chlorine residual, specific conductance, and heterotrophic bacteria plate count monthly (when in use), when maintenance is performed on the water treatment system, or at startup after a period of disuse longer than one month.

Analysis for metals is performed quarterly and the Bacteriological Water Quality Test or Use Test (to determine presence of toxic agents or growth promoting substances) shall be performed annually. Results of these analyses shall meet the specifications of the required method and records of analyses shall be maintained for five years. (An exception to performing the Bacteriological Water Quality Test shall be given to laboratories that can supply documentation to show that their water source meets the criteria, as specified by the method, for Type I or Type II reagent water.)

9.2 pH BUFFERS/CONDUCTIVITY STANDARDS

pH buffer and conductivity standard aliquots are used only once. Reagents containers are dated upon receipt and the date opened.

9.3 SPEC√ SECONDARY STANDARDS

Standards are used for retrieval and verification of the factory calibrated colorimeter and is used to verify consistent instrument calibration.

9.4 LABORATORY CONTROL WATER

Control water (20% dilute mineral water) is prepared by diluting (6) 750mL bottles of Perrier to 20 Liters with deionized water and aerating for 24 hours. The physical and chemical parameters for each new tank of water prepared are recorded and should fall within the following acceptable range:

1. pH - 7.9 to 8.3 units
2. D.O. - greater than 80% saturation in mg/L
3. Specific Conductance - ~215 micromhos/cm
4. Alkalinity - 57 to 64 mg $CaCO_3$/L
5. Hardness - 80 to 100 mg $CaCO_3$/L
6. Total Residual Chlorine - <0.1 mg/L

Control water (10% dilute mineral water) is prepared by diluting (3) 750mL bottles of Perrier to 20 Liters with deionized water and aerating for 24 hours. The physical and chemical parameters for each new tank of water prepared are recorded and should fall within the following acceptable range:

1. pH – 6.5 to 8.5 units
2. D.O. - greater than 80% saturation in mg/L
3. Specific Conductance - ~215 micromhos/cm
4. Alkalinity - 60 to 70mg $CaCO_3$/L
5. Hardness - 30 to 50mg $CaCO_3$/L
6. Total Residual Chlorine - <0.1mg/L

A given batch of control water is not used for more than 14 days following preparation.

9.5 BRINE SHRIMP

Artemia cysts are of platinum or gold grade, certified brine shrimp eggs from ARGENT chemical Laboratories. To determine the quality of the new lots of Brine shrimp, a side-by-side comparison test is performed using the new food and the food of known acceptable quality.

9.6 YCT

YCT is prepared in the laboratory. To determine the quality of the new lots of YCT a side-by-side comparison test is performed using the new food and the food of known acceptable quality.

9.7 ALGAE

Algae is commercially prepared. Upon arrival, each batch received has an accompanying Certificate of Algae Preparation History. The certificate provides the following quality control data: date prepared, species name, inoculation date, harvest date, concentration date and cell count.

9.8 GLASSWARE WASHING, STERILIZATION PROCEDURES AND EQUIPMENT STERILITY CHECKS

Glassware washing and preparation/sterilization procedures are performed according to EPA guidelines and are outlined in *SOP 030701 Glassware Cleaning* and *SOP 350334 Sterilization, Sanitization and Residue Testing of Microbiological Glassware and Equipment*. Before use, examine and discard items with chipped edges or etched inner surfaces. Reusable glassware is cleaned using the following protocol:

- Soak for 15 minutes in hot tap water with detergent and scrub. Rinse thoroughly with tap water. Rinse thoroughly with dilute nitric acid (10%). Rinse thoroughly with deionized water. Rinse thoroughly with pesticide grade acetone. Rinse well with deionized water.
- New glassware will be cleaned according to the same procedure as listed above except the first step will be preceded by soaking overnight in 10 % $HNO_{3.}$

Inspect glassware after washing for excessive water beading and rewash, if necessary. Perform checks on pH and test for inhibitory residues on glassware and plastic ware. Use utensils and containers of borosilicate glass, stainless steel, aluminum, or other corrosion resistant material for media preparation. All biological glassware is purchased pre-sterilized. Sterilization of any auxiliary equipment is performed via autoclave.

Pipettes of all sizes are checked for sterility by drawing up non-selective media into the pipette and re-dispensing the volume back into original tube that contained the media. The tube is then incubated and monitored for growth. All results are recorded and maintained within the laboratory.

10.0 ANALYTICAL PROCEDURES

10.1 A list of laboratory SOP's associated with the microbiology laboratory can be found in the following table:

TABLE 10.1: AQUATIC TOXICITY DEPARTMENT SOP'S

This Table is subject to revision without notice

SOP #	Title/Description
350301	Fathead Minnow, *Pimephales promelas*, Larval Survival and Growth Test, EPA Method 1000.0
350302	Cladoceran, *Ceriodaphnia dubia*, Chronic Survival and Reproduction Test, EPA Method 1002.0
350303	*Pimephales promelas* Acute Toxicity Testing
350304	*Ceriodaphnia dubia* Acute Toxicity Testing
350317	WET Reference toxicant testing
350318	Mini Chronic *C. dubia* NC
350319	Phase II Chronic *C. dubia* NC
350320	Acceptability Test of New Food Batches for WET Testing
350321	Pocket Colorimeter Chlorine Tester Maintenance and Calibration
350322	DO Meter Maintenance and Calibration
350323	Fluke Thermometer Operation and Maintenance
350324	Digital Light Meter Maintenance and Method of Operation
350325	pH Meter Maintenance and Calibration
350326	Thermometer Operation, Maintenance and Calibration Procedure
350327	Bottle Top Dispenser Maintenance and Method of Operation
350328	Conductivity Meter Maintenance and Calibration
350329	Taxonomic Verification/Identification of *Pimephales promelas* - Fathead Minnow
350330	Taxonomic Verification/Identification of *Ceriodaphnia dubia*
350303NC	Acute Toxicity - Minnow NC
350304NC	Acute Toxicity - *C. dubia* NC

10.2 Additional information regarding microbiological testing can be found in:

Method Resources: EPA/821/R-02/013, EPA/821/R-02/012

- 7-Day Fathead Minnow (*Pimephales promelas*) Larval Survival and Growth Test; Test Method 1000.0 from "Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" (EPA 821-R-02-013).
- 3-Brood *Ceriodaphnia dubia* Survival and Reproduction Test; Test Method 1002.0 from "Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" (EPA 821-R-02-013).
- Fathead Minnow (*Pimephales promelas*) Acute Toxicity Test (24, 48 or 96 hour duration); referenced in "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms" (EPA 821-R-02-012, 10-02).
- *Ceriodaphnia dubia* Acute Toxicity Test (24, 48 or 96 hour duration); referenced in "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms" (EPA 821-R-02-012, 10-02)

11.0 QUALITY CONTROL CHECKS

11.1 At a minimum, the following physical and chemical parameters are analyzed for each biomonitoring sample received:

- Temperature - recorded up to twice daily.
- pH - initial and final measurements recorded
- D.O. - initial and final measurements recorded
- Specific Conductance
- Alkalinity
- Hardness
- Total Residual Chlorine

11.2 FEEDING REGIME

- 7-Day Fathead Minnow Larval Survival and Growth Test - Test organisms are fed 0.15mL, per container of 10 organisms. Newly hatched brine shrimp (*Artemia*) are fed to minnow batches 2-3 times daily. Batch cultures are fed depending on organism density.
- 3-Brood *Ceriodaphnia dubia* Survival and Reproduction Test - test organisms are fed 0.15mL of Yeast, Cereal leaves, Trout chow (YCT) and 0.15mL *Selenastrum capricornutum* algal suspension once daily.
- 24 and 48 Hour Acute Toxicity Tests - organisms are fed 2-5 hours prior to introduction into sample but are not fed for the duration of the test.
- 96-Hour Acute Toxicity Tests – organisms are fed at the 48 hour renewal period.
- 3-Brood *Ceriodaphnia dubia* Survival and Reproduction Test for North Carolina - test organisms are fed .05mL of YCT/15mL test solution and .05 Selanastrum capricornutum algal concentrate once daily (1.7x10 to the 7th power cells/mL).

11.3 BATCH CULTURES

Batch cultures are identified by date set up or date received. The set-up date is recorded for each batch.

Ceriodaphnia dubia, fresh batch cultures are set up on Monday, Wednesday and Friday using newly hatched neonates less than 24 hours old. In addition, a minimum of 4 brood trays are set up daily in order to guarantee organisms of the right age to use in bioassays. Condition of cultures is monitored daily and documented in the daily log. The *C. dubia* brood trays are fed daily. The *C. dubia* are transferred into fresh water daily after their first brood of neonates is born. Third generation neonates, less than 24 hours old, are used for batch cultures and brood trays. Third generation neonates, less than 24 hours old and hatched within 8 hours of each other, are used for chronic tests. Adults are used as sources for neonates until 14 days of age.

Pimephales promelas, organisms less than 36 hours old are obtained from a commercial supplier and are used immediately for chronic bioassays. Upon receipt, temperature, conductivity, pH, alkalinity and hardness are recorded and the organisms are slowly acclimated to a temperature of 25°C. If more than 10% mortality has occurred in the batch shipment, the batch is rejected and supplier is contacted. The date of the batch culture is recorded and batches are maintained for 14 days after receipt to use in acute tests. Batch cultures are monitored and fed daily. The number of organisms used is recorded in the daily log. Lots are cleaned as needed by siphoning off the excess food and waste from the bottom of the vessel and renewing the water. Minnow lots are aerated to maintain adequate dissolved oxygen. *Pimephales promelas* lots are fed 2.5 mL of newly-hatched brine shrimp per batch, 2-3 times daily. The date, time and the amount the organisms are fed are documented.

11.4 REFERENCE TOXICANT

The reference toxicant used at ESC is potassium chloride. Acute and chronic reference toxicant tests are performed at a minimum of once monthly and upper and lower control limits have been established. In respect to FDER related samples ESC will perform acute and chronic reference toxicant tests for all in-house cultures done with each batch.

12.0 DATA REDUCTION, VALIDATION AND REPORTING

12.1 DATA REDUCTION

The analyst performs the data calculation functions and is responsible for the initial examination of the finished data. Data reduction steps applied to the raw data are outlined in *SOP 030201 Data Handling and Reporting.* The primary analyst reviews the quality of data based on the following guidelines:

- The appropriate SOP has been followed
- Sample preparation is correct and complete
- Analytical results are correct and complete
- QC is within criteria and complete

All calculations are performed according to the EPA methods manual. When applicable, software is used to perform statistical analysis. All formulas are chosen appropriately depending on the conditions and outcome of each individual test. Due to the complexity of each formula please see EPA/821/R-02/013 for formulas pertaining to Chronic Toxicity tests and EPA/821/R-02/012 for formulas pertaining to Acute Toxicity tests.

TABLE 12.1 Data Reduction Formulas

PARAMETER	FORMULA
IC25, NOEC, LC50, AEC	Toxcalc 5.0 Software

For chronic tests the PMSD and the % CV is calculated and reported.

12.2 VALIDATION

The validation process consists of data generation, reduction review, and reporting results. Once data reduction is complete, validation is conducted by reviewing all data entries and calculations for errors, reviewing all documentation to assure that sample information is correct, and that the tests have been performed appropriately and within the appropriate holding times. The secondary analyst reviews the quality of data based on the following guidelines:

- The appropriate SOP has been followed
- Sample preparation is correct and complete
- Analytical results are correct and complete

12.3 REPORTING

Reporting procedures are documented in *SOP 030201 Data Handling and Reporting.*

13.0 CORRECTIVE ACTION

13.1 In the event that a nonconformance occurs in conjunction with the analytical batch, a corrective action response (CAR) form must be completed. The reason for the nonconformance will be stated on the form and the measures taken to correct the nonconformance clearly defined. The effectiveness of the corrective action must be assessed and noted. The CAR will be kept on file by the QA department. Corrective action procedures are documented in SOP 030208 *Corrective and Preventive Action*

13.2 Required Corrective Action

All samples and procedures are governed by ESC's quality assurance program. Designated corrective actions are as follows:

13.2.1 Laboratory QC Criteria and Appropriate Corrective Actions

If the analytical method contains acceptance/rejection criteria and it is more stringent than those controls generated by the laboratory the method criteria will take precedence.

13.2.2 Out of control acute toxicity tests.

Rejection Criteria –More than 10% mortality occurs in the control organisms within the specified time frame of the test.

Corrective Action – The test will be considered invalid and must be repeated using fresh control water.

13.2.3 Out of control 3-Brood *Ceriodaphnia dubia* Survival and Reproduction Test.

Rejection Criteria –If more than 10% mortality occurs in the control organisms within 96 hours or more than 20% mortality occurs in the test organisms in the 3-brood period (approx. 7 days)

Corrective Action – The test will be considered invalid and must be repeated using fresh control water.

13.2.4 Out of control 3-Brood *Ceriodaphnia dubia* Survival and Reproduction Test.

Rejection Criteria – If the average number of young produced in the control is less than 15 per organism

Corrective Action – The test will be considered invalid and must be repeated using fresh control water.

13.2.5 Out of control 3-Brood *Ceriodaphnia dubia* Survival and Reproduction Test.

Rejection Criteria – A test will be considered invalid if or less than 60% (80% for NC tests) of the original number of adult daphnia loaded do not produce three broods within an eight day maximum (7 day maximum for NC tests).

Corrective Action – The test will be considered invalid and must be repeated using fresh control water.

13.2.6 Out of control 7-Day *Pimephales promelas* Larval Survival and Growth Test.

Rejection Criteria –If more than 10% mortality occurs in the control organisms within 96 hours or more than 20% mortality occurs in the test organisms in 7 day period.

Corrective Action – The test will be considered invalid and must be repeated using fresh control water.

13.2.7 Out of control 7-Day *Pimephales promelas* Larval Survival and Growth Test.

Rejection Criteria – The average weight of the control minnows is less than 0.2500 mg.

Corrective Action – The test will be considered invalid and must be repeated using fresh control water.

13.2.8 Out of control Monthly Reference Toxicant:

Rejection Criteria – KCl is the reference toxicant used for acute and chronic testing for the following methods: 1000.0, 1002.0, 2000.0, and 2002.0. If reference toxicant test results fail to meet ESC in-house established criteria (± 2 standard deviations from the mean and median).

Corrective Action – The test is deemed invalid and must be repeated twice. No test will be performed using organisms that fail to meet reference toxicant criteria.

13.2.9 Out of control PMSD 7-Day *Pimephales promelas* Larval Survival and Growth Test.

Rejection Criteria – The PMSD value is greater than the upper value of 30.

Corrective Action - The test may be deemed invalid and should be repeated.

13.2.10 Out of control PMSD 3-Brood *Ceriodaphnia dubia* Survival and Reproduction Test.

Rejection Criteria – The PMSD value is greater than the upper value of 47.

Corrective Action - The test may be deemed invalid and should be repeated.

13.2.11 Out of control %CV 3-Brood *Ceriodaphnia dubia* Survival and Reproduction Test and 7-Day *Pimephales promelas* Larval Survival and Growth Test.

Rejection Criteria – The %CV value is greater than the upper value of 40%.

Corrective Action - The test is deemed invalid and must be repeated.

14.0 RECORD KEEPING

Record keeping is outlined in SOP #010103 *Document Control and Distribution*, SOP #030203 *Reagent Logs and Records* and SOP #030201 *Data Handling and Reporting*

15.0 QUALITY AUDITS

System and data quality audits are outlined in the ESC Quality Assurance Manual Version 8.0.

1.0 SIGNATORY APPROVALS

Microbiology Laboratory
QUALITY ASSURANCE MANUAL

APPENDIX X TO THE ESC
QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

NOTE: The QAM has been approved by the following people. A signed cover page is available upon request

Judith R. Morgan, M.S., VP, Technical and Regulatory Affairs, 615-773-9657

Eric Johnson, B.S., Laboratory Director, 615-773-9654

Dixie Marlin, B.S., QC Manager, 615-773-9681

Kim Johnson, B.S., Microbiology Department Manager, 615-773-9687

2.0 APPENDIX TABLE OF CONTENTS

3.0 SCOPE AND APPLICATION

This appendix discusses specific QA requirements for general analytical protocols to ensure that analytical data generated from the Microbiology laboratory are scientifically valid and are of acceptable quality. Any deviations from these requirements and any deviations that result in non-conforming work must be immediately evaluated and their corrective actions documented.

4.0 LABORATORY ORGANIZATION AND RESPONSIBILITIES

ESC Lab Sciences offers diverse environmental capabilities that enable the laboratory to provide the client with both routine and specialized services, field sampling and broad laboratory expertise. A brief outline of the organization and responsibilities as they apply to the ESC Quality Assurance Program is presented in *Section 4.0 in the ESC Quality Assurance Manual Version 8.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Kimberly Johnson, with a B.S. degree in Biological Sciences, is the Department Manager of the Microbiology laboratory. Ms. Johnson reviews and approves all data reduction associated with Microbiological analyses. Her responsibilities include the coordination with clients regarding sample analysis for regulatory compliance, scheduling of testing and personnel, and data reduction, interpretation and validation. Ms. Johnson is also involved in biological assessments of aquatic habitats and Toxicity Identification Evaluations. Additionally, Ms. Johnson oversees the Protozoan laboratory and is also a certified mold analyst. In her absence, Shain Schmitt assumes responsibility for Microbiological and Aquatic Toxicity departmental decisions.

5.2 TRAINING

The primary analyst or Manager trains new laboratory analysts according to ESC protocol. ESC's training program is outlined in SOP #350355, *Technical Training and Personnel Qualification for Biomonitoring-Microbiology.* Performance is documented using an initial demonstration of capability (IDOCs) and continuing demonstration of capability (CDOC). On-going acceptable capability in microbiological analysis is also demonstrated by acceptable participation in the ERA proficiency testing program (PTs). Documentation of analyst training is maintained on file within the department.

6.0 FACILITIES AND LABORATORY SAFETY

6.1 FACILITIES

The main area of the laboratory has approximately 1440 square feet of area with roughly 280 square feet of bench area. There are 300 square feet of additional storage and the lighting is fluorescence. The air system is a five-ton Trane split unit with natural gas for heating. The laboratory reagent water is provided through the Siemans Elga UltraPure deionizer system. Waste disposal containers are located in the laboratory and Clean Harbors serves as ESC's hazardous waste disposal company. Biohazard containers are located in the laboratory and Stericycle Waste Removal serves as ESC'S biological waste disposal contractor. ESC's building information guides and site plan are shown in Appendix I.

6.2 LABORATORY SAFETY

- Laboratory access is limited when work is being performed.
- All procedures where chemicals are prepared or splashes may occur are conducted in laboratory exhaust hoods, where applicable.

ESC's laboratory safety guidelines are detailed in *the ESC Chemical Hygiene and Safety Plan.*

7.0 SAMPLING PROCEDURES

7.1 FIELD SAMPLING PROCEDURES, SAMPLE STORAGE, AND HANDLING

- Field Sampling procedure is described in Appendix III of this ESC Quality Assurance Manual. Sample information is recorded and kept on the ESC chain of custody and field logbooks.
- Samples for bacterial analysis are collected directly into pre-sterilized high-density polyethylene (HDPE) sample containers preserved with sodium thiosulfate. The container should be kept closed until sample collection. Once the container is open, do not wash, rinse or contaminate the cap or the inside of the container. For microbiological samples, the container is filled allowing at least 1 inch of headspace per container.
- Sources for microbiological samples are surface waters, waste and drinking water, ground water and soil/sludge.
- Holding times for microbiological drinking water samples is 30 hours (except HPC which has a 6 hour holding time). Soil and sludge samples have a holding time of 24 hour and 8 hours depending on the method used. All other water samples have a 6-hour hold time.

- Microbiological samples are shipped in a cooler lined with a heavy-duty plastic bag. Once the sample container lids are secure the samples are placed in appropriately sized polyethylene bags. The chain of custody is also placed in a plastic bag. The cooler liner is completely filled with ice and the plastic bag sealed tightly with a cable tie. The shipping label contains the name and address of the shipper and is affixed to the outside of the cooler.
- Samples are received in the laboratory login area and are tracked using LIMS (Laboratory Information Management System). A Chain of Custody Form accompanies all samples received by the lab. This is necessary to prove the traceability of the samples and to document the change in possession from sampling to delivery to receipt by the laboratory. Prior to analysis samples are checked for integrity. Sample handling, tracking and acceptance procedures are outlined in *SOP 060105, Sample Receiving.*

8.0 EQUIPMENT

8.1 EQUIPMENT LIST

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Microbiological Analysis ***This table is subject to revision without notice***			
Item	***Manufacturer***	***Model***	***Location***
Analytical Balance	Mettler	AT261 Delta Range	Microbiology Lab
Class “I” weights	(2 sets) Troemner		Microbiology Lab
Conductivity Meter	Orion	150 A+	Microbiology Lab
Autoclave	Pelton and Crane	Validator 8	Microbiology Lab
Water Bath	Lindberg Blue	WB1130A	Microbiology Lab
Water Bath	Blue M	MW-1110A-1	Microbiology Lab
Oven	Fisher	655F	Microbiology Lab
Incubator	Percival Scientific	1-37 VL	Microbiology Lab
Incubator	VWR	2030 22MFG	Microbiology Lab
Quantitray Sealer	IDEXX	2X	Microbiology Lab
Incubator	Precision Sci.	818	Microbiology Lab
Colony Counter	Quebecor		Microbiology Lab
pH Meter	Beckman	pH/Temp/mV/ISE	Microbiology Lab
Refrigerator	True	T-49	Microbiology Lab
Stereoscope (2)	Olympus	SZH-ILLD	Microbiology Lab
UV light; short and long wave	UVP		Microbiology Lab
Water Bath	VWR Scientific	1295PC	Microbiology Lab
Autoclave	SterlieMax	Harvey	Microbiology Lab
Stereoscope	Olympus	SZX-ILLK100	Microbiology Lab
Water Purifier	Siemans	Elga Purelab Plus	Microbiology Lab

8.2 EQUIPMENT PREVENTIVE MAINTENANCE, EQUIPMENT CALIBRATION

PREVENTATIVE MAINTENANCE FOR LABORATORY EQUIPMENT		
INSTRUMENT	***P. M. DESCRIPTION***	***FREQUENCY***
Analytical Balances	•Check with Class "I" weights	Daily-tolerance 1 gm - ±0.0001 gm
Analytical Balances	•Service/Calibration (semiannual contract maintenance and calibration check)	10 gm - ±0.01 gm
Analytical Balances	•Service/Calibration (semiannual contract maintenance and calibration check)	Semi-annually
Refrigerators, Incubators, and Water Baths	•Maintenance service	As needed - determined by twice daily temperature performance checks @ least 4 hours apart
Water Bath	•Check thermometer vs. N.B.S.	Annually
Water Bath	•Remove from service when not maintaining temperature and send off for repair or replace	As needed
Autoclave	•Check sterilization efficiency	Monthly – Geobacillus Stearothermophilus ampoule
Autoclave	•Check sterilization efficiency	Daily – Chemical Indicator Strip
Conductivity Meter	•Calibrate and clean probe	Daily
Conductivity Meter	•Replace or replatinize probe	Poor response not corrected by above
Stereoscope	• Clean optics and stage	Each Use
pH Meters	•Reference junction & electrode replacement	As needed
pH Meters	•Probe stored in 4 pH standard	At all times when not in use.
pH Meters	•Other	As described in the manufacturer's O & M manual
Autoclave	•Check timing device	Quarterly
pH meter	•Calibrate and check slope (acceptable range of 95-105 %)	Daily
Quanti-Tray Sealer	•Check sealer for leaks	Monthly
Water Purifier	•Conductivity check using a calibrated conductivity meter	Monthly
Water Purifier	•Check for TOC's, ammonia, nitrogen, TRC and heterotrophic bacteria	Monthly
Water Purifier	•Check for single and heavy total metals	Annually
Incubators and Water Baths	Perform temperature stability and load testing	Annually
Autoclave	•Check pressure (annual contract maintenance)	Annually
Stereoscope	• Clean optics and stage; microscope alignment (annual maintenance contract)	Annually

8.3 STANDARDS AND REAGENTS

All reagents and standards must meet the requirements listed in the analytical methods.

Table 8.3A: Commercially prepared agar/broth, reagent sources, and storage information. ***(subject to revision as needed)***

Agar Type	*Source*	*Storage*
M-FC Broth w/ Rosolic acid	Millipore	4 ± 2°C
mColiBlue Broth	Millipore	4 ± 2°C
A-1 Media (broth)	Hach	4 ± 2°C
mEndo Broth	Hach	4 ± 2°C
Lauryl Tryptose Broth	Hach	4 ± 2°C
Brilliant Green Lactose Broth	Hach	4 ± 2°C
EC media w/ mug broth	Hach	4 ± 2°C
HPC	Hach	4 ± 2°C
Colilert reagent powder	IDEXX	Room temp
Enterolert reagent powder	IDEXX	Room temp
Xylose Lysisne Deoxycholate Agar (XLD)	HealthLink	4 ± 2°C
Brilliant Green (BG) Agar	HealthLink	4 ± 2°C
Phosphate Buffer Solution	Weber Scientific	Room temp

All stock agar expirations are per manufacturer specification.

Table 8.3B: In-house prepared agar/broth, reagent sources, and storage information.
(subject to revision as needed)

Agar Type-Stock	*Source*	*Stock Storage*	*Stock Expiration*	*Preparation Components Media*	*Prepared Storage*	*Prepared Expiration*
Xylose Lysisne Deoxycholate Agar (XLD)	Fisher/Difco	Room Temp	As specified by Manufacturer	XLD + Water	4 ± 2°C	2 weeks
Brilliant Green (BG) Agar	Fisher/Difco	Room Temp	As specified by Manufacturer	BG + Water	4 ± 2°C	2 weeks
Plate Count Agar	Fisher/Difco	Room Temp	As specified by Manufacturer	PCA + Water	4 ± 2°C	3 months
Tryptic Soy Agar	Fisher/Difco	Room Temp	As specified by Manufacturer	TSA + Water	4 ± 2°C	3 months
Triple Sugar Iron (TSI)	Fisher/Difco	Room Temp	As specified by Manufacturer	TSI + Water	4 ± 2°C	3 months
Lysine Iron Agar (LIA)	Fisher/Difco	Room Temp	As specified by Manufacturer	LIA + Water	4 ± 2°C	3 months
Tetrathionate Broth (TTB)	Fisher/Difco	Room Temp	As specified by Manufacturer	TTB +Water + 1 drops Iodine	4 ± 2°C	24 hrs
Tryptic Soy Broth (TSB)	Fisher/Difco	Room Temp	As specified by Manufacturer	TSB + Water	4 ± 2°C	3 months
Lauryl Tryptose Broth (LTB)	Fisher/Difco	Room Temp	As specified by Manufacturer	LTB + Water	4 ± 2°C	3 months
Buffered Rinse Water	Fisher/Difco	4 ± 2°C	As specified by Manufacturer	KH_2PO_4 + $MgCl_2$+Water	Room temp.	1 year

Membrane Filters and Pads

Membrane filters and pads are purchased and certified to meet the following specifications:

- Filter diameter - 47 mm, mean pore diameter - 0.45 µm. Alternate filter and pore sizes may be used if the manufacturer provides data verifying performance equal to or better than that of 47mm-diam, 0.45-µm-pore size filter. At least 70% of filter area must be pores.
- When filters are floated on reagent water, the water diffuses uniformly through the filters in 15 s with no dry spots on the filters.
- Flow rates are at least 55 mL/min/cm2 at 25°C and a differential pressure of 93kPa.
- Filters are nontoxic, free of bacterial-growth-inhibiting or stimulating substances, and free of materials that directly or indirectly interfere with bacterial indicator systems in the media. Ink grid is nontoxic. The arithmetic mean of five counts on filters must be at least 90% of the arithmetic mean of the counts on five agar spread plates using the same sample volumes and agar media.
- Filters retain the organisms from a 100mL suspension of *Serratia marcescens* containing 1×10^3 cells.
- Water extractables in filters do not exceed 2.5% after the membrane is boiled in 100mL reagent water for 20min, dried, cooled, and brought to constant weight.
- Absorbent pad has diameter 47mm, thickness 0.8mm, and is capable of absorbing 2.0 ± 0.2mL Endo broth.
- Pads release less than 1mg total acidity calculated as $CaCO_3$ when titrated to the phenolphthalein endpoint with 0.02*N* NaOH.
- If the filter and absorbent pad are not sterile, they should not be degraded by sterilization at 121°C for 10min. Confirm sterility by absence of growth when a membrane filter is placed on a pad saturated with tryptic soy broth and incubated at 35 ± 0.5°C for 24h.

8.4 INSTRUMENT CALIBRATION

Autoclave

Prior to first use, autoclaves must be initially evaluated for performance. All initial checks must be recorded and records must be retained on file. With each use, a record of items sterilized, temperature, pressure, and time is kept for each batch processed. Operating temperature is checked and recorded at least weekly with a minimum/maximum thermometer. Performance is tested monthly with *Bacillus stearothermophilus* ampoules. Chemical strips are used daily to verify that supplies and materials have been sterilized. Records of autoclave operations shall be maintained for every cycle. Records shall include: date, contents, maximum temperature reached, pressure, time in sterilization mode, total run time (may be recorded as time in and time out) and analyst's initials.

Quebecor Colony counter

A dark field colony counter is used to count Heterotrophic Plate Count colonies. Maintenance is performed per manufacturer's instructions.

Quanti-tray Sealer

The Quanti-tray sealer is checked monthly using 100mL of bromcresol purple, or equivalent dye. The solution is poured into a test tray, sealed, and tested for leaks.

pH Meter/Conductivity Meter

With each use, calibrate the instrument according to the manufacturer's instructions. Verify that the slope of the calibration is within the 95-105% acceptable range prior to use.

Incubators & Waterbaths

Records of temperature checks are documented twice daily at least 4 hours apart when in use. Thermometers used for temperature checks are verified at least annually. Temperature stability and load testing is performed on an annual basis.

Analytical Balances

Analytical balances are checked at least daily prior to each use with class "I" weights. Records of these verifications are maintained within the laboratory. Balances are also serviced and verified and/or calibrated by an external calibration service at least semi-annually.

Volumetric Equipment, IDEXX and Commercially Prepared Phosphate Buffer Bottles

Equipment such as filter funnels, bottles, pipettes, non-Class A glassware and other containers with graduation must be calibrated once per lot prior to the first use.

IDEXX Bottles and Quanti-trays

Prior to first use, IDEXX bottles and Quanti-trays must be checked for fluorescence using a long wave UV light.

9.0 LABORATORY PRACTICES

9.1 REAGENT GRADE WATER

Reagent Grade water –Type II used in the Microbiology Laboratory is periodically checked for contamination. Type II water is checked annually for single and total heavy metals. Monthly checks for total organic carbon, ammonia and organic nitrogen, total residual chlorine and a heterotrophic plate count are also conducted. Resistivity and pH are checked continuously or with each use. Conductivity is also checked monthly using a calibrated conductivity meter.

9.2 GLASSWARE WASHING , STERILIZATION PROCEDURES AND EQUIPMENT STERILITY CHECKS

Glassware washing and preparation/sterilization procedures are performed according to EPA guidelines and are outlined in *SOP 030701 Glassware Cleaning and SOP 350334 Sterilization, Sanitization and Residue Testing of Microbiological Glassware and Equipment.* Before use, examine and discard items with chipped edges or etched inner surfaces. Reusable glassware is cleaned using the protocol established by the EPA:

- Soak for 15 minutes in hot tap water with detergent and scrub. Rinse thoroughly with tap water. Rinse thoroughly with dilute nitric acid (10%). Rinse thoroughly with deionized water. Rinse thoroughly with pesticide grade acetone. Rinse well with deionized water.
- New glassware will be cleaned according to the same procedure as listed above except the first step will be preceded by soaking overnight in 10 % HNO_3.

Inspect glassware after washing for excessive water beading and rewash, if necessary. Perform checks on pH and test for inhibitory residues on glassware and plastic ware. Use utensils and containers of borosilicate glass, stainless steel, aluminum, or other corrosion resistant material for media preparation. All biological glassware is purchased pre-sterilized. Sterilization of any auxiliary equipment is performed via autoclave.

Pipettes of all sizes are checked for sterility by drawing up non-selective media into the pipette and re-dispensing the volume back into original tube that contained the media. The tube is then incubated and monitored for growth. All results are recorded and maintained within the laboratory.

Inoculating loops are cultured by aseptically transferring the entire tip of the loop into a tube containing non-selective media. The tube is incubated and monitored for growth. Results are maintained within the laboratory.

A sterility check is performed on each batch of dilution and rinse water prepared in the laboratory and on each batch of commercially prepared water with non-selective growth media prior to first use.

In addition, stock solutions used for preparing rinse water are checked for turbidity prior to each use. If turbid, the stock buffer is discarded or re-sterilized.

9.3 MEDIA STERILITY VERIFICATION PROCEDURES

A sterility check must be analyzed for each lot of pre-prepared media and for each lot of media prepared in the laboratory. This is done prior to the first use of the media used for membrane filtration, MPN, pour plate and chromofluorogenic methods. For media used in the pour plate analytical technique, sterility blanks of the media must be made by pouring an uninoculated plate for each run in addition to sterility and lot comparison tests being performed on each lot prior to first use. Reagents and containers used in chromofluorogenic method tests are checked for fluorescence prior to first use.
All results of the sterility and lot comparison tests are documented.

9.4 POSITIVE AND NEGATIVE CONTROLS USING PURE CULTURES

ATCC Pure Cultures

Positive culture controls demonstrate that the media can support the growth of the target organism(s), and that the media produces the specified or expected reaction to the target organism(s). All media must be tested with at least one pure culture of a known positive reaction. This must be done prior to first use of the media.

Negative culture controls demonstrate that the media does not support the growth of non-target organisms or does not demonstrate the typical positive reaction of the target organism(s). All batches of selective media in the laboratory must be analyzed with one or more known negative culture controls. This must be done prior to first use of the media.

10.0 ANALYTICAL PROCEDURES

10.1 A list of laboratory SOP's associated with the microbiology laboratory can be found in the following table:

TABLE 10.1: MICROBIOLOGICAL DEPARTMENT SOP'S

This Table is subject to revision without notice

SOP #	Title/Description
350305	Fecal Coliform: Membrane Filter Technique
350334	HPC, Method 9215 B
350315	Fecal Coliform Determination in Biosolids: Membrane Filter Technique (SM9222D)
350316	Total Coliform
350325	PH Meter Maintenance and Calibration
350326	Thermometer Operation, Maintenance and Calibration Procedure
350328	Conductivity Meter Maintenance and Calibration
350331	Salmonella in Sludge
350332	Laboratory Maintenance of Bacteria Reference Cultures
350333	QA/QC of Microbiological Equipment and Testing Materials
350369	Sterilization, Sanitization and Residue Testing of Microbiological Glassware and Equipment
350359	Calibration and Maintenance of Autoclaves
350343	Colilert
350344	m-ColiBlue
350355	Technical Training and Personnel Qualification for Biomonitoring-Microbiology
350356	Water bath and Incubator Temperature Stability and Load Testing
350348	Enterolert

10.2 Additional information regarding microbiological testing can be found in:

- Standard Methods for the Examination of Water and Wastewater, 20th Edition, Section 9000.
- Heterotrophic Plate Count, SM 9215B
- Fecal Coliform Direct Test (A-1 Media), SM9221E
- Standard Total Coliform Membrane Filter Procedure, SM9222B.
- Fecal Coliform Membrane Filter Procedure, SM9222D.
- Enzyme Substrate Test, SM 9223B.
- Quantitative Salmonella Procedures, SM9260D.
- Environmental Regulations and Technology, Control of Pathogens and Vector Attraction in Sewage Sludge, Appendix F.

11.0 QUALITY CONTROL CHECKS

11.1 ESC participates in microbiological proficiency testing (PT's) by analyzing samples provided by Environmental Resource Associates (ERA). Unknowns are received and analyzed according to instructions from ERA and the standard operating procedure.

11.2 Plate count comparison between two analysts is conducted monthly. Acceptable plate count comparisons must be within 10%. Analyst deviations that are outside the 10% range are repeated. If the repeat inter-analyst count is unacceptable additional procedural training and method reviews are conducted.

11.3 Duplicate analyses are performed on 10% of samples or at least one sample per month for total and fecal coliform and *E.coli* tests. Due to the infrequent laboratory receipt of some samples, duplicate analysis is conducted per sample. If the RPD exceeds 20%, the data is qualified.

11.4 For membrane filtration analyses sterility control checks are conducted on the filter assembly at the beginning and end of each sequence and following every 10 samples analyzed. If QC blank fails, the run is rejected or qualified.

11.5 Verification of total coliform and fecal coliform colonies must be conducted monthly (10 colonies/month for wastewater). Colonies found in drinking water samples must have at least five typical sheen colonies and five atypical colonies verified.

11.6 For HPC analysis, duplicate plates are run for each dilution. A positive control and an uninoculated plate performed for each run. If the QC fails, the run is rejected or qualified.

12.0 DATA REDUCTION, VALIDATION AND REPORTING

12.1 DATA REDUCTION

The analyst performs the data calculation functions and is responsible for the initial examination of the finished data. Data reduction steps applied to the raw data are outlined in *SOP 030201 Data Handling and Reporting.* The primary analyst reviews the quality of data based on the following guidelines:

- The appropriate SOP has been followed
- Sample preparation is correct and complete
- Analytical results are correct and complete
- QC is within criteria and complete

12.2 VALIDATION

The validation process consists of data generation, reduction review, and reporting results. Once data reduction is complete, validation is conducted by reviewing all data entries and calculations for errors, reviewing all documentation to assure that sample information is correct, and that the tests have been performed appropriately and within the appropriate holding times. The secondary analyst reviews the quality of data based on the following guidelines:

- The appropriate SOP has been followed
- Sample preparation is correct and complete
- Analytical results are correct and complete

12.3 REPORTING

Reporting procedures are documented in *SOP 030201 Data Handling and Reporting.* Microbiological data is reported as Colony Forming Units (CFU) per unit volume, Presence/Absence, or Most Probable Number (MPN)/100mL.

13.0 CORRECTIVE ACTION

13.1 In the event that a nonconformance occurs in conjunction with the analytical batch, a corrective action response (CAR) must be completed. The reason for the nonconformance will be stated on the form and the measures taken to correct the nonconformance clearly defined. The effectiveness of the corrective action must be assessed and noted. The CAR will be kept on file by the QA department. Corrective action procedures are documented in SOP 030208 *Corrective and Preventive Action*

13.2 Required Corrective Action

All samples and procedures are governed by ESC's quality assurance program. Designated corrective actions are as follows:

13.2.1 Laboratory QC Criteria and Appropriate Corrective Actions

If the analytical method contains acceptance/rejection criteria and it is more stringent than those controls generated by the laboratory the method criteria will take precedence.

13.2.2 Out of control plate count comparisons between analysts.

Rejection Criteria – Comparisons must be within ±10% for monthly plate count comparisons.

Corrective Action – Duplicate counts are repeated. If repeat counts are still beyond acceptance range, procedural training and method reviews are conducted.

13.2.3 Out of control duplicate analyses for total and/or fecal coliform or *E.coli* .

Rejection Criteria – Duplicate RPDs must not exceed 20% for total and/or fecal coliform or *E.coli.*

Corrective Action – Data is qualified or the analysis is repeated. If repeat analysis is still beyond acceptance range, procedural training and method reviews are conducted.

13.2.4 Out of control QC blank for membrane filtration analysis.

Rejection Criteria – Blank analyses performed either at the beginning or end of the analytical sequence is positive.

Corrective Action – The analytical sequence may be rejected and reprocessed or qualified based on the nature of the contamination.

14.0 RECORD KEEPING

Record keeping is outlined in SOP #010103 *Document Control and Distribution,* SOP #030203 *Reagent Logs and Records* and SOP #030201 *Data Handling and Reporting*

15.0 QUALITY AUDITS

System and data quality audits are outlined in the ESC Quality Assurance Manual Version 8.0.

1.0 SIGNATORY APPROVALS

Mold Laboratory
QUALITY ASSURANCE MANUAL

APPENDIX XI TO THE ESC
QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615) 758-5858

NOTE: The QAM has been approved by the following people. A signed cover page is available upon request

Judith R. Morgan, M.S., VP, Technical and Regulatory Affairs, 615-773-9657

Eric Johnson, B.S., Laboratory Director, 615-773-9654

Dixie Marlin, B.S., QC Manager, 615-773-9681

Christabel Fernandes-Monteiro, PhD, Mold Department Manager 615-773-9683

2.0 APPENDIX TABLE OF CONTENTS

3.0 SCOPE AND APPLICATION

This appendix discusses specific QA requirements for general analytical protocols to ensure that analytical data generated from the Mold laboratory are scientifically valid and are of acceptable quality. Any deviations from these requirements and any deviations that result in nonconforming work must be immediately evaluated and their corrective actions documented.

4.0 LABORATORY ORGANIZATION AND RESPONSIBILITIES

ESC Lab Sciences offers diverse environmental capabilities that enable the laboratory to provide the client with both routine and specialized services, field sampling and broad laboratory expertise. A brief outline of the organization and responsibilities as they apply to the ESC Quality Assurance Program is presented in Section 4.0 in the *ESC Quality Assurance Manual Version 8.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Dr. Christabel Fernandes-Monteiro, with a Ph.D. in Applied Biology, is the Department Manager of the Mold laboratory. She gained experience in Mold analytical techniques at ESC, an AIHA accredited laboratory, and obtained additional training in microscopic techniques at the McCrone Research Institute. Her responsibilities include sample analysis, protocol development and quality control. Dr. Fernandes-Monteiro oversees the review and approval processes of all data associated with the Mold laboratory. She also reviews AIHA and EPA online training modules related to the methods being performed in the Mold Laboratory. In her absence, David Cooper assumes responsibility for departmental decisions.

David Cooper, with a BS degree in Biological Sciences, is the Primary Analyst in the Mold laboratory. He is proficient in Mold analytical methods as per AIHA guidelines. David has gained analytical experience at ESC, an AIHA accredited laboratory, and obtained additional training in Mold analysis at the McCrone Research Institute. He reviews AIHA and EPA online training modules related to the methods being performed in the Mold Laboratory.

5.2 TRAINING

All new analysts to the laboratory are trained by the Primary Analyst or Manager according to ESC protocol. ESC's training program is outlined in SOP #350355, *Technical Training and Personnel Qualification for Biomonitoring-Mold*. Performance for BOD analysis is documented using an initial demonstration of capability (IDOCs) and continuing demonstration of capability (CDOC). On-going acceptable capability in mold analysis is demonstrated by acceptable participation in the AIHA proficiency testing programs (EMPAT). On-going acceptable capability in BOD analysis is demonstrated by acceptable participation in the WP proficiency testing program and daily Quality Control sample analyses. Documentation of analyst training, including a copy of college transcripts or degree, is maintained on file within the department.

6.0 FACILITIES AND LABORATORY SAFETY

6.1 FACILITIES

MOLD LAB

The main area of the MOLD laboratory has approximately 532 square feet with 167 square feet of bench space. The lighting throughout the laboratory is fluorescence. The air system is a five-ton Trane split unit with natural gas for heating. The laboratory reagent water is provided through the ELGA PureLab Ultra deionizer system. Biohazard containers are located in the laboratory and Commodore Waste Removal serves as ESC'S biological waste disposal contractor. ESC's building information guides and site plan are shown in Appendix I.

BOD LAB

The main area of the BOD laboratory has approximately 532 square feet of area with 151 square feet of bench space. The lighting standard throughout the laboratory is fluorescence. The air system is a five-ton Trane split unit with natural gas for heating. The laboratory reagent water is provided through the ELGA PureLab Ultra deionizer system. Biohazard containers are located in the laboratory and Commodore Waste Removal serves as ESC'S biological waste disposal contractor. ESC's building information guides and site plan are shown in Appendix I.

6.2 LABORATORY SAFETY

- Laboratory access is limited when work is being performed.
- All procedures where infectious aerosols or splashes may occur are conducted in biological safety II cabinets.
- The following Biosafety Level 2 (BSL2) guidelines are adhered to:
  - Closed-toe shoes are worn in the laboratory
  - Floors and work surfaces are cleaned on a regular basis
  - Emergency numbers are posted in the laboratory
  - Biological safety hoods are tested and certified annually
  - Laboratory personnel are trained in the use of the biological spill kit and emergency safety equipment
- ESC's laboratory safety guidelines are detailed in the ESC *Chemical Hygiene and Safety Plan*.

7.0 SAMPLING PROCEDURES

7.1 FIELD SAMPLING PROCEDURES, SAMPLE STORAGE, AND HANDLING

- Field Sampling procedure is described in Appendix III of this ESC Quality Assurance Manual. Sample information is recorded and kept on the ESC chain of custody and field logbooks.
- Samples are received in the laboratory login area and are tracked using LIMS (Laboratory Information Management System). A Chain of Custody Form accompanies all samples received by the lab. This is necessary to prove the traceability of the samples and to document the change in possession from sampling to delivery to receipt by the laboratory. Prior to analysis samples are checked for integrity. Sample handling, tracking and acceptance procedures are outlined in SOP #060105, *Sample Receiving.*
- Sample storage procedures are followed using guidance from each approved method and associated department SOP.

8.0 EQUIPMENT

8.1 EQUIPMENT LIST

LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Mold/ BOD Analysis
This table is subject to revision without notice

Item	Manufacturer	*Model*	*Serial #*	*Location*
Analytical Balance	Mettler	PL602-S	1125081657	Bacteriology Lab
Analytical Balance	Ohaus	Adventure Pro	8029211055	Bacteriology Lab
Autoclave	Tuttnauer	2540EK	2906170	Mold Lab
Class I BSC	AirFiltronix	AirFiltronix HS 4500	41031	Mold Lab
Class II BSC	Labconco	Labconco 36213	60554894	Mold Lab
Class II BSC	Labconco	Labconco 36209	03076555	Bacteriology Lab
COD Reactor	HACH	45600	900903221	BOD
Microscope	NIKON	LABOPHOT	242008	Mold Lab
Microscope	NIKON	LABOPHOT	235267	Mold Lab
Microscope	Olympus	CH2	900216	Mold Lab
Microscope	Olympus	BH-2	708821	Mold Lab
Microscope	Leitz	Laborlux	512663	Mold Lab
Microscope	VWR Scientific	VWRC1	V167173	Mold Lab
Refrigerator	Whirlpool			Bacteriology Lab
Refrigerator	Whirlpool	El05PPXMQ	EEP3524864	Mold Lab
Refrigerator	Whirlpool	EL7ATRRMQ07	EWR4973976	Mold Lab
Refrigerator	Frigidaire	FRT17G4BW9	BA703306	Mold Lab
Stereoscope	VWR Scientific	VWRS1	V168430	Mold Lab
Incubator	Precision Scientific	FV199LRW2	WB02401046	Mold Lab
Incubator	Quincy Lab	10-100	I11-2454	Mold Lab
Incubator	Precision Scientific	30M	9303590	Bacteriology Lab
Incubator	Precision Scientific	30M		Bacteriology Lab
Incubator	VWR	2030	802202	BOD
Incubator	Fisher	Not Visible	100212	BOD
Incubator	Thermo Scientific Precision	3271	317217-1241	BOD
Incubator	Precision	818	35AK-10	BOD
Waterbath	VWR	129PC	1000797	Mold Lab
Waterbath	Blue M-MagniWhirlpool	MW-1110A	14991	Bacteriology Lab
Biolog MicroStation	Biolog, Inc.	Micrologg 3	342689	Bacteriology Lab
Turbidimeter	Biolog, Inc.	21907	6093898	Bacteriology Lab
Plate Reader	Biotek	ELX808BLG	203222	Bacteriology Lab
Vortex Genie2 Mixer	VWR	G-560	2-223236	Mold Lab
Vortex Genie2 Mixer	VWR	G-560	2-223236	Bacteriology Lab
Stir Plate	Corning	PC-420D	023507102961	Bacteriology Lab

LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Mold/ BOD Analysis ***This table is subject to revision without notice***				
Item	**Manufacturer**	***Model***	***Serial #***	***Location***
Stir Plate	Fisher	118	102	Bacteriology Lab
Stir Plate	VWR	205	7852	BOD
Stir Plate	VWR	220	5031	BOD
BOD SP Robotic Analyzer	Skalar	SP50	08124	BOD
BOD SP Robotic Analyzer	Skalar	SP50	08123	BOD
DO meter	YSI	5000	081C101451	BOD
DO meter	YSI	5000	081C101450	BOD
pH meter	Thermo	Orion 3 star	BOD pH	BOD
Spectrophotometer	Hach	DR 4000U	Not available	BOD

8.2 EQUIPMENT PREVENTIVE MAINTENANCE

INSTRUMENT	***P. M. DESCRIPTION***	***FREQUENCY***
Analytical Balances	•Check with Class "I" weights	Daily-tolerance 1 gm - ±0.0001gm
Analytical Balances	•Service/Calibration (semiannual contract maintenance and calibration check)	10 gm - ±0.01 gm
Analytical Balances	•Service/Calibration (semiannual contract maintenance and calibration check)	Semiannually
Refrigerators & Incubators	•Maintenance service	As needed - determined by daily temperature performance checks
Water Bath	•Check thermometer vs. NIST	Once each year
Water Bath	•Remove from service when not maintaining temperature and send off for repair or replace	As needed
Autoclave	•Check sterilization efficiency	Weekly – *G. stearothermophilus*
Autoclave	•Check sterilization efficiency	Per Use – Chemical Indicator
Class II Biosafety Cabinet	•Monitor air and UV lamps	Monthly
Class II Biosafety Cabinet	•Inspect for air flow	Quarterly
Class II Biosafety Cabinet	•Recertification according to NSF standard 49	Annually
Turbidimeter	•Maintenance Service	Annually
Turbidimeter	•Check for accuracy using NIST traceable stds	Per Use
Biolog MicroStation	•Maintenance Service	Annually
Microscope	•Service/calibration of each ocular micrometer	Annually
Microscope	•Clean optics and stage, Kohler Alignment	Each Use
pH meters	Reference junction & electrode replacement	As needed
pH meters	Probe stored in KCl	At all times when not in use
pH meters	Other	As described in manufacturer's O
BOD SP Robotic Analyzer	Calibrate DO probe	Daily
BOD SP Robotic Analyzer	Clean and Change DO probe membrane	Every week
BOD SP Robotic Analyzer	Rinse ATU (seed) dispenser using rinse pump option	As needed
BOD SP Robotic Analyzer	Clean rinsing vessel	Every 3 months or as needed
BOD SP Robotic Analyzer	Replace tubing for dispenser, diluent pump, and rinsing vessel	Annually or as needed

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8.3 STANDARDS AND REAGENTS

Table 8.3A lists commercially prepared agar sources. Table 8.3 B lists in-house prepared agar sources and storage information. Table 8.3C lists standard sources, receipt, and preparation information for BOD Analysis. Table 8.3D is designed to provide general calibration range information for BOD analysis. These ranges may change depending on regulatory requirements, procedural changes, or project needs.

Table 8.3A: Commercially prepared agar sources and storage information.
(subject to revision as needed)

Agar Type	***Source***	***Storage***
Malt Extract Agar w/chloramphenicol (MEA)	HealthLink	4 ± 2°C
DG18 Agar	HealthLink	4 ± 2°C
Modified Cellulose Agar	HealthLink	4 ± 2°C
Potato Dextrose Agar w/chloramphenicol (PDA)	HealthLink	4 ± 2°C
Tryptic Soy Agar w/Sheep Blood	HealthLink	4 ± 2°C
R2A w/cycloheximide	HealthLink	4 ± 2°C
2 % Malt Extract	Biolog	4 ± 2°C
Biolog Universal Agar (BUG)	Biolog	4 ± 2°C
BUG w/BL	Biolog	4 ± 2°C
Biolog Universal Anaerobic Agar (BUA)	Biolog	4 ± 2°C
BUA w/BL	Biolog	4 ± 2°C
Biolog Universal Yeast Agar (BUY)	Biolog	4 ± 2°C
TSA w/SB contact	HealthLink	4 ± 2°C
BUG w/0.25% Maltose	Biolog	4 ± 2°C
Malt Extract Agar w/chloramphenicol contact	HealthLink	4 ± 2°C
Chocolate Agar	Biolog	4 ± 2°C
Czapek Yeast Extract Agar	HealthLink	4 ± 2°C

All stock agar expirations are per manufacturer specification.

Table 8.3B: In-house prepared agar sources and storage information.
(subject to revision as needed)

Agar Type-Stock	*Source*	*Stock Storage*	*Stock Expiration*	*Preparation Components Media*	*Prepared Storage*	*Prepared Expiration*
Malt Extract Agar (MEA)	Fisher/Difco	Room Temp	As specified by Manufacturer	MEA + Water	4 ± 2°C	3 weeks
Potato Dextrose Agar (PDA)	Fisher/Difco	Room Temp	As specified by Manufacturer	PDA + Water	4 ± 2°C	3 weeks
Corn Meal Agar (CMA)	Fisher/Difco	Room Temp	As specified by Manufacturer	CMA +Water	4 ± 2°C	3 weeks
Inhibitory Mold Agar (IMA)	Fisher/Difco	Room Temp	As specified by Manufacturer	IMA + Water	4 ± 2°C	3 weeks
Modified Saboraud's Agar (MSA)	Fisher/Difco	Room Temp	As specified by Manufacturer	M-SAB Dex + Water	4 ± 2°C	3 weeks
R2A	Fisher/Difco	Room Temp	As specified by Manufacturer	R2A + Water	4 ± 2°C	3 weeks
2 % Malt Extract	Fisher/Oxoid	Room Temp	As specified by Manufacturer	Bacteriological Agar + Malt	4 ± 2°C	3 weeks
Biolog Universal Agar (BUG)	Biolog	Room Temp	As specified by Manufacturer	BUG + Water	4 ± 2°C	3 weeks
Biolog Universal Anaerobic Agar (BUA)	Biolog	Room Temp	As specified by Manufacturer	BUA + Water	4 ± 2°C	3 weeks
Biolog Universal Yeast Agar (BUY)	Biolog	Room Temp	As specified by Manufacturer	BUY + Water	4 ± 2°C	3 weeks
Biolog Universal Agar (BUG) with 0.25%	Biolog	Room Temp	As specified by Manufacturer	BUG + Water + Maltose	4 ± 2°C	3 weeks

Table 8.3C: Standard sources, description and calibration information.
(This table is subject to revision without notice)

Instrument Group	*Standard Source*	*How Received*	*Source/Storage*	*Preparation from Source*	*Lab Stock Storage*	*Preparation Frequency*
BOD	Lab preparation	As dry glucose and glutamic acid	Dessicator	150mg each/L	4 ± 2°C	Made fresh daily
pH meter	Commercial source	pH 7.0 buffer	Ambient	No prep required	NA	Annual/Expiration Date
pH meter	Commercial source	pH 10.0 buffer	Ambient	No prep required	NA	Annual/Expiration Date
Turbidity meter	Commercial source	Turbidity standard	Ambient	No prep required	NA	Annual/Expiration Date

Table 8.3D: Working Standard Calibration

Analysis	*Calibration Standard*
BOD	D.O.- Barometric pressure/temp, Glucose and glutamic acid reference standard

Source of Fungi

A collection of fungi is maintained in the laboratory as training and reference material. The fungi are isolated from various sources and stored as Malt Extract Agar slants for 3 months at 4 ± 2ºC. Cultures are sub-cultured every 3 months. Each culture is assigned an accession number, genus, specific epithet, authority, source, and name of collector. Records are maintained in the laboratory in the accession list database.

8.4 INSTRUMENT CALIBRATION

Autoclave

Operating temperature is checked and recorded with each use with a minimum/maximum thermometer. Performance is tested weekly with *Bacillus stearothermophilus* ampoules. Chemical strips are used with each use to verify that supplies and materials have been sterilized. Records of autoclave operations are maintained for every cycle. Records include: date, contents, maximum temperature reached, pressure, time in sterilization mode, total run time (may be recorded as time in and time out) and analyst initials.

Incubators & Waterbaths

The record of temperature checks is documented twice daily at least 4 hours apart when in use. Thermometers used for temperature checks are verified at least annually.

Analytical Balances

Analytical balances are checked at least daily prior to each use with class "I" weights. Records of these verifications are maintained within the laboratory. Balances are also serviced and verified and/or calibrated by an external calibration service at least semi-annually.

Microscope

A record of cleaning and alignment for each microscope is maintained in the laboratory. Each microscope has an ocular micrometer that is verified annually with a stage micrometer. All microscopes are calibrated annually by an external calibration service.

Biochemical Oxygen Demand Robotic Analyzer – SOP Number 340303A

The Dissolved oxygen meter is calibrated according to manufacturer's instructions with each use. Air calibration is performed on the DO meter probes to correct DO for the ambient temperature and pressure. The air calibration is confirmed daily using the Winkler Test. During the analytical sequence, the calibration stability of the DO probes is verified after every ten samples and at the end of sequence, by the analysis of continuing calibration verification (CCV). If either of the readings differs from the initial readings by more than 0.2 mg DO/L., the instrument automatically re-calibrates the DO meters and re-reads everything after the last passing CCVs.

A laboratory control sample (LCS) is prepared from glucose and glutamic acid, and is analyzed exactly like a field sample at the beginning of the workgroup, after every twenty samples throughout the, run and at the end of the workgroup, one for each probe to verify that the analytical process is performing accurately.

pH meter

With each use of pH meters, calibrate the instrument according to manufacturer's instructions. The slope is documented on a daily basis. Acceptable pH slope range is 95-105%.

Turbidimeter

With each use, calibrate instrument according to manufacturer's instructions. Adjust transmittance to a 100% using a blank reference test tube. Establish appropriate turbidity range on turbidimeter by adding or subtracting 2% T to the percent transmittance measured with appropriate turbidity standard.

Volumetric equipment

Equipment such as pipettes non-Class A and other containers with graduations are calibrated once per lot prior to first use. Volumetric equipment that is not disposed off after use is calibrated on an annual basis. The error of calibration must not exceed 2.5%.

9.0 LABORATORY PRACTICES

9.1 REAGENT GRADE WATER

Reagent Grade water –Type II used in the Mold Laboratory is periodically checked for contamination. Type II water is checked annually for single and total heavy metals. Monthly checks for total organic carbon, ammonia and organic nitrogen, total residual chlorine and a heterotrophic plate count are also conducted. Conductivity and pH are checked continuously or with each use.

Prior to first use, a sterility check with non-selective growth media is performed on each batch of dilution and rinse water prepared in the laboratory and on each batch of commercially prepared water.

9.2 GLASSWARE WASHING AND STERILIZATION PROCEDURES

Glassware washing and preparation/sterilization procedures are performed according to EPA guidelines and are outlined in SOP #030701, *Glassware Cleaning*. The glassware used in the mold laboratory is restricted to microscopic slides, cover slips, and screw capped bottles, vials or flasks for preparation of media. Before use, examine microscope slides, and discard items with chipped edges or etched inner surfaces. Prior to use, clean microscopic slides with 70 % isopropyl alcohol. Examine screw-capped bottles, vials or flasks for chipped inner edges that could leak. Screw-capped bottles, vials or flasks are cleaned using the following protocol:

- Prewash with hot tap water. Wash with hot tap water. Wash with non-foaming powder detergent. Rinse with tap water. Rinse with DI water. Dry and cool.
- New glassware will be cleaned according to the same procedure as listed above.

Inspect glassware after washing for excessive water beading and re-wash, if necessary. Perform checks on pH and test for inhibitory residues on glassware and plastic ware. Use utensils and containers of borosilicate glass, stainless steel, aluminum, or other corrosion resistant material for media preparation. Sterilization of any auxiliary equipment is performed via autoclave.

Pipettes of all sizes are checked for sterility by drawing up non-selective media into the pipette and re-dispensing the volume back into original tube that contained the media. The tube is then incubated and monitored for growth. All results are recorded and maintained within the laboratory.

Inoculating loops are cultured by aseptically transferring the entire tip of the loop into a tube containing non-selective media. The tube is incubated and monitored for growth. Results are maintained within the laboratory.

BOD analysis is performed in disposable, pre-sterilized bottles. In the event that glass bottles must be used, the BOD glassware is washed in a commercial laboratory dishwasher using a phosphate free detergent, followed by a nitric acid rinse, with a final rinse of laboratory DI water.

9.3 MEDIA STERILITY VERIFICATION PROCEDURES

A sterility check must be analyzed for each lot of pre-prepared media and for each lot of media prepared in the laboratory. This is done prior to the first use of the media used for membrane filtration or MPN or pour plate and chromofluorogenic methods. For media used in the pour plate testing technique, sterility blanks of the media must be made by pouring an uninoculated plate for each run in addition to sterility and lot comparison tests being performed on each lot prior to first use. All results are documented.

9.4 POSITIVE AND NEGATIVE CONTROLS USING PURE CULTURES

Positive culture controls demonstrate that the media can support the growth of the target organism(s), and that the media produces the specified or expected reaction to the target organism(s). All prepared media must be tested with at least one pure culture of a known positive reaction. This must be done prior to first use of the media.

Negative culture controls demonstrate that the media does not support the growth of non-target organisms or does not demonstrate the typical positive reaction of the target organism(s). All batches of prepared selective media in the laboratory must be analyzed with one or more known negative culture controls. This must be done prior to first use of the media.

New lots of pre-prepared media are evaluated for suitability using manufacturer QC data.

10.0 ANALYTICAL PROCEDURES

A list of laboratory SOPs associated with the mold laboratory can be found in the following table:

TABLE 10.1: MOLD DEPARTMENT SOPs

This Table is subject to revision without notice

SOP #	Title
340303	Biochemical Oxygen Demand
340303A	Biochemical Oxygen Demand, Automated
350306	Spore Traps
350307	Fungal Anderson
350308	Fungal Quantification
350309	Fungal Rodac
350310	Direct Exam Prep Procedure
350311	Fungal Identification
350312	Mold QA/QC
350313	Mold Lab Safety
350314	MUG Ecoli/Coliforms
350319	Processing of Bacterial Andersen Samples for Quantification
350334	Microscope Usage
350335	Fungal Spore Identification
350342	BART Testing
350347	Processing of Bacterial Swabs, Bulk, Dust and Water Samples for Quantification
350349	Bacterial Identifiication Using Biolog
350357	Actinomycetes Identification
350367	Labconco Flaskscrubber Operation and Maintenance
350371	Mold lab Autoclave Maintenance and Operation
350372	Mold Lab Balance Calibration and Verification
350373	Preparation of Culture media

11.0 QUALITY CONTROL CHECKS

11.1 ESC participates in proficiency testing (PT's) in support of various laboratory accreditations/recognitions. For mold analyses, PTs are administered quarterly by AIHA. The samples are received and analyzed by method according to the vendor's instructions and according to the ESC SOP.

For BOD and *Total coliform/E. coli* analysis, environmental PTs are purchased from Environmental Resource Associates (ERA). The WP and WS studies are completed every 6 months.

11.2 As part of the total spore analysis QC, the laboratory maintains a slide collection with various count levels and genera/groups of spores. Acceptance criteria for the slide collection include counts that are statistically determined (e.g. ±3STD). Each analyst reviews one slide from this collection on each day of analysis. The slides are reviewed on a rotational basis such that a different slide is reviewed each day until the entire slide collection has been examined. The total spore count and acceptance criteria for each slide are calculated and compared with the statistically determined acceptance criteria.

11.3 Each week, a different pure culture is chosen by the lab supervisor and is identified by each analyst as part of training and continuing QC program.

11.4 Inter- and intra-analyst precision is determined by the re-analysis of samples by the same and different analysts (where possible). The rate of re-analysis by the same analyst and by a second qualified analyst is 5%.

11.5 Media blanks for viable count analysis are used to monitor media and laboratory procedures for contamination. These blanks are utilized in two ways:

- Laboratory media blanks are unexposed fresh media (either recently received from the manufacturer or newly laboratory prepared) that is incubated under the same conditions as those used for analysis.
- Field blanks are unopened media that is handled identically to field samples. These samplers are returned to the laboratory with sampled media to demonstrate that media utilized was not originally contaminated and did not become contaminated during transport.

11.6 Environmental monitoring of the laboratory air and the surfaces in the mold laboratory is performed monthly. BSLII hoods are also monitored in the mold laboratory.

11.7 Round Robin studies are performed for direct examination of fungal air samples in accordance with AIHA policy requirements. Results for these studies include raw counts and final concentrations for each fungal structure. Acceptance criteria include organism identification, ranking and quantification.

11.8 Analysts also participate in other continuing education activities, including attending seminars and conferences, in-house training meetings, reviews of journal publications and self-taught training on CD.

11.9 For BOD analysis, Initial Demonstrations of Capabilility (IDOC's) are performed during new analyst training and/or prior to acceptance and use of any new method/instrumentation. Continuing Demonstration of Capability must be updated at least annually. The associated data is filed within the department and available for review.

11.10 For BOD analysis, samples are analyzed in batches of 1-20 samples. Each batch must include the following: method blank, seed blank, seed control, seed check, 1 laboratory control sample, 1 sample duplicate/ 10 samples. A calibration check (CCV) is performed every 10 samples and an additional LCS every twenty samples including the end of the sequence.

11.11 A method blank is analyzed for each probe at the beginning and end of the sequence. The method blank is used to define the level of laboratory background and reagent contamination. Only one acceptable method blank is required for each batch. If all method blanks fail, data is qualified. The depletion of the method blank should be between - 0.2 and + 0.2mg DO/L.

11.12 The Seed Blank/Seed Control/Seed Check must deplete to show that the microorganism population is viable. The seed correction factor should be 0.6-1 mg/L

11.13 The CCV should not vary more than 0.2g DO/L within a run.

11.14 The BOD value for the LCS must be within 167.5 and 228.5.

11.15 The RPD for the sample duplicate must be $\leq$5%.

12.0 DATA REDUCTION, VALIDATION AND REPORTING

12.1 DATA REDUCTION

The analyst performs the data calculation functions and is responsible for the initial examination of the finished data. Data reduction steps applied to the raw data are outlined in SOP #030201, *Data Handling and Reporting.* The primary analyst reviews the quality of data based on the following guidelines:

- The appropriate SOP is followed
- Sample preparation is correct and complete
- Analytical results are correct and complete
- QC is within criteria and complete

For BOD analysis, the Quality Control Department performs the secondary review of the data package using the ESC SOP#030227, *Data Review*. The QC Reviewer verifies that the analysis has performed as required and meets method criteria, all associate data is present and complete, and also ensures that any additional documentation is completed as required (i.e. Ohio VAP checklists, required flags on test reports, etc.)

TABLE 12.1 Mold Data Reduction Formulas

PARAMETER	FORMULA
Non-viable (Spore Traps) Mold	$\frac{SporeCount}{m^3} = \frac{\text{number on trace} \times 1000}{\text{Volume of air sampled in liters}}$
Andersen Fungal Viable (Culturable) Mold Spore Andersen Bacterial Viable (Culturable) Bacteria	$\frac{CFU}{m^3} = \frac{\text{raw counts} \times 1000}{\text{Volume of air sampled in liters}}$ $P_c = N\,[1/N + 1/N\text{-}1 + 1/N\text{-}2 + \ldots\ldots 1/N\text{-}r + 1]$
Quantitative Fungal/Bacterial	$\frac{CFU}{gm}$ or $\frac{CFU}{Swab} = \frac{\#\text{ of Colonies} \times \text{Dilution Factor}}{\text{Sample Amount}}$
BOD, 5-DAY	$\frac{\text{Initial D.O.} - \text{Final D.O.} - CF}{\%\text{ Dilution Sample}}$ *Calculations are performed by computer software*

12.2 VALIDATION

The validation process consists of data generation, reduction review, and reporting results. Once data reduction is complete, validation is conducted by reviewing all data entries and calculations for errors, reviewing all documentation to assure that sample information is correct, and that the tests have been performed appropriately and within the appropriate holding times. The secondary analyst reviews the quality of data based on the following guidelines:

- The appropriate SOP is followed
- Sample preparation is correct and complete
- Analytical results are correct and complete

For BOD analysis, once data reduction is complete, validation is conducted by verification that the QC samples are within acceptable QC limits and that all documentation is complete, including the analytical report and associated QC. See Table 12.3 for current QC targets, controls and current reporting limits for BOD analysis.

12.3 REPORTING

Reporting procedures are documented in SOP #030201, *Data Handling and Reporting.*

BOD Control Limits: BOD QC targets are statutory. The laboratory calculated limits verify the validity of the regulatory limits. The BOD QC targets are within the range of 5 to 15% for accuracy, depending on determinative method requirements, and, where applicable, <20 RPD for precision, unless laboratory-generated data indicate that tighter control limits can be routinely achieved. When using a certified reference material for QC sample analysis, the acceptance limits used in the laboratory will conform to the provider's certified ranges for accuracy and precision.

Table 12.3: QC Targets for BOD Lab Accuracy (LCS), Precision and RL's *This table is subject to revision without notice*					
Analyte	**Analysis Method**	**Matrix**	**Accuracy Range (%)**	**Precision (RPD)**	**RL (ppb)**
Biochemical Oxygen Demand	SM5210B	W	85-115	≤5	5000
Biochemical Oxygen Demand - Carbonaceous	SM5210B	W	85-115	≤5	5000

13.0 CORRECTIVE ACTION

13.1 In the event that a nonconformance occurs in conjunction with the analytical batch, a corrective action response (CAR) form must be completed. The reason for the nonconformance is stated on the form and the measures taken to correct the nonconformance clearly defined. The effectiveness of the corrective action must be assessed and noted. The CAR will be kept on file by the QA department. Corrective action procedures are documented in SOP #030208, *Corrective and Preventive Action*

13.2 Required Corrective Action

Control limits have been established for each type of analysis. When these control limits are exceeded, corrective action must be taken. All samples and procedures are governed by ESC's quality assurance program. General corrective actions are as follows; however additional and more specific direction is provided in the specific determinative procedure. For more information, see the appropriate SOP.

13.2.1 Laboratory QC Criteria and Appropriate Corrective Actions

If the analytical method contains acceptance/rejection criteria and it is more stringent than those controls generated by the laboratory the method criteria will take precedence.

13.2.2 Out of Control RPD for inter- and/or intra-analyst reanalysis.

Rejection Criteria - RPD value of the original analysis is calculated and must be below the current control limit.

Corrective Action - Both first and second analysts re-analyze the sample until a consensus is reached and the RPD value falls within control limits.

13.2.3 Out of Control RPD for inter-analyst analysis.

Rejection Criteria – All organisms must be accurately identified.

Corrective Action - Both first and second analysts review the sample. The second analyst results are reported to the client.

13.2.4 Calibration Verification criteria are not met: BOD Analysis

Rejection Criteria see section 8.4

Corrective Action- If the CCV fails, the data may still be used. If the failure persists, check cleanliness of the equipment and stability of the DO probe for subsequent runs. If a problem persists, the group supervisor or QA Department is notified for further action.

13.2.5 Out of Control Blanks: Applies to Method Blank

Rejection Criteria- Blank depletion is greater than established limit.

Corrective action- If samples have already been partially prepared or analyzed, the group leader or QA will be consulted to determine if data needs to be rejected or if samples need to be re-prepped.

13.2.6 Out of Control Laboratory Control Standards (LCS)

Rejection Criteria- If the performance of associated laboratory control sample(s) is outside of lab-generated control limits calculated as the mean of at least 20 data points +/- 3 times the standard deviation of those points. (Listed in Section 12).

Corrective Action- All samples bracketed by the failed LCS must be reported with a qualifier.

13.2.7 Out of Control Duplicate Samples

Rejection Criteria- Lab-generated maximum RPD limit (as listed under precision in Section12)

Corrective Action- The sample and duplicate are reported with a qualifier.

14.0 RECORD KEEPING

Record keeping is outlined in SOP #010103, *Document Control and Distribution*, SOP #030203, *Reagent Logs and Records* and SOP #030201, *Data Handling and Reporting*

15.0 QUALITY AUDITS

System and data quality audits are outlined in the ESC Quality Assurance Manual Version 8.0.

1.0 SIGNATORY APPROVALS

Protozoa Laboratory
QUALITY ASSURANCE MANUAL

APPENDIX XII TO THE ESC
QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615)758-5858

Prepared by

ESC LAB SCIENCES
12065 LEBANON ROAD
MT. JULIET, TENNESSEE 37122
(615)758-5858

NOTE: The QAM has been approved by the following people. A signed cover page is available upon request

Judith R. Morgan, M.S., VP of Technical and Regulatory Affairs 615-773-9657

Eric Johnson, B.S., Laboratory Director 615-773-9654

Dixie Marlin, B.S, QC Manager, 615-773-9681

Kimberly Johnson, B.S., Protozoan Department Manager 615-773-9687

2.0 APPENDIX TABLE OF CONTENTS

3.0 SCOPE AND APPLICATION

This manual discusses specific QA requirements for EPA Methods 1622 and 1623 to ensure that analytical data generated from the protozoan laboratory are scientifically valid and are of acceptable quality. Any deviations from these requirements and any deviations that result in nonconforming work must be immediately evaluated and their corrective actions documented.

4.0 LABORATORY ORGANIZATION AND RESPONSIBILITIES

ESC Lab Sciences offers diverse environmental capabilities that enable the laboratory to provide the client with both routine and specialized services, field sampling and broad laboratory expertise. A brief outline of the organization and responsibilities as they apply to the ESC Quality Assurance Program is presented in Section 4.0 in the *ESC Quality Assurance Manual Version 8.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Kasey Stapler, with a B.S. degree in Biological Sciences, is the Principal Analyst for the Protozoan laboratory. Ms. Stapler is proficient in performing EPA Methods 1622 and 1623. She gained analytical experience from an accredited Protozoan laboratory and obtained additional training on microscopic techniques. Also, she frequently reviews EPA online training modules related to the methods being performed.

5.2 TRAINING

The certified analyst trains all new analysts to the Protozoan laboratory according to ESC protocol and EPA guidelines. ESC's training program is outlined in SOP #350405, *Training Protocol for Method 1622/1623.* Documentation of training received and authorizations to perform these analyses are maintained within the department.

6.0 FACILITIES AND LABORATORY SAFETY

6.1 FACILITIES

The main area of the laboratory is approximately 420 square feet and has roughly 67.5 square feet of bench area. The microscope dark room is located in the back of the laboratory is 36 square feet with 18 square feet of bench area. Additionally, there is 40 square feet of storage and fluorescent lighting throughout all areas. The air handling system is a five-ton Trane split unit with natural gas for heating. The laboratory reagent water is provided through the Siemans® deionizer system. Biohazard containers are located in the protozoan laboratory and Stericycle serves as ESC'S biological waste disposal contractor. ESC's building information guides and site plan are shown in Appendix I.

6.2 LABORATORY SAFETY

- Laboratory access is limited when work is being performed.
- All procedures where infectious aerosols or splashes may occur are conducted in biological safety II cabinets.
- The following Biosafety Level 2 (BSL2) guidelines are adhered to:
  - Closed-toe shoes are worn in the laboratory
  - Floors and work surfaces are cleaned on a regular basis
  - Emergency numbers are posted in the laboratory
  - Biological safety hoods are tested and certified annually
  - Laboratory personnel are trained in the use of the biological spill kit and emergency safety equipment
- ESC's laboratory safety guidelines are detailed in SOP #350408, *Biosafety Guidelines for the Cryptosporidium Laboratory*.

7.0 SAMPLING PROCEDURES

7.1 FIELD SAMPLING PROCEDURES, SAMPLE STORAGE, AND HANDLING

- A description of field sample collection, containers, storage, temperature, and transport times are located in SOP #350402, *Method 1622/1623 Field-Filtering Sample Collection and Laboratory Delivery* and SOP #350403, *Method 1622/1623 Bulk Sample Collection and Laboratory Delivery*.
- Laboratory sample identification, handling, tracking and the information recording system are found in the following procedures: SOP #350404, *Method 1622/1623 Sample Receiving* and SOP #060105, *Sample Receiving*.
- A Chain of Custody and LT2 Sample Collection Form accompanies all samples received by the lab. This is necessary to prove the traceability of the samples and to document the change in possession from sampling through receipt by the laboratory. Prior to analysis, all samples are checked for integrity.
- Following analysis, the slides are maintained for a minimum of 2 months and disposed of following all State and Federal regulations governing disposal.
- Requirements for sample acceptance is located in SOP #350404, Section 7.0, *Method 1622/1623 Sample Receiving*.

8.0 EQUIPMENT

Laboratory equipment specifications are outlined in SOP #350407, *Microscope Analyst Verification,* SOP #350410, *IEC CRU-500 Centrifuge Operation and Maintenance,* SOP #350411, *Lab-Line Multi-Wrist Shaker Operation and Maintenance* and SOP #350413, *Olympus BX40 Microscope Operation and Maintenance.*

8.1 EQUIPMENT LIST

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Protozoan		
Item	***Manufacturer***	***Model***
Flow control valve	Plast-o-matic	FC050B
Centrifugal pump	Jabsco	18610-0271
Graduated container	Nalgene	20 Liter Carboy
Laboratory shaker	Lab-Line	3587-4
Laboratory shaker side arms	Lab-Line	3589
1500 XG swinging bucket centrifuge	Damon/IEC Division	CRU-5000
Sample mixer/rotator	DYNAL	Cat#: 947.01
Magnetic Particle Concentrator	DYNAL	MPC-1
Magnetic Particle Concentrator	DYNAL	MPC-S
Magnetic Particle Concentrator	DYNAL	MPC-6
Flat-sided sample tubes	DYNAL	Cat#: 740.03
Epifluorescence/differential interference contrast microscope	Olympus	BX-40
Excitation/band pass microscope for fluorescein isothiocyanate (FTIC)	C-Squared	UN3100
Excitation/band pass filters for 4',6-diamidino-2-phenylindole (DAPI)	C-Squared	UN41001

8.2 EQUIPMENT PREVENTIVE MAINTENANCE, EQUIPMENT CALIBRATION

Calibration of equipment is conducted on an annual and/or semi-annual basis and is documented. Maintenance and cleaning is conducted on an as needed basis or per manufacturer's instructions. Equipment cleaning is specified in SOP #350412, *Cryptosporidium Laboratory Equipment Cleaning.*

8.3 STANDARDS AND REAGENTS

Table 8.3A: Stock solution sources, description and related information.
(subject to revision as needed)

Description	Vendor	Concentration	Storage Req.	Expiration
Sodium Hydroxide (NaOH)	Fisher	Concentrated	ambient	1 year
Hydrochloric Acid (HCl)	Fisher	Concentrated	ambient	1 year
Laureth-12	VWR	--	ambient	1 year
Tris Stock	Fisher	--	ambient	1 year
EDTA	Sigma	0.5 M, pH 8.0	1-10°C	1 year
Antifoam A	Sigma Chemical	--	ambient	1 year
Dynabeads® GC-Combo/Crypto	Dynal	--	0 ± 8°C	2 years
Direct labeling kit for det. of oocysts and cysts, Merifluor Cryptosporidium/Giardia	Meridian Diagnostics	--	0 ± 8°C	1 year
Phosphate Buffered Saline (PBS) Solution, pH 7.4	Sigma Chemical	--	ambient	1 year
4', 6-diamidino-2-phenylindole (DAPI) stain	Waterborne, Inc	2mg/mL	0 ± 8°C/Darkness	When positive control fails
Purified, live *Cryptosporidium* oocysts stock suspension	WSLH	--	0 ± 8°C	1 month
Purified, live *Giardia* cysts stock suspension	WSLH	--	0 ± 8°C	1 month

TABLE 8.3B: Working Solution Descriptions and Related Information.
(subject to change)

Solution	Concentrations	Storage Requirements	Expiration
Sodium Hydroxide (NaOH)	6.0 N	ambient	1 year
Sodium Hydroxide (NaOH)	1.0 N	ambient	1 year
Hydrochloric Acid (HCl)	6.0 N	ambient	1 year
Hydrochloric Acid (HCl)	1.0 N	ambient	1 year
Hydrochloric Acid (HCl)	0.1 N	ambient	1 year
Laureth-12 stock vials	10g/100mL	-10°C to –20°C	1 year
Tris Working Solution	1 M, pH 7.4	ambient	3 months
Elution Buffer	--	ambient	1 week
1X SL Buffer A Solution	--	0 ± 8°C	1 week
Staining 1X wash buffer	--	ambient	3 months
Phosphate Buffered Saline (PBS) Solution, pH 7.4	--	ambient	1 week
Working DAPI stain	10mL Stock/50ml Phosphate Buffer	Ambient/Dark container	1 day

9.0 LABORATORY PRACTICES

9.1 REAGENT GRADE WATER

ASTM Type I grade water: Siemans® supplies reagent grade water. Reagent water is analyzed for total chlorine, heterotrophic bacteria and specific conductance on a monthly basis. Reagent water is tested for metals: Lead, Cadmium, Chromium, Copper, Nickel, and Zinc on an annual basis.

9.2 GLASSWARE WASHING AND STERILIZATION PROCEDURES

Glassware washing and preparation/sterilization procedures are outlined in SOP #350414, *Steamscrubber Operation and Maintenance*, SOP #350408, *Biosafety Guidelines for Cryptosporidium Laboratory* and SOP #350412, *Cryptosporidium Laboratory Equipment Cleaning*.

Laboratory glassware and plastic ware are checked for acceptability prior to use. Glassware acceptance criteria are documented in SOP #350412, *Cryptosporidium Laboratory Equipment Cleaning*.

9.3 FILTER ACCEPTANCE

Each new lot of filters are checked for acceptability prior to use by performing method blanks (MB) and ongoing precision and recovery testing (OPR) on the lot.

10.0 ANALYTICAL PROCEDURES

10.1 A list of laboratory SOP's associated with the protozoan laboratory can be found in the following table:

TABLE 10.1: PROTOZOAN DEPARTMENT SOP'S

This Table is subject to revision without notice

SOP #	Title
350401	Isolation & Identification of *Giardia* and/or *Cryptosporidium* in Water
350402	Method 1622/1623 Field-Filtering Sample Collection and Laboratory
350403	Method 1622/1623 Bulk Sample Collection and Laboratory Delivery
350404	Method 1622/1623 Sample Receiving
350405	Training Protocol for Method 1622/1623
350406	Data Collection and Verification for Method 1622/1623
350407	Microscope Analyst Verification
350408	Biosafety Guidelines for *Cryptosporidium* Laboratory
350409	IPR, OPR and MS Spiking Procedures and Corrective Actions
350410	IEC CRU-5000 Centrifuge Operation and Maintenance
350411	Lab-Line Multi-Wrist Shaker Operation and Maintenance
350412	*Cryptosporidium* Laboratory Equipment Cleaning
350413	Olympus BX40 Microscope Operation and Maintenance
350414	Steamscrubber Dishwasher Operation and Maintenance

10.2 The following references are used for analytical procedures conducted in the laboratory:

- EPA. Method 1623: *Cryptosporidium* and *Giarda* in Water by Filtration/IMS/FA, December 2005.
- EPA. Method 1622: *Cryptosporidium* in Water by Filtration/IMS/FA, December 2005.
- EPA. Microbial Laboratory Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule. February 2006.

11.0 QUALITY CONTROL CHECKS

11.1 ESC participates in proficiency testing (PT) through the analysis of spiked vials received from Wisconsin State Laboratory of Hygiene (WSLH) and analyzed according to study instructions and the ESC SOP. When the analysis is completed, the results are reported to Computer Sciences Corporation (CSC). CSC issues the testing results as either a "pass" or "fail". If the laboratory fails a PT round, a follow-up test is performed in an attempt to meet the necessary requirements. If the follow-up test results in a second failure, the laboratory takes part in a re-training program offered by the EPA or another accredited laboratory.

11.2 An Ongoing Precision and Recovery sample (OPR) is analyzed once weekly or per 20 samples. The OPR is spiked with 100-500 cysts and/or oocysts from a spiking vial received from the WSLH. Recoveries from the OPR must fall within EPA approved QC limits: Oocyts = 22-100% and Cysts = 14-100%.

11.3 A Method Blank is also analyzed once weekly or per 20 samples. The Method Blank must be free of other test organisms and serves as a sterility control on the analytical system.

11.4 If either sample falls outside acceptance parameters, corrective action must be taken and the samples re-analyzed until the QC criteria are met. Client samples may only be analyzed following acceptable QC sample results. Quality control information is located in SOP #350409, *IPR (Initial Precision and Recovery), OPR (Ongoing Precision and Recovery) and MS (Matrix Spike sample), Spiking Procedures and Corrective Actions.*

11.5 Clients are required to send a duplicate sample early in their sampling schedule and then again for every 20 field samples collected. This duplicate is utilized in the laboratory as a Matrix Spike (MS). The MS is spiked in the same manner and with the same number of organisms as the OPR to determine the effects of the matrix on the analytical process.

11.6 Inter/intra-analyst precision is determined, at least monthly.

12.0 DATA REDUCTION, VALIDATION AND REPORTING

12.1 DATA REDUCTION

The analyst performs the data calculation functions and is responsible for the initial examination of the finished data. Data reduction steps applied to the raw data are outlined in SOP #350401, *Isolation and Identification of Cryptosporidium and/or Giardia in Water* and SOP #350406, *Data Collection and Verification for Method 1622/1623.*

12.2 VALIDATION

Guidelines for data validation are found in SOP #350406, *Data Collection and Verification for Method 1622/1623.* In general, data integrity involves reviewing all data entries and calculations for errors, reviewing all documentation to assure that sample information is correct, and that the tests have been performed appropriately and within the appropriate holding times. The secondary analyst reviews the quality of data based on the following guidelines:

- The appropriate SOP is followed
- Sample preparation is correct and complete
- Analytical results are correct and complete

12.3 REPORTING

Reporting procedures are documented in SOP #350406, *Data Collection and Verification for Method 1622/1623.* Depending on the needs of the client one or more of the following may be included: Case narrative, Chain of Custody, Internal Chain of Custody, Final Report, Raw Data, etc. When the package involves more than just QC forms, it must contain a Table of Contents and Pagination. When the package is complete, it must be reviewed first by the Primary Analyst followed by the Department Manager or second qualified analyst, and finally by the QC Department. The final review person signs that the information is complete and the package is ready for submission to the client. A copy of the final package must be kept on file.

13.0 CORRECTIVE ACTION

13.1 In the event that a nonconformance occurs in conjunction with the analytical batch, a corrective action response (CAR) must be completed. The cause of the event is stated on the form and the measures taken to correct the nonconformance clearly defined. The effectiveness of the corrective action must be assessed and noted. The CAR is kept on file by the QA Department. Corrective action procedures are documented in the SOP #350409, *IPR (Initial Precision and Recovery), OPR (Ongoing Precision and Recovery) and MS (Matrix Spike sample), Spiking Procedures.*

13.2 Required Corrective Action

13.2.1 If a spiked sample or set of samples fails to meet quality control limits

Rejection Criteria - Recoveries from the OPR fall beyond the approved QC limits: Oocyts = 22-100% and Cysts = 14-100%.

Corrective Action - Examine the spiking suspension organisms directly. To determine if the failure of the spike is due to changes in the microscope or problem with the antibody stain, re-examine the positive staining control, check Köhler illumination, and check the fluorescence and DAPI. To determine if the failure of the spike is attributable to the separation system, check the system performance by spiking a 10mL volume of reagent water with 100-500 cysts and/or oocysts and processing the sample through the IMS, staining and examination procedures. Recoveries should be greater than 70%. If the failure of the spike is attributable to the filtration/elution/concentration system, check the system performance by processing spiked reagent water according to the method and filter, stain and examine the sample concentrate. This process is performed until the cause of the failure is isolated and corrected. The sample then must be re-analyzed until acceptable results are achieved.

13.2.2 Method Blank contains positive organism when analyzed.

Rejection Criteria – The Method Blank must be free of test organisms and serves as a sterility control on the analytical system.

Corrective Action - Equipment used to process the sample may be cleaned and/or replaced. Reagents used to process the sample may be disposed of and new reagents purchased or prepared. New method blank is prepared and analyzed. This process is repeated until the method blank passes the acceptance criteria.

13.2.3 Inter/intra-analyst precision analyses are beyond ±10%.

Rejection Criteria – Results for inter and/or intra-analyst precision must be within 10% of original results.

Corrective Action - The differences are discussed between analysts until a consensus is found.

14.0 RECORD KEEPING

Record keeping is outlined in SOP #010103, *Document Control and Distribution*, SOP #030203, *Reagent Logs and Records* and SOP #030201, *Data Handling and Reporting*

15.0 QUALITY AUDITS

System and data quality audits are outlined in the ESC Quality Assurance Manual Version 8.0.

End Of Document

QUALITY ASSURANCE/QUALITY CONTROL

MANUAL

ENVIRONMENTAL HAZARDS SERVICES, L.L.C.
7469 Whitepine Road
Richmond, VA 23237
(804) 275-4788

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia has been in business since 1984. EHS is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples. Sample analysis includes the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and fungal spore/pollen grain count and identification of common genera.

In July 2007, EHS purchased BTS laboratories and moved the entire laboratory down to Richmond. BTS Laboratories is a mold, lead and drinking water testing laboratory. EHS is able to continue to offer these same services for BTS clients as well as EHS clients.

EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

In 1998 EHS was acquired by Foxboro Capitol Ltd. Under this ownership EHS is a part of the National Testing Laboratories Network. The other laboratories in this network are:

- National Testing Laboratories, Ltd. – A drinking water laboratory located in Ypsilanti, Michigan.
- Broward Testing Laboratory, Ltd. – A drinking water laboratory located in Ft. Lauderdale, Florida.

The corporate headquarters is in Cleveland, Ohio.

1.2 Objectives, Policies and Authority of EHS Quality Assurance/Quality Control (QA/QC) Operations Manual

The Quality Management System as detailed in the QA/QC Operations Manual is issued under the authority of the President of Foxboro Capitol, Ltd. The QA/QC Operations Manual consists of the QA/QC Manual and the SOPs. The QA/QC Manual documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work that meet customer requirements and are in compliance with ISO/IEC17025 and with NELAC standards.

EHS will continually improve the effectiveness of its QA/QC Operations

Manual and its management system through the use of the quality policy statement and objectives, management reviews, audit results, analysis of data, corrective and preventive actions. This QA/QC Operations Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies.

The QA/QC Operations Manual is to be adhered to explicitly, except in cases of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary. Any changes made to the QA/QC Operations Manual or departures from documented procedures must be approved in order to ensure the integrity of the management system is maintained. The QA/QC Operations Manual is maintained in the QA/QC Office. Additionally, in each department copies of the QA/QC Manual and the SOPs which relate to that department can be found.

1.3 Maintenance and Update Procedures of EHS QA/QC Manual

The Laboratory Director and Quality Manager review the QA/QC manual at least annually to ensure that the management system is meeting customer requirements as well as statutory and regulatory requirements. All revisions/reviews are documented at the end of the QA/QC Manual. Each revision is brought to the attention of the corresponding department and a review log is kept to insure that each individual has read and understood the revision. Obsolete documents are removed from the manual, marked as obsolete, and placed in secure locations to insure that laboratory personnel only use current documentation. It is available at all times to EHS personnel and others including accrediting agencies. All personnel must review the QA/QC Manual at least annually.

1.4 Maintenance of EHS SOPs (Standard Operating Procedures)

Laboratory SOPs are revised as needed by the Laboratory Director and Quality Manager. They are revised to reflect any changes in laboratory practices and/or any updates to the reference methods. All revisions are documented in the Revision log found at the end of the each SOP. Copies of the latest revisions for pertinent SOPs are located in each laboratory section Operations Manual. Laboratory SOPs are located with the QA/QC Manual in the QA/QC Operations Manual. Invalid and/or obsolete SOP's and documents are promptly removed from use, marked as obsolete, and archived to insure that the only documents or SOPs in use are current. The generation of any analytical data is based in strict accordance to the pertinent EHS SOP. All analytical SOPs are based on established reference methods. The SOPs may contain slight modifications to the reference method. Whenever a reference method is modified, this will be

acknowledged by placing an M after the method number. All SOPs which contain a modification from the reference method shall be validated for compliance.

1.5 Maintenance of EHS Instrumentation

All new equipment are calibrated and/or checked prior to be placed into use. Any equipment taken outside of the laboratory is calibrated prior to use upon its return to the laboratory. Preventive maintenance and repairs, minor or major, for instruments within each department is the responsibility of department heads. Daily calibration and periodic checks are required to ensure proper functioning of all equipment and checks are recorded on instrumentation logs for each piece of equipment. Each piece of equipment is referenced by its serial number or a unique equipment identifier in an Instrument Log book. Records of all maintenance and repairs are kept in the instrumentation log books. Any instrument that is found to be out of calibration or defective is placed out of service. The Laboratory Director is notified in the event instruments are out of calibration and are in need of service. All instrumental conditions which affect the analysis are controlled and documented.

1.6 Accreditation Logos

EHS uses the NVLAP, AIHA and NELAP logos only in advertising. The logo being used has been pre-approved by the appropriate accrediting body. EHS does not use any of their accreditating bodies logos in reports, letters or any other documents associated with the laboratory.

1.6.1 NVLAP

1.6.1.1 The NVLAP logo stands by itself and is not combined with any other logo, symbol or graphic

1.6.1.2 The ratio of height to width is 1 to 2.25.

1.6.1.3 The NVLAP logo is accompanied by the NVLAP Lab Code in an approved caption. The caption will appear below and in close proximity to the logo.

1.6.1.4 The logo and caption is of a size that allows the caption to be easily read. The size of the caption shall not exceed the size of the logo.

1.6.1.5 The logo shall appear in black, blue or other color approved by NVLAP, and may be filled or unfilled. If the logo is filled then the same color is used for the outline and the fill.

1.6.2 AIHA

1.6.2.1 EHS will only use the AIHA logos for testing within the laboratory's scope of accreditation.

1.6.2.2 EHS will only use the approved logo provided by AIHA to the laboratory.

1.6.3 NELAC

1.6.3.1 EHS will only use the NELAC logos for testing within the laboratory's scope of accreditation.

1.6.3.2 The NELAC logo is accompanied by the phrase "NELAP accredited" and the laboratory's accreditation number or other identifier with their accrediting authorities name.

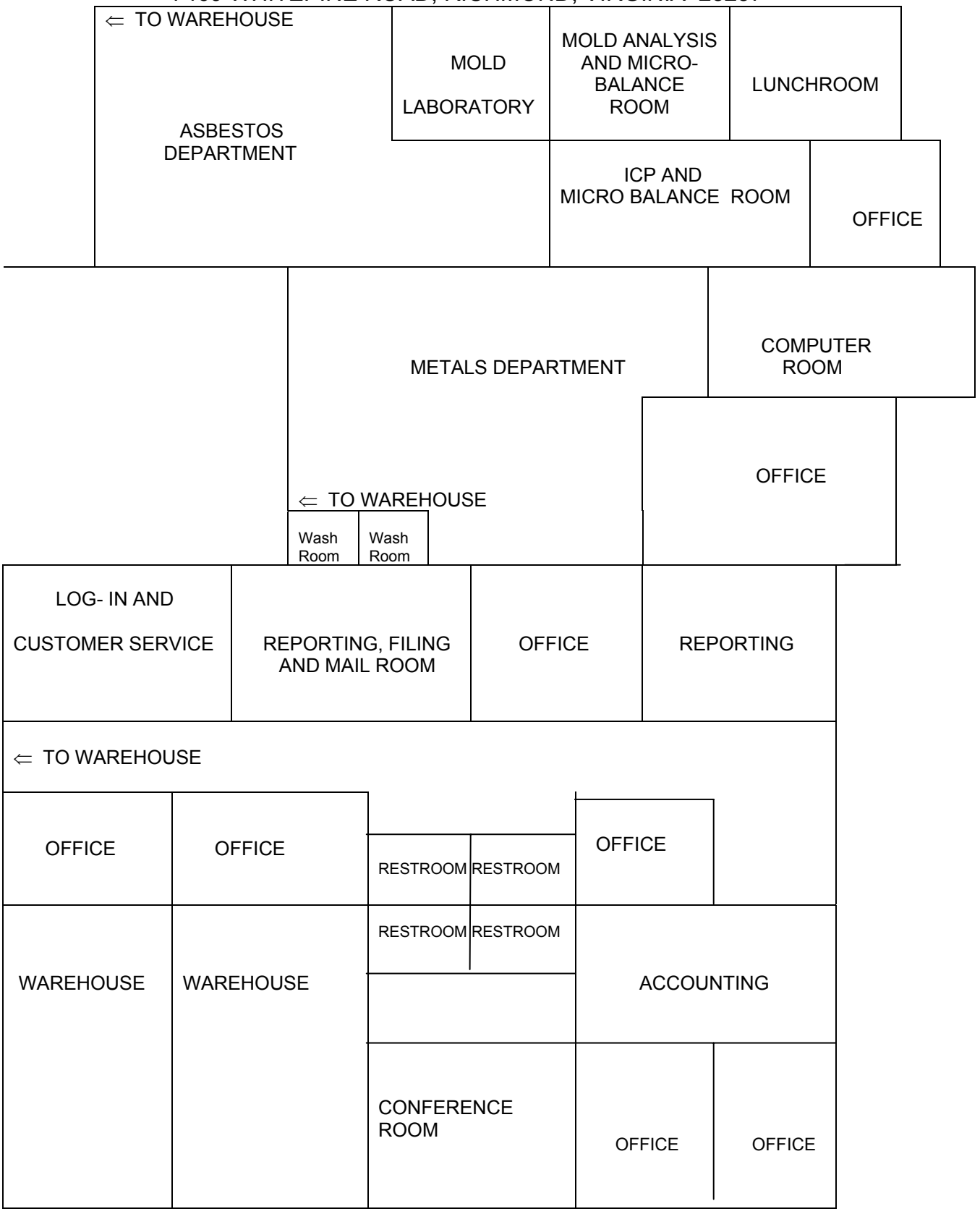
2. FACILITIES

2.1 Location

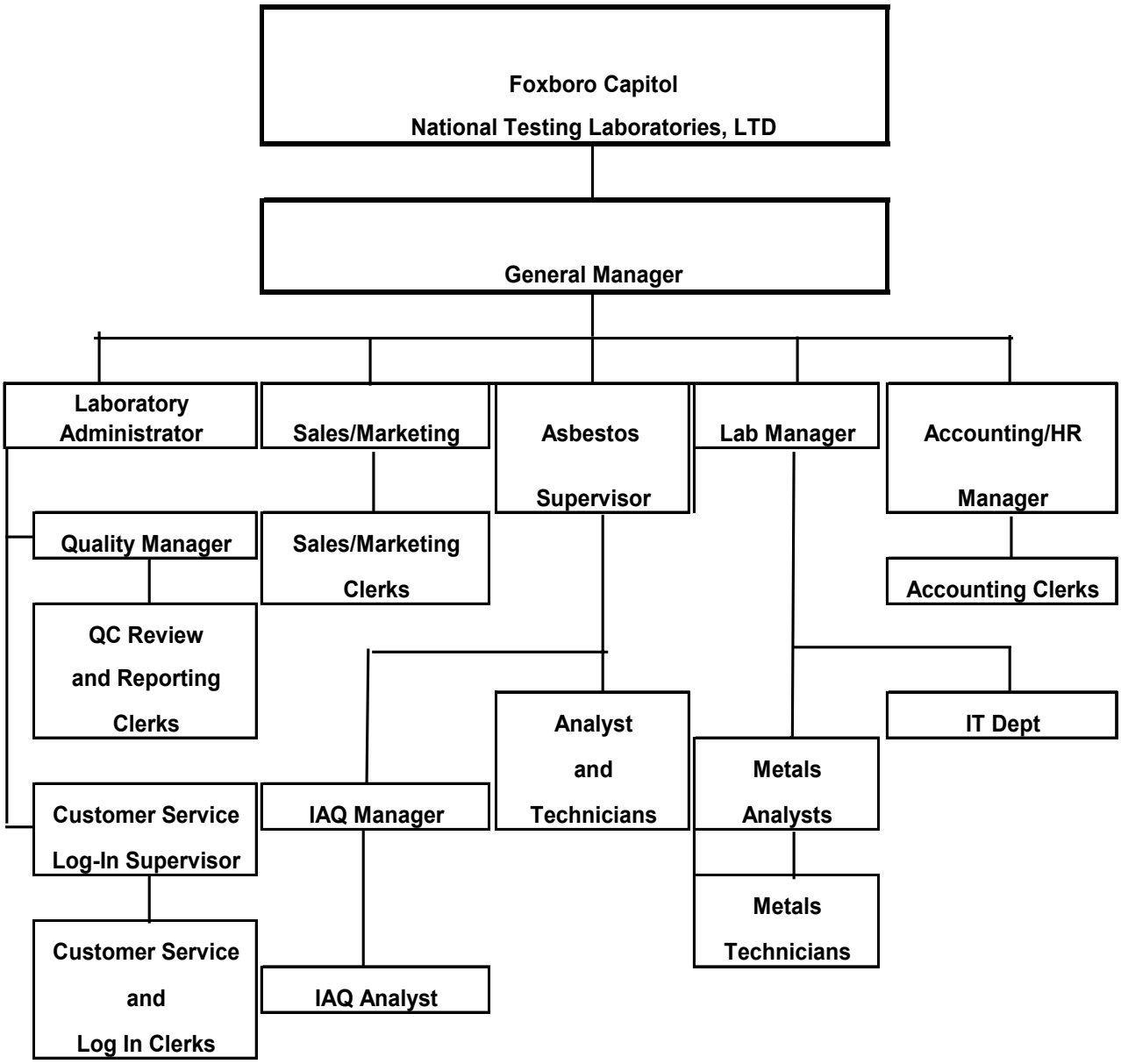
EHS is located at 7469 White Pine Road, Richmond, Virginia, 23237. All necessary utilities are available at this location for the safe and reliable operation of a fixed-site analytical testing laboratory. EHS has occupied its present location since December 1994. Facilities can be renovated or expanded as future needs dictate. Housekeeping duties are primarily the function of an independent cleaning agency as well as daily cleaning by laboratory and administrative personnel. All environmental conditions of the laboratory including microbial contamination that affect the analysis are controlled and documented. Every effort has been made to ensure the safety of EHS personnel and other occupants of the building. EHS occupies approximately 9000 square feet of total space. This includes 2000 square feet for office/administrative purposes, 4000 square feet for laboratory analysis and 3000 square feet for warehouse space.

2.2 Floor plan (See attached drawing.)

ENVIRONMENTAL HAZARDS SERVICES, LLC
7469 WHITEPINE ROAD, RICHMOND, VIRGINIA 23237



ENVIRONMENTAL HAZARDS SERVICES, LLC



3. PERSONNEL / ORGANIZATION / RESPONSIBILITIES / AND QUALIFICATIONS

3.1 President – (Foxboro Capital Ltd.)

The President has the ultimate responsibility for all aspects of every laboratory in the National Testing Laboratories Network.

3.2 General Manager

The General Manager reports directly to President and is responsible for all the day to day operations of Environmental Hazards Services, L.L.C.

3.3 Laboratory Manager (Technical Manager)

3.3.1 The Laboratory Manager's responsibilities include, but are not limited to:

- **a.** Review of all laboratory procedures
- **b.** Review of any change in laboratory procedure
- **c.** Employee training (Safety, new procedures, etc.)
- **d.** Review and approval of laboratory reports
- **e.** Review of all QA/QC activities
- **f.** Review of all laboratory manuals (Safety, QA/QC, Procedure)
- **g.** Insure all accreditations and licensing requirements are up-to-date
- **h.** Approval of new analysts prior to their reporting results for Clients
- **i.** Report opinions and interpretations of the test data when necessary. (This may only be done by the Laboratory Manager, Laboratory Administrator or the Quality Manager.)
- **j.** Any other Activity as needed

3.4 Laboratory Administrator

3.4.2 The Laboratory Administrator responsibilities include, but are not limited to:

- **a.** Log In of all samples received in the laboratory
- **b.** Reporting and Invoicing of laboratory reports
- **c.** All Customer Service activities
- **d.** Review and approval of laboratory reports
- **e.** Review of all QA/QC activities
- **f.** Insure all accreditations and licensing requirements are up-to-date
- **g.** Approval of new analysts prior to their reporting results for Clients
- **h.** Report opinions and interpretations of the test data when necessary. (This may only be done by the Laboratory Manager, Laboratory Administrator or the Quality Manager.)

i. Shipping of kits and supplies to customers

3.4.3 The Laboratory Administrator must meet at least the minimum of the following requirements:

a. B.A. or B.S. in Chemistry or a Physical Science
b. Five (5) years supervisory experience in a laboratory

3.4.4 In the event of the absence of the Laboratory Manager the Laboratory Administrator or the Quality Manager will accept the responsibilities of the Laboratory Manager.

3.5 Quality Manager

3.5.1 The Quality Manager's responsibilities include, but are not limited to:

a. An annual audit of the laboratory's QA/QC Program and review of the QA/QC Manual, with a report of findings to the Laboratory Director.
b. A quarterly review of the QA/QC Program, with a report to the Laboratory Director.
c. A monthly summary of QA/QC activities and performance, with a report to the Laboratory Director
d. Review and implementation of newly required method changes
e. Review and reporting of proficiency samples
f. Review and reporting of all round robin samples
g. Determination of intra-laboratory precision/accuracy
h. Deficiency corrections
i. Review and approval of laboratory reports
j. Report opinions and interpretations of the test data when necessary. (This may only be done by the Laboratory Manager, Laboratory Administrator or the Quality Manager.)

3.5.2 The Quality Manager must meet at least the minimum of the following requirements:

a. B.A. or B.S. in a Physical Science or Mathematics
b. Two (2) years laboratory experience
c. The IAQ Quality Manager must have 6 month microbiological experience and a formal QA/QC Microbiological course.
d. One (1) year experience implementing a QA/QC program and academic training in statistics

3.5.3 In the event of the absence of the Laboratory Manager or the Laboratory Administrator, the Quality Manager will accept the responsibilities of those duties.

3.6 IAQ Technical Manager

3.6.1 The IAQ Technical Manager's responsibilities include, but are not limited to:

a. Review of all IAQ laboratory procedures
b. Review of any change in IAQ laboratory procedure
c. Supervise IAQ Employee training (Safety, new procedures, etc.)
d. Review and approval of IAQ laboratory reports
e. Approval of new analysts prior to their reporting results for Clients
f. Any other activity as needed

3.6.2 The IAQ Technical Manager must meet at least the minimum of the following requirements:

a. B.S. in Microbiology with two (2) years of microbiological experience or.
b. Life Science Degree with two (2) years of microbiological experience with 20 semester hours in specific microbiological classwork, three (3) years experience with 16 semester hours, or four (4) years experience with 12 semester hours.

3.6.3 In the event of the absence of the Quality Manager, Laboratory Director, and the Laboratory Administrator the IAQ Technical Manager will accept full responsibility for all events within their department.

3.7 Asbestos Bulk (PLM) Analyst

3.7.1 The asbestos bulk analyst's responsibilities include, but are not limited to:

a. Analysis of bulk samples by Polarized Light Microscopy utilizing proper methodology
b. Following proper QA/QC methods as described within this manual

3.7.2 The asbestos bulk analyst must meet at least the minimum of the following requirements:

a. Training by the McCrone Institute "Microscopical Identification of Asbestos" or equivalent
b. Six months experience analyzing asbestos bulk samples
c. Exhibit initial competency at this type of analysis by the correct analysis of 50 reference samples. (See S.O.P. for Employee Training)
d. Exhibit continued competence annually with the

correct analysis of 50 reference samples.

3.8 Fiber Count (PCM) Analyst

3.8.1 The fiber count analyst's responsibilities include, but are not limited to:

- **a.** Analysis of air samples by Phase Contrast Microscopy utilizing the NIOSH 7400 Method.
- **b.** Following proper QA/QC methods as described within this manual.

3.8.2 The fiber count analyst must meet at least the minimum of the following requirements:

- **a.** NIOSH 582 (Sampling and Evaluating Airborne Asbestos Dust) course or equivalent training
- **b.** Exhibit competency at this type of analyst (See S.O.P. for Employee Training) with the analysis of 50 reference slides
- **c.** Exhibit continued competence by correctly analyzing at least 30 reference slides annually.

3.9 Fiber Count (PCM) Technician

3.9.1 The fiber count technician's responsibilities include, but are not limited to:

- **a.** Preparation of air samples
- **b.** Preparation of raw data worksheets using information provided by the client
- **c.** Following proper QA/QC methods as described in this manual

3.9.2 The fiber count technician must meet at least the minimum of the following requirements:

- **a.** Completion of the PCM Technician Training Checklist
- **b.** Exhibit competency (see S.O.P. for Employee Training) Technicians shall show their proficiency with the correct preparation of PCM samples under the supervision of a PCM analyst for a 3 month period.
- **c.** The technician will continue to demonstrate their proficiency by participating in an In-house training course annually which will be conducted by a PCM analyst to ensure that the technician is still performing in a proficient manner.

3.10 Metals Analyst

3.10.1 The metals analyst responsibilities include, but are not

limited to:

a. Maintenance of all equipment within the metals laboratory
b. Preparation/analysis of metals samples utilizing Atomic Absorption and ICP Emission Spectroscopy, and Mercury Cold Vapor Analysis
c. Follow proper QA/QC methods as described within the QA/QC Manual

3.10.2 The metals analyst must meet at least the minimum of following requirements:

a. B.A. or B.S. in chemistry or related science
b. One year relevant laboratory experience
c. Completed in-house training course which is indicated by the use of a checklist for each metals analysis method.
d. Exhibit competency (see S.O.P. for Employee Training)
- If less than three years experience, the analyst/technician must work under the direct supervision of the Laboratory Director or of an proficient analyst/chemist for a period of three months.
- Completion of 4 runs of 5 samples of lead certified reference material analysis for each matrix.
- The analyst must complete, every 6 months, 4 runs of 5 sets of lead certified reference material analyses for each matrix to continue to show proficiency.

e. Approval letter and date will be documented in the employee's file.

3.10.3 In the event of the absence of the Quality Manager, Laboratory Administrator and the Laboratory Director, the Metals Analyst(s) will accept full responsibility for all events within their department.

3.11 Metals Technician

3.11.1 A metals technician responsibilities include, but are not limited to:

a. Preparation of metals samples of varying media
b. Preparation of metals raw data worksheets using information provided by the client
c. Cleaning and maintenance of equipment within the metals laboratory

3.11.2 The metals technician must meet at least the minimum of the following requirements:

a. Completion of an In-house Training Program which indicated compliance through the use of checklist for each method.
b. Exhibited proficiency in all areas included on the Metals

Technician Training Checklists

c. Exhibit competency (see S.O.P. for Employee Training
- The technician must work under the direct supervision of an analyst for a period of three months.
- Preparation of 4 runs of 5 sets of lead certified reference material analyses for each matrix. This set of runs is to be performed every 6 months to show continued proficiency.

d. Approval letter and date will be documented in the employee's file.

3.12 IAQ Analyst

3.12.1 An IAQ Analyst responsibilities include, but are not limited to:

a. Maintenance of all equipment related to their analytical Assignments

b. Preparation and analysis of IAQ samples

c. Follow proper QA/QC methods as described within the QA/QC Manual

3.12.2 The IAQ analyst must meet at least the minimum of the following requirements:

a. B.A. or B.S. in microbiology, biology or a related life science

b. One year relevant IAQ experience

c. Completion of an In-house Training Program which indicates proficiency using a checklist for each method. Training covers an introduction to Fungi, with their structures and processes. Understanding the characteristics of the different divisions. Identification of spore types, with the ability to sketch the genera. Capability with sampling methodology, preparation, counting methods, detection limits and theory involved with analysis. (See S.O.P. for Employee Training)

d. Exhibit competency by the analysis of samples, counting slides, and reading spore reference samples.

e. Exhibit continued competency by the analysis of a minimum of 30 reference samples annually.

f. Analysts that have shown their proficiency but are not continually analyzing samples, must also complete one reference slide per week to demonstrate their continued proficiency.

3.12.3 In the event of the absence of the IAQ Laboratory Director, Laboratory Administrator and the Quality Manager, the IAQ Analyst will accept full responsibility for all events within their department.

3.13 IAQ Technician

3.13.1 The IAQ technician's responsibilities include but are not limited to:

a. Preparation of IAQ samples for analysis
b. Preparation of raw data worksheets using information supplied by the client.
c. Cleaning and maintenance of equipment within the IAQ Laboratory
d. Other duties as necessary

3.13.2 The IAQ technician must meet at least the minimum of the following requirements:

a. Completion of an IAQ course either outside of the laboratory or an In-house training course using a checklist for each method.

(See S.O.P. for Employee Training)

b. Checklist covers an introduction to Fungi, with their structures and processes. Understanding the characteristics of the different divisions. Compliance with sampling methodology and preparation.
c. Exhibited competency in necessary areas of the IAQ technician course.
d. Three (3) months IAQ experience

4. COC/SAMPLE RECEIVING / HANDLING / DOCUMENT CONTROL

4.1 Chain-of-Custody and Sample Receiving

Samples are received at EHS by US Mail, courier, or hand delivery. For specific information, see the SOP. for Log-in Procedures. EHS does not perform any sample collection, but if a client calls and request instructions see the SOP for Sample Collection.

4.1.1 Chain-of-Custody (COC) forms are supplied by EHS or clients may choose to utilize their own internal COC forms.

4.1.1.1 EHS recommends the following minimum information be provided on COC forms:

a. Project Name
b. Name and Signature of collection personnel
c. Sample identifiers
d. Date and time of collection
e. Grab or Composite designation
f. Signatures of persons involved in sample transfer
g. Date and time of sample transfers

h. Analysis requested
i. Sample condition is noted on the COC

4.1.2 At the time of sample receipt, all initial information requested by the COC is completed by the employee performing sample log-in duties. The date and time sample was received is noted on the COC, with the signature or initials of the receiver. The condition of the sample is noted in Wavefront as the samples are received into the LIMS system. Samples deemed unacceptable are marked unacceptable in Wavefront. The client is called about the samples and a note is placed in Goldmine. The samples are then placed in the hold bin. The samples are held for 90 days and then discarded unless the client authorizes analysis in written form or request that the samples be sent back to the client.

4.1.3 During receipt, samples are individually checked for leaks or contamination (i.e., samples opened in transport) and that information provided on COC matches samples (i.e., correct number of samples, correct analysis requested, correct sampling containers and/or correct sampling media, sample number on containers matches sample number on COC form, etc.). Any inconsistencies, leaks (leaking multiphasic samples cannot be considered representative), or contamination may be cause for sample rejection.

4.1.3.1 Temperature-, time-, and preservative-sensitive samples are additionally examined at this time for:

a. Temperature - temperature of the sample cooler is recorded on the COC.
b. Sample holding times - if the allowed sample holding time will expire before the analysis can be completed, the client is notified immediately. (Holding times can be found in the table 4.1.3.3)
c. Preservatives - the presence or absence of preservative information is recorded on the COC. The addition of any necessary preservatives occurs in the metals laboratory. (See table 4.1.3.3 for preservative information)

4.1.3.2 Containers

EHS does not provide any containers to clients for sampling except for centrifuge tubes and pre-weighed cassettes. EHS recommends the use of glass or plastic containers. In the event of the incorrect sampling, the samples are held and the client is notified of the problem.

Table for containers, preservation techniques,
and holding times for aqueous and solid matrices:

Sample	Container	Preservative	Holding Time
Metals			
Total (except mercury and Chromium VI)			
Aqueous	P, G *	HNO3 to pH<2	6 months
Solid	P, G *	None	6 months
Mercury			
Aqueous	P, G *	HNO3 to pH<2	28 days
Solid	P, G *	None	28 days store at 4 ± 2°C
ChromiumVI	EHS does not analyze for this metal.		
	* P – Plastic, G – Glass		

4.1.3.3 Sample Shipping and Handling

No special protocol for transport is necessary for all samples at EHS except for culturable IAQ samples. Regular mail and shipping times are acceptable. The only requirement is that samples be well sealed in order to control the homogeneity of the sample, to insure that no cross-contamination occurs and that no sample loss transpires during shipping.

All culturable IAQ samples must be shipped in an insulated container, protected from moisture, and refrigerated with an ice pack. Samples must be received within 24 hours of collection. The laboratory holds culturable samples that do not meet these requirements and the client is notified of the non-conformance. The samples are held in the refrigerated Hold Bin until the client notifies EHS of their needs. If the client instructs EHS to analyze the samples a disclaimer is placed on the report stating that due to the fact that the samples were not received in the proper manner the results may be affected.

4.1.4 Documentation of Acceptability

Upon examination of the samples, if the samples are found unacceptable due to lack of paperwork and/or incorrect COC or

other problems, the samples are received into the lab but marked unacceptable in LIMS. The samples are then placed on Hold and the client is notified. The samples are held until the problems are corrected or the client request disposal of the samples. Notes are put in Goldmine as to the reason they are on hold. The following statement shall be included on every final report. "The condition of the samples analyzed was acceptable upon receipt per laboratory protocol unless otherwise noted on this report."

4.1.4.1 If any samples are determined to be unacceptable and analysis is performed a notation must appear on the report with an appropriate explanation.

4.1.4.2 If problems are found with the sample or part of a group of samples, then the samples are unacceptable and a note is placed in Goldmine. Examples of problem samples would be missing samples, no COC, insufficient sample amount, composite wipes, non- refrigerated culturable IAQ sample, etc. If samples are missing from a group of samples the client is called and notified of the problem and the samples are sent to the lab for analysis. In the case of composite wipes, EHS has a written policy which is faxed to the client. For California samples sampling location, date and time must be noted on the COC; if not client must be notified and either the missing information is given by the client and recorded on the COC or the client must give approval for the samples to be analyzed even though sampling information is incomplete.

4.1.4.3 The problem sample or the problem part of a group of samples are held in a special bin until the client can be reached and the problem resolved. The client is made aware of the problems with the sample by a phone call and/or a fax. If after a three month period, the client has not contacted EHS with a remedy for the problem samples, the samples are disposed of in an appropriate manner.

4.2 Sample Receipt and Log-in

4.2.1 Samples are received into a Laboratory Information Management System (LIMS) and a job number is assigned. A label is printed with the job number and the due date. This job numbered is added to each individual sample when they are numbered. The sample receipt should include the following:

a. Customer Name and Number
b. Date received
c. Project/Test Address
d. Turn Around Time
e. Shipping Type

4.2.2 After samples are received they are logged into the LIMS system. The Log In information may consists of the following:

a. Customer Sample ID
b. Collection location
c. Surface type
d. Area dimensions
e. Air volumes or start and end times with flow rates

4.3 Sample Handling

4.3.1 Samples are then moved to sample preparation/analysis areas. Samples are placed in holding bins in each appropriate laboratory area until prep/analysis is conducted.

4.3.2

4.3.2.1 IAQ samples requiring refrigeration are placed in the appropriate refrigerated sample holding area. Daily checks of the refrigerator temperature are kept in the refrigerator temperature log. The acceptable temperature for the refrigerator is 4 $\pm$ 2°C.

4.3.1.1 Samples requiring preservation are preserved as shown in Table 4.1.3.3 on the previous page.

4.3.2 Sample Numbers are assigned by the LIMS number plus an additional number. This number always begins with one and increases by increments of one throughout the job. Sample numbers are assigned by personal within the specific departments. (Example the 1st sample for LIMS number 09-09-00123 is labeled 09-09-00123-1)

4.3.3 Prior to analysis of samples for metals a calibration curve is establish for with the use at least three calibration standards for FAA and two calibration standards for ICP. The calibration curves are checked with the use of a reporting limit verification standard and with a calibration check sample. As sample analysis is conducted, a batch number is assigned to each separate analysis. For example, the first analysis of wipe samples on June 3, 2010, will have a batch number of 060310W. The 06 stands for June, 03 the day of the month, 10 stands for the year and W refers to wipes. Soil samples would be shown by an S, Paints by a P, Airs by an A, and so on. If another group of wipes are run later on that same day the W would be followed by a one (1) to differentiate it from the 1st analysis run (060310W1).

4.3.4 The analyst records the batch number on the QC sheets for each run as well as on the raw data work sheets of each metals sample.

4.3.5 Batch numbers, which are based by date, can be traced to the standards purchased by referencing the Standards Preparation Log Book which list the purchased certified standards used to prepare the standards and the dates prepared.

4.3.6 Samples are maintained on-site for at least thirty days after analysis in dated containers. They are then either disposed of in accordance with all regulations or returned to the client. EHS contracts with a local contractor for hazardous waste disposal.

4.3.6.1 Lead paint, soil and TCLP samples are combined and a TCLP sample is collected and analyzed. If this sample is below regulatory limits, the waste is disposed of as normal waste. If the result is above a regulatory limit, the waste is disposed of in accordance with regulation as a hazardous waste.

4.3.6.2 All viable IAQ samples will be autoclaved at 121^{o}C/15 PSI for 30 minutes with a fast exhaust before disposal. Once samples have been autoclaved they may be disposed of with the normal laboratory waste.

4.4 Reviews

4.4.1 All raw data work sheets from the Asbestos, Metals, and IAQ departments are checked by the analyst and double-checked by a second analyst and/or qualified reviewer for completeness and accuracy prior to submission to administration for reporting. Any errors are marked with a single line, initialed and dated. Once checked, approval will be noted at the bottom of each worksheet by the initials of the reviewers in the appropriate blanks:

Checked By: _____ or Reviewed by: _____

This notation signifies that the worksheet has been checked and all data and calculations are correct.

4.4.2 QA/QC samples are completed and reviewed by the Quality Manager or Laboratory Administrator prior to reporting of results to clients. (See individual analyte S.O.P. for QA/QC Requirements.)

4.5 Data Reporting

Reports are reviewed by a trained reviewer for completeness and, after approval by the appropriate signatory or designate, released to the client. All reports whether electronic or paper are controlled and monitored to insure client confidentiality. For EHS clients a copy of the chain-of-custody and any raw data are kept in files by numerical report number. These files are kept in file cabinets for a minimum of two months, for easy response to

possible client questions. Every two to three months files are archived in the warehouse. Files are maintained for a minimum of five (5) years.

The Authorized Signatories are chosen by their training, education and/or technical experience. Each signatory is competent to review and sign off on the report that corresponds to their knowledge and training.

4.6 Client Confidentiality, Conflict of Interest and Ethical Responsibilities

All information supplied by the client shall remain confidential. All employees are given an employee handbook, which states that absolutely no COC information or client results will be released to third parties without written permission from the client. Employees are prohibited from engaging in any activities, which conflict with the interest of the Company, or its customers. Employees are trained in the ethical and legal responsibilities of the laboratory and that the potential punishment and penalties for improper, unethical or illegal actions can range from the termination of employment to the taking of legal action against said employee. Further information can be found in the employee handbook and a statement of the employee's knowledge of the information within the handbook is signed and dated by said employee. This signed statement is kept within the employee's personal file.

Employees only perform duties within the areas of their competence and quality analysis is paramount and never sacrificed to meet a turn around time. Clients are aware that our turn around time is a good faith estimate and EHS is not liable for delays in turn around time. Clients understand that we do not charge any additional fees for rush or Saturday analysis in exchange for the understanding that on occasion delays may occur due to excess sample receipt, instrument downtime, and any other problems. In the event of the before mentioned occurrences every attempt is made to communicate with the clients and prioritize samples based on client need.

Employees are made aware of these policies to ensure that there is no undue pressure or influences that may adversely affect the quality of work. In the event an employee feels undue pressure or stress which many adversely affect the quality of their work they are instructed to contact their supervisor or the quality assurance coordinator.

4.7 Corrective/Preventative Actions Policies

4.7.1 Corrective Action Policies

EHS, in compliance with ISO/IEC 17025 requirements, has established a program to take corrective action whenever quality control data are outside acceptance limits or any other nonconforming event has occurred. The Quality Manager has been designated to be the focal point of all corrective actions. Once a

corrective action has been initiated the form is given to the Quality Manager who distributes the form to those involved with the nonconformance. Procedures have been established that show the process involved in identifying the non-conformance, documenting the root cause analysis, tracking the correction process determined by the analysis and reviewing the process in order to insure that the corrective actions are effective. (See SOP F-6, SOP for Corrective/Preventive Actions)

4.7.2 Preventive Action Policies

EHS has implemented a Preventive Action Plan to reduce the potential of nonconformance. Through the use of internal audits, management review and input from laboratory personnel potential sources of nonconformance and necessary areas of improvement will be identified. (See SOP F-6, SOP for Corrective/Preventive Actions)

4.8 Sampling Materials and Procedures

Environmental Hazards Services L.L.C. has made a commitment not to be in the business of sample collection, in order to not compete with our clients. A brief discussion of sampling materials, containers, preservatives, shipping requirements and procedures for each test method offered by EHS is provided upon client request. This can be found in the SOP A-2. If samples are received which are determined to deviate from the correct sampling requirements, the sample is placed on hold until the client can be notified of the problems. Samples deemed unacceptable are held in a hold bin, clients are contacted to inform them of the problem and the samples are held for 90 days and are then discarded unless the client authorizes analysis in written form or request that samples be sent back.

4.9 Procurement

All suppliers of critical consumables, supplies and services that may affect the quality of testing must be evaluated to assure they meet the requirements of EHS. This evaluation procedure can be found in SOP F-7, The Evaluation and Use of Outside Vendors.

5. QUALITY ASSURANCE / QUALITY CONTROL

5.1 Internal Quality Control (QC)

5.1.1 Asbestos Bulk Samples

5.1.1.1 Intra-Laboratory Asbestos Bulk Sample QC

At least ten percent (10%) of all asbestos bulk samples analyzed at EHS are reanalyzed as part of a daily QC

Program. The reanalysis are performed “blind” (the QC analyst is unaware of the initial result) and must be 5% duplicate and 5% replicate analysis (by the original analyst or a different analyst, respectively).

5.1.1.2 Reference Bulk Asbestos QC

Each analyst will analyze at least one Reference Samples (past NVLAP proficiency samples, NIST-traceable reference materials, samples verified by other methods (TEM), etc.) daily. The Quality Manager verifies all reference sample results for accuracy. This functions as a measure of accuracy and ensures continued precision of the individual analyst.

5.1.1.3 Record keeping

All documents regarding internal QC of Asbestos bulk samples are maintained in a weekly QC file. Summaries for individual analysts are compiled and overall precision and accuracy are determined.

5.1.1.4 See S.O.P. for Bulk Asbestos QA/QC Program for additional information.

5.1.2 Airborne Fiber Counts

5.1.2.1 Intra-Laboratory QC

At least ten percent (10%) of all samples analyzed at EHS are reanalyzed as part of a daily QC program. The reanalysis are performed “blind” (the QC analyst is unaware of the initial result) and may be a duplicate or replicate analysis (by the original analyst or a different analyst, respectively).

5.1.2.2 Reference Fiber Count QC

EHS maintains a bank of air reference samples generated by regulatory programs (PAT, etc.) and other laboratories. At least one of these reference samples are analyzed by each EHS analyst daily. The Quality Manager verifies all reference sample results for accuracy. This functions as a measure of accuracy and ensures continued precision of the individual analyst.

5.1.2.3 Record keeping

All documents regarding internal QC of Airborne Fiber Counts are maintained in a weekly QC file. Summaries for individual

analysts are compiled and overall precision and accuracy are determined.

5.1.2.4 See S.O.P. for Airborne Fiber Count QA/QC Program for additional information.

5.1.3 Metals/Inorganics

5.1.3.1 Intra-Laboratory QC

EHS ensures accuracy and precision of metals analysis through the use of calibration verifications, internal blind samples, laboratory control samples, spiked matrix and blank samples, duplicate analyses, and the comparison of the generated QC data with specific information regarding individual QC procedures. Quality Control data is analyzed and, when found to be outside acceptance criteria, action is taken to correct the problem and to prevent incorrect results from being reported to the client.

5.1.3.2 See S.O.P for Metals QA/QC for additional information.

5.1.3.3 Record keeping

All documents regarding internal QC of metals analysis are maintained in a weekly QC file for lead samples and a quarterly QC file for multi-metal analysis. Summaries for individual analysts are compiled and overall precision and accuracy are determined.

5.1.4 IAQ

5.1.4.1 Laboratory QC

At least ten percent (10%) of all samples analyzed at EHS are reanalyzed as part of a daily QC program. The reanalysis are performed “blind” (the QC analyst is unaware of the initial result) and 5% is a intra analysis (same analyst) and 5% is the inter analysis (different analyst).

5.1.4.2 Reference IAQ QC

EHS maintains a library of air reference slides generated from round robin samples and in-house samples. At least one of these reference samples is analyzed by each EHS analyst each day before analyzing samples. All reference sample results are verified for accuracy by the Quality Manager.

5.1.4.3 See S.O.P for Indoor Air Quality Analysis for additional information.

5.1.4.4 Recordkeeping

All documents regarding internal QC of IAQ samples are maintained in a monthly QC file.

5.2 Inter-Laboratory QC

Although EHS is a participant in several proficiency programs and is accredited by several accrediting agencies, it does not use the logos of these agencies in any aspect of its operations except for its web site and ads.

5.2.1 Round Robin

EHS participates in Round Robin sample exchanges for PLM, PCM and sporetrap analysis on a semi-annual basis with at least two other laboratories. Records of all round robin activities are maintained in files specific to each analysis. The Round Robin program functions as an on-going external QC measure of samples received on a regular basis.

5.2.1.1 Asbestos Bulk Samples

EHS participates semi-annually in sample exchanges with other accredited laboratories. Sample exchanges are analyzed by the initial laboratory prior to being circulated to other laboratories in the program. Responsibility for issuing samples and summarizing results rotates between participating laboratories.

5.2.1.2 Airborne Fiber Counts

EHS participates semi-annually in sample exchanges with other accredited laboratories. Samples exchanged are analyzed by the initial laboratory prior to being circulated to other laboratories in the program. Responsibility for issuing samples and summarizing results rotates between participating laboratories.

5.2.1.3 Sporetrap Counts

EHS participates semi-annually in sample exchanges with other accredited laboratories. Samples exchanged are analyzed by the initial laboratory prior to being circulated to other laboratories in the program. Responsibility for issuing samples and summarizing results rotates between participating laboratories.

5.2.2 Proficiency

EHS is a participant in the following External Proficiency Programs:

5.2.2.1 Airborne Fiber Counts

- NIOSH/AIHA Proficiency Analytical Testing Program (PAT), Quarterly
- New York PCM Proficiency – Semi-Annually

5.2.2.2 Asbestos Bulk Samples

- National Voluntary Laboratory Accreditation Program (NVLAP), Semi-annually
- New York PLM Proficiency – Semi-Annually

5.2.2.3 Metals

- NIOSH/AIHA PAT Program, 3 Metals, Quarterly
- AIHA Environmental Lead Proficiency Testing Program (ELPAT),
- Lead samples in paint, soil, wipes, Quarterly
- AIHA Beryllium Proficiency (BEPAT) – Be in air, Tri-Annually
- ERA Multi-Metals Proficiency – Semi-Annually (California & South Carolina)
- New York Multi-Metals Proficiency – Semi-Annually

5.2.2.4 IAQ

- AIHA EMPAT Program, Bacterial and Fungal Identification, Tri-Quarterly

5.2.3 All materials pertinent to EHS participation in proficiency testing are maintained for future reference and training purposes. All records are maintained in specific files.

5.3 Control of Non-Conformances

Conformance to all aspects of EHS procedures and policies is essential to the successful implementation of our Quality System. The Laboratory Director, Laboratory Administrator, and/or Quality Manager, irrespective of their other responsibilities, have the authority to implement, maintain and improve the management system. They are also able to identify any departures from the management system and initiate actions to prevent or minimize such departures.

The Laboratory Director, Laboratory Administrator, and/or Quality Manager, irrespective of their other responsibilities, also have the authority to implement, maintain and improve all testing and calibration procedures. They are able to identify any departures from these procedures and initiate

actions to prevent or minimize such departures.

The following procedures must be followed if any aspect of management, testing or the results of the testing do not conform to EHS procedures or the agreed requirements of the client.

Quality Control data is analyzed and, when found to be outside acceptance criteria, action is taken to correct the problem and to prevent incorrect results from being reported to the client. Any departures (accidental or otherwise) from established EHS procedure trigger an immediate stop work action and withholding of test reports.

5.3.1 The Quality Manager, Laboratory Administrator or the Laboratory Director must be notified as soon as a nonconforming work has been noted and are responsible for examining the incident. A thorough investigation of all the possible causes for the non-conformance must be conducted.

5.3.2 Potential causes and consequences of the non-conformance are explored. The causes could include sample collection, client requirements, methods and procedures, standards and reagents, equipment and calibrations. The consequences range from improper analysis to faulty results.

5.3.3 Once the investigation is concluded all necessary corrective actions are taken to ensure that the problem has been corrected and controls must be put in effect to guarantee that the problem can be prevented from reoccurring.

5.3.4 A solution to bring any non-conforming aspect back into conformance must be reached and monitored before work can resume. Any samples affected during the period of non-conformance shall be re-analyzed if possible. If for whatever reason, a sample cannot be reanalyzed (ex. No additional sample available), then an explanation written by either the Quality Manager, Laboratory Administrator or Laboratory Director will be added to the final report. The client is notified of the non-conformance if necessary.

5.3.5 After any nonconformance incident, work may not resume until all log book entries are complete and approval by the Quality Manager, Laboratory Administrator or Laboratory Director is documented.

5.3.6 All departures shall be documented in the Nonconformance Log Book and on the worksheet of any affected samples.

The log book entry at a minimum shall include:

a. Date
b. Type of analysis
c. Analyst/Technician involved
d. An explanation of departure
e. Time of work stoppage
f. ID Numbers of samples affected and a note to distinguish if samples were reanalyzed or released with explanation of non-conformance on report
g. Results of cause analysis
h. Corrective action taken
i. Return to work approval signed by the Quality Manager or Laboratory Director
j. Date & Time of return to work approval
k. Notation which will appear on final reports, if applicable

5.4 Audits/Reviews/Inspections

5.4.1 Quarterly Review

Each quarter a review of laboratory procedures, practices will be performed. The purpose of this audit is to identify and evaluate trends and ensure that key elements of the quality plan are up to date.

This audit review will be completed during the first month of each quarter. The Quality Manager is responsible for ensuring this review is completed.

The Quality Manager will use a laboratory review checklist specific to each laboratory and will review the following during the audit:

a. On-Site Assessments by outside agencies
b. Previous internal audits
c. Proficiency testing results
d. Nonconformities
e. Review of Corrective/Preventive actions and follow-ups procedures

Once the quarterly review is finished a copy of the audit is given to the corresponding laboratory supervisor with a date by which the deficiencies must be corrected. Documentation of the corrective actions showing the type of correction, by whom and when the correction was performed or will be finalized will be signed by the Quality Manager and filed in the respective laboratory binder. Each quarterly review is also submitted to the management review team as a part of the Annual Management Audit (see 5.4.1.4). Any deficiencies found by a quarterly review must be addressed immediately. The next quarterly review will detail all corrective actions arising from any prior quarterly, management and internal

reviews. If it is found that deficiencies may have affected sample results, those clients involved will be immediately notified in writing.

5.4.2 Internal QA Audit

The purpose of the Internal QA Audit is to (1) determine if the quality system contains all the policies and procedures required under ISO 17025 and the accreditations held by the laboratory and (2) determine that those policies and procedures are being followed. This audit will be performed by the Quality Manager and reviewed and by the General Manager. This audit will be performed and completed by end of the 2nd quarter of the year. All deficiencies found by this audit will be addressed and corrections documented showing the type of correction, by whom and when the correction was performed or will be finalized will be signed by the Quality Manager and filed in the respective laboratory binder

The Internal QA Audit will include but is not limited to the following:

a. Analysis of Quarterly Reviews
b. Detailed review of AIHA Assessor Checklist
c. Detailed review of NVLAP Assessor Checklist
d. Detailed review of any state Assessor Checklist
e. A narrative summary of findings
f. Deficiencies, corrective/preventive actions and responses
g. Recommendations for improvement

5.4.3 Annual Management Audit

An annual audit is performed by the Laboratory Management Review Team. The purpose of this audit is to examine the entire laboratory management system and testing activities to ensure their continuing suitability and effectiveness and to introduce necessary changes or improvements. The Laboratory Management Review Team will include at a minimum; the General Manager, Laboratory Administrator, Laboratory Director, Quality Manager, and all section supervisors.

The Annual Management Audit will be accomplished through a series of meetings of the Management Review Team. The first meeting will take place during the first quarter of the year. At the first meeting, each team member will be assigned different segments of the review, which they will be required to perform and report their findings to the entire team. A time frame to complete the assigned tasks will also be determined at that meeting. Subsequent meetings will consist of presentations by the individual members, and questions and discussions by the team. These meetings will continue until all review categories have been fully addressed. This

audit shall be completed by the end of the second quarter.

The key areas to be reviewed are:

- **a.** Suitability of policies and procedures in Quality Manual
- **b.** Review of the overall objectives found in Quality Manual
- **c.** Previous Annual Management Audit
- **d.** Previous Internal QA Audit reports
- **e.** Previous Quarterly Audit reports
- **f.** Corrective/Preventive actions
- **g.** Onsite assessments by external bodies
- **h.** Status of Accreditations
- **i.** Proficiency testing programs and results
- **j.** Changes in the volume and type of work
- **k.** Customer feedback and complaints
- **l.** Quality Control activities
- **m.** Personnel resources and training
- **h.** Recommendations for Improvement
- **n.** One Year Plan
- **o.** General Status

Findings from the management review and the actions that arise from them shall be documented. Documentation will include what is to be done, by whom and by when it will be completed. Management shall ensure that those actions are carried out within an appropriate and agreed timeframe. Progress and follow-up of these actions will be reported in the quarterly QA reports.

5.4.4 Client Services Calls

Every day clients are asked on the service which is provided. The feedback from clients is analyzed and used to improve the management system, testing services and customer service. Customer calls are documented by notes on Goldmine, a computer customer base program. If a client has a significant complaint, a Corrective/Preventive Action form will be generated by Customer Service and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. The Accounting, Customer Service and Marketing Departments review Goldmine customer notes. Goldmine notes are reviewed in the Yearly Management Audit to assess customer feedback.

5.4.5 External Audits/Reviews/Inspections

EHS is occasionally audited, reviewed, or inspected by all accrediting agencies under which it performs analyses.

5.5 Review Of New Methods / Approval Of New Work

5.5.1 The Laboratory Director, Quality Manager, and any key technical personnel prior to approval for use must review all prospective new work, new methodologies or new analytical processes. (See SOP F-13; S.O.P. of Requests, Tenders, and Contracts) This review includes, but is not limited to:

a) Reagents (Are the required chemicals on-hand or readily available?)
b) Instrumentation (Are the required instruments on hand and fully operational?)
c) Personnel (Does the lab have trained, experienced personnel capable of performing the method without direct supervision?)
d) SOP development (Has the required SOP been developed and approved?)
e) Development of Instrument Detection Limits (Has the instrument's detection limit(s) been determined and documented?)
f) Documentation of analyst accuracy and precision (Have the necessary accuracy and precision checks for each analyst been performed and documented?)
g) Approval of Laboratory Director and Quality Manager (Has the approval of the appropriate Lab. Director and the Quality Manager been given?)

5.6 Data Integrity Plan

An integral part of a Quality System is the Data Integrity Plan. The Data Integrity Plan consists of procedures that provide assurance that a highly ethical approach to testing is a key component of all laboratory planning, training and implementation of methods. Environmental Hazards Services data integrity system emphasizes the paramount importance of ethics in the performance of all analytical work. EHS will ensure that laboratory staff consistently meet the specific ethical requirements defined in the Data Integrity Plan and will obtain the commitment of all laboratory staff to the principle that all analyses shall be performed in a controlled and documented manner.

EHS has established data integrity procedures that can be found in the SOP for Data Integrity. There are four required elements within the data integrity system. These are 1) data Integrity training, 2) signed data integrity documentation for all laboratory employees, 3) in-depth, periodic monitoring of data integrity, and 4) data integrity procedure documentation. These procedures and the associated implementation records shall be properly maintained and made available for assessor review. The data

integrity procedures shall be annually reviewed and updated by management.

EHS as part of their overall internal auditing program shall insure a review is conducted with respect to any evidence of inappropriate actions or vulnerabilities related to data integrity. Discovery of potential issues shall be handled in a confidential manner until such time as a follow up evaluation, full investigation, or other appropriate actions have been completed and the issues clarified. All investigations that result in finding of inappropriate activity shall be documented and shall include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. All documentation of these investigation and actions taken shall be maintained for at least ten years.

6. EQUIPMENT/MATERIALS/METHODS

6.1 Phase Contrast Microscopy

6.1.1 PCM Equipment List

- **6.1.1.1** 2 - Nikon Alphaphot-2 VS2 Phase Contrast Microscope
- **6.1.1.2** 1 - Nikon Labophot-2 Phase Contrast Microscope
- **6.1.1.3** 1 - "Quick Fix" Acetone Vaporizer
- **6.1.1.4** 1 - SKC Acetone Vaporizer
- **6.1.1.5** 1 - VWR Dylatherm hot plate

6.1.2 PCM Analytical Method

NIOSH 7400, Revision 3

6.1.3 PCM Calibration & Maintenance Policy

6.1.3.1 Daily calibration and other periodic checks are required to ensure proper functioning . See "S. O. P. C2, Section 3, Calibration of Phase Contrast Microscope" for all requirements.

6.2 Polarized Light Microscopy

6.2.1 Polarized Light Microscope Equipment List

- **6.2.1.1** 4 - Olympus BH-2 Polarized Light Microscope with accessories
- **6.2.1.2** 2 - Nikon Labophot-2 Polarized Light Microscope with accessories
- **6.2.1.3** 2 - NUAIRE Class II, Type A/B3 Biohazard negative pressurehood 6.2.1.3.1 HEPA Filtration
- **6.2.1.4** 2 - AirFiltronix 7400S negative pressure hood

6.2.1.4.1 HEPA Filtration

6.2.1.5 2 - GermFree Labs., Inc. BioPharm negative pressure hood

6.2.1.5.1 HEPA Filtration

6.2.1.6 4 - Thermolyne Nuova II hot plate

6.2.1.7 2 - Thermolyne Cimarec 2 hot plate

6.2.1.8 1 - Nikon SMZ-1 Stereomicroscope

6.2.1.9 1 - Meiji EMT Stereomicroscope

6.2.1.10 4 - Olympus SZ-30 Stereomicroscope

6.2.1.11 1 - Fisher Scientific Refractometer

6.2.2 Polarized Light Microscopy (PLM) Analytical Method E.P.A. Method 600/R-93/116

6.2.3 Polarized Light Microscopy (PLM) Calibration and Maintenance Policy

6.2.3.1 Daily calibration and other periodic checks are required to ensure proper functioning. See "S.O.P. for Polarized Light Microscope Alignment/Calibration" and "S.O.P. for Calibration of Refractive Index Liquids" for requirements.

6.3 Metals/Inorganics

6.3.1 Equipment

6.3.1.1 Varian 220FS Atomic Absorption Spectrophtometer with Spectra AA220 FS Version 3.10FS

6.3.1.2 Varian Vista MPX CCP Simultaneous ICP-OES Spectrophotometer

6.3.1.4 NIST traceable Brass Calibration Weights

6.3.1.5 Hamilton Vectaire Fume Hood

6.3.1.6 Thermolyne Nuova II Hot Plate

6.3.1.7 Eppendorf adjustable pipettes

6.3.1.8 Class A Volumetric Glassware

6.3.1.9 Corning 430 pH Meter

6.3.1.10 Barnstead NANOpure II water deionization system

6.3.1.11 Analytical Design 1.5 liter pressure filtration system

6.3.1.12 Analytical Design 12-vessel Rotary Extractor

6.3.1.13 Waring blender

6.3.1.14 Corning hot plate/stirrer

6.3.1.15 Oakton 110 Series Digital Conductivity Meter

6.3.1.16 3 - Sonicator, Model FS220H

6.3.1.17 Buck Scientific 410A Mercury Cold Vapor Analyzer

6.3.1.18 Precision heated water bath

6.3.1.19 Damon/IEC Division International Centrifuge

6.3.1.20 2 - Norge Refrigerator

6.3.1.21 Mettler B154 Balance
6.3.1.22 Mettler PB303-S Balance

6.3.2 Metals/Inorganics Methods

6.3.2.1 NIOSH 7082 (Lead by FAA)
6.3.2.2 NIOSH 7300 (Metals by ICP)
6.3.2.3 NIOSH 6009 (Mercury Vapor in air)
6.3.2.3 NIOSH 0500 (Total Particulates Not Otherwise Regulated)
6.3.2.4 NIOSH 0600 (Respirable Particulates Not Otherwise Regulated
6.3.2.5 OSHA ID-25 (Welding Fumes in air)
6.3.2.6 OSHA ID-145 (Particulate Mercury in air)
6.3.2.7 EPA SW846/7000B/7420 (Metals by FAA)
6.3.2.8 EPA SW846/1311 (Toxicity Characteristic Leaching Procedure, TCLP)
6.3.2.9 EPA SW846/3010A (Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Flame Atomic Absorption (FLAA) or Inductively Coupled Plasma (ICP) Spectroscopy)
6.3.2.10 EPA SW846/3050B (Acid Digestion of Sediments, Sludges, and Soils)
6.3.2.11 EPA SW846/6010C (Inductively Coupled Plasma - Atomic Absorption Spectroscopy)
6.3.2.12 EPA SW846/7470A (Mercury in Liquid Waste (Manual Cold Vapor Technique))
6.3.2.13 EPA SW846/7471B (Mercury in Semi-/Solid Waste (Manual Cold Vapor Technique))
6.3.2.14 EPA 600/R-93/200 (SOP for the Field Analysis of Lead in Air, TSP Air, Paint, Bulk Dust, and Soil by Ultrasonic, Acid Digestion).
6.3.2.15 ASTM E1979-04 (Ultrasonic Extraction of Dust Samples for Subsequent Determination of Lead).

6.3.3 Calibration and Maintenance

6.3.3.1 Daily calibration and other periodic checks are required to ensure proper functioning. See "SOP for the Set Up and Use of the Varian Vista MPX CCP Simultaneous ICP-OES Spectrophotometer ", "S.O.P. for the Set-up and Use of the Varian 220FS Atomic Absorption Spectrophotometer with Spectra AA220 FS Version 3.10FS ", "S.O.P. for the Maintenance and Calibration of Laboratory Balances", "S.O.P. for the Maintenance and Calibration of Adjustable Pipettes", "S.O.P. for the Calibration and Use of the Electronic pH Meter", "S.O.P. for the Use and Calibration of Digital Conductivity Meters", "SOP for the Set Up and Use of the Perkin Elmer 3100 Flame Atomic Absorption

Spectrophotometer/Perkin Elmer AA Winlab, Version 6.1Software “,”Set up and Use of the Varian 220Z AA spectrophotometer with VGA Assembly” and “SOP for the Set-Up and Use of the Buck Scientific 400A Mercury Cold Vapor Analyzer”.

6.4 IAQ Department

6.4.1 Equipment

6.4.1.1 Biological Microscope (Nikon Alphaphot-2), binocular, Khöler-type illumination with accessories:

6.4.1.1.1 Reticles
6.4.1.1.2 20X, 40X and 100X (oil immersion type) objectives
6.4.1.1.3 On board incandescent light source
6.4.1.1.4 Substage condenser with iris diaphragm

6.4.1.2 Microscope Slides (3” x 1” x 1mm)
6.4.1.3 Coverslips (18mm x 18mm or 22mm x 22mm)
6.4.1.4 Type-A immersion oil ($n_D = 1.5150 \pm 0.0002$)
6.4.1.5 Forceps (Fisherbrand – Jewelers Forceps)
6.4.1.6 Scotch™ Transparent Tape
6.4.1.7 Fast Drying Nail Enamel
6.4.1.8 Acetone Vaporizer
6.4.1.9 Stereomicroscope
6.4.1.10 Sterile transfer pipets (6” blood bank, 25 drops/mL)
6.4.1.11 Sterile inoculating loops (1ul, 10ul)
6.4.1.12 16 x 100mm test tubes
6.4.1.13 Bio-Safety Cabinet
6.4.1.14 Sterile specimen containers (4 oz.)
6.4.1.15 Vortex mixer
6.4.1.16 Culture Media

6.4.1.16.1 Malt Extract Agar with 0.01% Chloramphenicol
6.4.1.16.2 Dichloran Glycerol 18 Agar
6.4.1.16.3 Czapek Yeast Agar
6.4.1.16.4 Cellulose Agar

6.5.2 S.O.P. for Indoor Air Quality Analysis

6.6 Reagents and Standards

6.6.1 All reagents and standards will be certified standards which are of a quality specified by the analytical method used. Reagents and standards are stored in the proper manner according to manufacturer’s specifications.

6.6.2 Reagents and standards will be inspected, dated and initialed at the time of receipt. All reagents and standards will be checked for impurities or nonconformance before being placed into service.

6.6.3 The source, name, lot number, catalog number, date of receipt and the expiration date of each reagent and standard shall be written down in the Standard Lot Book and given a specific number such as SLB-20. This SLB number is to be used whenever the standards or reagents are used for any preparations or analysis.

6.6.4 Documentation of standard and solution preparations shall include the date of preparation, final volume and concentration, SLB number of parent material, concentration and expiration date of parent material, assigned expiration date and the preparer's initials. Each preparations is given a unique label (xx-xxxx), which is used to identify the standards or solutions when used in the preparation or analysis of samples.

6.6.5 Each standard and reagent used in the analysis of samples are listed on the worksheet by their unique identification (xx-xxxx). This ensures the traceability of all standards and reagents from purchase to final sample analysis.

6.6.6 Strict controls and documentation of any reagent solutions and calibrations standards shall be maintained.

6.6.7 Reagents and standards, and any prepared solutions are not to be used beyond their assigned expiration date. Materials specified for reevaluation, and which are concluded to have adequate purity upon reevaluation, shall be given a new expiration date.

6.6.8 Purchased calibration standards and Laboratory Control Standards shall be traceable to National Institute of Standards and Technology or an equivalent national or international standard. All certificates are kept in a binder in the QA/AC Office.

7. TRACEABILITY OF MEASUREMENTS

7.1 Reference standards and testing equipment shall be subject to in-service checks between calibration and verifications as needed. Yearly calibrations are performed by qualified technicians to insure that the instrumentation have been tested and certified to insure traceability to national standards of measurement. All certificates are kept in the QA/QC file cabinet.

7.2 Reference standards shall be calibrated by a source that is ISO/IEC17025 certified.

7.3 Reference standards shall be used only for calibration unless it can be shown that their performance as reference samples has not been invalidated.

8. EMPLOYEE TRAINING

EHS employees are made aware of the importance they play in ensuring that the objectives of the Quality Management System are achieved. Each employee is taught that the Quality Management System as detailed in the QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. The adherence to these standards will ensure

that EHS is able to provide and maintain a reliable and consistently accurate system of analytical work in compliance with ISO/IEC17025 and with NELAC standards.

These standards establish the QA/QC systems throughout the laboratory, which allow the analytical system to be constantly monitored and indicate where adjustments or corrections may be necessary. Communication between management and laboratory personnel will ensure the effectiveness of the management system. All employees are made aware that any questions, concerns or problems can be brought to management at any time. Any changes in laboratory policy are brought to the attention of all employees at the time of the change through departmental meetings.

All EHS employees must read the QA/QC manual and the SOPs that pertain to their position. All employees undergo a training period in which they will be provided with the necessary instruction in order to perform their anticipated tasks. During this training period the new employee will be supervised by a member of the staff competent in the area of instruction. Once the employee has demonstrated proficiency in the area of training they will be allowed to work without supervision.

Technical employees have specific requirements that must be fulfilled in order to demonstrate proficiency. A checklist is used to follow the progress of the training program. For PLM, PCM and IAQ analyst, initial competence is shown through the analysis of 50 reference samples. For Metals analysts a series of analytical runs must be completed and passed to complete the initial training process. PCM and metals technicians must demonstrate their competence in the preparation of samples, before being allowed to prepare client samples unsupervised. Only trained employees are authorized to use equipment and to prepare and analyze samples.

Every year technicians and analyst must re-demonstrate their competence in order to continue to prepare and analyze samples. This re-demonstration evaluates the effectiveness of the training program. For specific technical laboratory training see the SOP for Employee Training.

9. SUBCONTRACTORS

Clients are aware that EHS subcontracts for TEM analysis, Radon analysis and drinking water analysis. This information is listed in the EHS New Client Handbook which is given to all EHS clients. When the need arises for samples normally analyzed by EHS to be analyzed by another laboratory, the client is informed and written permission is received prior to sending out the samples. Samples are sent to competent laboratories that are accredited by the appropriate agencies. Asbestos laboratories must be NVLAP accredited and in compliance with the NVLAP handbook. Every subcontractor must be compliant with the necessary accrediting bodies and ISO/IEC 17025 prior to receipt of samples from EHS. EHS maintains a file for each lab that is

subcontracted. This file contains all applicable accreditations for samples that are analyzed for EHS. The results (reports) from the subcontracted lab are submitted directly to the client in the original format provided to EHS. A copy of EHS's sub-contractors can be found in Appendix 1.

10. POLLUTION PREVENTION

Pollution prevention encompasses any technique that reduces or eliminates the quantity or the toxicity of waste at the point of generation. Many opportunities for pollution prevention exist in laboratory operation. EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address waste generation. The Pollution Prevention Act of 1990, Congress established a national policy that: pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

SOP REVISION LOG
DATE AND ACTIONS

8/14/00

Section Revised:

1.1 Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples, primarily the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and other parameters as needed. EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service and a 24-hour turnaround for PCM, PLM and Lead analysis. EHS is committed to providing quality services to its clients through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

Revision:

1.1 Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples, primarily the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and other parameters as needed. EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service and a 24-hour turnaround for PCM, PLM and Lead analysis. EHS is committed to providing quality services to its clients through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

In 1998 EHS was acquired by Foxboro Capitol Ltd. Under this ownership EHS is a part of the National Testing Laboratories Network. The other laboratories in this network are:

- National Testing Laboratories, Ltd. – A drinking water laboratory located in Ypsilanti, Michigan.
- Broward Testing Laboratory, Ltd. – A drinking water laboratory located in Ft. Lauderdale, Florida.
- Free-Col Laboratories, Ltd. – A full service Environmental and Industrial Hygiene laboratory located in Meadville, Pennsylvania. The corporate headquarters is in Cleveland, Ohio.

8/14/00

Section Revised:

1.2 Purpose of EHS Quality Assurance/Quality Control (QA/QC) Manual

The QA/QC Manual documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies. The QA/QC Manual is to be adhered to explicitly, except in case of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary to permit any departure from documented procedures.

Revision:

1.2 Purpose and Authority of EHS Quality Assurance/Quality Control (QA/QC) Manual

The QA/QC Manual is issued under the authority of the President of Foxboro Capitol, Ltd. and documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work in compliance with ISO/IEC 17025. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies. The QA/QC Manual is to be adhered to explicitly, except in case of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary to permit any departure from documented procedures.

8/14/00

Section Revised:

1.4 Maintenance of EHS S.O.Ps (Standard Operating Procedures)

Laboratory SOPs are reviewed at least annually by the Laboratory Director and Quality Manager. They are revised as necessary to reflect any changes in laboratory practices. All revisions/reviews are documented in the S.O.P. Revisions/Review log found at the end of the Laboratory General Operations Manual. The General Operations Manual is maintained in the Laboratory Technical Library. Copies of the latest revisions for pertinent SOPs are located in each laboratory section Operations Manual. Copies of all laboratory SOPs are located in the General Operations Manual. Invalid and/or obsolete SOP's and documents are promptly removed from use and disposed to insure that the only documents or SOP in use are current.

Revision:

1.4 Maintenance of EHS S.O.Ps (Standard Operating Procedures)

Laboratory SOPs are reviewed at least annually by the Laboratory Director and Quality Manager. They are revised as necessary to reflect any changes in laboratory practices and/or any updates to the reference methods. All revisions/reviews are documented in the S.O.P. Revisions/Review log found at the end of the Laboratory General Operations Manual. The General Operations Manual is maintained in the Laboratory Technical Library. Copies of the latest revisions for pertinent SOPs are located in each laboratory section Operations Manual. Copies of all laboratory SOPs are located in the General Operations Manual. Invalid and/or obsolete SOP's and documents are promptly removed from use and disposed to insure that the only documents or SOP in use are current. The generation of any analytical data is based in strict accordance to the pertinent EHS S.O.P. All analytical SOPs are based on established reference methods. The SOPs may contain slight modifications to the reference method. Whenever a reference method is modified, this will be acknowledged by placing an M after the method number. All SOPs which contain a modification from the reference method shall be validated for compliance.

8/14/00

Section Revised:
Organizational Chart

Revision:
The President of Foxboro Capitol and the Vice President of Operations of NTL Network was added to the Organizational Chart ahead of the General Manager of EHS.

8/14/00

Section Revised:

3. Personnel/Organization/Responsibilities/Qualifications

Revision:

The following Personnel was added to the beginning of this section with the corresponding change to the numbering system of this section.

3.1 President – (Foxboro Capital Ltd.)

The President has the ultimate responsibility for all aspects of every laboratory in the National Testing Laboratories Network.

3.2 Vice President of Operations – National Testing Laboratories Network, Cleveland, OH.

The Vice President of Operations answers directly to the president of Foxboro Capital, Ltd. The General Managers of each laboratory report directly to the Vice President.

Responsibilities of the Vice President include, but are not limited to:

a. Budget Approvals
b. Approval of Staffing
c. Capitol Equipment Expenditures
d. Market Strategies

3.3 General Manager

The General Manager reports directly to Vice President of Operations and is responsible for the day to day operations of Environmental Hazards Services, L.L.C.

8/14/00

Section Revised:

5.4 Corrective/Preventative Actions Policies

EHS has established a protocol for the identification of complaints and the documentation of their resolution. Complaints may be external (i.e. from clients, vendors, etc.) or internal (i.e. staff members, fellow employees, etc.) in origin. EHS, in compliance with ISO Guide 25 requirements, has established a program to identify the complaint, document the rectification, and track the process of these actions. This program can be found documented in S.O.P. F-6, for Complaint Identification, Resolution, and Tracking.

Revision:

5.5 Corrective/Preventative Actions Policies

EHS has established a protocol for the identification of complaints and the documentation of their resolution. Complaints may be external (i.e. from clients, vendors, etc.) or internal (i.e. staff members, fellow employees, etc.) in origin. EHS, in compliance with ISO/IEC 17025 requirements, has established a program to identify the complaint, document the rectification, track the process of these actions and review the process in order to establish or amend policies to prevent problem reoccurrences. This program can be found

documented in S.O.P. F-6, for Complaint Identification, Resolution, and Tracking.

8/14/00

Section Revised:
5.3 Departures From EHS Procedures

All departures (accidental or otherwise) from established EHS procedures are quickly dealt with and are documented by the technician or analyst and approved by the Laboratory Director and/or Quality Manager prior to continuing with further preparation and analysis or any notifications to the client occur.

Revision:
5.3 Departures From EHS Procedures

Conformance to all aspects of EHS procedures and policies is integral to the successful implementation of our Quality System. Any departures (accidental or otherwise) from established EHS procedures trigger an immediate stop work action. Whenever a stop work action has occurred either the Quality Manager or the Laboratory Director must be notified to review the incident. A solution to bring any non-conforming aspect back into conformance must be reached and monitored before work can resume. Any samples affected during the period of non-conformance shall be re-analyzed. If for whatever reason, a sample cannot be reanalyzed (ex. No additional sample available), then an explanation written by either the Quality Manager of Laboratory Director will be added to the final report. All departures shall be documented in the Non-Conformance Log Book and on the worksheet of any affected samples.
The log book entry at a minimum shall include:

1. Date
2. Type of analysis
3. Analyst/Technician involved
4. An explanation of departure
5. Time of work stoppage
6. ID Numbers of samples affected and a note to distinguish if samples were reanalyzed or released with explanation of non-conformance on report
7. Corrective action taken
8. Return to work approval signed by the Quality Manager or Laboratory Director
9. Date & time of return to work approval
10. Notation which will appear on final reports, if applicable

After any stop work action, work may not resume until all log book entries are complete and approval by the Quality Manager or Lab Director is documented.
8/14/00

Section Revised:
Section 5 Quality Assurance/Quality Control

Revision:
The addition of the following with corresponding numbering adjustments

5.4.2 Internal QA Audit

The purpose of the audit is to determine if and make sure that all of the aspects of the quality system are being followed and are up to date. This audit will be performed by a representative from each department under the guidance of the Quality Manager and reviewed by the General Manager. This audit will be performed at least quarterly, however all deficiencies must be re-reviewed within 15 days. A copy of this audit outline can be found at the end of this section.

8/14/00

Section Revised:
6.5.1 All reagents and standards will be certified standards which are of a quality specified by the analytical method used.

Revision:

6.5.1 All reagents and standards will be certified standards which are of a quality specified by the analytical method used. Reagents and standards are stored in the proper manner according to manufacturer's specifications.

8/14/00

Section Revised:

6.5.2 Reagents and standards will be inspected, dated and initialed at the time of receipt. All reagents. Reagents and standards are stored in the proper manner according to manufacturer's specifications.

Revision:
6.5.2 Reagents and standards will be inspected, dated and initialed at the time of receipt. All reagents and standards will be checked for impurities or nonconformance before being placed into service.

8/14/00

Section Revised:
6.5.3 The source, name, lot number, catalog number, and the expiration date of each reagent and standard shall be written down in the Standard Lot Book and given a specific number such as SLB-20. This SLB number is to be used whenever the standards or reagents are used for any preparations or analysis.

Revision:
6.5.3 The source, name, lot number, catalog number, date of receipt and the expiration date of each reagent and standard shall be written down in the Standard Lot Book and given a specific number such as SLB-20. This SLB number is to be used whenever the standards or reagents are used for any preparations or analysis.

8/14/00

Section Revised:
6.5.7 Documentation of standard and solution preparations shall include the date of preparation, concentration, SLB number of parent material, assigned expiration date and the preparer's initials.

Revision:
6.5.7 Documentation of standard and solution preparations shall include the date of preparation, final volume and concentration, SLB number, concentration and expiration date of parent material, assigned expiration date and the preparer's initials.

8/18/00

Section Revised:
Section 3.2 Laboratory Director
Revision:
Addition of:
i. Report opinions and interpretations of the test data when necessary. (This may only be done by the Lab Director or the Quality Manager.)

Renumbering as necessary.
Section Revised:
Section 3.3 Quality Manager
Revision:
Addition of:
j. Report opinions and interpretations of the test data when necessary. (This may only be done by the Lab Director or the Quality Manager.)

8/21/00
Section Revised:
6.5.4 Strict controls and documentation of any reagent solutions and calibrations standards shall be maintained.

Revision:

Changed numbering to 6.5.6

8/21/00

Section Revised:
6.5.7 Documentation of standard and solution preparations shall include the date of preparation, final volume and concentration, SLB number, concentration and expiration date of parent material, assigned expiration date and the preparer's initials.
Revision: (Changed numbering and content)
6.5.4 Documentation of standard and solution preparations shall include the date of preparation, final volume and concentration, SLB number of parent material, concentration and expiration date of parent material, assigned expiration date and the preparer's initials. Each preparations is given a unique label (xx-xxxx), which is used to identify the standards or solutions when used in the preparation or analysis of samples.

8/21/00

Section Revised:
Sections 6.5.5 and 6.5.6

Revision:
Sections were renumbered to be 6.5.7 and 6.5.8

8/21/00

Section Revised:
Addition of the following paragraph in section 6.5.5. taking place of what was previously there.

6.5.5 Each standard and reagent used in the analysis of samples are listed on the worksheet by their unique identification (xx-xxxx). This ensures the traceability of all standards and reagents from purchase to final sample analysis.

10/19/00

Section Revised:
Removal of the following forms from the end of Section A1: Employee Yearly Review, Annual Management Audit, Laboratory Quarterly Review, EHS Internal QA Audit, Daily Follow Up Call Form, EHS Sample Log Sheet, Refrigerator Temperature Log, and Hold Sample Form.
12/11/00

Section Revised:
Removal of the following from the end of Section A1:

- Free-Col Laboratories, Ltd. – A full service Environmental and Industrial Hygiene laboratory located in Meadville, Pennsylvania.

03/14/01

Sections Revised:
Revised the Organizational Chart to include the QA Manager and the removal of the Office Manager.
Revised the Building Layout Chart to show the change in office areas and the addition of the Micro-Balance room.
05/09/01

Addition of following section:
9. Subcontractors
Prior to any samples being subcontracted, the client is notified of the need for their samples to be analyzed by another laboratory and written approval is obtained from the client to allow the samples to be transferred. If this written approval is not received by EHS, samples will be returned to the client. When the need arises for samples to be analyzed by laboratories other than EHS, the samples are sent to laboratories that are accredited by the appropriate agencies. This would include all sample matrices that are listed under the scope of accreditations held by EHS as well as those matrices not covered by any EHS accreditations. When subcontracted, samples that are listed under EHS's scope of accreditation are to be sent to an accredited laboratory whose scope of accreditation includes at least the same scope of accreditation as EHS. When subcontracted, a laboratory that is accredited to analyze a specific matrix (if applicable) will analyze sample matrices that are not covered under EHS's scope of accreditation. EHS maintains a file for each lab that is subcontracted. This file contains all applicable accreditations for samples that are analyzed for EHS. The results (reports) from the subcontracted lab are submitted directly to the client in the original format provided to EHS. A copy of EHS list of contractors can be found in Appendix 1.

01/15/03

Section Revised:

1.1 Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples, primarily the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and other parameters as needed. EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service and a 24 hour turnaround for PCM, PLM and Lead analysis. EHS is committed to providing quality services to its clients through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

Revision:

1.1 Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia has been in business since 1984. EHS is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples. Sample analysis includes the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and fungal spore/pollen grain count and identification of common genera. EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service to its clients through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

02/27/04

Section Revised:
9. Subcontractors
Prior to any samples being subcontracted, the client is notified of the need for their samples to be analyzed by another laboratory and

written approval is obtained from the client to allow the samples to be transferred. If this written approval is not received by EHS, samples will be returned to the client. When the need arises for samples to be analyzed by laboratories other than EHS, the samples are sent to laboratories that are accredited by the appropriate agencies. This would include all sample matrices that are listed under the scope of accreditations held by EHS as well as those matrices not covered by any EHS accreditations. When subcontracted, samples that are listed under EHS's scope of accreditation are to be sent to an accredited laboratory whose scope of accreditation includes at least the same scope of accreditation as EHS. When subcontracted, a laboratory that is accredited to analyze a specific matrix (if applicable) will analyze sample matrices that are not covered under EHS's scope of accreditation. EHS maintains a file for each lab that is subcontracted. This file contains all applicable accreditations for samples that are analyzed for EHS. The results (reports) from the subcontracted lab are submitted directly to the client in the original format provided to EHS. A copy of EHS's sub-contractors can be found in Appendix 1.

Revision:

9. Subcontractors

Prior to any samples being subcontracted, the client is notified of the need for their samples to be analyzed by another laboratory and written approval is obtained from the client to allow the samples to be transferred. If this written approval is not received by EHS, samples will be returned to the client. When the need arises for samples to be analyzed by laboratories other than EHS, the samples are sent to competent laboratories that are accredited by the appropriate agencies. Asbestos laboratories must be NVLAP accredited and in compliance with the NVLAP handbook. Every subcontractor must be compliant with the necessary accreditating bodies prior to receipt of samples from EHS. When subcontracted, samples that are listed under EHS's scope of accreditation are to be sent to an accredited laboratory whose scope of accreditation includes at least the same scope of accreditation as EHS. EHS maintains a file for each lab that is subcontracted. This file contains all applicable accreditations for samples that are analyzed for EHS. The results (reports) from the subcontracted lab are submitted directly to the client in the original format provided to EHS. A copy of EHS's sub-contractors can be found in Appendix 1.

08/27/04

Section Revised:

3. PERSONNEL / ORGANIZATION / RESPONSIBILITIES / QUALIFICATIONS

Revision:

Addition of the following information to the section:

3.13 Environmental Laboratory Technician

3.13.1 The environmental laboratory technician's responsibilities include but are not limited to:

- **a.** Preparation of environmental samples for analysis
- **b.** Preparation of raw data worksheets using information supplied by the client
- **c.** Cleaning and maintenance of equipment within the Environmental Chemistry Laboratory
- d. Other duties as necessary

3.13.2 The environmental laboratory technician must meet at least the minimum of the following requirements:

- **a.** Completion of the Environmental Chemistry Laboratory Technician Checklist
- **b.** Exhibited competency in all areas included on the Environmental Chemistry Laboratory Technician Checklist

3.14 IAQ Analyst

3.14.1 An IAQ Analyst responsibilities include, but are not limited to:

- **a.** Maintenance of all equipment related to their analytical assignments
- b. Preparation and analysis of IAQ samples
- c. Follow proper QA/QC methods as described within the QA/QC Manual

3.14.2 The IAQ analyst must meet at least the minimum of the following requirements:

- **a.** B.A. or B.S. in a life science with strong emphasis on microbiological classwork.
- **b.** One year relevant IAQ experience
- **c.** Exhibit competency

3.14.3 In the event of the absence of the IAQ Laboratory Director and the Quality Manager, the IAQ Analyst will accept full responsibility for all events within their department.

3.15 IAQ Technician

3.15.1 The IAQ technician's responsibilities include but are not limited to:

a. Preparation of IAQ samples for analysis
b. Preparation of raw data worksheets using information supplied by the client.
c. Cleaning and maintenance of equipment within the IAQ Laboratory

d. Other duties as necessary

3.15.2 The IAQ technician must meet at least the minimum of the following requirements:

a. Completion of an IAQ course either outside of the laboratory or an In-house training course.
b. Exhibited competency in necessary areas of the IAQ technician course.
c. Three (3) months IAQ experience

Section Revised:

4.3.6 Samples are maintained on-site for at least thirty days after analysis in dated containers. They are then either disposed of in accordance with all regulations or returned to the client. EHS contracts with a local contractor for hazardous waste disposal.

4.3.6.1 Lead paint, soil and TCLP samples are combined and a TCLP sample is collected and analyzed. If this sample is below regulatory limits, the waste is disposed of as normal waste. If the result is above a regulatory limit, the waste is disposed of in accordance with regulation as a hazardous waste.

Revision:

4.3.6 Samples are maintained on-site for at least thirty days after analysis in dated containers. They are then either disposed of in accordance with all regulations or returned to the client. EHS contracts with a local contractor for hazardous waste disposal.

4.3.6.1 Lead paint, soil and TCLP samples are combined and a TCLP sample is collected and analyzed. If this sample is below regulatory limits, the waste is disposed of as normal waste. If the result is above a regulatory limit, the waste is disposed of in accordance with regulation as a hazardous waste.

4.3.6.2 All viable IAQ samples will be autoclaved at 121°C/15 PSI for 30 minutes with a fast exhaust before disposal.

Addition of following to Section :

6.5 IAQ

6.5.1 Equipment
6.5.1.1 Biological Microscope (Nikon Alphaphot-2), binocular, Khöler-type illumination with accessories:
6.5.1.1.1 Reticle
6.5.1.1.2 20x, 40x and 100X (oil immersion type)objectives
6.5.1.1.3 On board incandescent light source
6.5.1.1.4 Substage condenser with iris diaphragm
6.5.1.2 Microscope Slides (3" x 1" x 1mm)
6.5.1.3 Coverslips (18mm x 18mm or 22mm x 22mm)
6.5.1.4 Type-A immersion oil ($n_D = 1.5150 \pm 0.0002$)
6.5.1.5 Forceps (Fisherbrand – Jewelers Forceps)
6.5.1.6 Scotch™ Transparent Tape
6.5.1.7 Fast Drying Nail Enamel
6.5.1.8 Acetone Vaporizer
6.5.1.9 Stereomicroscope
6.5.1.10 Sterile transfer pipets (6" blood bank, 25 drops/mL)
6.5.1.11 Sterile inoculating loops (1ul, 10ul)
6.5.1.12 16 x 100mm test tubes
6.5.1.13 Bio-Safety Cabinet
6.5.1.14 Sterile specimen containers (4 oz.)
6.5.1.15 Vortex mixer
6.5.1.16 Trypticase Soy Broth (Soybean Casein Digest)
6.5.1.17 Culture Media
6.5.1.17.1 Malt Extract Agar with 0.01% Chloramphenicol

6.5.1.17.2 Dichloran Glycerol 18 Agar
6.5.1.17.3 Czapek Yeast Agar
6.5.1.17.4 Cellulose Agar

6.5.2 IAQ Methods

6.5.2.1 S.O.P. For the preparation of Trypticase Soy Broth
6.5.2.1 S.O.P for the Sterilization of Distilled Water
6.5.2.2 S.O.P. for Indoor Air Quality Analysis

11/05/04

Revision of the following sections:
Table of Contents
Parts: 1.3, 1.5, 2.1, 3.0, 4.1.4.3, 4.4, 4.5, 4.6, 4.7, 5.4, 6.3, and 8.0

Addition of new parts: 5.1.4, 5.2.1.3, 4.8, 4.9 and 6.5

12/5/05

Revision of the Chain of Command Chart to different format

Revision of the following Section:

4.2.2 The EHS Job Number is generated as follows. A first set of four numbers indicate the year the samples were received. A second set of two numbers indicates the month the samples were received. A third set of four numbers indicates the sequential job number. (The first job of each month is assigned job XX-19XX-0001.) Each new job number is increased by a factor of one. All number sets are separated by hyphens.

EXAMPLE: 11-1998 -0123
Month received - Nov (11)
Year received - 1998
EHS Job Number - 0123 (123rd job in Nov.)

Revision:

4.2.2 The EHS Job Number is generated as follows. A first set of four numbers indicate the year the samples were received. A second set of two numbers indicates the month the samples were received. A third set of four numbers indicates the sequential job number. (The first job of each month is assigned job 20XX – XX - 0001.) Each new job number is increased by a factor of one. All number sets are separated by hyphens.

EXAMPLE: 2006 -01-0123
Year received - 2006
Month received - Jan (01)
EHS Job Number - 0123 (123rd job in Jan.)

03/16/06

Revision of the following Section:

1.6 Accreditation Logos

EHS, at the present time, does not use any of their accreditating bodies logos in advertisements, reports, letters or any other documents associated with the laboratory.

Revision:

1.6 Accreditation Logos

EHS uses the NVLAP, AIHA and NELAP logos only in advertising. The logo being used has been pre-approved by the appropriate accrediting body. EHS does not use any of their accreditating bodies logos in reports, letters or any other documents associated with the laboratory.

1.6.1 NVLAP
1.6.1.1 The NVLAP logo stands by itself and is not combined with any other logo, symbol or graphic

1.6.1.2 The ratio of height to width is 1 to 2.25.
1.6.1.3 The NVLAP logo is accompanied by the NVLAP Lab Code in an approved caption. The caption will appear below and in close proximity to the logo.
1.6.1.4 The logo and caption is of a size that allows the caption to be easily read. The size of the caption shall not exceed the size of the logo.
1.6.1.5 The logo shall appear in black, blue or other color approved by NVLAP, and may be filled or unfilled. If the logo is filled then the same color is used for the outline and the fill.

1.6.2 AIHA
1.6.2.1 EHS will only use the AIHA logos for testing within the laboratory's scope of accreditation.
1.6.2.2 EHS will only use the approved logo provided by AIHA to the laboratory.

1.6.3 NELAC
1.6.3.1 EHS will only use the NELAC logos for testing within the laboratory's scope of accreditation.
1.6.3.2 The NELAC logo is accompanied by the phrase "NELAP accredited" and the laboratory's accreditation number or other identifier with their accrediting authorities name.

07/20/06

Revision of the following Section:

1.2 Objectives, Policies and Authority of EHS Quality Assurance/Quality Control (QA/QC) Manual

The QA/QC Manual is issued under the authority of the President of Foxboro Capitol, Ltd. and documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work in compliance with ISO/IEC17025. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies. The QA/QC Manual is to be adhered to explicitly, except in case of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary to permit any departure from documented procedures.

Revision:

1.2 Objectives, Policies and Authority of EHS Quality Assurance/Quality Control (QA/QC) Manual

The QA/QC Manual is issued under the authority of the President of Foxboro Capitol, Ltd. and documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work in compliance with ISO/IEC17025 and with NELAC standards. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies. The QA/QC Manual is to be adhered to explicitly, except in case of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary to permit any departure from documented procedures.

Section Revised:

Part of Section 5.4.5:

The key areas to be reviewed are:

a. Previous Annual Management Audit
b. Internal QA Audit
c. Status of Accreditations
d. Proficiency Testing Programs
e. Quality Assurance Manual Review
f. Operations Manual Review
g. New Methods Offered
h. Pre-existing Methods
i. Personnel
j. One Year Plan
k. General Status

Revision:

The key areas to be reviewed are:

a. Previous Annual Management Audit
b. Internal QA Audit

c. Status of Accreditations
d. Proficiency Testing Programs
e. Quality Assurance Manual Review
f. Operations Manual Review
g. Corrective/Preventive Actions
h. New Methods Offered
i. Pre-existing Methods
j. Personnel
k. One Year Plan
l. General Status

Addition of following sections:

5.6 Data Integrity Plan

An integral part of a Quality System is the data integrity procedures. The data integrity procedures provide assurance that a highly ethical approach to testing is a key component of all laboratory planning, training and implementation of methods. Environmental Hazards Services Data Integrity System emphasizes the paramount importance of ethics in the performance of all analytical work. EHS will ensure that laboratory staff consistently meet the specific ethical requirements defined in the data integrity plan and will obtain the commitment of all laboratory staff to the principle that all analyses shall be performed in a controlled and documented manner.

EHS has established data integrity procedures that can be found in the SOP for Data Integrity. There are four required elements within the data integrity system. These are 1) data Integrity training, 2) signed data integrity documentation for all laboratory employees, 3) in-depth, periodic monitoring of data integrity, and 4) data integrity procedure documentation. These procedures and the associated implementation records shall be properly maintained and made available for assessor review. The data integrity procedures shall be annually reviewed and updated by management.

EHS as part of their overall internal auditing program shall insure a review is conducted with respect to any evidence of inappropriate actions or vulnerabilities related to data integrity. Discovery of potential issues shall be handled in a confidential manner until such time as a follow up evaluation, full investigation, or other appropriate actions have been completed and the issues clarified. All investigations that result in finding of inappropriate activity shall be documented and shall include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. All documentation of these investigation and actions taken shall be maintained for at least ten years.

10. POLLUTION PREVENTION

Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Many opportunities for pollution prevention exist in laboratory operation. EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address waste generation. When it is not feasible to reduce wastes at the source, the Agency recommends recycling as the next best option. The acids used in this Method should be reused as practicable by purifying by electrochemical techniques. The only other chemicals used in this Method are the neat materials used in preparing standards. These standards are used in extremely small amounts and pose little threat to the environment when managed properly. Standards should be prepared in volumes consistent with laboratory use to minimize the disposal of excess volumes of expired standards.

Revision to the title page:

ENVIRONMENTAL HAZARDS SERVICES, L.L.C.

QUALITY ASSURANCE/QUALITY CONTROL

MANUAL

Revision:

QUALITY ASSURANCE/QUALITY CONTROL

MANUAL

ENVIRONMENTAL HAZARDS SERVICES, L.L.C.
7469 Whitepine Road
Richmond, VA 23237
(804) 275-4788

Howard Varner
General Manager

Michael Mueller
Laboratory Director

Irma Faszewski
Quality Manager

09/17/07

Removal of the following Section:

Weekly Summary

A summary of all laboratory QC data, discrepancies, corrective actions, and any relevant information is provided by the Quality Manager to the Laboratory Director each week. Examples of these weekly summary forms are located at the end of this section. A copy of weekly summaries is also stored in dedicated files in the QA/QC Library. Exceptions are made in the case of certain analyses which are run too infrequent for weekly summaries. In that case, monthly or quarterly summaries of these analysis are provided (i.e., Mercury Analysis).

Examples of items which will be part of the weekly summary include but are not limited to the following:

dentification of all outliers and corrective/preventive
action taken for each.
A summary of the Client Services
A summary of corrective/preventive actions procedures

Section Revision:

5.3 Control of Nonconforming Testing

Conformance to all aspects of EHS procedures and policies is essential to the successful implementation of our Quality System. The following procedures must be followed if any aspect of the testing or the results of the testing do not conform to EHS procedures or the agreed requirements of the client.

Any departures (accidental or otherwise) from established EHS procedure trigger an immediate stop work action and withholding of test reports.

Revision:

5.3 Control of Non-Conformances

Conformance to all aspects of EHS procedures and policies is essential to the successful implementation of our Quality System. The Laboratory Director, Laboratory Administrator, and/or Quality Manager, irrespective of their other responsibilities, have the authority to implement, maintain and improve the management system. They are also able to identify any departures from the management system and initiate actions to prevent or minimize such departures.

The Laboratory Director, Laboratory Administrator, and/or Quality Manager, irrespective of their other responsibilities, also have the authority to implement, maintain and improve all testing and calibration procedures. They are able to identify any departures from these procedures and initiate actions to prevent or minimize such departures.

The following procedures must be followed if any aspect of management, testing or the results of the testing do not conform to EHS procedures or the agreed requirements of the client.

Any departures (accidental or otherwise) from established EHS procedure trigger an immediate stop work action and withholding of test reports.

Section Revised:

1.1 Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples, primarily the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and other parameters as needed. EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service and a 24-hour turnaround for PCM, PLM and Lead analysis. EHS is committed to providing quality services to its clients through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

In 1998 EHS was acquired by Foxboro Capitol Ltd. Under this ownership EHS is a part of the National Testing Laboratories Network. The other laboratories in this network are:

- National Testing Laboratories, Ltd. – A drinking water laboratory located in Ypsilanti, Michigan.
- Broward Testing Laboratory, Ltd. – A drinking water laboratory located in Ft. Lauderdale, Florida.

The corporate headquarters is in Cleveland, Ohio.

Revision:

Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia has
been in business since 1984. EHS is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples. Sample analysis includes the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and fungal spore/pollen grain count and identificaion of common genera.

In July 2007, EHS purchased BTS laboratories and moved the entire laboratory down to Richmond. BTS Laboratories was a mold, lead and drinking water testing laboratory. EHS is able to continue to offer these same services for BTS clients as well as EHS clients.

EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

In 1998 EHS was acquired by Foxboro Capitol Ltd. Under this ownership EHS is a part of the National Testing Laboratories Network. The other laboratories in this network are:

- National Testing Laboratories, Ltd. – A drinking water laboratory located in Ypsilanti, Michigan.
- Broward Testing Laboratory, Ltd. – A drinking water laboratory located in Ft. Lauderdale, Florida.

The corporate headquarters is in Cleveland, Ohio

Section Revised:

EMPLOYEE TRAINING

All EHS employees must read the QA/QC manual and the SOPs that pertain to their position. All employees undergo a training period in which they will be provided with the necessary instruction in order to perform their anticipated tasks. During this training period the new employee will be supervised by a member of the staff competent in the area of instruction. Once the employee has demonstrated proficiency in the area of training they will be allowed to work without supervision.

Technical employees have specific requirements that must be fulfilled in order to demonstrate proficiency. A checklist is used to follow the progress of the training program. For PLM, PCM and IAQ analyst, initial competence is shown through the analysis of 50 reference samples. For Metals analysts a series of analytical runs must be completed and passed to complete the initial training process. PCM and metals technicians must demonstrate their competence in the preparation of samples, before being allowed to prepare client samples unsupervised. Only trained employees are authorized to use equipment and to prepare and analyze samples.

Every year technicians and analyst must re-demonstrate their competence in order to continue to prepare and analyze samples. For specific technical laboratory training see the SOP for Employee Training.

Revision:

EMPLOYEE TRAINING

EHS employees are made aware of the importance they play in ensuring that the objectives of the Quality Management System are achieved. Each employee is taught that the Quality Management System as detailed in the QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. The adherence to these standards will ensure that EHS is able to provide and maintain a reliable and consistently accurate system of analytical work in compliance with ISO/IEC17025 and with NELAC standards.

These standards establish the QA/QC systems throughout the laboratory, which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. Communication between management and laboratory personnel will ensure the effectiveness of the management system. All employees are made aware that any questions, concerns or problems can be brought to management at any time. Any changes in laboratory policy are brought to the attention of all employees at the time of the change through departmental meetings.

All EHS employees must read the QA/QC manual and the SOPs that pertainto their position. All employees undergo a training period in which they will be provided with the necessary instruction in order to perform their anticipated tasks. During this training period the new employee will be supervised by a member of the staff competent in the area of instruction. Once the employee has demonstrated proficiency in the area of training they will be allowed to work without supervision.

Technical employees have specific requirements that must be fulfilled in order to demonstrate proficiency. A checklist is used to follow the progress of the training program. For PLM, PCM and IAQ analyst, initial competence is shown through the analysis of 50 reference samples. For Metals analysts a series of analytical runs must be completed and passed to complete the initial training process. PCM and metals technicians must demonstrate their competence in the preparation of samples, before being allowed to prepare client samples unsupervised. Only trained employees are authorized to use equipment and to prepare and analyze samples.

Every year technicians and analyst must re-demonstrate their competence in order to continue to prepare and analyze samples. This re-demonstration evaluates the effectiveness of the training program. For specific technical laboratory training see the SOP for Employee Training.

Section Revised:

Objectives, Policies and Authority of EHS Quality Assurance/Quality Control (QA/QC) Manual

The QA/QC Manual is issued under the authority of the President of Foxboro Capitol, Ltd. and documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work in compliance with ISO/IEC17025 and with NELAC standards. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies. The QA/QC Manual is to be adhered to explicitly, except in case of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary to permit any departure from documented procedures.

Revision:

The Quality Management System as detailed in the QA/QC Manual is issued under the authority of the President of Foxboro Capitol, Ltd. The QA/QC Manual documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work that meet customer requirements and are in compliance with ISO/IEC17025 and with NELAC standards.

EHS will continually improve the effectiveness of its QA/QC Manual and its management system through the use of the quality policy and objectives, management reviews, audit results, analysis of data, corrective and preventive actions. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies.

The QA/QC Manual is to be adhered to explicitly, except in cases of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary. Any changes made to the QA/QC Manual or departures from documented procedures must be approved in order to ensure the integrity of the management system is maintained.

Section Revised:

Client Services Daily Follow-up Review

Every day a minimum of three (3) clients are selected at random for a telephone survey. If a client is unavailable for comments then an additional client is selected. Any one client will not be selected for an interview more than once every three weeks, unless it is to follow-up on corrective actions resulting from complaints. If a client has a concern or complaint, a complaint documentation form will be generated by client services, and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. Each client survey is reviewed by the Accounting and Marketing Departments.

Revision:

Client Services Daily Follow-up Review

Every day a minimum of three (3) clients are selected at random for a telephone survey. If a client is unavailable for comments then an additional client is selected. Any one client will not be selected for the survey more than once every three weeks, unless it is to follow-up on corrective actions resulting from complaints. The feedback from clients is analyzed and used to improve the management system, testing services, and customer service. If a client has a concern or complaint, a complaint documentation form will be generated by client services, and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. The Accounting, Customer Service and Marketing Departments review client surveys.

Section Revised:

The key areas to be reviewed are:

a. Previous Annual Management Audit
b. Internal QA Audit

c. Status of Accreditations
d. Proficiency Testing Programs
e. Quality Assurance Manual Review
f. Operations Manual Review
g. Corrective/Preventive Actions
h. New Methods Offered
i. Pre-existing Methods
j. Personnel
k. One Year Plan
l. General Status

Revision:

The key areas to be reviewed are:

a. Previous Annual Management Audit
b. Internal QA Audit
c. Status of Accreditations
d. Proficiency Testing Programs
e. Quality Assurance Manual Review
f. Operations Manual Review
g. Corrective/Preventive Actions
h. New Methods Offered
i. Pre-existing Methods
j. Personnel
k. Recommendations for Improvement
l. One Year Plan
m. General Status

02/08/08
Revision:

Replace QA/QC Coordinator with Quality Manager

Section Revised

6.3.2 Metals/Inorganics Methods

6.3.2.1	NIOSH 7082 (Lead in Paint Chips, Wipes, Air Samples)
6.3.2.2	NIOSH 7048-M (Cadmium in air)
6.3.2.3	NIOSH 7024-M (Chromium in air)
6.3.2.4	NIOSH 7030-M (Zinc in air)
6.3.2.5	OSHA ID-25 (Welding Fumes in air)
6.3.2.6	NIOSH 0500 (Total Particulates Not Otherwise Regulated)
6.3.2.7	NIOSH 0600 (Respirable Particulates Not otherwise Regulated)
6.3.2.8	9 (Mercury Vapor in air)
6.3.2.9	OSHA ID-145 (Particulate Mercury in air)
6.3.2.10	EPA SW846/1311 (Toxicity Characteristic Leaching Procedure, TCLP)
6.3.2.11	EPA SW846/3010A (Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Flame Atomic Absorption (FLAA) or Inductively Coupled Plasma (ICP) Spectroscopy)
6.3.2.12	EPA SW846/3050B (Acid Digestion of Sediments, Sludges, and Soils)
6.3.2.13	EPA SW846/6010B (Inductively Coupled Plasma - Atomic Absorption Spectroscopy)
6.3.2.14	EPA SW846/7470A (Mercury in Liquid Waste (Manual Cold Vapor Technique))
6.3.2.15	EPA SW846/7471A (Mercury in Semi-/Solid Waste (Manual Cold Vapor Technique))
6.3.2.16	EPA 600/R-93/200 (SOP for the Field Analysis of Lead in Air, TSP Air, Paint, Bulk Dust, and Soil by Ultrasonic, Acid Digestion).
6.3.2.17	ASTM E1979-98 (Ultrasonic Extraction of Dust Samples for Subsequent Determination of Lead).

Revised With:

6.3.2 Metals/Inorganics Methods

6.3.2.16 NIOSH 7082 (Lead by FAA)
6.3.2.17 NIOSH 7300 (Metals by ICP)
6.3.2.3 NIOSH 6009 (Mercury Vapor in air)
6.3.2.18 NIOSH 0500 (Total Particulates Not Otherwise Regulated)
6.3.2.19 NIOSH 0600 (Respirable Particulates Not Otherwise Regulated
6.3.2.20 OSHA ID-25 (Welding Fumes in air)
6.3.2.21 OSHA ID-145 (Particulate Mercury in air)
6.3.2.22 EPA SW846/7000 (Metals by FAA)
6.3.2.23 EPA SW846/1311 (Toxicity Characteristic Leaching Procedure, TCLP)
6.3.2.24 EPA SW846/3010A (Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Flame Atomic Absorption (FLAA) or Inductively Coupled Plasma (ICP) Spectroscopy)
6.3.2.25 EPA SW846/3050B (Acid Digestion of Sediments, Sludges, and Soils)
6.3.2.26 EPA SW846/6010C (Inductively Coupled Plasma - Atomic Absorption Spectroscopy)
6.3.2.27 EPA SW846/7470A (Mercury in Liquid Waste (Manual Cold Vapor Technique))
6.3.2.28 EPA SW846/7471B (Mercury in Semi-/Solid Waste (Manual Cold Vapor Technique))
6.3.2.29 EPA 600/R-93/200 (SOP for the Field Analysis of Lead in Air, TSP Air, Paint, Bulk Dust, and Soil by Ultrasonic, Acid Digestion).
6.3.2.30 ASTM E1979-98 (Ultrasonic Extraction of Dust Samples for Subsequent Determination of Lead).

06/0809

SECTIONS REVISED:

Sample Log-in

4.2.1 EHS Samples

4.2.1.1 Samples are logged into a computer spreadsheet program and a job number is assigned. The computer spreadsheet contains the following for each job number:

a. Date Received
b. EHS Job Number
c. Client Name
d. Client Project Name
e. Sample Acceptability
f. Sample Type/Number of samples received
g. Notes (Includes Sample Rejection Information)

4.2.1.1.1 "Logbook" spreadsheet information is printed daily and stored in a notebook binder. The information is also downloaded onto a computer "floppy" disk and stored in the computer "hard drive". At any time, one software copy and two "hard" copies of the log-in information exist, one "hard" copy is found in the Log-in Department and the other copy is found in the accounting department.

4.2.1.2 The EHS Job Number is generated as follows. A first set of four numbers indicate the year the samples were received. A second set of two numbers indicates the month the samples were received. A third set of four numbers indicates the sequential job number. (The first job of each month is assigned job 20XX – XX - 0001.) Each new job number is increased by a factor of one. All number sets are separated by hyphens.

EXAMPLE: 2008 -01-0123
Year received - 2008
Month received - Jan (01)
EHS Job Number - 0123 (123rd job in Jan.)

4.2.2 BTS Samples

4.2.2.1 After a sample is received by BTS, it is received into the BTS LIMS system and assigned a BTS sample number. The number is recorded on the chain of custody and also labeled on the container. For example, the fifth sample of the second batch received on April 1, 2008 would be assigned a BTS sample number of 08040100002-0005.

4.2.2.2 All samples received should be recorded on the sample login sheet in the BTS LIMS system. The sample login sheet contains, at a minimum, the following:

a. BTS batch number and sample number
b. Date/time received
c. Customer and project information
d. Sample acceptability
e. Initials of the individual receiving samples

4.3.2 Sample Numbers are assigned by the job number plus an additional number. This number always begins with one and increases by increments of one throughout the job. Sample numbers are assigned by analysts within the specific department. Example, the first sample of the job number used would be assigned EHS number 2006-01- 0123-1.

REVISIONS:

4.2 Sample Receipt and Log-in

4.2.2 Samples are received into a Laboratory Information Management System (LIMS) and a job number is assigned. The number is recorded on the chain of custody and also labeled on the individual samples when they are numbered. The sample receipt should include the following:

a. Customer Name and Number
f. Date received
g. Project/Test Address
h. Turn Around Time
i. Shipping Type

4.2.2 After samples are received they are logged into the LIMS system. The Log In information may consists of the following:

a. Customer Sample ID
b. Collection location
c. Surface type
d. Area dimensions
e. Air volumes or start and end times with flow rates

4.3.2 Sample Numbers are assigned by the LIMS number plus an additional number. This number always begins with one and increases by increments of one throughout the job. Sample numbers are assigned by personal within the specific departments. (Example the 1st sample for LIMS number 09-09-00123 is labeled 09-09-00123-1)

Section Revised:

5.4.4 Client Services Daily Follow-up Review

Every day a minimum of three (3) clients are selected at random for a telephone survey. If a client is unavailable for comments then an additional client is selected. Any one client will not be selected for the survey more than once every three weeks, unless it is to follow-up on corrective actions resulting from complaints. The feedback from clients is analyzed and used to improve the management system, testing services, and customer service. If a client has a concern or complaint, a complaint documentation form will be generated by client services, and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. The Accounting, Customer Service and Marketing Departments review client surveys.

Revision:

5.4.4 Client Services Calls

Every day clients are asked on the service which is provided. The feedback from clients is analyzed and used to improve the management system, testing services and customer service. Customer calls are documented by notes on Goldmine, a computer customer base program. If a client has a significant complaint, a Corrective/Preventive Action form will be generated by Customer Service and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. The Accounting, Customer Service and Marketing Departments review Goldmine customer notes. Goldmine notes are reviewed in the Yearly Management Audit to assess customer feedback.

12/16/09

Section Revised:
Amended Organizational Chart to show new employees and to remove old employees.

02/01/10

Section Revised:

7.2 Reference standards shall be calibrated by a source that can provide traceability to a national standard of measurement.

Revision:

7.2 Reference standards shall be calibrated by a source that is ISO/IEC17025 certified.

Section Revised:

6.2.1.11 1 - Fisher Price Refractometer

Revision:

6.2.1.11 1 - Fisher Scientific Refractometer

Section Revised:

6.3.1.5 NIST certified Brass Calibration Weights

Revision:

6.3.1.5 NIST traceable Brass Calibration Weights

Section Revised:

4.1.2 At the time of sample receipt, all initial information requested by the COC is completed by the employee performing sample log-in duties. The date and time sample was received is noted on the COC, with the signature or initials of the receiver.

4.1.3 During the log-in phase, samples are individually checked for leaks or contamination (i.e., samples opened in transport) and that information provided on COC matches samples (i.e., correct number of samples, correct analysis requested, correct sampling containers and/or correct sampling media, sample number on containers matches sample number on COC form, etc.). Any inconsistencies, leaks (leaking multiphasic samples cannot be considered representative), or contamination may be cause for sample rejection. The condition of the sample is noted on the COC with a stamp that states whether the samples are acceptable or unacceptable. Samples deemed unacceptable are placed in the Hold bin and documented in the Hold Log. The samples are held for 90 days and then discarded unless the client authorizes analysis in written form or request that the samples be sent back to the client.

Revision:

4.1.2 At the time of sample receipt, all initial information requested by the COC is completed by the employee performing sample log-in duties. The date and time sample was received is noted on the COC, with the signature or initials of the receiver. The condition of the sample is noted in Wavefront as the samples are received into the LIMS system. Samples deemed unacceptable are marked unacceptable in Wavefront. The client is called about the samples and a note is placed in Goldmine. The samples are then placed in the hold bin. The samples are held for 90 days and then discarded unless the client authorizes analysis in written form or request that the samples be sent back to the client.

4.1.3 During receipt, samples are individually checked for leaks or contamination (i.e., samples opened in transport) and that information provided on COC matches samples (i.e., correct number of samples, correct analysis requested, correct sampling containers and/or correct sampling media, sample number on containers matches sample number on COC form, etc.). Any inconsistencies, leaks (leaking multiphasic samples cannot be considered representative), or contamination may be cause for sample rejection.

Section Revised:

9. SUBCONTRACTORS

Prior to any samples being subcontracted, the client is notified of the need for their samples to be analyzed by another laboratory and written approval is obtained from the client to allow the samples to be transferred. If this written approval is not received by EHS, samples will be returned to the client. When the need arises for samples to be analyzed by laboratories other than EHS, the samples are sent to competent laboratories that are accredited by the appropriate agencies. Asbestos laboratories must be NVLAP accredited and in compliance with the NVLAP handbook. Every subcontractor must be compliant with the necessary accrediting bodies prior to receipt of samples from EHS. When subcontracted, samples that are listed under EHS's scope of accreditation are to be sent to an accredited laboratory whose scope of accreditation includes at least the same scope of accreditation as EHS. EHS maintains a file for each lab that is subcontracted. This file contains all applicable accreditations for samples that are analyzed for EHS. The results (reports) from the subcontracted lab are submitted directly to the client in the original format provided to EHS. A copy of EHS's sub-contractors can be found in Appendix 1.

10. POLLUTION PREVENTION

Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Many opportunities for pollution prevention exist in laboratory operation. EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address waste generation. When it is not feasible to reduce wastes at the source, the Agency recommends recycling as the next best option. The acids used in this Method should be reused as practicable by purifying by electrochemical techniques. The only other chemicals used in this Method are the neat materials used in preparing standards. These standards are used in extremely small amounts and pose little threat to the environment when managed properly. Standards should be prepared in volumes consistent with laboratory use to minimize the disposal of excess volumes of expired standards.

Revision:

9. SUBCONTRACTORS

Clients are aware that EHS subcontracts for TEM analysis, Radon analysis and drinking water analysis. This information is listed in the EHS New Client Handbook which is given to all EHS clients. When the need arises for samples normally analyzed by EHS to be analyzed by another laboratory, the client is informed and written permission is received prior to sending out the samples. Samples are sent to competent laboratories that are accredited by the appropriate agencies. Asbestos laboratories must be NVLAP accredited and in compliance with the NVLAP handbook. Every subcontractor must be compliant with the necessary accrediting bodies and ISO/IEC 17025 prior to receipt of samples from EHS. EHS maintains a file for each lab that is subcontracted. This file contains all applicable accreditations for samples that are analyzed for EHS. The results (reports) from the subcontracted lab are submitted directly to the client in the original format provided to EHS. A copy of EHS's sub-contractors can be found in Appendix 1.

10. POLLUTION PREVENTION

Pollution prevention encompasses any technique that reduces or eliminates the quantity or the toxicity of waste at the point of generation. Many opportunities for pollution prevention exist in laboratory operation. EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address waste generation. The Pollution Prevention Act of 1990, Congress established a national policy that: pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

Section Revised:

1.2 Objectives, Policies and Authority of EHS Quality Assurance/Quality Control (QA/QC) Manual

The Quality Management System as detailed in the QA/QC Manual is issued under the authority of the President of Foxboro Capitol, Ltd. The QA/QC Manual documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work that meet customer requirements and are in compliance with ISO/IEC17025 and with NELAC standards.

EHS will continually improve the effectiveness of its QA/QC Manual and its management system through the use of the quality policy and objectives, management reviews, audit results, analysis of data, corrective and preventive actions. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies.

The QA/QC Manual is to be adhered to explicitly, except in cases of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary. Any changes made to the QA/QC Manual or departures from documented procedures must be approved in order to ensure the integrity of the management system is maintained.

1.3 Maintenance and Update Procedures of EHS QA/QC Manual

The QA/QC Manual and SOPs are maintained in the QA/QC Office. Additionally, in each department copies of the QA/QC Manual and the SOPs which relate to that department can be found. The Laboratory Director and Quality Manager review the QA/QC manual at least annually to ensure that the management system and SOPs are meeting customer requirements as well as statutory and regulatory requirements. The QA/QC Manual is revised as necessary to reflect any changes in laboratory practices. All revisions/reviews are documented in the Revisions/Review log found at the beginning of the QA/QC Manual. Each revision is brought to the attention of the corresponding department and a review log is kept to insure that each individual has read and understood the revision. Obsolete documents are removed from the manual, marked as obsolete, and placed in secure locations to insure that laboratory personnel only use current documentation. It is available at all times to EHS personnel and others including accrediting agencies. All personnel must review the QA/QC Manual and the

SOPs which relate to their department at least annually.

1.4 Maintenance of EHS SOPs (Standard Operating Procedures)

Laboratory SOPs are reviewed at least annually by the Laboratory Director and Quality Manager. They are revised as necessary to reflect any changes in laboratory practices and/or any updates to the reference methods. All revisions/reviews are documented in the S.O.P. Revisions/Review log found at the end of the Laboratory General Operations Manual. The General Operations Manual is maintained in the QA/QC Office. Copies of the latest revisions for pertinent SOPs are located in each laboratory section Operations Manual. Copies of all laboratory SOPs are located in the General Operations Manual. Invalid and/or obsolete SOP's and documents are promptly removed from use, marked as obsolete, and archived to insure that the only documents or SOP in use are current. The generation of any analytical data is based in strict accordance to the pertinent EHS S.O.P. All analytical SOPs are based on established reference methods. The SOPs may contain slight modifications to the reference method. Whenever a reference method is modified, this will be acknowledged by placing an M after the method number. All SOPs which contain a modification from the reference method shall be validated for compliance.

Revision:

1.2 Objectives, Policies and Authority of EHS Quality Assurance/Quality Control (QA/QC) Operations Manual

The Quality Management System as detailed in the QA/QC Operations Manual is issued under the authority of the President of Foxboro Capitol, Ltd. The QA/QC Operations Manual consists of the QA/QC Manual and the SOPs. The QA/QC Manual documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work that meet customer requirements and are in compliance with ISO/IEC17025 and with NELAC standards.

EHS will continually improve the effectiveness of its QA/QC Operations Manual and its management system through the use of the quality policy statement and objectives, management reviews, audit results, analysis of data, corrective and preventive actions. This QA/QC Operations Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies.

The QA/QC Operations Manual is to be adhered to explicitly, except in cases of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary. Any changes made to the QA/QC Operations Manual or departures from documented procedures must be approved in order to ensure the integrity of the management system is maintained. The QA/QC Operations Manual is maintained in the QA/QC Office. Additionally, in each department copies of the QA/QC Manual and the SOPs which relate to that department can be found.

1.3 Maintenance and Update Procedures of EHS QA/QC Manual

The Laboratory Director and Quality Manager review the QA/QC manual at least annually to ensure that the management system is meeting customer requirements as well as statutory and regulatory requirements. All revisions/reviews are documented at the end of the QA/QC Manual. Each revision is brought to the attention of the corresponding department and a review log is kept to insure that each individual has read and understood the revision. Obsolete documents are removed from the manual, marked as obsolete, and placed in secure locations to insure that laboratory personnel only use current documentation. It is available at all times to EHS personnel and others including accrediting agencies. All personnel must review the QA/QC Manual at least annually.

1.4 Maintenance of EHS SOPs (Standard Operating Procedures)

Laboratory SOPs are revised as needed by the Laboratory Director and Quality Manager. They are revised to reflect any changes in laboratory practices and/or any updates to the reference methods. All revisions are documented in the Revision log found at the end of the each SOP. Copies of the latest revisions for pertinent SOPs are located in each laboratory section Operations Manual. Laboratory SOPs are located with the QA/QC Manual in the QA/QC Operations Manual. Invalid and/or obsolete SOP's and documents are promptly removed from use, marked as obsolete, and archived to insure that the only documents or SOPs in use are current. The generation of any analytical data is based in strict accordance to the pertinent EHS SOP. All analytical SOPs are based on established reference methods. The SOPs may contain slight modifications to the reference method. Whenever a reference method is modified, this will be acknowledged by placing an M after the method number. All SOPs which contain a modification from the reference method shall be validated for compliance.

Section Revised:

4.1.4 Documentation of Acceptability

Upon examination of the sample, if the sample is found unacceptable due to lack of paperwork and/or incorrect COC or other problems, the samples are placed on Hold and the client is notified. The

samples are held until the problems are corrected or the client request disposal of the samples. Notes are put in Goldmine as to the reason they are on hold. The following statement shall be included on every final report. "The condition of the samples analyzed was acceptable upon receipt per laboratory protocol unless otherwise noted on this report."

Revision:

4.1.4 Documentation of Acceptability

Upon examination of the samples, if the samples are found unacceptable due to lack of paperwork and/or incorrect COC or other problems, the samples are received into the lab but marked unacceptable in LIMS. The samples are then placed on Hold and the client is notified. The samples are held until the problems are corrected or the client request disposal of the samples. Notes are put in Goldmine as to the reason they are on hold. The following statement shall be included on every final report. "The condition of the samples analyzed was acceptable upon receipt per laboratory protocol unless otherwise noted on this report."

Section Revised:

4.5 Data Reporting

Reports are reviewed by a trained reviewer for completeness and, after approval by the appropriate signatory or designate, released to the client. All reports whether electronic or paper are controlled and monitored to insure client confidentiality. For EHS clients a copy of the report, data worksheets, and chain-of-custody are kept in the client file. For BTS clients a copy of the chain-of-custody and any raw data are kept in files by date of receipt. These files are kept in file cabinets for a minimum of two months, for easy response to possible client questions. Every two to three months files are archived in the warehouse. Files are maintained for a minimum of ten (10) years.

Revision:

4.5 Data Reporting

Reports are reviewed by a trained reviewer for completeness and, after approval by the appropriate signatory or designate, released to the client. All reports whether electronic or paper are controlled and monitored to insure client confidentiality. For EHS clients a copy of the chain-of-custody and any raw data are kept in files by numerical report number. These files are kept in file cabinets for a minimum of two months, for easy response to possible client questions. Every two to three months files are archived in the warehouse. Files are maintained for a minimum of five (5) years.

Section Revised:

5.4 Audits/Reviews/Inspections

5.4.6 Quarterly Review

Each quarter a thorough review of laboratory procedures, practices and weekly summaries will be performed. The purpose of this audit is to identify and evaluate trends and ensure that key elements of the quality plan are up to date.

This audit review will be completed during the first month of each quarter. The Quality Manager is responsible for ensuring this review is completed, however parts of the review may be delegated to other persons who possess the technical training necessary for this review and are independent of the areas being reviewed.

This review shall include but is not limited to:

- **a.** Trend analysis for each test area
- **b.** Corrective/Preventive Actions
- **c.** Client Services
- **d.** On-Site Assessments by outside agencies
- **e.** Proficiency testing results
- **j.** Personnel updates
- **k.** Training
- **i.** Equipment/Instrumentation
- **j.** Review of corrective actions taken in response to previous Quarterly Review.

The quarterly review is reviewed by the laboratory Director and is on file in the QA/QC Library. Each quarterly review is also submitted to the management review team as a part of the Annual Management Audit (see 5.4.1.4). Any deficiencies found by a quarterly review must be addressed

immediately. Documentation of corrective actions will be signed by the Laboratory Director and the Quality Manager and filed in the QA/QC Library. The next quarterly review will detail all corrective actions arising from the prior review. If it is found that deficiencies may have affected sample results, those clients involved will be immediately notified in writing.

5.4.7 Internal QA Audit

The purpose of the Internal QA Audit is to (1) determine if the quality system contains all the policies and procedures required under ISO 17025 and the accreditations held by the laboratory and (2) determine that those policies and procedures are being followed. This audit will be performed by a representative from each department under the guidance of the Laboratory Administrator and the Quality Manager and reviewed and signed by the General Manager. This audit will be performed and completed each January. All deficiencies found by this audit will be addressed and responses documented no later than the end of the 1st quarter of the year.

The Internal QA Audit will include but is not limited to the following:

- **i.** Analysis of Quarterly Reviews
- **j.** Detailed review of AIHA Assessor Checklist
- **k.** Detailed review of NVLAP Assessor Checklist
- **l.** Detailed review of any state Assessor Checklist
- **m.** A narrative summary of findings
- **n.** Deficiencies, corrective/preventive actions and responses
- **o.** Recommendations for improvement

5.4.8 Annual Management Audit

An annual audit is performed by the Laboratory Management Review Team. The purpose of this audit is to examine the entire laboratory system and to ensure adequacy for the achievement of the laboratory quality objectives. The Laboratory Management Review Team will include at a minimum; the General Manager, Laboratory Administrator, Laboratory Director, Quality Manager, and all section supervisors.

The Annual Management Audit will be accomplished through a series of meetings of the Management Review Team. The first meeting will take place during the first week of February. At the first meeting, each team member will be assigned different segments of the review, which they will be required to perform and report their findings to the entire team. A time frame to complete the assigned tasks will also be determined at that meeting. Subsequent meetings will consist of presentations by the individual members, and questions and discussions by the team. These meetings will continue until all review categories have been fully addressed.

The key areas to be reviewed are:

- **p.** Previous Annual Management Audit
- **q.** Internal QA Audit
- **r.** Status of Accreditations
- **s.** Proficiency Testing Programs
- **t.** Quality Assurance Manual Review
- **u.** Operations Manual Review
- **v.** Corrective/Preventive Actions
- **w.** New Methods Offered
- **x.** Pre-existing Methods
- **y.** Personnel
- **p.** Recommendations for Improvement
- **z.** One Year Plan
- **aa.** General Status

This audit shall be completed by the end of the first quarter.

5.4.9 Client Services Calls

Every day clients are asked on the service which is provided. The feedback from clients is analyzed and used to improve the management system, testing services, and customer service. If a client has a concern or complaint, a complaint documentation form will be generated by client services, and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. The Accounting, Customer Service and Marketing Departments review client surveys. Customer calls are documented on Goldmine.

Revision:

5.4 Audits/Reviews/Inspections

5.4.10 Quarterly Review

Each quarter a review of laboratory procedures, practices will be performed. The purpose of this audit is to identify and evaluate trends and ensure that key elements of the quality plan are up to date.

This audit review will be completed during the first month of each quarter. The Quality Manager is responsible for ensuring this review is completed.

The Quality Manager will use a laboratory review checklist specific to each laboratory and will review the following during the audit:

f. On-Site Assessments by outside agencies
g. Previous internal audits
h. Proficiency testing results
i. Nonconformities
j. Review of Corrective/Preventive actions and follow-ups procedures

Once the quarterly review is finished a copy of the audit is given to the corresponding laboratory supervisor with a date by which the deficiencies must be corrected. Documentation of the corrective actions showing the type of correction, by whom and when the correction was performed or will be finalized will be signed by the Quality Manager and filed in the respective laboratory binder. Each quarterly review is also submitted to the management review team as a part of the Annual Management Audit (see 5.4.1.4). Any deficiencies found by a quarterly review must be addressed immediately. The next quarterly review will detail all corrective actions arising from any prior quarterly, management and internal reviews. If it is found that deficiencies may have affected sample results, those clients involved will be immediately notified in writing.

5.4.11 Internal QA Audit

The purpose of the Internal QA Audit is to (1) determine if the quality system contains all the policies and procedures required under ISO 17025 and the accreditations held by the laboratory and (2) determine that those policies and procedures are being followed. This audit will be performed by the Quality Manager and reviewed and by the General Manager. This audit will be performed and completed by end of the 2nd quarter of the year. All deficiencies found by this audit will be addressed and corrections documented showing the type of correction, by whom and when the correction was performed or will be finalized will be signed by the Quality Manager and filed in the respective laboratory binder

The Internal QA Audit will include but is not limited to the following:

q. Analysis of Quarterly Reviews
r. Detailed review of AIHA Assessor Checklist
s. Detailed review of NVLAP Assessor Checklist
t. Detailed review of any state Assessor Checklist
u. A narrative summary of findings
v. Deficiencies, corrective/preventive actions and responses
w. Recommendations for improvement

5.4.12 Annual Management Audit

An annual audit is performed by the Laboratory Management Review Team. The purpose of this audit is to examine the entire laboratory management system and testing activities to ensure their continuing suitability and effectiveness and to introduce necessary changes or improvements. The Laboratory Management Review Team will include at a minimum; the General Manager, Laboratory Administrator, Laboratory Director, Quality Manager, and all section supervisors.

The Annual Management Audit will be accomplished through a series of meetings of the Management Review Team. The first meeting will take place during the first quarter of the year. At the first meeting, each team member will be assigned different segments of the review, which they will be required to perform and report their findings to the entire team. A time frame to complete the assigned tasks will also be determined at that meeting. Subsequent meetings will consist of presentations by the individual members, and questions and discussions by the team. These meetings will continue until all review categories have been fully addressed. This audit shall be completed by the end of the second quarter.

The key areas to be reviewed are:

a. Suitability of policies and procedures in Quality Manual
b. Review of the overall objectives found in Quality Manual
c. Previous Annual Management Audit
d. Previous Internal QA Audit reports
e. Previous Quarterly Audit reports
f. Corrective/Preventive actions
g. Onsite assessments by external bodies
h. Status of Accreditations
i. Proficiency testing programs and results

j. Changes in the volume and type of work
k. Customer feedback and complaints
l. Quality Control activities
m. Personnel resources and training
n. Recommendations for Improvement
o. One Year Plan
p. General Status

Findings from the management review and the actions that arise from them shall be documented. Documentation will include what is to be done, by whom and by when it will be completed. Management shall ensure that those actions are carried out within an appropriate and agreed timeframe. Progress and follow-up of these actions will be reported in the quarterly QA reports.

5.4.13 Client Services Calls

Every day clients are asked on the service which is provided. The feedback from clients is analyzed and used to improve the management system, testing services and customer service. Customer calls are documented by notes on Goldmine, a computer customer base program. If a client has a significant complaint, a Corrective/Preventive Action form will be generated by Customer Service and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. The Accounting, Customer Service and Marketing Departments review Goldmine customer notes. Goldmine notes are reviewed in the Yearly Management Audit to assess customer feedback.

11/08/10

Section Revised:

Section 4.3.3: Changed year on analytical run description to 2010. (ex. 060310W)

Section 5.5: Added reference to SOP F-13

Section 6:3.2.15: Changed method number from ASTM E1979-98 to ASTM E1979-04

QUALITY MANUAL

for the

Survey Products Group Laboratory

W. L. Gore and Associates, Inc.
100 Chesapeake Blvd.
Elkton, MD 21921

Responsible Parties

Name	Function (Unit)	Phone	Signatures	Date
Harry Anderson, III	Business Leader (Laboratory Director and Product Specialist for GORE™ Surveys for Oil and Gas Exploration and Minerals Exploration	(410)506-4852		7-29-10
Jay W. Hodny, Ph.D.	Product Specialist – GORE™ Surveys for Environmental (Deputy Laboratory Director)	(410)506-4774		7-29-10
Don D'Apolito	Laboratory Leader (Laboratory Manager, Technical Director, Deputy Quality Manager)	(410)506-4880		7/29/10
James E. Whetzel	Quality Manager, (Deputy Product Specialist for GORE™ Surveys for Environmental)	(410)506-4779		7/29/10
Ian McMullen	Deputy Laboratory Manager, Technical Director	(410)506-4971		7/29/10
Paul Harrington	Deputy Product Specialist for GORE™ Surveys for Oil and Gas Exploration and Minerals Exploration	(410)506-4773	for Paul Harrington	7-29-10

Revision Number:	2	Effective Date:	August 1, 2010

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SECTION 2 - TABLE OF CONTENTS

SECTION 3 – INTRODUCTION AND SCOPE

The purpose of this *Quality Manual* is to outline the quality system for the laboratory. The *Quality Manual* defines the policies, procedures, and documentation that assure analytical services continually meet a defined standard of quality that is designed to provide clients with data of known and documented quality and, where applicable, demonstrate regulatory compliance.

POLICY
The Quality Manual sets the standard under which all laboratory operations are performed including the laboratory's organization, objectives, and operating philosophy.

3.1 Scope of Testing

The laboratory scope of analytical testing services includes the analysis of GORE™ Modules that have been exposed to soil vapor, air, and water. Modules are used for environmental testing, oil and gas exploration surveys, and mineral exploration surveys.

The GORE™ Survey uses several different methods for the analysis of the modules. A list of current methods follows:

Environmental Methods:
SPG-WI-0292 – Level 2 Screening Method
SPG-WI-0318 - Environmental Analysis By 8260 Modified Method

Oil and Gas Exploration Methods:
SPG-WI-0300 – Geochemical Exploration Analysis Method
SPG-WI-0332 – Oil Slick Geochemical Method

Minerals Exploration Method:
SPG-WI-0311 – Geochemical Minerals Exploration Method

Compounds associated with each of the analytical methods are noted in SPG-FCD-8893. At present, accreditation to DOD, NELAC and ISO-17025 standards are applicable to only the Environmental Analysis by 8260 Modified Method, SPG-WI-0318, for water, soil gas, and air and the associated compounds as noted in SPG-FCD-8893.

3.2 Table of Contents and References

The table of contents is in Section 2 of this Manual. This *Quality Manual* uses the references from the 2003 NELAC Standard, Chapter 5, Appendix A. Additional references are as follows:

SW846 Method 5040A Revision 1, November 1992 Proposed August 31, 1993, Sorbent Cartridges from Volatile Organic sampling train GC/MS

Adapted 7.4 Qualitative analysis
8.0 Quality Control

SW 846 Method 8000C Revision 3, March 2003, Determinative Chromatographic Separations

SW 846 Method 8260C Revision 3, August 2006, Volatile Organic Compounds by Gas Chromatography/ Mass Spectrometry (GC/MS)

7.3 Initial Calibration
7.6 Qualitative Analysis

SW 846 Method 8270C Revision 3, December 1996 Semivolatile Organic Compounds by Gas Chromatography/ Mass Spectrometry (GC/MS)

3.3 Glossary and Acronyms Used

Quality control terms are generally defined within the section that describes the activity.

Glossary
Appendix A, Chapter 1, 2003 NELAC Standards

The following terms are in addition or supersede those included in Appendix A, Chapter 1, 2003 NELAC Standards.

Accuracy - the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations The bias is used as the data quality indicator as recommended by EPA and ASTM rather than the term accuracy.

Bias - the systematic or persistent distortion of a measurement process that deprives the results of representativeness (i.e., the expected sample measurement is different from the sample's true value). It is calculated as the percent recovery, percent error, or percent difference.

BFB Tuning Check Standard: A GC/MS tuning check standard prepared from a 4-Bromofluorobenzne solution. Acceptance criteria are listed in the appropriate method.

Calibration Standard: A substance or reference material used to calibrate an instrument. (NELAC)

Continuing Calibration Verification Standard (CCV): A standard made from the same source as the calibration curve used to verify the calibration.

Demonstration of Capability: A procedure to establish the ability of the analyst to generate acceptable accuracy. (NELAC)

Field Blank - a clean module that is carried to the sampling site, exposed to the sampling conditions, and returned to the laboratory and treated as a sample. Field blanks are used to check for analytical artifacts or background interference from sampling procedures as a result of field operations. (e.g., sample container opened, module removed, and replaced in same sample container).

Independent Performance Check Standard - a substance or reference material (also referred to as a second source reference standard) obtained from a source independent from the source of the calibration standards. It is generally used to establish the stability of the analytical system, but may be used to assess the performance of all or a portion of the measurement system.

Initial Calibration Verification Standard (ICV): A check standard analyzed to verify the initial calibration. The ICV is prepared from a source independent from the source of the

calibration standards. The ICV is analyzed after the last calibration standard and before the method blank. A laboratory control sample (LCS) can be used as an ICV.

Instrument Blank – an empty thermal desorption tube that is processed through the instrumental steps of the measurement process. An Instrument Blank is used to determine the absence or presence of instrument contamination.

Instrument Performance Check Solution (IPC): A substance or reference material (also referred to as a second source reference standard) obtained from a source independent from the source of the calibration standards. It is generally used to establish the stability of the analytical system, but may be used to assess the performance of all or a portion of the measurement system. This solution may be used as the Initial Calibration Verification Check Standard (ICV) or Laboratory Control Sample (LCS).

Laboratory Duplicate - two samples taken from, and representative of, the same population and carried through all steps of the analytical procedure in an identical manner. Laboratory duplicate samples are used to assess variance of the total analysis process.

Laboratory Fortified Matrix (LFM): A prepared sample to which known quantities of the analytes are added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations. The LFM is also referred to as a Matrix Spike (MS). A duplicate of the LFM is also called a matrix spike duplicate (MSD).

Limit of Detection (LOD): an estimation of the minimum amount of a substance required to be detected at 99% confidence. At the LOD the false positive rate is 1%.

Limit of Quantitation (LOQ): the lowest concentration that produces a quantitative result within the required precision and bias.

Linear Calibration Range: The concentration range over which the instrument response is linear. Laboratory Control Sample (LCS): A packed sorbent tube to which known quantities of the analytes are added in the laboratory. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements. The LCS is also referred to as a Laboratory Fortified Blank (LFB).

Manufacturing Blank: Selected modules from a given manufacturing lot that have completed the manufacturing process including the thermal treatment.

Material Safety Data Sheet (MSDS): Written information provided by vendors, concerning a chemical's toxicity, health hazards, physical properties, fire and reactivity data including storage, spill and handling precautions.

Method Blank: Clean sorber(s) processed through all steps of the analytical procedure simultaneously with and under the same conditions as samples. The Method Blank is also referred to as the Laboratory Reagent Blank or Preparation Blank.

Method Detection Limit (MDL): The minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, qualitatively or quantitatively measured, and reported to be greater than zero. At the MDL the false

negative rate is 1%. The MDL is used to help determine the LOD and is typically less than the LOD.

Percent Recovery (%R) - a measure of bias calculated as follows:

For spiked blanks and samples:

$$\%\,Rms = \frac{S - U}{Csa} \times 100$$

For standards and reference materials:

$$\%\,Rs = \frac{Result}{True\ Value} \times 100$$

where: S = measured concentration in spiked aliquot
U = measured concentration in unspiked aliquot
Csa = actual concentration of spike added

Note: Does not give a valid measure of bias when $U > 4 \times Csa$

Performance Evaluation Sample: A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to them. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms. (NELAC).

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. QC samples may be Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking.

Quantitation - calculation to determine the mass of an analyte using standards of known concentration and same identity.

Mass concentration calculation:

$$Concentration, ug = \frac{As \times Cis \times D}{Ais \times RF_{avg}}$$

where: As = Peak area of the analyte or surrogate
Ais = Peak area of the internal standard
Cis = Concentration of the internal standard, ug
D = Dilution factor, if the sample was diluted prior to analysis.
If no dilution was made, D = 1.

Relative Percent Difference (RPD) - a measure of the precision of duplicate measurements calculated as follows:

$$RPD = \frac{R1 - R2}{(R1 + R2)/2} \times 100$$

where: R1 = Larger of two observed values

R2 = Smaller of two observed values

Reporting Limit (RL) or Limit of Quantitation (LOQ): The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. (NELAC) Client-specific or project-specific RLs may be higher or lower than the standard laboratory RLs.

Response Factor (RF) – the ratio between a signal response produced by an analyte, and the quantity of analyte which produced the signal.

$$RF = \frac{As \times Cis}{Ais \times Cs}$$

where: As = Peak area of the analyte or surrogate
Ais = Peak area of the internal standard
Cs = Concentration of the analyte or surrogate
Cis = Concetrati0n of the internal standard

Semi-quantitation - estimate of mass based on a single level reference standard or calibration based on a dissimilar identity.

Standard Deviation – the measure of variation within a statistical population as determined by the square root of the average square distance from the data points to the mean.

Where:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

σ = standard deviation

n = number of data points

x = value of data point

Stock Standard Solution: A concentrated solution containing the method analytes that is purchased from a commercial source.

Trip Blank - a clean module, sealed in it's container, that is carried to the sampling site and transported to the laboratory for analysis without having been exposed to sampling procedures. Trip blanks are used to check for background interference from sampling and analytical procedures as a result of transport.

Tuning - the process of adjusting a measurement device or instrument, before its use, to ensure that it works properly and meets established performance criteria (e.g., mass tuning for mass analysis).

Acronyms

A list of acronyms used in this document and their definitions are:

AA	–	Accrediting Authority
ANSI	–	American National Standards Institute
ASQC	–	American Society for Quality Control

ASTM	–	American Society for Testing and Materials
Blk	–	Blank
°C	–	degrees Celsius
cal	–	calibration
CAS	–	Chemical Abstract Service
CCV	–	Continuing calibration verification
COC	–	Chain of custody
DO	–	Dissolved oxygen
DOC	–	Demonstration of Capability
DOD	–	Department of Defense
EPA	–	Environmental Protection Agency
g/L	–	grams per liter
GC/MS	–	gas chromatography/mass spectrometry
ICP-MS	–	inductively coupled plasma-mass spectrometry
ICV	–	Initial calibration verification
IPD	-	Industrial Products Division
IS	-	Internal Standard
IT	-	Information Technology
ISO/IEC	–	International Organization for Standardization/International Electrochemical Commission
ISU	-	Internal Standard Unit
lb/in2	–	pound per square inch
LCS	–	Laboratory control sample
LFB	–	Laboratory fortified blank
LOD	-	Limit of Detection
LOQ	-	Limit of Quantification
MDL	–	method detection limit
mg/Kg	–	milligrams per kilogram
mg/L	–	milligrams per liter
MS	–	matrix spike
MSD	–	matrix spike duplicate
NELAC	–	National Environmental Laboratory Accreditation Conference
NELAP	–	National Environmental Laboratory Accreditation Program
NIST	–	National Institute of Standards and Technology
ppb	-	parts-per-billion
ppm	-	parts-per-million
ppbV	-	parts-per-billion by volume
ppmV	-	parts-per-million by volume
PT	–	Proficiency Test(ing)
PTOB	–	Proficiency Testing Oversight Body
PTPA	–	Proficiency Testing Provider Accreditor
QA	–	Quality Assurance
QC	–	Quality Control
QM	–	*Quality Manual*
QAM	–	Quality Assurance Manager
QSM	–	Quality System Manual
RL	–	Reporting level
RPD	–	Relative percent difference
RSD	–	Relative standard deviation
SOPs	–	Standard operating procedures
SPG	-	Survey Products Group
spk	–	spike
std	–	standard
TD	-	thermal desorption
TNI	-	The NELAC institute
ug	-	microgram
ug/L	–	micrograms per liter
ug/m^3	-	micrograms per cubic meter

UV	–	Ultraviolet
VOC	–	Volatile organic compound
WET	–	Whole effluent toxicity

SECTION 4 – ORGANIZATIONAL ROLES AND RESPONSIBILITIES

POLICY

The laboratory is a legally identifiable organization. Through application of the policies and procedures outlined in this chapter, the laboratory assures that it is impartial and that personnel are free from undue commercial, financial, or other undue pressures that might influence their technical judgment. The laboratory is responsible for carrying out testing activities that meet the requirements of ISO 17025, DOD QSM, and the NELAC Standard and that meet the needs of the client.

4.1 Laboratory Organizational Structure

Policy

The Survey Products Group is part of W. L. Gore & Associates, Inc., an international company specializing in creative technologies. The W. L. Gore & Associates ongoing program of research, development, engineering, and service has produced what is known as the "total system approach."

The organizational structure within Gore is known as the "Lattice System". An outgrowth of the business philosophy of the founder, Bill Gore, the lattice system is characterized by team approaches to problem solving, direct communication between associates, and commitment on the part of associates to the enterprise. The four guiding principles in the organization are fairness, freedom, commitment, and waterline.

Fairness describes the associates' approach in relationships with customers, suppliers, and each other. Gore associates have the *Freedom* to explore and make their own commitments and to contribute to the enterprise in a way that maximizes their individual strengths. Gore associates are expected to make and honor C*ommitments* to activities that contribute to the success of the enterprise. Finally, the involvement of the proper associates in decisions that are critical to Gore business or its reputation is referred to as the *Waterline* principle.

The laboratory is a commercial laboratory analyzing samples in support of the Survey Products Group (SPG) businesses. Three businesses exist within SPG, GORE™ Surveys for Environmental, GORE™ Surveys for Oil and Gas Exploration, and GORE™ Surveys for Mineral Exploration.

The tax ID number is available upon request.

The laboratory operates in Elkton, MD.

The organizational structure, as indicated in Figures 1 and 2 (below), minimizes the potential for conflicting or undue interests that might influence the technical judgment of analytical personnel. At present, a project manager is also fulfilling the role of quality manager.

Figure 1.

Survey Products Group Organizational Chart

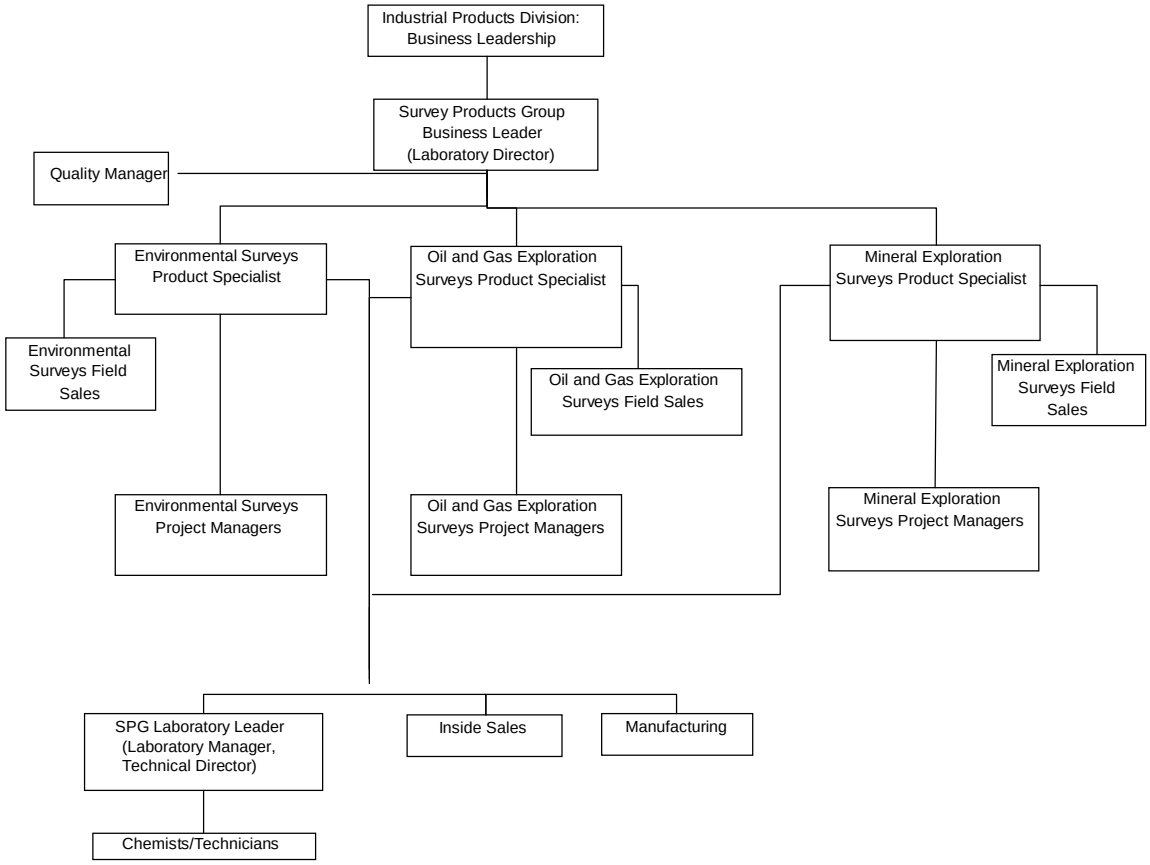
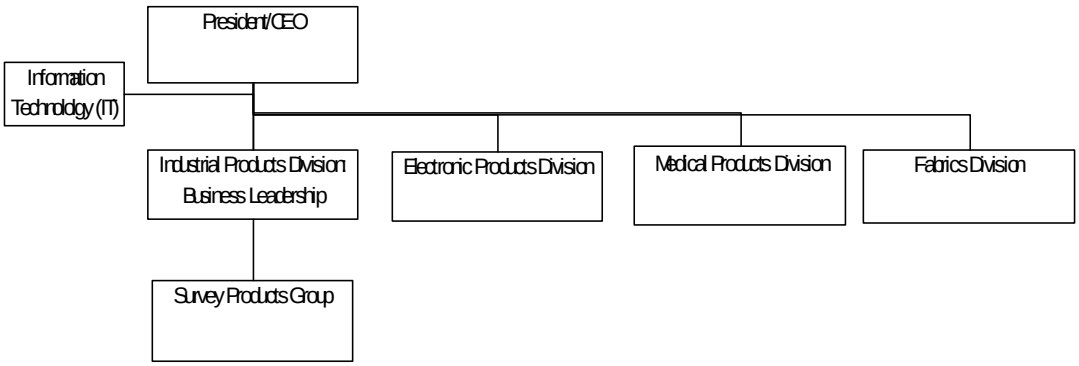

Industrial Products Division: Business Leadership
Survey Products Group Business Leader (Laboratory Director)
Quality Manager
Environmental Surveys Product Specialist
Oil and Gas Exploration Surveys Product Specialist
Mineral Exploration Surveys Product Specialist
Environmental Surveys Field Sales
Oil and Gas Exploration Surveys Field Sales
Mineral Exploration Surveys Field Sales
Environmental Surveys Project Managers
Oil and Gas Exploration Surveys Project Managers
Mineral Exploration Surveys Project Managers
SPG Laboratory Leader (Laboratory Manager, Technical Director)
Inside Sales
Manufacturing
Chemists/Technicians

Figure 2.

Survey Products Group Relationship to Parent Organization



4.2 Responsibility and Authority

MANAGEMENT includes the titles Business Leader (fulfills role of Laboratory Director), Laboratory Leader (fulfills NELAC role of Laboratory Manager and Technical Director), Product Specialist, and the Quality Manager.

Policy

Management has overall responsibility for the technical operations and authority needed to generate the required quality of laboratory operations.

Management's commitment to quality and to the Quality System is stated in the Quality Policy, which is upheld through the application of related policies and procedures.

Management ensures technical competence of personnel operating equipment, performing tests, evaluating results, or signing reports, and limits authority to perform laboratory functions to those appropriately trained and/or supervised.

Procedure

The assignment of responsibilities, authorities, and interrelationships of the personnel who manage, perform, or verify work affecting the quality of environmental tests is documented in Figure 1 and job descriptions found in section 17.

Management bears specific responsibility for maintenance of the Quality System. This includes defining roles and responsibilities to personnel, approving documents, providing required training, providing a procedure for confidential reporting of data integrity issues, and periodically reviewing data, procedures, and documentation.

Management ensures that audit findings and corrective actions are completed within required time frames.

Designated alternates are appointed by management during the absence of the Laboratory Leader or the Quality Manager, and always if the absence is more than 15 days.

Management is responsible for defining the minimal level of education, qualifications, experience, and skills necessary for all positions in the laboratory and assuring that technical staff have demonstrated capabilities in their tasks.

Training is kept up to date as described in Section 17.4 by periodic review of training records and through employee performance review.

SECTION 5 – QUALITY SYSTEMS

The laboratory's Quality System is documented in this *Quality Manual* and associated quality system documents. Together they describe the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of the organization for ensuring quality in its work processes, products, and services.

5.1 Quality Policy

A Quality Policy statement, including objectives and commitments by top management is required in the Quality Manual. The quality policy is signed and dated, and is issued under the authority of the highest level of laboratory management, which demonstrates management's commitment to integrity, ethics, the quality system and associated standards.

Quality Policy Statement

The objective of the quality system and the commitment of management are to consistently provide our customers with data of known and documented quality that meets their requirements. Our policy is to use good professional practices, to maintain quality, to uphold the highest quality of service, and to comply with the DOD QSM, NELAC, and ISO 17025 standards. The laboratory ensures that personnel are free from any commercial, financial, and other undue pressures, which might adversely affect the quality of work. This policy is implemented and enforced through the unequivocal commitment of management, at all levels, to the Quality Assurance (QA) principles and practices outlined in this manual. However, the primary responsibility for quality rests with each individual within the laboratory organization. Every laboratory employee must ensure that the generation and reporting of quality analytical data are a fundamental priority. Every laboratory employee is required to familiarize themselves with the quality documentation and to implement the policies and procedures in their work. All employees are trained annually on ethical principles and procedures surrounding the data that is generated. The laboratory maintains a strict policy of client confidentiality.

The Survey Products Group believes that good quality is good business. Achieving good quality is not a static process, but a dynamic one. The Survey Products Group is committed to Operational Efficiency and Customer Satisfaction through:

- Dialogue with Customers to Accurately Understand Their Needs
- Associate Involvement
- Continuous Improvement
- Measuring Performance to Established Objectives
- Ongoing Communication with All Associates

Harry Anderson
SPG Business Leader/ Surveys for Exploration
Product Specialist

Jay Hodny, Ph.D.
Surveys for Environmental
Product Specialist

James E. Whetzel, Quality Manager

Don D'Apolito, Laboratory Leader

5.2 Quality Manual

Policy

Management ensures that the laboratory's policies and objectives for quality are documented by reference or by inclusion in the *Quality Manual*, and that the *Quality Manual* is communicated to, understood by, and implemented by all personnel concerned.

Policy

Where the *Quality Manual* documents laboratory requirements, a separate SOP or policy is not required.

Procedure

All employees document through training logs that they have read and understood the *Quality Manual*, including the quality policy. The *Quality Manual* is reviewed annually by the Business Leader, Product Specialists, Laboratory Leader, and the Quality Manager.

The *Quality Manual* is maintained current and up-to-date by the Quality Manager.

SECTION 6 – DOCUMENT MANAGEMENT

This Section describes procedures for document management, which includes controlling, distributing, reviewing, and accepting modifications. The purpose of document management is to preclude the use of invalid and/or obsolete documents.
The laboratory manages three types of documents, 1) controlled, 2) approved, and 3) obsolete.
A CONTROLLED DOCUMENT is one that is uniquely identified, issued, tracked, and kept current as part of the quality system. Controlled documents may be internal documents or external documents.
APPROVED means reviewed, and either signed and dated, or acknowledged in writing or secure electronic means by the issuing authority(ies).
OBSOLETE DOCUMENTS are documents that have been superseded by more recent versions or become unnecessary due to changes in practices.

POLICY

All documents that affect the quality of laboratory data are managed appropriate to the scope and depth required.

6.1 Controlled Documents

Policy

Documents are reviewed and approved for use at a minimum annually by the appropriate Product Specialist(s), the Quality manager, and the area leader prior to issue and made available to all applicable personnel. Documents clearly note the release for use date and when replaced or made obsolete, the final date.

Procedure

Controlled internal documents, which include general SOPs (overview documents describing a process), work instructions (detailed procedures to perform a task, including analytical methods), and form control documents, are stored and maintained through a Lotus Notes based document management system called QSi System. Currently, the QSi System is being shared with the Disk Drive Filtration Technologies (DDFT) group of W.L. Gore and Associates, Incorporated. The Document Control Procedure is noted in SPG-SOP-0413.

6.1.1 Document Changes to Controlled Documents

6.1.1.1 Paper Document Changes

Policy

Paper documents are issued to areas or individuals as needed by the Quality Manager, who maintains a distribution list (SPG Master Controlled Internal Document List. All paper documents are recalled and destroyed following obsolescence or revision.

Controlled external documents are maintained by the Quality Manager. Any additions or removal of external documents are submitted to the Quality Manager.

Procedure

Procedures for making changes to controlled documents are included in SPG-SOP-0413, Document Control Procedure.

6.1.1.2 Electronic Document Changes

Procedure
Revisions to electronic documents are made as needed according to SPG-SOP-0413. Where practicable, the altered text or new text in the draft is identified during the revision or review process to provide for easy identification of the modifications.

Electronic copies of external documents are maintained on a Lotus Notes Database, SPG Tech Team Reference Library, under the headings “Laboratory Matters” and “Quality Assurance.” Documents are added, removed, and controlled by the Quality Manager per SPG-SOP-0413.

6.2 Obsolete Documents

Policy
All invalid or obsolete documents are removed from general distribution, or otherwise prevented from unintended use.

Procedure
Obsolete documents retained for legal use or historical knowledge preservation are appropriately marked and retained.

6.3 Standard Operating Procedures and Work Instructions

Standard Operating Procedures (SOPs) and Work Instructions (WIs) are used to ensure consistency of application of common procedures, are written procedures that describe in detail how to accurately reproduce laboratory processes. SOPs document the more general organizational procedures and the handling of data and information. WIs have specifically required details to perform a method or task and provide instructions for generating information or data.

SOPs and WIs do not have to be formal documents with predefined section headings and contents. They can be less formal descriptions of procedures described in the *Quality Manual* or other documents.

Policy
Copies of all SOPs and WIs are accessible to all personnel, as needed.

Procedure
Each SOP and WI indicate the effective date, the revision number, and the signature(s) of the appropriate Product Specialist(s), document manager, and document owner.

6.3.1 Work Instructions

Work instructions provide details as to how to complete a task. Work instructions can be used for any functional area. Analytical test procedures are recorded as Work Instructions.

Policy

The laboratory has WIs for all test methods within its scope and for procedures that are part of the Quality System that accurately reflect how the analytical process is performed. Where equipment manuals or published methods accurately reflect laboratory procedures in detail, a separate SOP or WI is not required.

Any deviation from a test method is documented, including both a description of the change made and a technical justification. The deviation from a test method is reported to the client.

Procedure

Each Test Method Work Instruction includes or references (as applicable) the following:

a) identification of the test method;
b) applicable matrix or matrices;
c) detection limit;
d) scope and application, including components to be analyzed;
e) summary of the test method;
f) definitions;
g) interferences;
h) safety;
i) equipment and supplies;
j) reagents and standards;
k) sample collection, preservation, shipment and storage;
l) quality control, including acceptance criteria (5.4.10.6);
m) calibration and standardization;
n) procedure;
o) data analysis and calculations;
p) method performance;
q) pollution prevention;
r) data assessment and acceptance criteria for quality control measures;
s) corrective actions for out-of-control ;
t) contingencies for handling out-of-control or unacceptable data;
u) waste management;
v) references; and, any tables, diagrams, flowcharts and validation data.

SECTION 7 – REVIEW OF REQUESTS, TENDERS AND CONTRACTS

POLICY

The review of all new work assures that oversight is provided so that requirements are clearly defined, the laboratory has adequate resources and capability, and the test method is applicable to the customer's needs. This process assures that all work will be given adequate attention without shortcuts that may compromise data quality.

Contracts for new work may be formal bids, signed documents, verbal, or electronic.

PROCEDURE

7.1 Procedure for the Review of Work Requests

7.1.1 Project Manager and Lab Leader Review

For requests for proposals or quotations and for projects having specific Statement of Work terms and projects of greater than 50 modules, the Project Manager and Laboratory Leader together determine if the laboratory has the necessary accreditations, resources, including schedule, equipment, deliverables, and personnel to meet the work request.

7.1.2 Field or Inside Sales Review

For routine projects (repeat customers with requirement similar to previous projects), a review by the Field or Inside Sales associate using information regarding the recent laboratory schedule and sampler inventory is considered adequate. This person confirms that the laboratory has any required certifications, that it can meet the client's data quality and reporting requirements, and that the lab has the capacity to meet the clients turn around needs.

7.1.3 Product Specialist Review

For complex (e.g. non-standard method or reporting requirements), the proposed work contract is given to the Product Specialist for review. The Product Specialist will in turn consult with the appropriate personnel to evaluate such items as, but not limited to:

- contractual obligations, bonding issues and payment terms
- method capabilities, analyte lists, reporting limits, and quality control limits
- turnaround time feasibility
- QA/QC issues, including certification/accreditation
- formal laboratory quote
- final report formatting and electronic deliverable documents
- time required to keep sample in house
- final sample disposal requirements
- review PT sample results

The Product Specialist submits the bid and formal quote to the client. The Product Specialist or his/her designee maintains electronic and/or hard copies of all signed contracts.

7.2 Tenders

Quotes (or tenders) may be verbal or written. Review of quotes are performed by the reviewer of the project request prior to submission to the customer. If the reviewer is unavailable, the Product Specialist or their designee may review the quote. When a specific method is not requested by a client, the laboratory will choose an appropriate method to meet all project specifications.

7.3 Contracts

Contracts may be verbal or written agreements to the quote. All differences between the request and the final contract are resolved and recorded before any work begins. It is necessary that the contract be acceptable to both the laboratory and the client. The client is informed of any deviation from the contract including the test method or sample handling processes. The review process is repeated when there are amendments to the original contract by the client.

7.4 Documentation of Review

Records are maintained for every contract or work request, including any work to be subcontracted, when appropriate. This includes pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. Verbal and written communication and signed contracts and amendments are saved electronically and stored on the network drive. The parties involved are notified by e-mail.

SECTION 8 – SUBCONTRACTING OF TESTS

A SUBCONTRACT LABORATORY is defined as a laboratory external to this laboratory, or at a different location than the address indicated on the front cover of this manual, that performs analyses for this laboratory.

POLICY

When subcontracting analytical services, the laboratory assures work requiring accreditation is placed with an appropriately accredited laboratory or one that meets applicable statutory and regulatory requirements for performing the tests.

PROCEDURE

A confidential list of subcontractors is maintained, as is the copy of the certificate and analyte list for subcontractors which may be maintained as evidence of compliance. The laboratory notifies the client of the intent to subcontract the work in writing. The laboratory gains the approval of the client to subcontract their work prior to implementation, preferably in writing. The laboratory performing the subcontracted work is identified in the final report. The laboratory assumes responsibility to the client for the subcontractor's work, except in the case where a client or a regulating authority specified which subcontractor is to be used.

SECTION 9 – PURCHASING SERVICES AND SUPPLIES

POLICY

The laboratory ensures that purchased supplies and services that affect the quality of environmental tests are of the required or specified quality by using approved suppliers and products. Any changes to supplier or products must be approved by the Product Specialists and Quality Manager.

POLICY

The laboratory has procedures for purchasing, receiving, and storage of supplies that affect the quality of environmental tests.

PROCEDURE

The Laboratory Leader (Laboratory Manager) or his/her designee reviews and approves the supplier of services and supplies and approves technical content of purchasing documents prior to ordering.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality.

The laboratory keeps a confidential list of approved suppliers and materials, SPG-FCD-8895.

All laboratory supplies and services are ordered through the W.L. Gore & Associates corporate purchasing department (MRO).

New suppliers are evaluated based on ability to supply products of sufficient quality within required time frames. A rating is given to each supplier as follows:
A - rating given to new suppliers/ service providers and suppliers/ service providers who provide consistently provide products in times processed and of required quality.
B- rating given to suppliers/ service providers who have missed promised delivery times or incorrect products.
C - rating given to suppliers/ service providers with B rating who have missed promised delivery times, provided incorrect products or services, or products/ services of unacceptable quality.
Dropped - indicates suppliers/ service providers dropped from the approved vendor list due to while having a C rating missed promised delivery times, provided incorrect products or service, or products/ service of unacceptable quality.
Other indicators include:
S - Supplier, including, but necessarily limited to analytical standard suppliers and gas suppliers.
P - Service Provider, including, but necessarily limited to calibration services, transportation services, instrument repair services.
Suppliers or service providers can regain a higher rating following 6 months without missing delivery times, or errors in providing products or services.

New materials are evaluated based on their compatibility with required specifications according to the SPG Change Management Procedure, SPG-SOP-0463.

PROCEDURE
Receipt of Supplies:
Supplies received are reconciled against the packing list and inspected for damage. Supplies, reagents and chemical standards are checked-in. Containers are labeled with receipt date, initials of lab associate, and expiration date (where appropriate) and distributed to the appropriate individuals, departments, or storage areas.

Storage of Supplies:
Supplies received are stored according to manufacturer's instructions, laboratory SOP, or test method specifications.

SECTION 10 – SERVICE TO THE CLIENT

The laboratory collaborates with clients and/or their representatives in clarifying their requests and in monitoring of the laboratory performance related to their work. Each request is reviewed to determine the nature of the request and the laboratory's ability to comply with the request within the confines of prevailing statutes and/or regulations without risk to the confidentiality of other clients.

Through follow-up phone calls and/or email communication, customers are asked to provide feedback, both positive and negative, on services received. Records of communication are maintained. Where actions are requested or required, corrective or preventive actions and suggestions for improvements are handled according to SPG-SOP-0424, Handling Non-conformance Potential Problems and Corrective Actions. Records are reviewed during Management review (section 16.4).

10.1 Client Confidentiality

Policy
The laboratory confidentiality policy is to not divulge or release any information to a third party without proper authorization from the client.

Policy

All electronic data (storage or transmissions) are kept confidential, based on technology and laboratory limits, as required by client or regulation. The laboratory's data storage requirement is five years from the date of the final report.

Procedure
See SPG-SOP-0416 - Client Confidentiality Procedure for additional information regarding the Laboratory's confidentiality procedures. Access to the laboratory, offices and data storage areas are secured and restricted to authorized personnel only. See Section 18 (Accommodations and Environmental Conditions) and Section 19.6 (Control of Data) for additional information.

The general procedure for issuing data tables, contour maps, and written reports is electronically via e-mail. File format are protected against unauthorized viewing by password protecting files and sending applicable passwords via separate email.

SECTION 11 – COMPLAINTS

The purpose of this section is to assure that customer complaints are addressed and corrected. This includes requests to verify results or analytical data.

POLICY

The applicable product specialist and Quality Manager review all complaints and determine/ approve appropriate action.

PROCEDURE

All customer complaints are documented by the person receiving the complaint and addressed by appropriate personnel. If it is determined that a complaint is without merit, it is documented, and the client is contacted. If it is determined that the complaint has merit, a corrective action is initiated. See SPG-SOP-0424 for corrective action procedures.

SECTION 12 – CONTROL OF NON-CONFORMING WORK

NON-CONFORMING WORK is work that does not meet acceptance criteria or requirements. Non-conformances can include unacceptable quality control results (see Section 23 Quality of Test Results Assuring the Quality of Results) or departures from standard operating procedures or test methods. Requests for departures from laboratory procedures are approved by Quality Manager and Product Specialist and documented in Corrective Action Documentation Form (SPG-FCD-0283). If a client requests a departure from laboratory procedures, the laboratory does not have to consider that departure as a non-conformance that requires corrective action. However, that change must be documented and approved by the appropriate Product Specialist, Quality Manager, and client.

POLICY

The policy for control of non-conforming work is to identify the non-conformance, determine if it will be permitted, and take appropriate action. All employees have the authority to stop work on samples when any aspect of the process does not conform to laboratory requirements.

PROCEDURE

The responsibilities and authorities for the management of non-conforming work are detailed in SPG-SOP-0424. The procedure for investigating and taking associated corrective actions of non-conforming work are also described in SPG-SOP-0424.
Employees must immediately notify the QA Manager or Product Specialist of any non-conformance. The Quality Manager or Product Specialist reviews the significance of non-conformance and

develops a course of action. Customers are notified within one business day after completion of non-conformance review if data are questionable.
When an investigation of non-conformance indicates that corrective action requires a method to be restricted or not used until modifications are implemented, the Quality Manager or Product Specialist will immediately notify all personnel. Personnel are notified by the Quality Manager or Product Specialist when resumption of work is authorized.
Whenever a client requests a departure from laboratory procedures a project specific method/ procedure is prepared. This may be prepared by any associate, but must be approved by the appropriate Product Specialist, Quality Manager, and client. The approved procedure is documented in the project file and all laboratory personnel are notified of the requirement.

SECTION 13 – CORRECTIVE ACTION

CORRECTIVE ACTION is the action taken to eliminate the causes of an existing nonconformity, defect, or other undesirable situation in order to prevent recurrence (NELAC, 2003).

POLICY

Deficiencies cited in external assessments, internal quality audits, data reviews, complaints, or leadership reviews are documented and require corrective action. Corrective actions taken are appropriate for the magnitude of the problem and the degree of risk.

PROCEDURE

Corrective actions are initiated by any associate discovering or who is made aware of a problem or potential problem.
For routine data reviews the chemist reviewing the data are responsible for initiating the corrective action. Corrective actions following data review typically involve, but are not limited to: changes to report formats, re-integration of chromatographic peaks, recalculation of results, reanalysis of samples due to failing QC criteria. For these types of actions, documentation is made of the actions taken and kept with analysis and/or project files. Only when the error is recurring, indicates significant training needs, and/or corrective actions require changes to procedures, is the event escalated to require following steps outlined in SPG-SOP-0424. The applicable Product Specialist or Quality Manager is responsible for monitoring corrective actions and ensuring corrective actions are completed in a timely manner. If deemed necessary, work is halted until necessary actions are completed. The applicable product specialist or the Quality Manager may give approval for restart of work once corrective actions are completed.
All deficiencies are investigated and a corrective action plan developed and implemented if determined necessary. The implementation is monitored for effectiveness.
Specific corrective action protocols specified in test methods may over-ride general corrective action procedures specified in this manual.

13.1 Selection and Implementation of Corrective Actions

ROOT CAUSE is the condition or event that, if corrected or eliminated, would prevent the recurrence of a deficiency.

Policy

Once an excedence or nonconformance is noted, the first action is an investigation to determine the root cause. Records are maintained of nonconformances requiring corrective action to show that the root cause(s) was investigated, and includes the results of the investigation, SPG-FCD-0283. This form is maintained by the Quality Manager.

Where uncertainty arises regarding the best approach for analysis of the cause of excedences that require corrective action, appropriate personnel will recommend corrective actions to be initiated.

The appropriate Product Specialist or Quality Manager ensures that corrective actions are discharged within the agreed upon time frame.

13.2 Monitoring of Corrective Action

Policy

The appropriate Product Specialist or Quality Manager will monitor implementation and documentation of the corrective action to assure that the corrective actions were effective.

Procedure

Corrective action documentation is completed as outlined in SPG-SOP-0424. The initiated Corrective Action Documentation form (SPG-FCD-0283) is provided to the appropriate Product Specialist or Quality Manager for approval and follow-up The applicable Product Specialist or Quality Manager will verify the action was completed by the proposed completion date as noted on the form. Acceptable completion of the corrective action is noted on the form. If additional follow-up is required, the date of scheduled follow-up audit is noted on the form. Findings of the follow-up audit are recorded.

13.3 Technical Corrective Action

CAUSE ANALYSIS in corrective action investigates the root cause of the problem.

Policy

Sample data associated with a failed quality control are evaluated for the need to be reanalyzed or qualified.

Procedure

Unacceptable quality control results are documented, and if the evaluation requires cause analysis, the cause and corrective action are recorded according to SPG-SOP-0424.

The analyst is responsible for initiating or recommending corrective actions and ensuring that excedences of quality control acceptance criteria are documented.

Analysts routinely implement corrective actions for data with unacceptable QC measures. First level correction may include re-analysis without further assessment. If the test method SOPs addresses the specific actions to take, they are followed. Otherwise, corrective actions start with assessment of the cause of the problem.

The Product Specialist reviews the corrective action reports and suggest improvements, alternative approaches, and procedures where needed. If the data reported are affected adversely by the nonconformance, the client is notified in writing and a record of the notification is kept with the project file. Affected data must be reported with appropriate qualifiers and/or documentation of failure and potential impact on results.

The discovery of a non-conformance for results that have already been reported to the client must be immediately evaluated for significance of the non-conformance, its acceptability to the client, and determination of the appropriate corrective action.

13.4 Exceptionally Permitting Departures from Documented Policies and Procedures

Policy

The laboratory allows the release of non-conforming data only with approval by the appropriate Product Specialist or their designee on a case-by-case basis. Planned departures from procedures or policies do not require audits or investigations.

Procedure

Permitted departures for non-conformances, such as QC failures, are fully documented and include the reason for the departure, the affected SOP(s), the impact of the departure on the data, and the impacted data.

SECTION 14 – PREVENTIVE ACTION

PREVENTIVE ACTION, rather than corrective action, aims at minimizing or eliminating inferior data quality or other non-conformance through scheduled maintenance and review, before the non-conformance occurs.

Preventive action includes, but is not limited to; review of QC data to identify quality trends, regularly scheduled staff quality meetings, regularly scheduled laboratory staff meetings, and other actions taken to prevent problems.

All employees have the authority to recommend preventive action procedures, however the Product Specialist and/or Quality Manager are responsible for approving and implementing of preventive actions.

Preventive actions are documented on the Corrective Action Documentation Form, SPG-FCD-0283. The QA Manager or Product Specialist reviews the preventive actions and develops a course of action. It is the responsibility of the Quality Manager to maintain records of preventive actions. Any changes to procedures or process must be evaluated according to SPG-SOP-0463.

SECTION 15 – CONTROL OF RECORDS

RECORDS are a subset of documents, usually data recordings that include annotations, such as daily refrigerator temperatures posted to a laboratory form, lists, spreadsheets, or analyst notes on a chromatogram. Records may be on any form of media, including electronic and hard copy. Records allow for the historical reconstruction of laboratory activities related to sample-handling and analysis.

POLICY

The laboratory maintains a record system appropriate to its needs, records all laboratory activities, and complies with applicable standards or regulations as required.

PROCEDURE

The laboratory retains all original observations, calculations and derived data, calibration records, and a copy of the test report for a minimum of five years.

Retained records must contain, but are not limited to the following information:

- identity of personnel involved in sampling, sample receipt, preparation, or testing;
- information related to equipment, test methods, sample receipt, sample preparation, and data verification;
- changes to records are signed or initialed by laboratory staff and includes the reason for signature or initials, such as “reviewed by” or “sampled by”;
- records, except those generated by automated systems, are generated directly, promptly, and legibly in permanent ink;
- entries are not obliterated by methods such as erasures, over-writings, or markings. All changes are made by one line marked through the entry with the entry signed or initialed and dated by the individual making the change;
- changes other than transcription errors the reason for the correction is documented; and
- changes to electronic records are tracked through the data system audit tracking system or by notations made in the electronic system.

Types of records include, but are not limited to the following:

- records of all procedures to which a sample is subjected while in the possession of the laboratory are kept.
- sample preservation, including appropriateness of sample container and compliance with holding time requirement;
- sample identification, receipt, acceptance or rejection and log-in;
- sample storage and tracking including shipping receipts, sample transmittal forms (chain of custody form);
- documented procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples;
- all original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' worksheets and data output records (chromatograms, strip charts, and other instrument response readout records);
- written descriptions or references to the specific test methods used, which include a description of the specific computational steps used to translate parametric observations into a reportable analytical value;
- copies of final reports;
- archived SOPs;
- correspondence relating to laboratory activities for a specific project;
- all corrective action reports, audits and audit responses;
- proficiency test results and raw data;
- results of data review, verification, and cross-checking procedures;
- analytical records (such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs) that include:
- laboratory sample ID code;
- date of analysis and time of analysis
- analysis type;
- all manual calculations, e.g., manual integrations;
- analyst's or operator's initials/signature;
- sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;
- sample analysis;
- standard and reagent origin, receipt, preparation, and use;
- calibration criteria, frequency and acceptance criteria;
- data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions;
- quality control protocols and assessment;
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries;
- method performance criteria including expected quality control requirements;
- administrative records;
- personnel qualifications, experience and training records;
- records of demonstration of capability for each analyst;
- a log of names, initials and signatures for all individuals who are responsible for signing or initialing any laboratory record.
- quality records;
- internal audit reports;
- management reviews; and
- corrective and preventive actions.

15.1 Records Management and Storage

Policy
Records, including electronic records, are easy to retrieve, legible, and protected from deterioration or damage; held secure and in confidence; and are available to accrediting authorities for a minimum of five years.

Policy
The laboratory maintains a record management system for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage, and reporting.

Policy
Archived information and access logs are protected against fire, theft, loss, environmental deterioration, vermin, and in the case of electronic records, electronic or magnetic sources.

Policy
In the event that the laboratory transfers ownership or goes out of business, records are maintained or transferred according to the clients' instructions.

Procedure
All electronic records are backed-up as follows:

Instrument Acquired Data: following completion of run, data are copied to a network drive and/or another computer. Data are maintained at a minimum on two drives until data processing is complete and then data are moved to a network drive for storage.

Data stored on network drives are backed-up daily.

Access to protected records is limited to laboratory management or their designees to prevent unauthorized access or amendment.

Identification: Records are uniquely identified.

Collection: Observations, data and calculations are recorded at the time they are made. When mistakes are made in technical records, each mistake is crossed out with a single line (not erased, made illegible, or deleted) and the correct value entered alongside. Corrections are signed or initialed by the person making the correction. For electronic systems, all changes are tracked by the audit trail or by added notes. When changes are made to technical records for reasons other than for correction of transcription errors, the reason for the change is recorded on the document. Captured information must be sufficient to allow test to be repeated as performed and to identify any condition affecting uncertainty.

Storage: All records stored on electronic media are supported by the hardware and software required for retrieval and have hard-copy or write-protected backup copies.

Paper records are placed into boxes and boxes are labeled. Box label includes a sequential box number, a description of the enclosed files. The project tracking system is updated to show the box number for each project archived.

Filing: Records are filed promptly and in an organized fashion.

Access: Access to archived information is documented with an access log. The log contains at a minimum: the name of associate accessing records, the reason, date accessed, date returned, and authorization signature of the appropriate product specialist.

Disposal: Records are disposed of according to applicable regulation, client request, or after five years. Disposal of records prior to five years requires written documentation noting the

reason for disposal along with names, titles, affiliations, and signature of those requesting disposal. This disposal record must be retained for the remainder of the 5 year term.

The procedure for document control can be found in SPG-SOP-0413.

15.2 Legal Chain of Custody Records

EVIDENTIARY SAMPLE DATA are used as legal evidence.

Policy
This section is not applicable. Evidentiary samples are not analyzed within the Survey Products Group.

SECTION 16 – AUDITS AND MANAGEMENT REVIEW

AUDITS measure laboratory performance and verify compliance with accreditation/ certification and project requirements. Audits specifically provide management with an on-going assessment of the quality system. They are also instrumental in identifying areas where improvement in the quality system will increase the reliability of data. Audits are of four main types: internal, external, performance, and system.
It is the responsibility of the appropriate product specialist or Quality Manager to notify clients, in writing, for events that cast doubt on the validity of the results is completed within one business day after completion of non-conformance review.

Policy
System and area audits are conducted annually to ensure that policies and procedures meet the requirements of NELAC, ISO 17025, and DOD Environmental Laboratory quality standards. The Quality Manager along with the quality team review the quality system.

16.1 Internal Audits

Policy
The laboratory conducts internal audits of its quality system activities, including data integrity, and the use of trained and qualified personnel at least annually. Internal audits shall be conducted by an associate familiar with the technical operations of the area being audited, but not directly involved on a day-to-day basis except when it can be demonstrated that an effective audit will be carried out.

Procedure
Annually, the laboratory prepares a schedule of internal audits to be performed during the year. These audits verify compliance with the requirements of the quality system, including analytical methods, SOPs, work instructions, ethics policies, other laboratory policies, and the DOD, NELAC, and ISO 17025 quality standards.

It is the responsibility of the Quality Manager and the SPG quality team to plan and organize audits as required by the schedule and requested by management. The area audited, the audit findings, and corrective actions are recorded.

All investigations that result in findings of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. Internal audits are performed according to SPG-SOP-0461 and are conducted according to the schedule as noted in SPG-FCD-8891. Audits are reviewed after completion to assure that corrective actions were implemented and effective.

16.2 External Audits

Policy

It is the laboratory's policy to cooperate and assist with all external audits, whether performed by clients or an accrediting authority. All external audits are fully documented and tracked to closure. Visitors, including auditors, are required to enter into a non-disclosure agreement (NDA) to protect themselves and Gore from accidental or intentional disclosure of intellectual property, trade secrets, or similar information considered confidential and proprietary by Gore.

Procedure
Management ensures that all areas of the laboratory are accessible to auditors as applicable and that appropriate personnel are available to assist in conducting the audit.
Any findings related to an external audit follow corrective action procedures.
The Product Specialist or Quality Manager ensures that corrective actions are carried out within the timeframe specified by the auditor(s).

16.3 Performance Audits

Performance audits may be Proficiency Test Samples, internal single-blind samples, double-blind samples through a provider or client, or anything that tests the performance of the analyst and method.

The policy and procedures for Proficiency Test Samples are discussed in Section 23.7.

16.4 Management Reviews

Policy
Management reviews are conducted annually to ensure that the quality system and testing activities continue to be suitable and effective and to determine needed changes or improvements.

Procedure
A management review is conducted annually, and findings are recorded and communicated to SPG personnel. Area leaders assure that actions are performed within agreed time frames.

Items reviewed included, but are not limited to, the following:

- The Quality Policy Statement (Sect. 5.1)
- The suitability of policies and procedures
- Reports from managerial and supervisory personnel
- The outcome of recent internal audits
- Corrective and preventive actions
- Suggestions for improvement
- Assessments by external bodies
- The results of inter-laboratory comparisons or Proficiency Tests
- Changes in the volume and type of the work
- Client feedback
- Complaints
- Recommendations for improvement
- Other relevant factors, such as:
  - Quality control activities
  - Resources
  - Staff training

Findings from management reviews are recorded and changes and/or suggestions for improvement are reviewed, appropriate actions, responsible associates, and time frames for

completion are determined. Findings of management reviews are communicated to SPG Associates.

Management reviews are scheduled using SPG-FCD-8891.

SECTION 17 – PERSONNEL, TRAINING, AND DATA INTEGRITY

17.1 Job Descriptions

Policy

Job descriptions are available for all positions that manage, perform, or verify work affecting data quality, and are maintained by the human resources generalist.

Procedure

Job descriptions include the specific tasks, minimum education and qualifications, skills, and experience required for each position.

17.1.1 Business Leader

The Business Leader fulfills the NELAC roll of Laboratory Director and is in charge of all laboratory activities, and is the highest level manager. The Business Leader signs the *Quality Manual*. The Business leader has the authority to appoint deputies for key managerial positions. In the absence of the Business Leader, a product specialist has the authority to assume the Business Leader's role.

17.1.2 Product Specialist

The Product Specialist has overall responsibility for a specific testing service, including and related to the manufactured products, sales, client services, analytical testing, and reporting of results.

17.1.3 Laboratory Leader

Laboratory Leader fulfill the NELAC role of Technical Director and Laboratory Manager. Day to day supervision of technical laboratory operations is the responsibility of the Laboratory Leader, who is a full-time member of the staff and who assures reliable data through the following activities: monitoring quality control, corroborating the analysis performed, and signing demonstrations of capability.

The Laboratory Leader certifies that personnel with appropriate educational and/or technical background perform all tests for which the laboratory is accredited. The laboratory leader also contributes to setting standards and goals with respect to education, training, and skills of laboratory personnel.

The Laboratory Leader ensures efficient laboratory operations and that technical challenges are addressed.
The Laboratory Manager has direct access to all laboratory personnel and acts as a point of reference between laboratory personnel and the Quality Manager, Product Specialist, and Business leader. The laboratory leader is responsible for ensuring all lab associates are adequately trained on equipment and test methods. The laboratory leader:

- is knowledgeable in the NELAC quality system and has documented training and/or experience in QA/QC procedures;
- has a general knowledge of analytical procedures for which data review is performed;
- has a minimum of BA/BS in Chemistry (or other related technical degree);
- has experience in an analytical laboratory environment focused on working with gas chromatographs combined with mass spectrometers.

17.1.4 Quality Manager

The Quality Manager has the authority and responsibility for ensuring that the quality system is implemented and followed. Minimum qualifications for the Quality Manager include:

- is knowledgeable in the DOD and NELAC quality systems and has documented training and/or experience in QA/QC procedures;
- has a general knowledge of analytical procedures for which data review is performed.

The Quality Manager has direct access to the Laboratory Director and is independent of operations where the Quality Manager has oversight.

The Quality Manager:

- is the focal point for the quality system and has oversight of quality control data.
- evaluates data objectively and performs assessments without managerial influence.
- arranges for, or conducts, internal audits annually; and,
- notifies laboratory management of deficiencies (or opportunities for continuous improvement) and monitors corrective actions.
- keeps the Quality Manual current.
- signs the demonstrations of capability.
- ensures that all personnel understand their contributions to the quality system.
- evaluates effectiveness of training.
- ensures that communication takes place at all levels within the laboratory regarding the effectiveness of the quality system.
- using audit and surveillance results, control charts, proficiency testing results, data analysis, corrective and preventive actions, customer feedback and management reviews, monitors trends and continually improves the quality system.

17.1.5 Chemist

The chemist operates instrumentation and processes data according to standardized methods. A chemist:

- has a minimum of BA/BS in Chemistry (or other related technical degree)

17.1.6 Lab Technician

The operates instrumentation according to standardized methods. Lab technician:

- has a minimum of associates degree in any technical field or relevant experience.

17.1.7 Environmental or Exploration Project Manager

Project Managers are the technical contacts for all customers and responsible for helping to design surveys, helping clients to understand survey results, and acting as the focal point for all project related issues. Project manager:

- has a minimum of BA/BS in Geology, Environmental Science or related earth science degree, and /or relevant work experience in environmental investigations or oil and gas exploration, as applicable.

17.1.8 Inside Sales Associate

Inside sales associates are responsible for, but not limited to: creating and sending quotes, review of contracts, entering orders, invoicing, and acting as a liaison during initial customer contact. The inside sales associate:

- has a minimum of Associates degree;
- excellent communication skills, verbal and written;

- basic computer skills;
- high level command of word processing and data entry.

17.1.9 Field Sales Associate

Field sales associates are responsible for creating and maintaining customer relationships, managing their territory, customer follow-up on quotes and finished projects, and act as a technical spokesperson for the business. The field sales associate:

- has a minimum of BA/ BS degree in a technical discipline, preferably geological or environmental fields;
- able to use contact management software systems;
- excellent communication skills, verbal and written;

17.1.10 Manufacturing Associate

Manufacturing associates are responsible for manufacturing GORE™ Modules following all quality assurance/ quality control procedures. Manufacturing associates are also responsible for assisting in shipping and receiving of modules, and preparing modules for analysis. Manufacturing associate:

- has a minimum of Associates degree, or related work experience

17.2 Data Integrity and Ethics

DATA INTEGRITY is the result of the processes that together assure valid data of known and documented quality.

Data integrity and ethics procedures in the laboratory include training, signed, and dated integrity documentation for all laboratory employees, periodic monitoring of data integrity, and documented data integrity procedures.

Policy
Management uphold the spirit and intent by supporting integrity procedures, by enforcing data integrity procedures, and by signing and dating the data integrity procedure training forms.

Policy
Data integrity procedures and evidence of inappropriate actions are reviewed annually or through regularly scheduled internal audits, and are updated by management.

Policy
The mechanism for confidential reporting of ethics and data integrity issues is (1) unrestricted access to senior management and human resources, (2) an assurance that personnel will not be treated unfairly for reporting instances of ethics and data integrity breaches, and (3) anonymous reporting.

Policy
Employees are required to understand, through training and review of quality systems documents, that any infractions of the laboratory data integrity procedures will result in a detailed investigation that could lead to very serious consequences such as immediate termination, or civil/criminal prosecution.

Policy
Any potential data integrity issue is handled confidentially until a follow-up evaluation, full investigation, or other appropriate actions have been completed and the issues clarified. Inappropriate activities are documented, including disciplinary actions, corrective actions,

and notifications of clients, if applicable. These documents are maintained for a minimum of 5 years.

Procedure
Any determination of an ethics or data integrity issues must be communicated to the plant or group HR associate, associate's sponsor, or the legal group. Allegations are investigated and remain confidential to the extent necessary.

Documentation for all investigations that result in findings of inappropriate activity include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

Data integrity procedures are reviewed annually and are periodically monitored through in-depth data review, records review, or other thorough check processes.

Procedures are reviewed according to SPG-SOP-0461, SPG Internal Audit Procedure, as scheduled in SPG-FCD-8891, Audit Schedule.

17.3 Data Integrity and Ethics Training

Policy
Data integrity training is provided for all employees initially upon hire and annually thereafter.

Procedure
Attendance at an initial data integrity training (part of new employee orientation) and the annual refresher training is recorded with a signature attendance sheet or other form of documentation that demonstrates all staff have participated and understand their obligations related to data integrity.

Training records regarding data integrity and ethics are signed and dated by the Business Leader (Laboratory Director).

When contracted technical or support personnel are used, management is responsible for ensuring that they are trained to the laboratory's quality system and data integrity procedures, competent to perform the assigned tasks, and appropriately supervised.

Training will include, but may not be limited to:

- the organizational mission and its relationship to the need for honesty and full disclosure in all analytical reporting;
- how and when to report data integrity issues;
- recordkeeping;
- discussion regarding all data integrity procedures;
- data integrity training documentation;
- in-depth data monitoring;
- data integrity procedure documentation;
- improper data manipulations;
- adjustments of instrument time clocks;
- inappropriate changes in concentrations of standards;
- the importance of proper written narration on the part of the analyst with respect to those cases where analytical data may be useful, but are in one sense or another partially deficient;
- written ethics agreements (not all labs can legally sign a written ethics agreement so the commitment is made by attendance at training sessions);

- examples of improper practices;
- examples of improper chromatographic manipulations;
- requirements for external ethics program training;
- any external resources available to employees; and
- consequences for data integrity infractions.

17.4 General Training

Policy

All personnel are appropriately trained and competent in their assigned tasks before they contribute to functions that can affect data quality. It is management's responsibility to assure personnel are trained.

Policy

Only trained personnel are authorized to perform specific tasks.

Policy

Training records are kept on individual training forms and/or eMaps database.

Procedure

New staff members, as well as, temporary and/or contract personnel are given introductory training and orientation upon arrival. Introductory training includes ensuring that personnel are aware of how their role contributes to meeting the objectives of the management system. Training is documented by signature sheets of all who attended.

Attendance at Gore corporate and Gore sponsored training sessions is documented on signature sheets. Training information is then entered by human resources in the Gore training database through eMaps. The training database, eMaps, is accessed through the Gore intranet, HR page. Training performed within SPG team is also documented on signature sheets, which are kept by area leader initiating training. External training is documented on eMaps by the associate following completion of the course.

Prior to independent performance of new work functions, associates and temporary and/or contract personnel must meet the defined minimum level of education, experience, and skills for the position and complete appropriate training. Training includes, but is not limited to: reading applicable SOPs and work instructions, hands on training with experienced and fully trained associates, internal and/or external classroom training as needed. Job related training is documented on signature sheets, which are kept by the applicable area leader.

Initial training for all new associates includes, but is not limited to the following:

- Participate in Gore general, and plant specific orientation,
- The trainee must be familiarized with the sensitivity of the analytical method to background contamination and the need avoid the following: wearing perfumes, using products with perfumes, fueling car prior to starting work, and directly handling the adsorbent media.
- The trainee must read the Survey Products Group Quality Assurance Manual and applicable work instructions and procedures. After reading each document the trainee must sign off on the applicable Standard Methods & Procedures Training Log (SPG-FCD-0345).

The initial training for a new lab associate also includes the following:

- The trainee must read the Survey Products Group Quality Assurance Manual and applicable methods and procedures. After reading each document the trainee must sign off on the applicable Standard Methods & Procedures Training Log (SPG-FCD-0345).
- Trainee must also complete applicable safety training including familiarization with the Chemical Hygiene Plan (UC-SOP-0349).
- The trainee must review all associated documents listed in the analytical associate training checklist per SPG-FCD-8901.
- The trainee must complete the necessary performance qualifications specified in the appropriate SOP or WI.
- Each step of the training process is documented.

Ongoing training will consist of the following:

- The analyst attests, through signature that they have read, understood, and agreed to perform the latest version of the *Quality Manual* and any method SOP's that the analyst performs.
- Annually, the analyst shows continued proficiency in each method they perform.
- Other training as determined by management.
- Proof of acceptable on-going training is documented by the annual demonstrations of capability for each analyst and each method.
- Records of training and continued proficiency are maintained by the Laboratory Leader.

SECTION 18 – ACCOMMODATIONS & ENVIRONMENTAL CONDITIONS

POLICY
Laboratory facilities are designed and organized to facilitate testing of GORE™ Modules. Environmental conditions are monitored to ensure that conditions do not invalidate results or adversely affect the required quality of any measurement.
The Survey Products Group utilizes approximately 5000 square feet of the Upper Chesapeake plant. The manufacturing facilities are located on the ground floor in a large open area adjacent to office areas and facility shipping and receiving. The testing laboratory is located on the mezzanine floor next to the manufacturing area. The remaining functions of the Survey Products Group, including mapping, reporting, and administration, are located in office facilities in the western portion of the plant.
The testing laboratory is physically isolated from the rest of the facility, being located on a mezzanine. The laboratory is operated under positive pressure to maintain a clean environment for volatile/semi-volatile organic analysis. All analytical standards are kept inside a monitored freezer. Standards are prepared inside a fume hood, which is monitored daily and inspected quarterly, to prevent contamination. GORE™ Modules, prior to shipment, are cleaned and then prepared inside a clean room in order to minimize incidental contamination. Each lot of GORE™ Modules are tested for cleanliness according SPG-SOP-0428.

POLICY
Environmental tests are stopped when the environmental conditions jeopardize the results.

POLICY
Access to, and use of areas affecting the quality of the environmental tests is controlled by restriction of areas to authorized personnel only.
Access to the facility is strictly controlled due to the proprietary nature of all work performed at the facility. Visitors are required to register at the front desk and may not enter the facility unless preapproved as a vendor, consultant, or contractor. Each visit is recorded and signed by an associate. All visitors must be escorted by an associate throughout the visit and depending on

access to the facility and nature of intended discussions, may be required to sign a confidentiality agreement. All consultants or contractors must sign a confidentiality agreement before starting work for W.L. Gore & Associates. Visitors are strictly prohibited from bringing cameras or cell phones with camera capabilities into the facility. Such devices must be left at the reception desk for the duration of the visit.
Visitors are given ID badges that must be worn in a conspicuous place on their person during their visit. Badges are returned at the end of the visit. A photo identification badge is issued to each associate and temporary and/or contract personnel. The badge must be worn in a conspicuous place while at the facility and must be returned at the end of their employment.

POLICY
The laboratory work spaces are adequate for their use, and appropriately clean to support environmental testing and ensure an unencumbered work area.
Adequate heating, cooling, ventilation, lighting, and utilities are provided throughout the facility. All heating, cooling, ventilation, lighting, utilities, and housekeeping are maintained by the administrative associates operating under a quality system program. The testing laboratory maintains a weekly cleaning schedule to ensure a safe and effective analytical environment.
PROCEDURE
Laboratory space is arranged to minimize cross-contamination between incompatible areas of the laboratory.
If the laboratory environment is required to be controlled by method or regulation, the adherence is recorded.
The laboratory procedure for good housekeeping includes such measures as

- janitorial service either internal or contracted,
- periodic dedicated clean-up days, and ,
- each employee is responsible for straightening up their work area at the end of the day.

SECTION 19 – TEST METHODS AND METHOD VALIDATION

POLICY
A method is validated before it is put into use. All methods are published or documented. All routine procedures and practices are performed according to a written standard operating procedure (SOP) or work instruction (WI). SOPs and WIs describe the routine operation.

Due to the proprietary nature of procedures and methods, discretion must be used in providing copies for review by clients or their representative. Approval by the applicable product specialist should be obtained prior to providing electronic or paper copies to clients or their representatives.

19.1 Demonstration of Capability (DOC)

A Demonstration of Capability (DOC) is a procedure to establish the ability of the analyst to generate data of acceptable accuracy and precision.

Procedure
The DOC is documented on the Demonstration of Capability form SPG-FCD-0351 , and these completed forms are kept in the training files for each analyst.

A DOC is performed for each analyte whenever the method, analysts, analytes, or instrument type is changed.

The Laboratory Leader and Quality Manager certifies that technical staff members in their area of expertise are trained and authorized to perform all tests for which we are accredited by signing the DOC form.

The process for DOC is documented in SPG-SOP-0450.

19.2 On-Going (or Continued) Proficiency

After the demonstration of capability is completed, on-going proficiency is maintained and demonstrated at least annually through the analysis of either single-blind samples, performing another DOC, or use of four consecutive laboratory control samples compared to pre-determined acceptance limits for precision and accuracy. This is documented in the training file of each analyst.

19.3 Initial Test Method Evaluation

For chemical analyses, the INITIAL TEST METHOD EVALUATION involves the determination of the Method Detection Limit (MDL), confirmation of the Reporting Limit (RL), an evaluation of precision and bias, and an evaluation of the selectivity of the method.

19.3.1 Method Detection Limit (MDL)

The METHOD DETECTION LIMIT (MDL) (ALSO REFERRED TO AS LIMIT OF DETECTION (LOD) is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An MDL is analyte-and matrix specific and may be laboratory-dependent. (NELAC Glossary 2003).

19.3.2 Reporting Limit (RL)

The Reporting Limit (also referred to as LIMIT OF QUANTITATION (LOQ)) is an estimate of the minimum amount of a substance that can be reported with a specified degree of confidence (NELAC Glossary 2003).
If an MDL study is not performed, concentrations less than the RL are not reported. If results are not reported outside of the calibration range (low), the MDL determination is not required.

Policy
The lowest calibration standard is equal to the RL.

Policy
The RL will always be equal to or greater than the MDL.

Procedure
MDLs are determined from a quality system matrix using all sample processing steps, and are verified annually or when there is a change in the test method or instruments affects sensitivity. The guidelines for determining MDLs can be found in SPG-WI-0280.

19.3.3 Precision and Bias

PRECISION is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms.

BIAS is the systematic error that contributes to the difference between the mean of a significant number of test results and the accepted reference value.

Policy
Precision and bias are determined for standard and non-standard methods.

Procedure

Precision and bias are determined for standard methods through the performance of a Demonstration of Capability.

Precision and bias using non-standard, modified standard or laboratory-developed methods are compared to the criteria established by the client (when requested), the method, or the laboratory.

Replicate spikes in a quality system matrix are analyzed according SPG-SOP-0460, which is consistent with the procedures outlined in 2003 NELAC Standard, Appendix C.3.3.b.

19.3.4 Selectivity

SELECTIVITY is the capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances.

Policy

The laboratory evaluates selectivity through procedures defined in the test method SOPs.

19.4 Estimation of Uncertainty

ESTIMATION OF UNCERTAINTY consists of the sum (combining the components) of the uncertainties of the numerous steps of the analytical process, including, but not limited to, sample plan variability, spatial and temporal sample variation, sample heterogeneity, calibration/calibration check variability, extraction variability, and weighing variability.

Policy

The laboratory is only responsible for estimating the measurement uncertainty under its control. Field sampling is not considered under the control of the laboratory. Measurement uncertainty values are reported when required by the project, when required by specification or regulation, or when the result is being used to determine conformance to a specified limit. The uncertainty is reported along with the coverage factor (see below) and in the same units and number of significant digits as the measurement result. If bias is observed from average recovery values, the potential bias is also reported.

Methods performed by the Survey Products Group are considered category 3 methods as defined by A2LA P103b – Annex: Policy on Estimating Measurement Uncertainty for Life Sciences Testing Labs. Category 3 methods are methods based on published regulatory or consensus methods (e.g. EPA Methods). Determined laboratory control sample (LCS) control limits may be reported as the estimation of measurement uncertainty at the 99% level.

Procedure

The laboratory estimates the minimum contribution to measurement uncertainty using the standard deviation calculated from routine quality control samples that have gone through the entire analytical method, Laboratory Control Samples (LCSs). By using laboratory control samples all elements of uncertainty are included in the calculation for measurement uncertainty.

Details of the procedure are included in SPG-SOP-0474, Estimation of Measurement Uncertainty and Bias.

19.5 Laboratory-Developed or Non-Standard Method Validation

Policy

Laboratory developed, modified standard methods, and non-standard methods require method validation.

Procedure
METHOD VALIDATION is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled (NELAC 2003).

Policy
Where applicable, the laboratory validates non-standard methods, laboratory-designed/developed methods, standard methods used outside their published scope, and amplifications and modifications of standard methods to confirm that the methods are fit for the intended use.

Policy
The range and accuracy of the values obtainable from validated methods (e.g. the uncertainty of the results, detection limit, selectivity of the method, linearity, limit of repeatability and/or reproducibility, robustness against external influences and/or cross-sensitivity against interference from the matrix of the sample/test object), is assessed for the intended use and whether it is relevant to the clients' needs.

Procedure
The laboratory's method validation procedures include, at a minimum, the steps described in Appendix C.3 to Chapter 5 (NELAC 2003). The laboratory records method validation results, the procedure used for the validation, and a statement as to whether the method is fit for the intended use.

19.6 Control of Data

Policy
All calculations and all relevant data are subject to appropriate checks in a systematic manner.

Policy
Commercial off-the-shelf software (e. g. word processing, database and statistical programs) used within the designed application range is considered sufficiently validated when in-house programming is not used.

Procedure
The laboratory assures that computers and software are protected, maintained, and secure through measures such as documentation, locked access, and control of the laboratory environment.

All computers and software are maintained and controlled by the Gore Information Technology Group. Access to the computers are password protected. All software licenses are maintained and kept current. No unauthorized software may be installed on computers. Computers connect to the internet through secure Web servers.

The laboratory procedure to insure that reported data are free from transcription and calculation errors is found in SPG-SOP-0426.

The laboratory procedure that all quality control measures are reviewed and evaluated before data are reported is found in SPG-SOP-0426.

The laboratory procedure to address manual calculations, including manual integrations is found in SPG-SOP-0426.

The laboratory assures that computers, user-developed computer software, automated equipment, or microprocessors used for the acquisition, processing, recording, reporting, storage, or retrieval of environmental test data are:

a) documented in sufficient detail and validated as being adequate for use;

b) protected for integrity and confidentiality of data entry or collection, data storage, data transmission and data processing;

c) maintained to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of environmental test data; and

d) held secure including the prevention of unauthorized access to, and the unauthorized amendment of, computer records.

User-developed or third party supplied computer software is validated through comparison of generated results with results generated through original equipment manufacturer or previously validated software.

SECTION 20 – EQUIPMENT

20.1 General Equipment Requirements

Policy

The laboratory provides all the necessary equipment required for the correct performance of the scope of environmental testing presented in this *Quality Manual*.

All equipment and software used for testing and sampling is capable of achieving the accuracy required and complies with the specifications of the environmental test method as specified in the laboratory SOP. No instrumentation or equipment is used that does not meet requirements of NELAC, DOD, and ISO 17025, including equipment outside of direct laboratory control.

Equipment is operated only by authorized personnel trained in proper use either as part of test method training or separate instruction. Authorized personnel are listed in the equipment log book or for analytical instrumentation used in testing, within training records. The laboratory procedure for safe handling, transport, storage, use and planned maintenance of measuring equipment to ensure proper functioning and in order to prevent contamination or deterioration is found below and/or in applicable instrument operation instructions. Scheduled preventative maintenance is also performed per SPG-FCD-0332. All ATD-GC/MS equipment has an instrument specific maintenance logbook that is used to capture preventative and corrective maintenance that is performed.

Procedure

Up-to-date instructions on the use and maintenance of equipment (including any relevant manuals provided by the manufacturer of the equipment) are readily available for use by laboratory personnel.

All equipment is calibrated or checked before being placed into use to ensure that it meets laboratory specifications and the relevant standard specifications.

Test equipment, including hardware and software, are safeguarded from adjustments which would invalidate the test results measures by limiting access to the equipment and using password protection where possible. All equipment is password protected restricting access to essential network drives. Facility security measures, outlined in SECTION 18: Accommodations and Environmental Conditions, are in place to eliminate visitor access to unauthorized areas of the facility.

Equipment that has been subject to overloading, mishandling, given suspect results, or been shown to be defective or outside specifications is taken out of service, isolated to prevent its use, or clearly labeled as being out of service until it has been shown to function properly. If it is shown that previous tests are affected, then procedures for non-conforming work are

followed. All GC/MS data generated must meet quality control measures outlined in SPG-FCD-0320. If specific requirements of the document are not met then the instrument is taken out of service and maintenance is performed to correct the out-of-specification results.

Each item of equipment and the software used for testing and significant to the results is uniquely identified and records of equipment and software are maintained in SPG-FCD-0355. Specific instrument information is maintained in the Instrument Maintenance Logbooks. This information includes the following:

a) identity of the equipment and its software;

b) manufacturer's name, type identification, serial number or other unique identifier;

c) checks that equipment complies with specifications of applicable tests;

d) current location;

e) manufacturer's instructions, if available, or a reference to their location;

f) dates, results and copies of reports and certificates of all calibrations, adjustments, acceptance criteria, and the due date of next calibration;

g) maintenance plan where appropriate, and maintenance carried out to date; documentation on all routine and non-routine maintenance activities and reference material verifications;

h) any damage, malfunction, modification or repair to the equipment;

i) date received and date placed into service (if available); and

j) condition when received, if available (new, used, reconditioned).

20.2 Support Equipment

SUPPORT EQUIPMENT includes, but is not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices, volumetric dispensing devices, and thermal/pressure sample preparation devices.

Policy

All support equipment is maintained in proper working order and records are kept of all repair and maintenance activities, including service calls.

Procedure

All raw data records are retained to document equipment performance. These records may include logbooks, data sheets, or equipment computer files.

All support equipment is calibrated or verified annually over the entire range of use using NIST traceable references where available. The results of the calibration of support equipment are within specifications or (1) the equipment is removed from service until repaired, or (2) records are maintained of correction factors to correct all measurements.

Support equipment such as balances, ovens, refrigerators, freezers, and water baths are checked with a NIST traceable reference if available, each day prior to use, to ensure they are operating within the expected range for the application for which the equipment is to be used.

20.2.1 Support Equipment Maintenance

Procedure

Regular maintenance of support equipment, such as balances and fume hoods is conducted at least annually.

Maintenance on other support equipment, such as ovens, freezers, refrigerators, and thermometers is conducted on an as needed basis.
Records of maintenance to support equipment are documented in the shop maintenance database (Datastream 7i). Each piece of support equipment does not necessarily have its own logbook. Maintenance logbooks may be shared with equipment that is housed in the same laboratory area.

Procedure
In the event of a freezer/refrigerator failure (not able to maintain temperature), all standards in a container, other than a sealed ampule, will be discarded. Standards that are sealed in an ampule may be stored at ambient temperature until the freezer/refrigerator is repaired or replaced. If possible, unopened should be stored in a cooler with ice. Only after the failed refrigerator is replaced or serviced, and temperature is being maintained within acceptable limits, may opened standards be stored. Calibration and second-source standards that have been stored outside of a freezer or refrigerator are verified to meet the requirements of test methods through internal QC checks as specified in the analytical method.

20.2.2 Support Equipment Calibration

Calibration requirements for analytical support equipment are found in the table below. For analytical instrumentation, the calibration requirements are found in the specific test methods.

Table 20.2 - 2 Calibration And Maintenance

Instrument	Activity	Frequency	Documentation
Thermometers:	NIST certified thermometer. Documentation retained	Replaced annually	Certification documentation retained.
Freezers/ Refrigerators	1. NIST certified thermometer is placed in freezer/refrigerator for continuous monitoring	Temperatures are recorded each day in use	Log book
Ovens	1.Temperature and/or thermometer calibrations. 2. Temperature monitoring	1.Anually 2. Recorded each day in use	1. Sticker placed on oven and shop maintenance database 2. Log book

20.3 Analytical Equipment

20.3.1 Maintenance for Analytical Equipment

Policy
All equipment is properly maintained, inspected, and cleaned.

Procedure
Maintenance of analytical instruments and other equipment may include regularly scheduled preventive maintenance or maintenance on an as-needed basis due to instrument malfunction and is documented in Instrument Maintenance Logs, which become part of the laboratory's permanent records.

20.3.2 Initial Instrument Calibration

Initial instrument calibration and continuing instrument calibration verification are an important part of ensuring data of known and documented quality. If more stringent

calibration requirements are included in a mandated method or by regulation, those calibration requirements override any requirements outlined here or in laboratory SOPs or Work Instructions. Generally, instrument calibrations are provided in test methods.

Policy

All initial instrument calibrations are verified with a standard obtained from a second source traceable to a national standard when commercially available. If a second source is not available, a standard prepared from a separate lot may be used as long as the manufacturer can demonstrate the lot was prepared independently from other lots purchased.

Any samples that are analyzed after an unacceptable initial calibration are re-analyzed or the data are reported with qualifiers, appropriate to the scope of the unacceptable condition.

Quantitation is always determined from the initial calibration unless the test method or applicable regulations require quantitation from the continuing calibration.

The lowest calibration standard is the lowest concentration for which quantitative results can be reported without qualification. The lowest calibration standard is equal to the Limit of Quantitation or Reporting Limit and is greater than or equal to the limit of detection.

The highest calibration standard is the highest concentration for which quantitative results can be reported.

Data reported that are greater than the highest calibration standard without dilution are considered to be an estimate and are reported with a qualifier code and explained in the case narrative.

Procedure

Initial instrument calibration includes calculations, integrations, acceptance criteria, and associated statistics referenced in the appropriate test method SOP.

Sufficient raw data records are collected to allow reconstruction of the initial instrument calibration. These include, at a minimum, calibration date, test method, instrument, analysis date, analyte names, analysts signature or initials, concentration and response, calibration curve or response factor, or unique equation or coefficient used to reduce instrument responses to concentration.

Corrective actions are performed when the initial calibration results are outside acceptance criteria. Calibration points are not dropped from the middle of the curve unless the cause is determined and documented. If the cause cannot be determined, the calibration curve is re-prepared. If the low or high calibration point is dropped from the curve, the working curve is adjusted and sample results outside the curve are qualified.

Results that are less than the lower calibration standard are considered to have increased uncertainty, and are either reported with a qualifier code or explained in the case narrative.

Results that are greater than the highest calibration standard are either diluted to within the calibration range, or considered to be an estimate; and are reported with a qualifier code and explained in the case narrative.

20.3.3 Continuing Instrument Calibration

Policy

The validity of the initial calibration is verified prior to sample analysis by use of continuing instrument calibration verification (CCV) standard.

Corrective action is initiated for continuing instrument calibration verification results that are outside of acceptance criteria.

Procedure
Continuing instrument calibration verification is performed according to the appropriate test method SOP.

Continuing instrument calibration verification is performed for all analytical systems that have a calibration verification requirement.

Calibration is verified for each compound, element, or other discrete chemical species.

The calculations and associated statistics for continuing instrument calibration are included or referenced in the test method SOP.

Sufficient raw data records are retained to allow reconstruction of the continuing instrument calibration verification. Continuing instrument calibration verification records connect the continuing verification date to the initial instrument calibration.

20.3.4 Unacceptable Continuing Instrument Calibration Verifications

If routine corrective action for continuing instrument calibration verification fails to produce a second consecutive (immediate) calibration verification within acceptance criteria, then a new calibration is performed or acceptable performance is demonstrated after corrective action with two consecutive calibration verifications.
For any samples analyzed on a system with an unacceptable calibration for target analytes, some results may be useable if qualified and under the following conditions:

a) If the acceptance criteria are exceeded high (high bias) and the associated samples are below detection, then those sample results that are non-detects may be reported as non-detects.
b) If the acceptance criteria are exceeded low (low bias) and there are samples that exceed the maximum regulatory limit, then those exceeding the regulatory limit may be reported.
c) If the acceptance criteria are exceeded low (low bias) and there are samples that are non-detected, then those samples must be re-analyzed.
d) If the acceptance criteria are exceeded low (low bias) or exceeded high (high bias) and there are samples which have detected target analytes that exceed acceptance criteria AND are above the reporting limit AND do not exceed the maximum regulatory limit, then those samples must be re-analyzed.

SECTION 21 – MEASUREMENT TRACEABILITY

Measurement quality assurance comes in part from traceability of standards to certified materials.

POLICY
All equipment used that affects the quality of test results are calibrated prior to being put into service and on a continuing basis. These calibrations are traceable to national standards of measurement where available.

POLICY
Measurements from laboratory equipment provide the uncertainty required by test method or client.

POLICY
If traceability of measurements to SI units is not possible or not relevant, evidence for correlation of results through inter-laboratory comparisons, proficiency testing, or independent analysis is provided.

PROCEDURE

All equipment that affects the quality of test results are calibrated according to the minimum frequency suggested by the manufacturer, by regulation, by method, or as needed.

The following equipment used in the SPG laboratory are summarized in this manual. Detailed operational instructions are found in the referenced methods.

Balances

Balances are used in the manufacturing of sorbers. Balance specifications include:

- sensitive to 0.1 mg
- located away from heavy traffic patterns
- maintained at ambient temperature and
- kept clean at all times.

Each day of use, the balances are visually checked for leveling. Balance calibration is performed semi-annually according to facility maintenance scheduling. Balance calibration is performed by accredited contractors. A sticker indicating service and acceptable calibration is placed on the side of the balance. Information regarding balance performance and maintenance is recorded in the balance logbook.

Automated Thermal Desorption Unit/ Gas Chromatograph/ Mass Spectrometer (GC/MS)

Calibration and system performance verifications are performed according to the specific requirements of the analytical method being used.

General considerations are noted below:

Automated Thermal Desorption (ATD) Unit

Performance checks are built in to the instrumentation by the manufacturer. These include, but may not be limited to checks to ensure proper tube loading and sealing and system leak checks. Routing maintenance procedures are intended to minimize any instrument failures.

GC/MS Computer

All computer software for control, acquisition, and reporting of data for the GC/MS instruments is purchased and maintained through the original equipment manufacturer or their designated representative.

Mass Spectrometer Tuning

The mass spectrometer is tuned using the tuning material recommended by the instrument manufacturer. Tuning reports are kept in a binder near the instrument. The mass spectrometer tune is verified using the tuning check compound designated in the analytical method. A total ion count is produced for the compound detected by the mass spectrometer under the analytical conditions of the method. The tuning check compound used is recorded in the tuning verification reports, which are maintained in the project file.

System Performance Check

The ongoing system performance is monitored by analysis of the tuning check compound, performance of initial calibrations, analysis of instrument and method blanks, and the analysis of second source reference standards, as determined under the analytical conditions of the method.

Compound Identification

Compounds are identified as specified in the method.

Quantitation

Quantitation of the analyte mass observed from the thermally desorbed adsorbent is performed according to the appropriate analytical procedures.

Clean-up Checks
A minimum of one empty thermal desorption tube is analyzed before the start of every analytical run to ensure the cleanliness of the equipment.

Method Blanks
The method blank is a clean sorber or sorber set that is analyzed after every tuning check.

Method Duplicates
Method duplicates are defined as part of the project quality assurance requirements. Unless requested, method duplicates are not analyzed.

Method Spikes
Method spikes are defined as part of the project quality assurance requirements. Unless requested, method spikes are not analyzed.

Demonstration of Method Performance
Method performance is defined as part specific analytical methods.

Method Detection Limit (MDL)
MDLs are determined for each analytical method and for each target compound prior to analyzing samples. If changes are made to the analytical method that could affect instrument sensitivity, the MDL determination must be repeated. Compounds for which no MDL has been determined may be reported, but data must be flagged appropriately and client must be notified prior to sample analysis.

Clients can verify that required uncertainty is achieved by reviewing the internal quality control criteria, if requested.

21.1 Reference Standards

Reference standards are standards of the highest quality available at a given location, from which measurements are derived.

Policy
Reference Standards, such as NIST thermometers, may be used for routine measurements, but if so, cannot be used for calibration purposes. No other reference standards are currently being used.

Procedure
NIST thermometers are calibrated by an entity that can provide traceability to national or international standards.

21.2 Reference Materials

Reference materials are substances that have concentrations that are sufficiently well established to use for calibration or as a frame of reference.

Policy
Reference materials, where commercially available, are traceable to national standards of measurement, or to Certified Reference Materials, usually by a Certificate of Analysis. Reference material providers are to be accredited to ISO Guide 34 in combination with ISO/IEC 17025 by Asia Pacific Laboratory Accreditation Cooperation (APLAC) signatory recognized for accrediting reference material producers. Requirement stands where such providers are available.

Policy
Internal reference materials, such as working standards or intermediate stock solutions, are checked as far as technically and economically possible.

Procedure

Purchased Reference Materials require a Certificate of Analysis where available. Otherwise, purchased reference materials are verified by application to a certified reference material, interlaboratory comparison, and/or demonstration of capability.

Internal Reference Materials, such as working standards and intermediate stock solutions, are checked by comparing standards with previously certified materials.

Standards Preparation

Stock Standards

Stock Standards are purchased from reference material suppliers as described above. Certified solutions at the required concentrations are prepared by the supplier in an appropriate solvent. Separate stock solutions are not prepared by the lab. Supplier certificates of traceability are maintained in a logbook. The certificate can be compared to the ampules to ensure that all ampules contain the appropriate lot number and expiration date. The date received and the receiving analytical associate's initials are recorded on the certificate. These solutions are used before the expiration date listed by the supplier. Stock standards are stored in a standards freezer or refrigerator as indicated by the manufacturer and the freezer or refrigerator is monitored for temperature.

Secondary Dilution

Secondary dilution standards may be prepared from working standards. Expiration dates for dilutions are the same as that of the working standard used. Vials must be labeled with the name of the standard, concentration, preparation date, expiration date, preparer's initials. Information on stock standard supplier, stock concentration and lot number, solvent used, preparation procedure, preparation date, expiration date and preparer's initials are all documented in the standards log book.

Working Standards

Stock standards are used "as is" for working standards. Standards are transferred into screw-capped vials for easier use. No dilutions or other changes are normally made to the purchased solutions. Working standards, once opened, are given a one-month expiration. The working standard is labeled with descriptive name (e.g. "VOC Standard"), lot number, expiration date, and preparer's initials. Gaseous standards (in cylinders) expire as per supplier recommendations. Standards may be used past their expiration date for retention time purposes only. Standards are stored in the freezer or as recommended by supplier and checked frequently for degradation or contamination by visual inspection of solution for evidence of particulates or solids in the solution, comparisons with calibration or second source reference standard responses, and review of mass spectral information. The working standard used for analysis is documented in the instrument run logbook.

Tuning Standard

The tuning standard is received in a sealed ampule and is prepared by opening the ampule and transferring the contents into a screw-capped vial for easier use. No dilutions or other changes are made to the purchased solution. The tuning standard is labeled with the name, lot number, the tuning standard's expiration date (two months from the date opened), and the preparer's initials. The solution is stored in the freezer and checked frequently for degradation or contamination by reviewing the standards' spectra. The tuning standard used for analysis is documented in the instrument logbook by recording all the information from the tuning standard vial. The tuning standard provides monitoring of the ability of the GC/MS to produce adequate fragmentation patterns.

Internal Standards

Internal standard use, when appropriate, is specified in the method, the project quality assurance program or the project file.

21.3 Transport and Storage of Reference Standards and Materials

Policy
The laboratory handles and transports reference standards and materials in a way that protects their integrity.

Procedure
Reference standard and material integrity is protected by separation from incompatible materials and/or minimizing exposure to degrading environments or materials.

Reference standards and materials are stored according to manufacturer's recommendations and separately from working standards or samples.

21.4 Labeling of Reference Standards, Reagents, and Materials

Policy
Reference standards and materials are tracked from purchase, receipt, and storage through disposal.

Policy
Reagent quality is verified during routine blank analyses.

Procedure
Records for all standards, reagents, reference materials, and media include:

1. the manufacturer/vendor name (or traceability to purchased stocks or neat compounds)
2. the manufacturer's Certificate of Analysis or purity (if supplied)
3. the date of receipt (certificate of analysis is stamped with receipt date and initialed by receiver).
4. reference to the method of preparation
5. date of preparation, if applicable
6. recommended storage conditions, if applicable
7. an expiration date after which the material shall not be used (unless its reliability is verified by the laboratory). It may be documented elsewhere if referenced.
8. preparer's or initial users' (person opening vial) initials

In methods where the purity of reagents is not specified, analytical reagent grade is used. If the purity is specified, that is the minimum acceptable grade. Purity is verified and documented according to Section 9, Purchasing, Services, and Supplies.

All containers of standards, reagents, or materials, whether original or prepared, are labeled with an expiration date.

All containers of prepared standards and reference materials have a descriptor, an expiration date, preparer's initial, and a unique identifier, that is in the following format:

LogBook#-Page#-entry#
Example: 47-32-1, log book number SPG47, page 32, entry 1.

Standard preparation records are kept in the standards logbook and indicate traceability to purchased stocks or neat compounds, reference to the method of preparation, date of preparation, expiration date, and preparer's initials.

Prepared reagents are verified to meet the requirements of the test method through internal QC checks as specified by the analytical method. A typical check is performed by analysis of a second source reference material and comparison with analysis of primary source material.

SECTION 22 – SAMPLE MANAGEMENT

22.1 Module Shipping

Policy
Modules are shipped with unique identifiers which are the manufacturing serial numbers. The serial number allows tracking back to manufacturing information including manufacturing lot cleanliness data.

Procedure
Modules are shipped according to Manufacturing Module Shipping, SPG-WI-0288.

22.2 Sample Receipt

Policy
Once received back from the field, modules are considered samples.

Procedure
When samples are received at the laboratory, their condition is documented and they are logged into the sample tracking system. Sample check-in is performed according to the Sample Module Internal Custody SOP, SPG-SOP-0418.

22.3 Sample Acceptance

Policy
The minimum conditions a sample must meet on receipt are:

- module containers must be unbroken
- and labels on module containers or module tags must be present and legible.

If these conditions are not met, the client is contacted prior to any further processing.

Procedure
The laboratory checks samples for the conditions above, where appropriate, to evaluate sample acceptance.

22.4 Sample Identification

Policy
Modules are shipped with unique identifiers, as noted in 22.1. Once received back at laboratory, this same unique identifier is used to prevent mix-up and to document receipt of all sample containers. Subsamples, extracts, and digestates, are not applicable in the analysis of modules.

Procedure
Identification of modules is done during the manufacturing and is described in SPG-WI-0287, Module Assembly. During preparation for sample analysis, thermal desorbtion tubes are labeled with the module serial number or the last few digits of the serial number

(enough to uniquely identify the sample). A suffix is also added to tube label to indicate if the sample is a trip blank, "T," or duplicate, "D."

22.5 Sample Storage

Procedure

Samples are held secure, as required. Samples are stored apart from standards, reagents, food or potentially contaminating sources, and such that cross-contamination is minimized. Monthly plant safety inspections include monitoring for proper solvent storage and general housekeeping.

22.6 Sample Disposal

Policy

Samples are disposed of according to Federal, State and local regulations.

Procedure

Once analyzed, any remaining adsorbent packets (sorbers), pieces of tubing, and tags are kept for a minimum of two weeks following submittal of the final report.

22.7 Sample Transport

Policy

Samples that are transported under the responsibility of the laboratory, where necessary, are done so safely and according to storage conditions. This includes moving sample containers within the laboratory. Specific safety operations are addressed outside of this document.

22.8 Sampling Records

Policy

Sampling plans are based on project requirements and objectives, which are determined by the customer and/or in consultation with project managers.

Sub-sampling within the laboratory is performed according to test method work instructions.

SECTION 23 – QUALITY OF TEST RESULTS

POLICY

All essential quality control elements are collected and assessed on a continuing basis.

POLICY

The qualities of test results are recorded in such a way that trends are detectable, and where practicable, are statistically evaluated. Electronic spreadsheets are generated for internal uses that include results of quality control samples. Results of quality control samples can be statistically evaluated for trends.

POLICY

For test methods that do not provide acceptance criteria for an essential quality control element or where no regulatory criteria exist, acceptance criteria are developed. Control limits are developed using the mean, plus or minus 3 standard deviations; or static limits such as +/- 20 percent. These limits can be found in the specific method work instruction and/or SOP.

POLICY

The quality control procedures specified in test methods are followed by laboratory personnel. The most stringent of control procedures is used in cases where multiple controls are offered. If it is not clear which is the most stringent, that mandated by test method or regulation is followed.

23.1 Monitoring

PROCEDURE

To monitor the validity of environmental tests performed, review includes any one or combination of the techniques below:

a) use of certified reference materials and/or internal quality control using secondary reference materials;

b) participation in proficiency testing programs;

c) replicate testing using the same or different methods;

d) retesting of retained samples; and/or

e) correlation of results for different characteristics of a sample.

Written procedures to monitor quality controls including acceptance criteria are located in the test method work instructions and SOPs, except where noted, and include such procedures as:

a) use of laboratory control samples and blanks to serve as positive and negative controls for chemistry methods;

b) use of laboratory control samples to monitor test variability of laboratory results;

c) use of calibrations, continuing calibrations, certified reference materials and/or PT samples to monitor accuracy of the test method;

d) measures to monitor test method capability, such as limit of detection, limit of quantitation, and/or range of test applicability, such as linearity;

e) use of regression analysis, internal/external standards, or statistical analysis to reduce raw data to final results;

f) use of reagents and standards of appropriate quality;

g) procedures to ensure the selectivity of the test method;

h) measures to assure constant and consistent test conditions, such as temperature, humidity, flow rate, etc., when required by test method;

23.2 Internal Quality Control Practices

Analytical data generated with QC samples that fall within prescribed acceptance limits indicate the test method is IN CONTROL.
QC samples that fall outside QC limits indicate the test method is OUT OF CONTROL (non-conforming) and that corrective action is required or that the data are qualified.

Policy

Detailed QC procedures and QC limits are included in test method work instructions and SOPs, or where unspecified in the SOPs, are detailed elsewhere.

Policy

All QC measures are assessed and evaluated on an on-going basis, so that trends are detected.

Procedure

The following general controls are used:
Positive and Negative Controls such as:

a) Blanks (negative)
b) Laboratory control sample (positive)

Selectivity is assured through:

a) absolute and relative retention times in chromatographic analyses;
b) use of acceptance criteria for mass-spectral tuning (found in test method SOPs);
c) use of the correct method according to its scope assessed during method validation; and

Consistency, Variability, Repeatability, and Accuracy are assured through:

a) proper installation and operation of instruments according to manufacturer's recommendations or according to the processes used during method validation;
b) monitoring and controlling environmental conditions (temperature, access, proximity to potential contaminants);
c) selection and use of reagents and standards of appropriate quality; and
d) following SOPs and documenting any deviation, assessing for impact, and treating data appropriately;
e) testing to define the variability and/or repeatability of the laboratory results, such as replicates;
f) use of measures to assure the accuracy of the test method, including calibration and/or continuing calibrations, use of certified reference materials, proficiency test samples, or other measures;

Acceptance or rejection criteria are created according to laboratory policy where no method or regulatory criteria exist. Acceptance criteria define the boundary for the appropriate response from laboratory personnel, such as corrective action, reporting with qualifiers, reanalysis, review, and others.

Test Method Capability is assured through:

a) establishment of the limit of detection where appropriate;
b) establishment of the limit of quantitation or reporting level; and/or
c) establishment of the range of applicability such as linearity;

Data reduction is assured to be accurate by:

a) selection of appropriate formulae to reduce raw data to final results such as regression;
b) periodic review of data reduction processes to assure applicability;

The following tables summarize the key elements of the quality control system for a laboratory performing chemical analysis.

Table 23.2-1 Essential Quality Control Elements for Chemistry

Item	Minimum Frequency	Acceptance Criteria	Corrective action
Negative Control (Method Blank)	1/batch	Method specific or reporting limit	Qualify data and take corrective action

Table 23.2-1 Essential Quality Control Elements for Chemistry			
Item	Minimum Frequency	Acceptance Criteria	Corrective action
Positive Control (Laboratory Control Sample)	1/batch	Method specific or determined by laboratory	Reprocess, reanalyze, or qualify data.
Surrogate spikes	Per method requirement	Method specific or determined by laboratory	Corrective action and qualify data
Continuing Calibration Verification	Per method requirement	Method specific or determined by laboratory	Reanalyze standard immediately; Corrective action
Initial calibration Verification	Start of each analytical run	Method specific or determined by laboratory	Reanalyze standard immediately; Corrective action
Tune verification	Start of each analytical run and 1/batch	Method specific	Reanalyze standard immediately; Corrective action

23.2 Method Blanks

Policy

Contaminated blanks are identified according to the acceptance limits in the test method SOPs or laboratory documentation.

Policy

Samples associated with a contaminated blank are evaluated as to the appropriate corrective action for the samples (e.g. reprocessing or data qualifying codes).

Procedure

Our laboratory identifies a blank as contaminated when analyte results are greater than those specified by the analytical method.

When a blank is determined to be contaminated, the cause must be investigated and measures taken to minimize or eliminate the problem.

Data that are unaffected by the blank contamination (non-detects or other analytes) are reported unqualified.

Sample data that are suspect due to the presence of a contaminated blank are reanalyzed or qualified.

23.3 Laboratory Control Samples

LABORATORY CONTROL SAMPLES (LCS) are prepared according to the specific analytical method by analyzing verified and known amounts of analytes for the purpose of establishing precision or bias measurements.

Policy

Laboratory control samples are analyzed at a frequency mandated by method, regulation, or client request, whichever is more stringent.

Procedure

The results of laboratory control samples (LCS) are calculated in percent recovery or other appropriate statistical technique that allows comparison to established acceptance criteria. The laboratory documents the calculation as noted in the specific analytical method.

The individual LCS is compared to the acceptance criteria as published in the mandated test method, or where there are no established criteria, the laboratory's established limits.

23.4 Matrix Spikes

MATRIX SPIKES (MS) are samples fortified with a known amount of analyte to help assess the effect of the matrix on method performance. Due to number of sorbers housed within the GORE™ Module, analysis of a matrix spike duplicate is not possible.

Policy

The MS results are used to help assess the effect of the sample matrix on method performance. MS samples are analyzed as required by the specific analytical method and/or project requirements.

Procedure

The laboratory procedure for MS includes spiking appropriate analytes at appropriate concentrations, and calculating percent recoveries.

Where there are no established criteria, the laboratory uses +/- 30% as the control limits for MS.

For MS results outside established criteria corrective action is documented and reported.

23.5 Surrogate Spikes

SURROGATES are substances with chemical properties and behaviors similar to the analytes of interest used to assess method performance in individual samples.

Policy

Surrogates are added according to the specific analytical method.

Procedure

Surrogate recovery results are compared to the acceptance criteria as published in the mandated test method.

Where there are no established criteria, the laboratory uses +/- 50% as surrogate control limits.

For surrogate results outside established criteria, data are evaluated to determine the impact. Corrective actions include reanalysis and/or qualifying of data, as appropriate.

23.6 Proficiency Test Samples or Inter-laboratory Comparisons

Policy

The laboratory participates in proficiency test (PT) samples twice per year.

Policy

The laboratory institutes corrective action procedures for failed PT samples.

Policy

The laboratory does not share PT samples with other laboratories, does not communicate with other laboratories regarding current PT sample results, and does not attempt to obtain the assigned value of any PT sample from the PT provider.

Procedure

Proficiency Testing (PT) or Proficiency Evaluation (PE) samples are treated as typical samples in the normal production process where possible, including the same preparation, calibration, quality control and acceptance criteria, sequence of analytical steps, and number of replicates. PT samples are not analyzed multiple times unless routine samples are analyzed multiple times. Analysis of PT/PE samples is evenly distributed among qualified analysts.

PT or PE samples containing any number of target compounds are obtained as single blind samples from approved suppliers. Sample concentrations must fall within the calibration

range of the analytical method. Actual concentrations of the sample are held by the provider until results are reported.

PT/PE samples are obtained for each field of testing (FOT). Since the matrix being analyzed on instrumentation is always a sorber, instructions for exposure of sorber to the media may differ. PT/PE sample preparation may be modified as necessary. If provided sample preparation instructions for the PT sample are not applicable, the sample is prepared in the same manner as samples analyzed for the DOC. Procedures for the DOC are included in each analytical method. If the PT sample is not a part of a multi-laboratory study for which acceptance limits are provided, required QC limits are considered to be the vendor supplied value +/- two times the standard deviation obtained from the DOC analyses. Results of the PT testing, including pass/ fail results are provided to the accrediting authority.

If any reported result falls outside the acceptance limits a corrective action is initiated per SPG-SOP-0424, Handling Non-conformance Potential Problems and Corrective Actions. Results of the investigation and action items are provided to any applicable accreditation authority. Following, completion of any required actions, a new PT sample is ordered and the analysis is repeated. The new PT sample cannot have a value of 0 for any compound which failed in original analysis.

23.7 Data Review

Policy
The laboratory reviews all data generated in the laboratory for compliance with method, laboratory and, where appropriate, client requirements.

Policy
All data review is documented.

Procedure
Initially, the analyst reviews data for acceptability of quality control measures and accuracy of the final result(s).

After the initial review, a second reviewer, a chemist fully trained and capable of analysis using the analytical method, considers all manual transfers and calculations of data in detail and spot checks all electronic transfers of data. Secondary data review is performed according to SPG-SOP-0426.

Prior to release of final reports, contents of report are compared to raw data, analysis notes, data review documentation, corrective actions (if applicable) and project file information, including any documented correspondence.

SECTION 24 – REPORTING OF RESULTS

POLICY
The result of each test carried out is reported accurately, clearly, unambiguously, and objectively and complies with all specific instructions contained in the test method and customer requirements.

POLICY
Data from accredited methods are reported without qualification if they are greater than the lowest calibration standard, lower than the highest calibration standard, and without compromised sample or method integrity. Data for screening level methods do not require qualifiers for values outside of the calibration range, but report must clearly indicate the data are for screening purposes.

24.1 Test Reports

Test reports may include, but are not limited to data tables with analytical results, contour maps showing distribution of analytical results, and final reports.

Policy

The report format has been designed to accommodate each type of test performed and to minimize the potential for misunderstanding or misuse.

Procedure

Reports generated for GORE™ Surveys for Environmental are prepared according to SPG-SOP-0426, GORE Surveys for Environmental Reporting Procedure. When using accredited methods, the following information is included in test reports or if not required for reporting by client, available:

a) a title, such as Test Report or Test Results;

b) the name and address of the laboratory, the location of the laboratory if different from the address, and the phone number and name of a contact person;

c) unique identification of the test report, such as production order number and report date, on each page and a pagination system that ensures that each page is recognized as part of the test report and a clear identification of the end of the report, such as 3 of 10;

d) the name and address of the client if applicable;

e) the identification of the test method used;

f) an unambiguous identification of the sample(s);

g) the date and time of sample receipt, date and time of sample collection, dates and time the tests were performed;

h) reference to the sampling plan and procedures used by the laboratory where these are relevant to the validity or application of the results;

i) the test results with failures identified, units of measurement, an identification of the statistical package used if applicable;

j) the name, function, and signature or an equivalent electronic identification of the person authorizing the test report, and the date of issue;

k) a statement to the effect that the results relate only to the samples;

l) at the laboratory's discretion, a statement that the report shall not be reproduced except in full without written approval of the laboratory;

m) certification that the results are in compliance with the DOD and NELAC Standards if accredited to be in compliance or provide reasons and/or justification if they do not comply

24.2 Supplemental Test Report Information

When necessary for interpretation of the results or when requested by the client, test reports include the following additional information

a) deviations from, additions to, or exclusions from the test method, information on specific test conditions, such as environmental conditions, and any non-standard conditions that may have affected the quality of the results, and any information on the use and definitions of data qualifiers;

b) a statement of compliance/non-compliance when requirements of the quality systems are not met, including identification of test results that did not meet NELAC and DoD QSM sample acceptance requirements, such as holding time, preservation, etc. (statement regarding NELAC/ DOD QSM compliance is not required for non-accredited methods);

c) where applicable and when requested by the client, a statement on the estimated uncertainty of the measurement;

d) where appropriate and needed, opinions and interpretations - when opinions and interpretations are included, the basis upon which the opinions and interpretations are documented. Opinions and interpretations are clearly marked as such in the test report.

e) additional information which may be required by specific methods or client;

f) qualification of results with values outside the working range.

For test reports that contain the results of sampling, the following is provided if necessary and available for the interpretation of the results:

a) the date of sampling;

b) unambiguous identification of the material sampled;

c) the locations of the sampling, including diagrams, sketches, or photographs;

d) a reference to the sampling plan and procedures used;

e) details of any environmental conditions during sampling that may affect the interpretations of the test results

f) any standard or other specification for the sampling method or procedure, and deviations, additions to or exclusions from the specification concerned.

24.3 Environmental Testing Obtained from Subcontractors

In the event that testing by an outside laboratory occurs:

Test results obtained from test performed by subcontractors are clearly identified on the test report by subcontractor name and/or accreditation number if applicable.

The test results from subcontractors are reported in writing or electronically. A copy of the subcontractors report is made available to the client or appended to this laboratory's report if requested.

Refer to Section 8 (Subcontracting of Tests) for more information.

24.4 Electronic Transmission of Results

Policy

All test results transmitted by telephone, fax, telex, e-mail, or other electronic means comply with the requirements of this *Quality Manual*, associated procedures, DOD QSM, NELAC, and ISO 17025 to protect the confidentiality and proprietary rights of the client.

24.5 Amendments to Test Reports

Policy

Material amendments to a test report after it has been issued are made only in the form of another document or data transfer. All supplemental reports meet all the requirements for the initial report and the requirements of this *Quality Manual*.

Procedure

Amended test reports are titled, "Supplement to Test Report *Production Order Number, Report Date*" or an equivalent form of wording to assure they can be differentiated from other test reports.

When it is necessary to issue a complete new report, the new report is uniquely identified and contains a reference to the original that it replaces.

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 102075-0

S&ME, Inc.

Charlotte, NC

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

BULK ASBESTOS FIBER ANALYSIS

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2010-01-01 through 2010-12-31

Effective dates

DEPARTMENT OF COMMERCE ★ UNITED STATES OF AMERICA ★

Sally S. Bruce

For the National Institute of Standards and Technology

National Voluntary Laboratory Accreditation Program

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

S&ME, Inc.
9711 Southern Pine Blvd.
Charlotte, NC 28273
Ms. Jane Wasilewski
Phone: 704-940-1830 x11690 Fax: 704-565-4929
E-Mail: jwasilewski@smeinc.com
URL: http://www.smeinc.com

BULK ASBESTOS FIBER ANALYSIS (PLM) **NVLAP LAB CODE 102075-0**

NVLAP Code	*Designation / Description*
18/A01	EPA-600/M4-82-020: Interim Method for the Determination of Asbestos in Bulk Insulation Samples

2010-01-01 through 2010-12-31
Effective dates

Sally S. Bruce
For the National Institute of Standards and Technology

S&ME, INC.

POLARIZED LIGHT MICROSCOPY (PLM)
QA/QC PROCEDURES MANUAL
SEVENTEENTH REVISION

PLM QA/QC PROCEDURES MANUAL
OF
S&ME, INC.

Revision Number: 17

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Author: Jane Wasilewski
1 October, 2006

Revisions By: _____
Jane Wasilewski
QA/QC Director

Approved By: _____
C. Mike Cashio, Jr., C.I.H.
Manager, Industrial Hygiene Services

Copy Number: 1

Issued To: Lab

ASBESTOS BULK SAMPLE ANALYSIS LABORATORY
QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES MANUAL

QUESTIONS AND COMMENTS
TO BE DIRECTED TO
JANE WASILEWSKI, CHARLOTTE BRANCH
(704) 940-1830 ext 11690

S&ME, Inc.
9731G Southern Pine Boulevard
Charlotte, North Carolina 28273

S&ME, Inc. Quality Policy Statement

S&ME, Inc. is a high-quality, award-winning engineering, environmental, and industrial hygiene service provider. We will strive to provide the quality services that our clients require and have come to expect from S&ME.

No less is expected of our asbestos bulk material identification laboratory. We will meet the requirements of the National Institute of Science and Technology and maintain a state-of-the-industry QA/QC Program to ensure that the deliverables we produce meet our quality standards.

Mike Cashio

C. Mike Cashio, Jr., CIH
Manager, Industrial Hygiene Services

ASBESTOS BULK SAMPLE ANALYSIS LABORATORY
PLM QA/QC PROCEDURES MANUAL

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1.0
Introduction

1.0

The purpose of this manual is to define Quality Assurance/Quality Control (QA/QC) procedures for the asbestos bulk sample laboratory of S&ME, Inc. The procedures described herein will ensure that the S&ME laboratory does everything within reason to safeguard the accuracy of their analyses. This manual only relates to Polarized Light Microscopy (PLM) of bulk samples analyzed in S&ME's NVLAP-accredited laboratory by an approved analyst (see 2.1.1 for a definition).

In addition, the manual itself and the documentation generated by following these procedures will provide all necessary evidence as to the accuracy of the analytical results. This manual is written to satisfy all relevant QA/QC requirements for bulk asbestos analyses as defined in the National Voluntary Laboratory Accreditation Program (NVLAP) Procedures and General Requirements, NIST Handbooks 150 (dated 2/06) and 150-3 (dated 8/94). These manuals shall be reviewed annually by the laboratory manager to ensure they are kept up to date.

The procedures as explained here must be followed; however, some projects may call for measures stricter than those required by these procedures. Such cases will be evaluated on a project-specific basis.

Each S&ME laboratory analyst and the laboratory manager are required to be familiar with and knowledgeable about the contents of this manual relating to their individual scopes of responsibility and authority. The Laboratory QA/QC Director will keep on file a sign-off sheet documenting that each analyst and manager has read and understands the manual (see Appendix F-9). In addition, the laboratory must keep at least one complete and current copy of the manual on the premises for easy reference by all laboratory personnel. It is imperative that the S&ME laboratory maintain its QA/QC documentation. Compliance is critical for the national accreditation of the laboratory. Should the laboratory not maintain its documentation at any time, it will be removed from the NVLAP accreditation. Complete retraining will be required for readmission.

1.1
Objectives of this Manual

The objectives of this manual are to ensure the following:

- Quality and accuracy of analytical results.
- Conformance with all analytical methodologies, including QA/QC requirements.
- Delivery of the highest quality of professional services and technical excellence to our clients.
- Ensure data integrity.

To achieve these objectives, this manual directs implementation of the Quality Control Program, describes responsibilities and duties of all personnel, and addresses all aspects of Quality Assurance for polarized light microscopy (PLM).

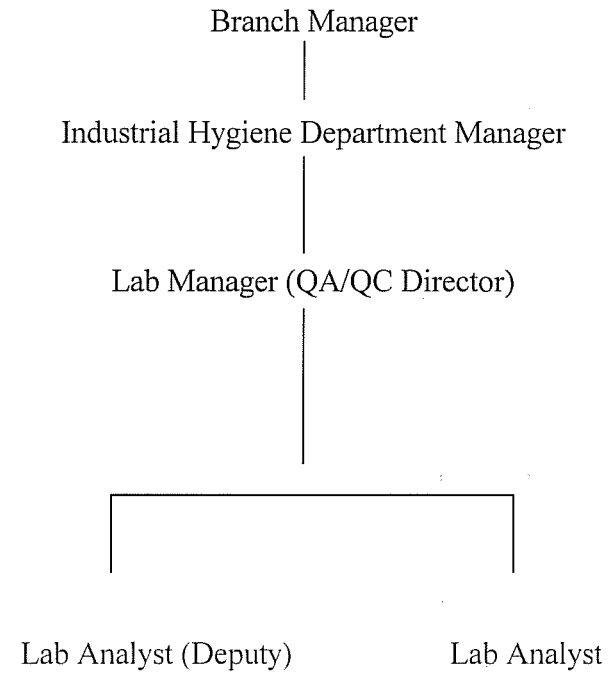
It is our intention to ensure that all objectives of our Quality Program are met and maintained. Quality policies and procedures are integrated into our daily work and are constantly reviewed by the Laboratory Supervisor and the IH Department Manager. To ensure integrity of sample results, these policies include:

- Clear job descriptions delineating responsibilities of each employee involved at all steps of laboratory procedures, data analysis and report generation.
- Completion of Quality Control samples.
- Proper documentation of analytical data.
- Good laboratory technique that ensures a contamination-free environment.
- Use of appropriate analytical technology including review of current literature to capture recent applicable developments.
- Understanding and compliance with procedures which insure client confidentiality

2.0
Organization

This S&ME PLM laboratory QA/QC program for asbestos analysis will be administered by the lab manager. The lab manager will also provide technical assistance to all other S&ME analysts. The QA/QC program is the responsibility of the QA/QC Director. The laboratory manager has complete control of the laboratory analyses and its' procedures, independent of S&ME branch managers, department managers, or outside clients.

PLM QA/QC ORGANIZATIONAL CHART



The laboratory manager (QA/QC director) reports directly to the Industrial Hygiene department manager. The laboratory, department manager and senior IH consultant will determine the overall operational procedures for the laboratory. The laboratory manager will conduct relations with subcontracting for materials submitted to outside laboratories. All laboratory personnel will be responsible for dealing with clients to ensure the highest quality of work and client satisfaction.

2.1
Personnel - Responsibilities and Qualifications

2.1.1
Laboratory Manager

The Laboratory Manager shall be responsible for the technical operations in the laboratory, for the management and supervision of all personnel in the laboratory, and is responsible for acting as approved signatory for NVLAP-endorsed test reports. She must have a two- or four-year degree in a field related to either geology, science, or microscopy and have equivalent experience in managing an asbestos analysis laboratory.

2.1.2
Laboratory QA/QC Director

The Laboratory QA/QC Director shall be responsible for overseeing QA/QC procedures within the laboratory. He must have a two or four-year degree in a field related to either geology, science or microscopy and have equivalent experience in managing an asbestos QA/QC program. He shall also be responsible for maintaining requisite laboratory QA/QC records and for forwarding requisite records and data per this QA/QC procedures manual.

2.1.3
Laboratory Analyst/Approved Signatory

The laboratory analyst shall be responsible for performing analytical microscopy in accordance with the QA/QC manual. The analyst shall be recognized by NVLAP as competent to sign accredited laboratory test results. He must have a two or four-year degree in a field related either to geology, science or to microscopy or have equivalent experience performing asbestos analysis. (See PLM Analyst Job Description at the end of section 2)

Note: Analysts will not be subjected to undue pressure or inducement that might influence their judgement or results. If a conflict of interest arises, it must be resolved as quickly as possible by the lab manager.

2.1.4
Deputy

A laboratory analyst, who is approved by the laboratory manager to fulfill managerial duties during her absence.

2.2
Training

New analysts will, prior to performing any reportable billable analyses, be thoroughly trained by the Laboratory Manager or the Manager's designee. Training will consist of familiarizing the new employee with the appearance and optical characteristics of asbestos and other commonly found non-asbestos materials under the stereomicroscope and polarized light microscope. After the analyst, Laboratory manager and Laboratory QA/QC Director are fully confident in the abilities of the analyst, the analyst shall re-analyze previously completed samples and compare the re-analyses with the original results. An approved analyst will verify and document that the new analyst has accurately analyzed (positive and negative identifications agree) 50 bulk samples that are typical of the laboratory work load. After training and documentation of the analyst's competence by the Laboratory Manager, the new analyst may begin to perform regular analysis. (See PLM Training checklist at the end of section 2)
All laboratory analysts should, after about one month of internal training, be enrolled in an asbestos bulk sample analysis course that follows the guidelines set by the most recent EPA Test Method. For this, the McCrone Research Institute's "Microscopical Identification of Asbestos" course is acceptable. Additional advanced training may be made available as needed.

NOTE: Equivalent PLM labs and course work as part of a BS/BA program may meet the training requirement.

2.3
Education Documentation

By December 1 of each year, or more frequently as needed, the Laboratory Manager will maintain, on each laboratory staff member, a file that will include the following information:

1. Position Description/Job Responsibilities
2. Resumé of Qualifications and Training Completed
3. Documentation of the properly analyzed 50 samples noted in 2.2
4. Assigned Laboratory Procedures
5. Accuracy/Precision Data
6. Error Data
7. Deficiency Corrections

PLM ANALYST
Job Description

Qualifications
Two to four year degree in a field related to either geology, science or to microscopy or have equivalent experience performing asbestos analysis.

Job Description
The Laboratory analyst is responsible for routine analysis of PLM samples by the analytical methods the analyst is assigned and approved to perform. The analyst shall perform routine analysis of samples according to S&ME protocol. The analyst shall not be quoted, compensated or otherwise rated on the number of samples performed during any time period.

Specific Duties:

1. Prepare and analyze PLM bulk samples

2. Perform QA/QC analyses including Re-analyses, Round Robin samples, and daily calibration samples as prescribed in the QA/QC manual.

3. Participate in NVLAP PLM Proficiency program.

4. Have detailed knowledge of analytical instrumentation used during analyses and be able to calibrate this instrumentation within specified parameters.

5. Be available to answer client questions regarding PLM analyses or refer questions to senior PLM analysts or Laboratory Manager

6. Work with QA/QC Manager to resolve any discrepancies with generated PLM QA/QC data or calibrations.

7. Be extremely familiar with all PLM preparation and analytical procedures including EPA 600/R-93/116, EPA 600/M4-82-020, AHERA, OSHA, NESHAPS

8. Have knowledge of LIMS and computer software used in calculating analytical results.

9. Participate in on-going in house training programs

Each laboratory analyst reports to the Laboratory Manager

PLM TRAINING CHECKLIST

ANALYST:_____

TASK	DATE	ANALYST	LAB MANAGER AUTHORIZATION
Asbestos handling and hazards			
PLM microscope alignment			
Preparation techniques: melting, solvents			
Asbestos Identification: Chrysotile			
Amosite			
Crocidolite			
Tremolite			
Actinolite			
Anthophyllite			
Optical properties: Morphology			
Sign of elongation			
Extinction angle			
Refractive index			
Pleochroism			
Birefringence			
Asbestos "look-a-likes"			
Non-asbestos fibrous material			
Non-fibrous binder material			
Difficult samples: Floor tile			
Roofing			
Caulking			
Quantification: Visual area estimation			
Point counting			
Passed 50 training samples			
Passed 5 sets of previous NVLAP samples			
Passed provisional QC period (100% QC)			
Authorized to analyze asbestos by PLM			

There are four main areas of study:

1. **Care, maintenance and proper alignment of the PLM.**
   This includes the knowledge of each function of the microscope and how it relates to asbestos analysis.

2. **Sample Preparation**
   Procedures for friable and non-friable samples, melting techniques, and proper use of solvents.

3. **Identifying asbestos types**
   Identification of each asbestiform mineral, minerals that mimic asbestos traits and distinguishing asbestos which is covered with binders.

4. **Techniques for quantification of asbestos**
   How to properly utilize Visual Area Estimation and point counting to determine asbestos concentration.

3.0
Analytical Methods and Procedures

3.1
Standards

The laboratory shall use the definitions and optical properties found in EPA-600/M4-82-020 Interim Method for the Determination of Asbestos in Bulk Insulation Samples, Table 1-1 Optical properties of asbestos fibers. Also in EPA/600/R-93/116 Method for the Determination of Asbestos in Bulk Building Materials, Table 2-2 Optical Properties of Asbestos Fibers.

3.2
Standard Operating Procedures for Processing Bulk Samples

See the following pages:

1. Main Outline for Processing Incoming Bulk Samples.
2. Bulk Sample Analysis (PLM)
3. Procedure for Archiving Samples
4. Sample Disposal

MAIN OUTLINE FOR PROCESSING INCOMING BULK SAMPLES

Sample(s) have been dropped off or mailed in:

1. Check integrity of sample container(s). Where there is any doubt as to the suitability of sample size, possible sample contamination, samples missing, or client is requesting inappropriate analysis, the Laboratory Supervisor will contact the client by phone or e-mail immediately to resolve the issue. Once the issue is resolved, the action taken will be documented on the chain of custody form and initialed.

2. Register sample(s) in Laboratory Bulk Sample Log (see F-2).

    a. Sample No.: The samples are cataloged according to their job number. Remember this may not be the first set to come in for a given job.

    b. Condition: List condition of samples as they are brought in.

    c. "Lab I.D.": Samples will also be cataloged numerically as they are brought in. Each sample shall have its own "Lab I.D."

3. Establish date by which samples should be analyzed and determine their order of priority relative to other samples.

4. If samples cannot be analyzed within the requested turnaround time, contact client to discuss alternate turnaround time.

5. Analyze samples – enter data into asbestos LIMS program. (See Bulk Samples Analysis).

6. After completion of analysis, samples are to have a 10 percent recheck (See QA/QC Procedures).

7. Samples are archived. (See Procedure for Archiving Bulk and Air Samples).

8. The original Chain-of-Custody sheet (F-1) and Final Test Report are put into the corresponding job file which will be kept permanently in a secure and confidential manner.

9. Final Test Reports can be either emailed or faxed to clients. See Chain of Custody for client instructions. Hard copies of the Test Reports are sent to clients via regular mail within 3 days.

BULK SAMPLE ANALYSIS (PLM)

Procedure:

I. Examine Sample Under Stereoscope.
Remember: Always work with sample under Class I hood or better.
   A. Place sample in hood.
   B. Remove sample from container onto disposable dish.
   C. View under stereoscope. Note general sample characteristics.
      1. overall morphology, including color, consistency, homogeneity, shapes, layers, etc.
      2. fibrous nature
      3. sample constituency:
         a. The number of easily separable different layers will be listed under the gross sample description and the layers will be individually analyzed.
         b. Individual fiber characteristics are noted.
            - fiber types
            - fiber consistency

Optical Properties for non-asbestos fibers shall be documented as follows:

Bench sheet

Code	Non-asbestos fiber	Description
1	Cellulose	tapered, flat ribbons, parallel and incomplete extinction
2	Glass fibers, mineral wool	isotropic, exotic shapes, tear drops, single filaments
3	Synthetic	uniform cross section, high aspect ratio
4	Hair	single fibers with scales and or medula
5	Wollastonite	straight needles and blades, + and – sign of elongation
6	Fibrous talc	thin cleavage ribbons and wavy fibers, In 1.550 DS E-W yellow, N-S blue/orange
7	Heated Amosite	Briddle, pleochroic E-W brown, becke lines above 1.680

This examination will comprise most of the analysis time. In this stage the analyst will look at the overall gross characteristics of the sample and determine the different types of fibers in it. Ideally, the analyst can get a good idea of what each type of fiber is and calculate their percentages. Percentages will be visually estimated by volume.

If the following is the definition of Trace:
Trace = >0 & <1%
Lab Blank Level = 0
DL = 1 Fiber

It is the laboratory policy not to use the term "trace" on any laboratory results.

The definition of <1% is as follows:
After 6 coverslip mounts if the analyst observes 3 or less than 3 asbestos fibers the result shall be documented as <1%.
Note – At the analyst's discretion she/he can continue to make mounts.

The definition of none detected (ND) is as follows:
After 3 coverslip mounts no asbestos fibers are observed the result shall be documented as none detected (ND)

Section II will assure that no fiber type has been missed or that two kinds of fibers are not being considered as one.

II. Examine Sample under Polarized Light Microscope

1. On each slide, use the refractive index liquid that corresponds to the type each fiber is thought to be. Under the hood, mount a small amount of each type of fiber on separate slides. Tease the fiber bundles in order to flatten them on the slide. Place cover slip over fibers and then put a drop of refractive index liquid on edge of cover slip.

2. Place under microscope and, under Plane Polarized Light (PPL) (analyzer out), note:

   a. Observe color of particle or fiber under PPL.

   b. Pleochroism-look at fiber color and how it changes with orientation (rotating of stage).

3. Under cross polarized light (XPL) (analyzer in, compensator out) note:

   a. Morphology-check relief and structural characteristics of fiber.

   b. Birefringence-low, moderate or high.

   c. Extinction characteristics:

      1. Isotropic (fiber disappears completely) or inscribed (still visible under most orientations).

      2. Extinction angles (angle relative to polars at which fiber goes extinct), this will be:

         a. Parallel-fiber goes extinct when oriented parallel or perpendicular to polars (oriented vertically or horizontally), or

         b. Oblique-extinction occurs at an angle to polars.

         c. Rolling-as fiber is rotated different parts go extinct at different orientations. (This is a good indicator of natural fibers).

4. Check sign of elongation (analyzer in, compensator in) all asbestos fibers are positive (blue when orientated at 2 o'clock, yellow at 10 o'clock) except crocidolite in which the colors are reversed.

5. Dispersion Staining (analyzer out, switch to dispersion staining lens) (ideally this last step will confirm the fiber identity as determined in the steps above) check dispersion colors of fibers oriented parallel then again oriented perpendicular. See chart below.

Asbestos Mineral	Oil	Perpendicular	Parallel	Extinction	Elongation
Chrysotile	1.550	Blue	Blue – Magenta	Parallel	(+)
Amosite	1.680	Blue	Gold – Yellow	Parallel & Oblique	(+)
Crocidolite	1.680	Pale Yellow	Blue Blue – Magenta Yellow	Parallel & Oblique	(-)
Tremolite	1.605	Pale – Blue	Yellow	Oblique & Parallel	(+)
Anthophyllite	1.605	Gold – Magenta Blue – Magenta	Yellow	Parallel	(+)
Actinolite	1.605	Yellow	Pale Yellow	Parallel & Oblique	(+)

NOTE: When heated over time, chrysotile will acquire a negative sign of elongation and crocidolite will acquire a positive sign.

Upon completing the analyses, dispose of the slides in the appropriate receptacle and, under the hood, put the bulk sample back into its container. Dispose of the dish in which the sample was analyzed. Make sure that all forceps or other tools are cleaned before they are used again.

PROCEDURE FOR ARCHIVING BULK SAMPLES

Samples will be archived for at least 90 days after the date of analyses unless a longer period is requested by the Client. Once the analysis is complete and the analyst stores the samples in the appropriate storage box marked for that month.

NOTE: Sample sets will be stored in ziploc style re-closeable bags. Archive boxes should contain tops that can be closed.

SAMPLE DISPOSAL

Bulk samples will be stored in enclosed marked containers. When ready for disposal asbestos-contaminated lab waste will be double bagged in six-mil bag (thick leak-tight polyethylene bag). The top of each bag will be twisted and sealed with at least three wraps of duct tape bent over and sealed again with at least three wraps of duct tape. The bags used must be labeled as follows:

CAUTION
Contains Asbestos Fibers
Avoid Opening or Breaking Container
Breathing Asbestos is Hazardous to your Health

and

In Accordance with
Current DOT Regulations

and

With a Generator Label

All asbestos waste will be disposed in a site approved for asbestos waste. Local contractors may be used to transport the waste during one of their scheduled trips to a landfill. Disposal must also be in accordance with any applicable local or state regulations. The Laboratory Supervisor will attach to the disposal manifest a list of the samples disposed of. The list will include laboratory ID numbers and dates received and analyzed. The disposal manifest with the attached documentation will be retained for at least 3 years.

The laboratory test results, archived samples, samples to be analyzed, test equipment, testing standards, and all relevant testing materials will be kept in a secure area with access limited to authorized personnel.

PROCEDURE FOR CONSUMABLE MATERIALS

All materials necessary for laboratory operation, not including microscopes or hoods, shall be purchased from appropriate vendors. Materials that might be purchased are, but not limited to, Refractive Index Oils, coverslips, slides, Kimwipes, and/or HEPA filters. Items such as storage bags or moist wipes for cleaning may be purchased from local stores. All other materials can be purchased from the following approved vendors:

1. McCrone Microscopes and Accessories
2. Environmental Monitoring Systems, Inc.
3. VWR Scientific Products

The following procedure must be used when purchasing laboratory materials:

1. Determine which supplies are needed
2. Obtain approval from Laboratory Manager or Department Manager to order supplies
3. Obtain Purchase Order for payment
4. Order necessary items from approved vendor(s), see above
5. Upon arrival of supplies, submit packing slip to accounts payable
6. Store items in laboratory.

Flammable materials must be kept in a safety storage cabinet. Refractive Index Oils must be kept boxed. Oils that are used on a regular basis may be kept at each workstation. These oils include 1.550, 1.605 and 1.680.

All materials are stored within the laboratory itself, which remains locked when laboratory personnel are not present. The laboratory business hours are 8AM – 5 PM, Monday – Friday.

3.3
Procedures for the Review of Requests, Tenders and Contracts

a. All asbestos bulk sample analyses shall be conducted in accordance with the requirements of EPA Method 600/R-93/116. There shall be no exceptions.

b. The Laboratory Supervisor shall be responsible for ensuring that:

   1. Laboratory supplies are maintained in sufficient quality and quantity such that analyses may be conducted on time and in accordance with established methodology,

   2. Laboratory equipment is maintained in good repair and proper calibration, and

   3. Staffing is adequate to meet deadlines. (In the event that deadlines cannot be met, the Laboratory Supervisor is authorized and required to decline the work).

c. The terms and conditions on the attached document (chain of custody) shall apply to laboratory work. Where other terms and conditions are requested, the Laboratory Supervisor is not authorized to accept the work. Any modifications to the terms and conditions may only be made with the authorization of the Industrial Hygiene Department Manager, Branch Manager, Vice President or President in accordance with the Limits of Authority currently in effect. This restriction applies to all agreements including requests for modifications of terms after commencement of the work.

4.0
Quality Assurance/Quality Control Procedures

4.1
Recordkeeping and Documentation

The lab must have a file for QA/QC information and results. Its maintenance and updating will be the responsibility of the Laboratory QA/QC Director. The file will be updated on a monthly basis or sooner if necessary. The daily QC analysis will be reviewed daily. The file will include:

1. Results of the 10 percent recheck on bulk samples; original and re-analysis results and analysts who performed tests.

2. Results of each analysts out-of-house testing.

3. QA/QC statistical analysis for each individual analyst and the laboratory.

4. Number of total samples done by lab in the course of month and total number of samples rechecked.

5. Steps taken by Lab QA/QC Director to correct any deficiencies noted with analysts on bulk analyses.

6. A summary of all the above information (See F-7).

NOTE: In response to a consistently low degree of accuracy on the part of an analyst, the QA/QC Director will endeavor to retrain the individual, either through one-to-one work sessions in the lab or through additional course work. When the QA/QC Director determines that the analyst is sufficiently retrained, he/she may resume with daily, reportable analyses. In extreme cases of an analyst's inability or unwillingness to improve his/her accuracy, reassignment or termination of that employee may be required. The QA/QC Director will assign tasks as required to ensure quality and efficiency from an analyst.

At the beginning of each month, the Lab QA/QC Director will compile that month's QA/QC file results along with any comments. The monthly update also serves as an excellent vehicle for other lab personnel to submit comments or suggestions on the QA/QC system in accordance with NVLAP requirements. The monthly reports will be due for completion and review by the seventh of the following month. This is a requirement of the NVLAP program. Failure to provide and complete these monthly reports will ultimately lead to the suspension of a lab from the program.

All QA/QC information and personnel information for the lab will also be kept on file. Its maintenance and upkeep will be the responsibility of the QA/QC Director. By the end of the following month, the QA/QC Director will submit comments as needed to each lab on its previous month's report (see Appendix F-7).

All documentation will remain in a locked room at all times. Records stored on the computer will be accessible to laboratory personnel, department secretary(s) and project managers of the industrial hygiene department.

4.1.2
Document Control

Document approval and Issue

All documents issued to personnel in the laboratory shall be reviewed and approved for use by the laboratory manager and laboratory director.

A master list of the current revision status and distribution of documents will be maintained by the laboratory manager. This list will be readily available to preclude the use of invalid and obsolete documents.

Only authorized editions of appropriate documents will be readily available in the laboratory.

Documents will be reviewed and where necessary revised annually to ensure continuing suitability and compliance with applicable requirements.

Obsolete documents will be promptly removed from all points of issue or use to assure against unintended use.

Documents generated by the laboratory will have the following identifications:
* Date of Issue and/or revision
* Page numbering
* Total number of pages
* Issuing authorities

4.1.3
Technical Records
Observations, data and calculations shall be recorded at the time they are made and shall be identifiable to the specific task.

When mistakes occur in records, each mistake shall be crossed out, not erased, made illegible or deleted, and correct value entered alongside. All such alterations to records shall be signed or initialed by the person making the corrections.

4.1.4
Amendments to test reports and calibrations certificates

Material amendments to test reports after issue will include the following statement:
"Revised test report page(s) __ of __."

When it is necessary to issue a complete new test report the report will be uniquely identified with the following statement: "Revised test report to replace report dated MM/DD/YY."

4.2
Bulk Sample QA/QC

Statistical procedures for determining Accuracy and Precision for the laboratory and each analyst will be performed on a monthly basis. See Appendix E for Statistical analysis.

4.2a
Re-Analysis by 2nd Analysis (QA/QC Precision Determination)

Upon the immediate completion of each sample set, a minimum of ten percent of the sample set will be re-analyzed by a second analyst. Sample results will not leave the lab until the minimum ten percent has been re-analyzed. After the 10% has been re-analyzed, the QC results should be checked immediately. If a client is not willing to wait, he can be informed of the fact that the samples are not QA/QC'ed and that the lab will not be held to the results.

In the event of a discrepancy (negative and positive results are reported for a given sample), a third analysis will be performed. Should a discrepancy remain unresolved and time is critical, the sample will be sent to an outside NVLAP accredited laboratory for resolution. However, the analysts should continue to strive to resolve the discrepancy. If necessary, alternate methods of analyses such as TEM, SEM, or XRD may be used, and should be fully documented.

If at a later date any sample result given to a client is found to be erroneous, the client will be notified by the QA/QC Director of the correct result as soon as possible.

4.2b
Re-Analysis by S&ME Analyst and Analysis of Standards (QA/QC Accuracy Determination)

Each analyst will perform monthly in-house analyses other than the daily QA/QC. The reference standard samples will be previously analyzed NVLAP proficiency testing samples. All parameters for bulk sample identification will be compared. This will verify the accuracy of our analyst's ability to correctly determine the optical properties of asbestos.

Analyst Precision is determined by calculating the coefficient of variation (CV).

Analyst Accuracy is determined by calculating percent recovery (% R).

$$\%R = (R/S) \times 100$$

Where: R = the analytical result
S = the formulated standard weight

4.2c
Intra-Analyst QC Determination

The original analyst reanalyzes the test sample. Results are submitted to the QA/QC Director for statistical evaluation. Measure of variance are calculated and plotted over time to determine trends and problems in analysis.

4.2d
Round Robin – Interlab QC

S&ME, Inc. participates with three other commercial laboratories in a quarterly PLM round robin program. Results are compared and charted.

4.2e
Suggested Acceptable Errors for PLM Analysis - Table 2-1 EPA 600/R-93/116

% Asbestos	Acceptable Mean Result	% Area Asbestos	Acceptable Mean Result
1	>0 - 3%	50	40-60%
5	>1-9%	60	50-70%
10	5-15%	70	60-80%
20	10-30%	80	70-90%
30	20-40%	90	80-100%
40	30-50%	100	90-100%

4.2f
Proficiency Testing Procedures
Each analyst will analyze the set of proficiency samples separately. After all analysts have completed all four samples, results are compared. If discrepancies arise the sample or samples in question will be remounted by all analysts. A discussion will follow to determine the correct answer. The laboratory manager will make the final decision as to the correct results and will submit her results only. Test results for each analyst will be documented and filed with the final results.

4.3
Out-of-the-Ordinary Samples

See Appendix C for procedures relating to out of the ordinary samples

Bulk sample standards, permanently mounted slides, slide projection slides, and textbooks are available to assist in sample identification. Bulk sample standards and photocopies of calibrated sample mounts are available for assisting in point counting.

Should the analyst be unsure of his/her results, a second analyst should be consulted. At the analyst's discretion, samples may be sent out to another NVLAP-accredited lab for PLM, TEM or XRD analysis.

4.4
Subcontracting of Tests and Calibrations

When samples are subcontracted out, the laboratory manager will gain the approval of the customer, preferably in writing.

The client must be notified in writing if S&ME is unable to perform the bulk sample analysis and wishes to subcontract to another laboratory. The subcontracting laboratory must be an active NVLAP-accredited Polarized Light Microscopy laboratory in good standing. The sub-contracted laboratory should archive the samples for at least 90 days, which is consistent with S&ME's archive policy.

The laboratory will be responsible to the customer for the subcontractor's work. Except in the case where the customer specifies which subcontractor is to be used.

In the event of a discrepancy (negative and positive results are reported for a given sample), a third analyses will be performed. Should a discrepancy remain unresolved and time is critical, the sample will be sent to an outside NVLAP accredited laboratory for resolution. However, the analysts should continue to strive to resolve the discrepancy. If necessary, alternate methods of analyses such as TEM, SEM, or XRD may be used, and should be fully documented.

Testing and Calibration results obtained from subcontractors
When the test report contains results of tests performed by subcontractors, those results will be clearly identified.

The laboratory performing the subcontracting work will issue the calibration certificate to S&ME. The subcontractor will report the results in writing or electronically.

4.5
Sampling

The laboratory staff of S&ME does not participate in collecting samples or preparing sample plans.

Sampling of substances as it relates to preparation and splitting of samples for subsequent testing.

If the customer requests or the laboratory manager deems it necessary to send a sample to another laboratory for subsequent testing the following procedure will be followed:

* Half of the original sample will be placed in a ziplock bag and clearly marked with the customer's sample number and appropriate project number. (Note: to ensure the validity of the subsequent testing, care must be taken when splitting the sample. The sub sample must represent the original sample.)
* A chain of custody form for the laboratory receiving the sample will be signed by S&ME personnel. If the customer requests special instructions for subsequent testing, this information will be documented on the chain of custody at this time. The sample with all relevant documentation will be placed in a shipping container and sent via FedEx.
* The original sample will have a note attached with a date and statement that the sample was split and sent to another laboratory for subsequent testing. The sample will be returned to the original group of samples from that customer and archived in accordance with S&ME archiving procedures.

4.6
Contamination Control Procedures

Each lab must keep all surfaces and equipment free of dust and asbestos contamination. A microscope station blank will be analyzed each time a microscope station is used. The blank will be made with a known non-asbestos material to determine if asbestos contamination is present at a particular workstation. All non-disposable equipment directly in contact with samples will be wet-wiped between each analysis. Also, each analyst will once a week wet-wipe all counter tops. Once a month each analyst will wet mop and HEPA vacuum the floor.

Each analyst will perform contamination testing once a week at the beginning of each week. Contamination testing will consist of:

1. Visual inspection of lab equipment and supplies including microscopes, work stations, sample analysis tools, glass slides, cover slides, and any cleaning fluids to identify any asbestos or non-asbestos contamination. If contamination is identified, that tool or area will be cleaned to remove the contamination. If that is not possible, it will be discarded.

2. To check for contamination of refractive index liquids, one sample of a known non-asbestos substance will be prepared with each type of refraction liquid used in analysis. Each refraction liquid bottle will be lightly agitated just prior to the sample preparation. The sample will be analyzed under the polarized light microscope to identify any contamination. If contamination is identified, that bottle of refraction liquid will be discarded. The results of all blank tests will be recorded by the Lab QA/QC Director as well as included in the monthly report.

Ambient Air Testing

Once per quarter, or more frequently if reason for concern exists, one air sample of the laboratory shall be collected and analyzed. If air levels are found to be higher than 0.01 fibers/ cc, all analyses will stop. The lab will be emptied of people and cleaned with a HEPA vacuum by a person wearing disposable protective clothing and an appropriate respirator. After cleaning, another air sample will be run. The lab may be reentered only when sample results indicate airborne fiber levels less than or equal to 0.01 fibers/cc air. All contamination control will be documented in the QC monthly summary.

4.7

Mandatory Laboratory Equipment

Each lab will have the following equipment in working order:

1. Polarized light microscope with:
   a. Eyepiece(s) of at least 8x magnification and a cross-hair reticule.
   b. 10x, 20x and 40x objectives or similar magnifications.
   c. Light source.
   d. 360 degree rotatable stage.
   e. Sub-stage condenser with iris diaphragm.
   f. Polarizer and analyzer which can be placed at 90 degrees to each other.
   g. Accessory slot for wave plates and compensators.
   h. Wave retardation plate: Approximately 550 nanometer.
   i. Dispersion staining objective.
   j. Test slide or alignment fiber.
2. Binocular stereoscope, approximately 10-45x, with light source.
3. Fume hood of Class I or better, or equivalent.
4. Index of refraction liquids: 1.490 to 1.570 and 1.590 to 1.720 in increments of 0.005.
5. Microscope slides and cover slips.
6. Sample analysis utensils: dissecting needles (2 per analyst), fine-tip forceps, scalpel with blade.

7. Petri dish or equivalent (disposable glassine paper).

8. Mortar and pestle.

9. Hand bottles with 10% Hydrochloric Acid and Chloroform.

10. Spray bottle with water.

11. thermometer

In addition, each lab will have on hand NIST traceable reference materials for chrysotile, amosite, crocidolite, tremolite, anthophyllite, actinolite, and fibrous glass.

The following reference documents will be available in the laboratory:

1. General text on optical mineralogy or crystallography.

2. 40 CFR Part 763, Vol. 52, No. 210, "Asbestos-Containing Material in Schools; Final Rule and Notice".

3. EPA's "Methods for the Determination of Asbestos in Bulk Building Materials," (EPA/600-R-93/116). (Appendix B)

4. S&ME's laboratory copy of Asbestos Bulk Sample Analysis Laboratory PLM QA/QC Procedures Manual.

5. Copy of "Interim Methods for the Determination of Asbestos in Bulk Samples." (Appendix A)

6. Text on statistics and quality assurance.

7. NIST Handbooks #150 and #150-3.

8. Copy of "Rapidly and Accurately Determine Refractive Indices of Asbestos Fibers by Using Dispersion Staining Method." (Appendix D)

4.8
Equipment Calibration

Equipment will be calibrated when new and at the interval specified below or sooner if the analyst has reason to believe the equipment has gone out of calibration. Details of all calibrations will be documented and kept on file. Each piece of equipment requiring calibration will have on file:

1. Manufacturer's name.
2. Model.
3. Serial number.
4. Major components.
5. Date received and placed in service.
6. Current location.
7. Maintenance details.
8. Date of last calibration, date next calibration due, calibration report references.
9. Manufacturer's Instructions.

If any equipment is damaged or suspected to be functioning improperly, it will be taken out of service. Upon completion of equipment service or calibration the laboratory Supervisor will verify that the equipment has been properly serviced and is acceptable. This acceptability will be documented on the Equipment Service and Repair form for that specific piece of equipment. If during analyses equipment is not functioning properly, the Laboratory Supervisor will determine the cause of the malfunction. If re-calibration is needed, the Laboratory Supervisor will assist the analyst in re-calibration. If it is determined that the equipment is broken and needs servicing, the Laboratory Supervisor will take the equipment out of service and contact a vendor for repair. After repair the equipment will be placed back in service in accordance with this section.

All equipment will be serviced annually for cleaning, alignment and any repairs that may be necessary. Records will be filed to document all servicing of the microscopes.

Safe handling, transport, storage and maintenance
All equipment in the laboratory will be handled with care to prevent damage.

Safe handling
If microscopes or other equipment need to be moved, laboratory personnel will gently lift it with two hands and place it down on a stable surface.

Transport
If the laboratory and its equipment need to be moved to a new location, microscopes will be transported one by one by the laboratory manager in a secure vehicle to insure safe handling.

Storage
Microscopes and other equipment not used will be covered with dust covers to prevent contamination and deterioration. All equipment will be stored in a secure area.

Maintenance
All microscopes and equipment will be maintained in accordance with manufacture's instructions. The laboratory manager is responsible for equipment maintenance. If the need arises, the laboratory manager will schedule service repairs with a reputable vendor.

4.9
Verification of Refractive Index Liquid

Upon opening a new bottle, the refractive index of the immersion liquid will be verified within ±0.004. A material with a known refractive index identical to the assumed value of the liquid will be mounted in that liquid. The Cargille Precision Calibrated Optical Glass Reference Set is recommended for calibrating each oil. The increment for each Calibrated Optical Glass is 0.01. The increment for each refractive index oil is 0.004. In order to obtain an oil refractive index calibration of ±0.004, the refractive index oil must be checked with the matching calibrated optical glass. To determine if the liquid is within calibration standards of ±0.004, use the method "Refractive Index Liquid Calibration using Optical Glass Standards" by Shu-ChunSu, Ph.D.

The verification of the Refractive Index Liquids will be performed quarterly on four (4) Refractive Index liquids; 1.550^{HD}, 1.605^{HD}, 1.680, 1.700. The remaining Refractive Index Liquids will be calibrated annually or as they are used. This data will be recorded, documented, and kept on file.
To ensure that refractive index oils are subject to an appropriate temperature range, the lab will at all times be kept between 16°C (60°F) and 29°C (85°F). See Appendix D for this laboratory's guidance document for "Rapidly And Accurately Determine Refractive Indices Of Asbestos Fibers By Using Dispersion Staining Method". In order to make a ±2°C temperature correction, the following formula will be used:

$$\text{Calibrated Oil R.I.} = \text{Oil R.I.} + (T_1 - T_2)\,(dn_d/dt)$$

Where T_1 is the temperature of the room, is T_2 the temperature of the oil (obtained from the bottle), and dn_d/dt is obtained from the bottle. This data will be recorded, documented, and kept on file.

Measure the temperature of the immersion oil:

Measure and record t (in °C), the temperature of the immersion oil on the microscope slide. If the temperature of the liquid, slide, cover glass and sample can be reasonably assumed to be in equilibrium with the room temperature, t can be assumed to be equal to the room temperature. The temperature data is needed for making temperature correction. Certain microscopes tend to heat up the slide, resulting an increase 2° or more in the oil temperature.

4.9.1

Reference Standards

S&ME laboratory will only purchase reference standards from a body that can provide traceability as described in HB 150 5.6.2.1. Such reference standards of measurement held by the laboratory shall be used for calibration only and for no other purpose. S&ME purchases its reference standards from NIST.

Reference Material

Reference material shall be where possible, traceable to SI units of measurement, or to certified reference materials. Internal reference materials shall be checked as far as technically and economically practicable.

Intermediate checks

Checks to maintain confidence in the calibration status of reference, primary, transfer or working standards and reference material will be accomplished on an as needed basis by the laboratory manager.

Transport, safe handling and storage

For routine samples see section 3.2 Standard operating procedures for processing bulk samples.

To prevent contamination or deterioration and in order to protect the integrity of reference standards and reference material the following guidelines of transport, safe handling, and storage are to be followed:

Transport

Reference standards and material will be transported separately from routine samples. Care must be taken to monitor the movement of these samples within the laboratory to insure they don't become lost among the routine samples.

Safe handling

Reference standards and material will be handled with care to prevent contamination. Only one reference standard or material will be opened at a time. When analysis is complete, the container will be closed and all surfaces and tools used will be wiped clean before another reference standard or material is opened.

Storage

All reference standards and material will be stored in one place in the laboratory. The storage area will be free of light and at the appropriate temperature to prevent deterioration and protect their integrity.

5.0
Internal Audits by S&ME, Inc.

5.0

The S&ME Laboratory Manager will perform annual audits of the laboratory controlled by this QA/QC procedures manual, as appropriate, to verify the adherence of the requirements of this QA/QC program. This will be done in conjunction with the annual review of the QA/QC manual itself.

These audits will be performed both to help assure S&ME management that this QA/QC program is meeting all laboratory accreditation commitments and client contract commitments. These audits will also serve to help the QA/QC Director to keep the QA/QC procedures manual current with changes in regulatory and client requirements as well as to provide verification that the laboratory records are complete and in order.

Each audit will be conducted as if a NVLAP assessor is performing a site visit. By using the forms that are used by NVLAP to assess the laboratory, the Laboratory Manager or QA/QC Director will be able to assure compliance during future site visits.

When audit findings cast doubt on the effectiveness of the operations or on correctiveness or validity of the laboratory's test or calibration results, the laboratory manager will take timely corrective action, and shall notify customers in writing if investigations show that the laboratory results may have been affected.

The area of activity audited, the audit findings and corrective actions that arise from them will be documented by the laboratory manager.

5.1

Management Review

The S&ME Laboratory Management shall periodically conduct a review of the laboratory's quality system and testing activities to ensure their continuing suitability and effectiveness, and to introduce necessary changes or improvements. This review shall be conducted annually.

6.0
Client Relations

6.0

In the event of a client complaint, the issue will be clearly defined, documented and resolved by the laboratory manager and project personnel. The manager should, within bounds of practicality, attempt to correct the problem and appease the client. If a client has a substantial reason to question the accuracy of the analyses, the subject samples will be re-analyzed by a different analyst at no extra charge to the client. The original and re-analyses results will be documented as stemming from a complaint. The results of the re-analyses will be included in the monthly report to the QA/QC Director.

The client must be notified in writing if S&ME is unable to perform the bulk sample analysis and wishes to subcontract to another laboratory. The subcontracting laboratory must be an active NVLAP-accredited Polarized Light Microscopy laboratory in good standing. The sub-contracted laboratory should archive the samples for at least 90 days, which is consistent with S&ME's archive policy.

6.1
Cause Analysis

Where a failure of procedure has resulted in an incorrect analysis, the Laboratory Supervisor will determine the source of the error and discuss the error with the analyst. Potential causes for error could include, but are not limited to: type of sample (floor tile, roofing etc…), analyst's training, equipment and proper equipment calibration. If the investigation indicated a systemic or repeated error or failure of the program, the Laboratory Supervisor and the IH Department Manager shall evaluate laboratory procedures to determine specific causes and initiate specific procedures as required.

After completion of the cause analysis if the IH Department Manager is unsure of laboratory compliance with the laboratory procedures, then he shall require that an internal audit be completed by the Laboratory Supervisor as described in the QA Manual Section 5.0, Internal Audits.

6.2
Preventive Action

On a monthly basis, the Laboratory Supervisor will scrutinize the analysts' QC data specifically looking for trends and abnormalities in analysis. Proficiency testing results will also be reviewed. This proactive approach will identify areas that need improvement before an error or problem occurs.

When improvement opportunities are identified or if preventative action is required, the laboratory manager will develop and implement an action plan. This plan will be monitored to reduce the likelihood of the occurrence of such nonconformities and to take advantage of the opportunities for improvement.

6.3
Corrective Action

Where corrective action is needed, the laboratory manager will identify potential corrective actions. The manager will select and implement the actions most likely to eliminate the problem and to prevent recurrence.

The corrective actions selected will be appropriate to the magnitude and the risk of the problem.

The laboratory manager will document and implement any required changes resulting from corrective action investigations.

The laboratory manager will monitor the results to ensure that the corrective actions taken have been effective.

If the Laboratory Supervisor believes that aspects of the testing do not conform to procedures stated in the laboratory QA manual, work will stop immediately. The client shall be contacted and advised of the situation. Examples of work stoppage are as follows, but are not limited to: cross contamination of samples, insufficient amount of sample to be tested, or a client requesting inappropriate method of analysis.

It is the responsibility of the Laboratory Supervisor to determine nonconformance and work stoppage. The Laboratory Supervisor will contact the client immediately to resolve the issue of nonconformance. The IH Department Manager will then be notified that an issue of nonconformance was identified and resolved. If the issue cannot be resolved by the Laboratory Supervisor, the IH Department Manager will be notified and will take responsibility at that time to resolve the issue. Once the issue of nonconformance is resolved, the Laboratory Supervisor or the IH Department Manager will authorize resumption of work.

7.0
Data Validation and Retention

7.0

All test results generated by S&ME laboratory personnel on computers, or otherwise, must be printed, reviewed and maintained on the S&ME property for a minimum of three years. Data generated by laboratory personnel will be backed up daily by the S&ME backup system.

S&ME

MEMORANDUM

TO: Jane Wasilewski

CC:

FROM: Mark Petersen

DATE: 8/23/10

SUBJECT: Data Backup Procedure

All data located on the Charnc1 fileserver and the Charmail1 mailserver, including IH Lab data and email are backed up on a daily schedule Monday through Friday. The backup schedule is automated using Backup Exec 12.5 for Windows Servers. The backup procedure entails daily "disk to disk" backups that occur during non-peak hours Monday through Friday. The "disk to disk" backup jobs are archived to LTO4 tape on Saturday. The tapes are removed from the tape library on Monday and are rotated back into service on a bi-weekly basis. The backup logs are monitored on a weekly basis by one of the ITG staff members. The tape media are stored locally and offsite.

Signed,

Mark F. Petersen

Senior Regional Network Administrator

8.0
NVLAP Logo and Laboratory ID

8.0

The NVLAP laboratory ID must be on all bulk sample analysis sheets generated by an active NVLAP-accredited polarized light microscopy laboratory.

Utilization of NVLAP Term and Logo
S&ME will follow guidelines stated in Annex 1 of NIST HB 150.

It is S&ME's policy to use the NVLAP term and lab code on each test report. S&ME will not use the NVLAP logo.

QUALITY ASSURANCE/QUALITY CONTROL

MANUAL

ENVIRONMENTAL HAZARDS SERVICES, L.L.C.
7469 Whitepine Road
Richmond, VA 23237
(804) 275-4788

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia has been in business since 1984. EHS is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples. Sample analysis includes the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and fungal spore/pollen grain count and identification of common genera.

In July 2007, EHS purchased BTS laboratories and moved the entire laboratory down to Richmond. BTS Laboratories is a mold, lead and drinking water testing laboratory. EHS is able to continue to offer these same services for BTS clients as well as EHS clients.

EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

In 1998 EHS was acquired by Foxboro Capitol Ltd. Under this ownership EHS is a part of the National Testing Laboratories Network. The other laboratories in this network are:

- National Testing Laboratories, Ltd. – A drinking water laboratory located in Ypsilanti, Michigan.
- Broward Testing Laboratory, Ltd. – A drinking water laboratory located in Ft. Lauderdale, Florida.

The corporate headquarters is in Cleveland, Ohio.

1.2 Objectives, Policies and Authority of EHS Quality Assurance/Quality Control (QA/QC) Operations Manual

The Quality Management System as detailed in the QA/QC Operations Manual is issued under the authority of the President of Foxboro Capitol, Ltd. The QA/QC Operations Manual consists of the QA/QC Manual and the SOPs. The QA/QC Manual documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work that meet customer requirements and are in compliance with ISO/IEC17025 and with NELAC standards.

EHS will continually improve the effectiveness of its QA/QC Operations

Manual and its management system through the use of the quality policy statement and objectives, management reviews, audit results, analysis of data, corrective and preventive actions. This QA/QC Operations Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies.

The QA/QC Operations Manual is to be adhered to explicitly, except in cases of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary. Any changes made to the QA/QC Operations Manual or departures from documented procedures must be approved in order to ensure the integrity of the management system is maintained. The QA/QC Operations Manual is maintained in the QA/QC Office. Additionally, in each department copies of the QA/QC Manual and the SOPs which relate to that department can be found.

1.3 Maintenance and Update Procedures of EHS QA/QC Manual

The Laboratory Director and Quality Manager review the QA/QC manual at least annually to ensure that the management system is meeting customer requirements as well as statutory and regulatory requirements. All revisions/reviews are documented at the end of the QA/QC Manual. Each revision is brought to the attention of the corresponding department and a review log is kept to insure that each individual has read and understood the revision. Obsolete documents are removed from the manual, marked as obsolete, and placed in secure locations to insure that laboratory personnel only use current documentation. It is available at all times to EHS personnel and others including accrediting agencies. All personnel must review the QA/QC Manual at least annually.

1.4 Maintenance of EHS SOPs (Standard Operating Procedures)

Laboratory SOPs are revised as needed by the Laboratory Director and Quality Manager. They are revised to reflect any changes in laboratory practices and/or any updates to the reference methods. All revisions are documented in the Revision log found at the end of the each SOP. Copies of the latest revisions for pertinent SOPs are located in each laboratory section Operations Manual. Laboratory SOPs are located with the QA/QC Manual in the QA/QC Operations Manual. Invalid and/or obsolete SOP's and documents are promptly removed from use, marked as obsolete, and archived to insure that the only documents or SOPs in use are current. The generation of any analytical data is based in strict accordance to the pertinent EHS SOP. All analytical SOPs are based on established reference methods. The SOPs may contain slight modifications to the reference method. Whenever a reference method is modified, this will be

acknowledged by placing an M after the method number. All SOPs which contain a modification from the reference method shall be validated for compliance.

1.5 Maintenance of EHS Instrumentation

All new equipment are calibrated and/or checked prior to be placed into use. Any equipment taken outside of the laboratory is calibrated prior to use upon its return to the laboratory. Preventive maintenance and repairs, minor or major, for instruments within each department is the responsibility of department heads. Daily calibration and periodic checks are required to ensure proper functioning of all equipment and checks are recorded on instrumentation logs for each piece of equipment. Each piece of equipment is referenced by its serial number or a unique equipment identifier in an Instrument Log book. Records of all maintenance and repairs are kept in the instrumentation log books. Any instrument that is found to be out of calibration or defective is placed out of service. The Laboratory Director is notified in the event instruments are out of calibration and are in need of service. All instrumental conditions which affect the analysis are controlled and documented.

1.6 Accreditation Logos

EHS uses the NVLAP, AIHA and NELAP logos only in advertising. The logo being used has been pre-approved by the appropriate accrediting body. EHS does not use any of their accreditating bodies logos in reports, letters or any other documents associated with the laboratory.

1.6.1 NVLAP

1.6.1.1 The NVLAP logo stands by itself and is not combined with any other logo, symbol or graphic

1.6.1.2 The ratio of height to width is 1 to 2.25.

1.6.1.3 The NVLAP logo is accompanied by the NVLAP Lab Code in an approved caption. The caption will appear below and in close proximity to the logo.

1.6.1.4 The logo and caption is of a size that allows the caption to be easily read. The size of the caption shall not exceed the size of the logo.

1.6.1.5 The logo shall appear in black, blue or other color approved by NVLAP, and may be filled or unfilled. If the logo is filled then the same color is used for the outline and the fill.

1.6.2 AIHA

1.6.2.1 EHS will only use the AIHA logos for testing within the laboratory's scope of accreditation.

1.6.2.2 EHS will only use the approved logo provided by AIHA to the laboratory.

1.6.3 NELAC

1.6.3.1 EHS will only use the NELAC logos for testing within the laboratory's scope of accreditation.

1.6.3.2 The NELAC logo is accompanied by the phrase "NELAP accredited" and the laboratory's accreditation number or other identifier with their accrediting authorities name.

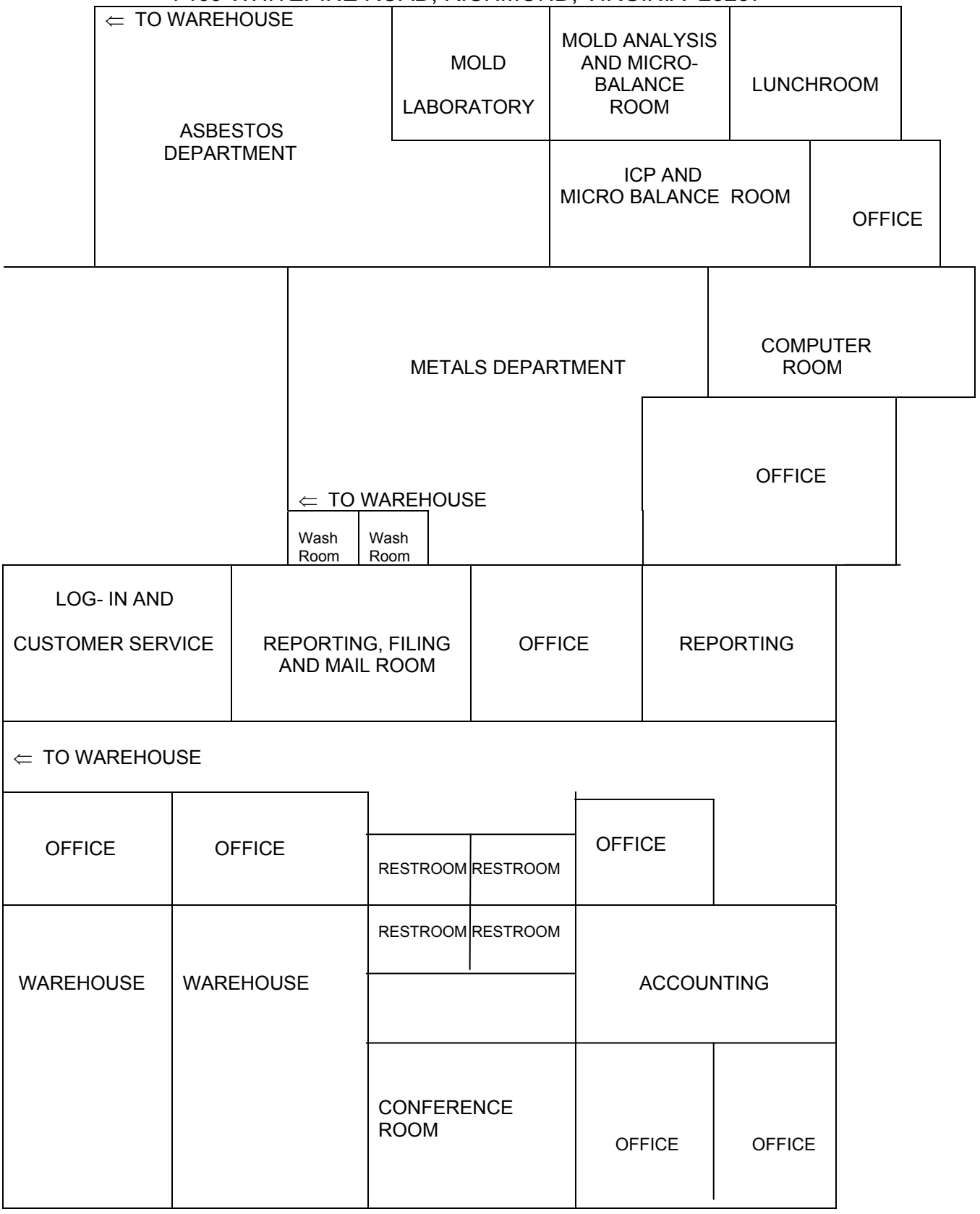
2. FACILITIES

2.1 Location

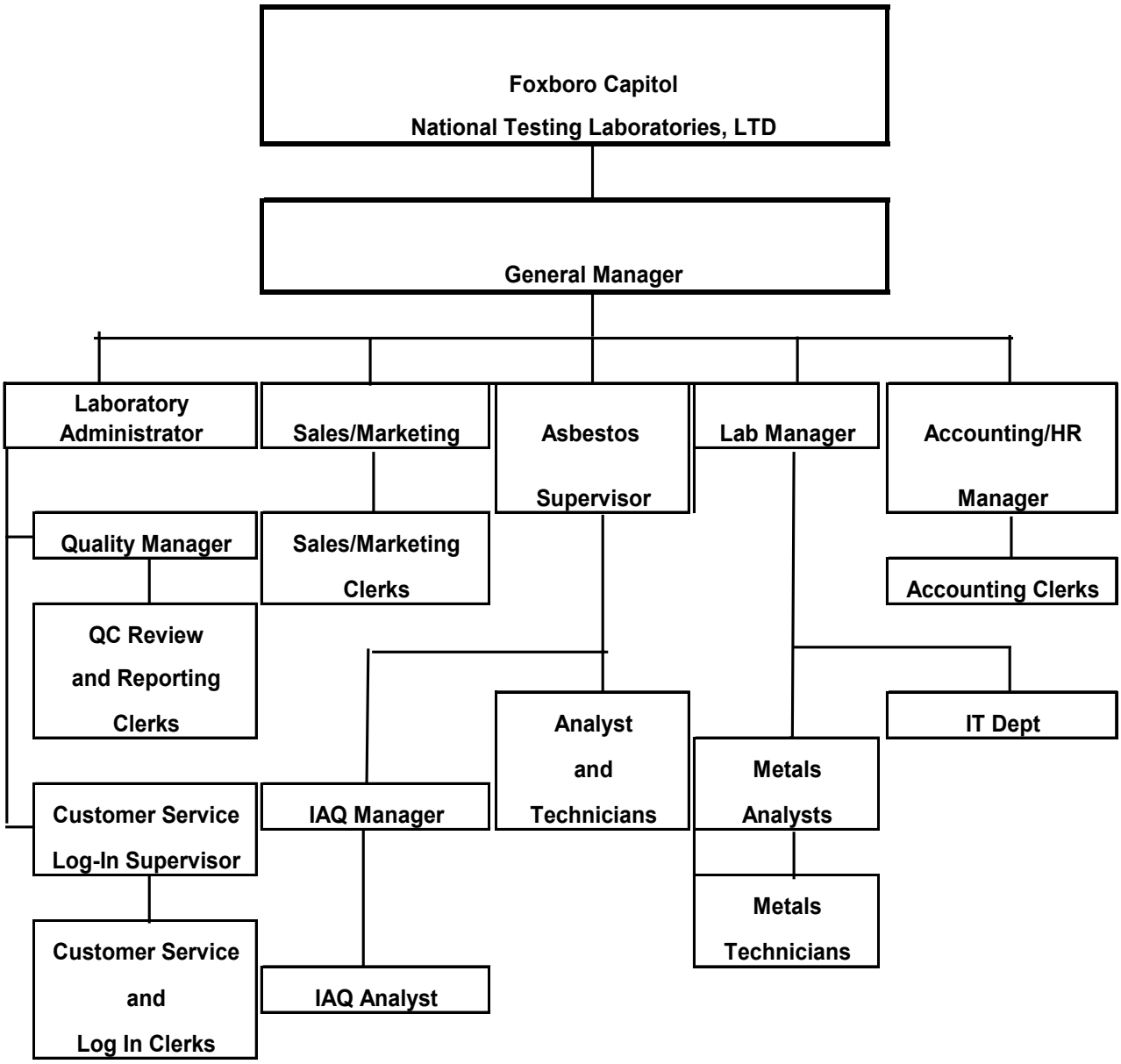
EHS is located at 7469 White Pine Road, Richmond, Virginia, 23237. All necessary utilities are available at this location for the safe and reliable operation of a fixed-site analytical testing laboratory. EHS has occupied its present location since December 1994. Facilities can be renovated or expanded as future needs dictate. Housekeeping duties are primarily the function of an independent cleaning agency as well as daily cleaning by laboratory and administrative personnel. All environmental conditions of the laboratory including microbial contamination that affect the analysis are controlled and documented. Every effort has been made to ensure the safety of EHS personnel and other occupants of the building. EHS occupies approximately 9000 square feet of total space. This includes 2000 square feet for office/administrative purposes, 4000 square feet for laboratory analysis and 3000 square feet for warehouse space.

2.2 Floor plan (See attached drawing.)

ENVIRONMENTAL HAZARDS SERVICES, LLC
7469 WHITEPINE ROAD, RICHMOND, VIRGINIA 23237



ENVIRONMENTAL HAZARDS SERVICES, LLC



3. PERSONNEL / ORGANIZATION / RESPONSIBILITIES / AND QUALIFICATIONS

3.1 President – (Foxboro Capital Ltd.)

The President has the ultimate responsibility for all aspects of every laboratory in the National Testing Laboratories Network.

3.2 General Manager

The General Manager reports directly to President and is responsible for all the day to day operations of Environmental Hazards Services, L.L.C.

3.3 Laboratory Manager (Technical Manager)

3.3.1 The Laboratory Manager's responsibilities include, but are not limited to:

- **a.** Review of all laboratory procedures
- **b.** Review of any change in laboratory procedure
- **c.** Employee training (Safety, new procedures, etc.)
- **d.** Review and approval of laboratory reports
- **e.** Review of all QA/QC activities
- **f.** Review of all laboratory manuals (Safety, QA/QC, Procedure)
- **g.** Insure all accreditations and licensing requirements are up-to-date
- **h.** Approval of new analysts prior to their reporting results for Clients
- **i.** Report opinions and interpretations of the test data when necessary. (This may only be done by the Laboratory Manager, Laboratory Administrator or the Quality Manager.)
- **j.** Any other Activity as needed

3.4 Laboratory Administrator

3.4.2 The Laboratory Administrator responsibilities include, but are not limited to:

- **a.** Log In of all samples received in the laboratory
- **b.** Reporting and Invoicing of laboratory reports
- **c.** All Customer Service activities
- **d.** Review and approval of laboratory reports
- **e.** Review of all QA/QC activities
- **f.** Insure all accreditations and licensing requirements are up-to-date
- **g.** Approval of new analysts prior to their reporting results for Clients
- **h.** Report opinions and interpretations of the test data when necessary. (This may only be done by the Laboratory Manager, Laboratory Administrator or the Quality Manager.)

i. Shipping of kits and supplies to customers

3.4.3 The Laboratory Administrator must meet at least the minimum of the following requirements:

a. B.A. or B.S. in Chemistry or a Physical Science
b. Five (5) years supervisory experience in a laboratory

3.4.4 In the event of the absence of the Laboratory Manager the Laboratory Administrator or the Quality Manager will accept the responsibilities of the Laboratory Manager.

3.5 Quality Manager

3.5.1 The Quality Manager's responsibilities include, but are not limited to:

a. An annual audit of the laboratory's QA/QC Program and review of the QA/QC Manual, with a report of findings to the Laboratory Director.
b. A quarterly review of the QA/QC Program, with a report to the Laboratory Director.
c. A monthly summary of QA/QC activities and performance, with a report to the Laboratory Director
d. Review and implementation of newly required method changes
e. Review and reporting of proficiency samples
f. Review and reporting of all round robin samples
g. Determination of intra-laboratory precision/accuracy
h. Deficiency corrections
i. Review and approval of laboratory reports
j. Report opinions and interpretations of the test data when necessary. (This may only be done by the Laboratory Manager, Laboratory Administrator or the Quality Manager.)

3.5.2 The Quality Manager must meet at least the minimum of the following requirements:

a. B.A. or B.S. in a Physical Science or Mathematics
b. Two (2) years laboratory experience
c. The IAQ Quality Manager must have 6 month microbiological experience and a formal QA/QC Microbiological course.
d. One (1) year experience implementing a QA/QC program and academic training in statistics

3.5.3 In the event of the absence of the Laboratory Manager or the Laboratory Administrator, the Quality Manager will accept the responsibilities of those duties.

3.6 IAQ Technical Manager

3.6.1 The IAQ Technical Manager's responsibilities include, but are not limited to:

a. Review of all IAQ laboratory procedures
b. Review of any change in IAQ laboratory procedure
c. Supervise IAQ Employee training (Safety, new procedures, etc.)
d. Review and approval of IAQ laboratory reports
e. Approval of new analysts prior to their reporting results for Clients
f. Any other activity as needed

3.6.2 The IAQ Technical Manager must meet at least the minimum of the following requirements:

a. B.S. in Microbiology with two (2) years of microbiological experience or.
b. Life Science Degree with two (2) years of microbiological experience with 20 semester hours in specific microbiological classwork, three (3) years experience with 16 semester hours, or four (4) years experience with 12 semester hours.

3.6.3 In the event of the absence of the Quality Manager, Laboratory Director, and the Laboratory Administrator the IAQ Technical Manager will accept full responsibility for all events within their department.

3.7 Asbestos Bulk (PLM) Analyst

3.7.1 The asbestos bulk analyst's responsibilities include, but are not limited to:

a. Analysis of bulk samples by Polarized Light Microscopy utilizing proper methodology
b. Following proper QA/QC methods as described within this manual

3.7.2 The asbestos bulk analyst must meet at least the minimum of the following requirements:

a. Training by the McCrone Institute "Microscopical Identification of Asbestos" or equivalent
b. Six months experience analyzing asbestos bulk samples
c. Exhibit initial competency at this type of analysis by the correct analysis of 50 reference samples. (See S.O.P. for Employee Training)
d. Exhibit continued competence annually with the

correct analysis of 50 reference samples.

3.8 Fiber Count (PCM) Analyst

3.8.1 The fiber count analyst's responsibilities include, but are not limited to:

- **a.** Analysis of air samples by Phase Contrast Microscopy utilizing the NIOSH 7400 Method.
- **b.** Following proper QA/QC methods as described within this manual.

3.8.2 The fiber count analyst must meet at least the minimum of the following requirements:

- **a.** NIOSH 582 (Sampling and Evaluating Airborne Asbestos Dust) course or equivalent training
- **b.** Exhibit competency at this type of analyst (See S.O.P. for Employee Training) with the analysis of 50 reference slides
- **c.** Exhibit continued competence by correctly analyzing at least 30 reference slides annually.

3.9 Fiber Count (PCM) Technician

3.9.1 The fiber count technician's responsibilities include, but are not limited to:

- **a.** Preparation of air samples
- **b.** Preparation of raw data worksheets using information provided by the client
- **c.** Following proper QA/QC methods as described in this manual

3.9.2 The fiber count technician must meet at least the minimum of the following requirements:

- **a.** Completion of the PCM Technician Training Checklist
- **b.** Exhibit competency (see S.O.P. for Employee Training) Technicians shall show their proficiency with the correct preparation of PCM samples under the supervision of a PCM analyst for a 3 month period.
- **c.** The technician will continue to demonstrate their proficiency by participating in an In-house training course annually which will be conducted by a PCM analyst to ensure that the technician is still performing in a proficient manner.

3.10 Metals Analyst

3.10.1 The metals analyst responsibilities include, but are not

limited to:

a. Maintenance of all equipment within the metals laboratory
b. Preparation/analysis of metals samples utilizing Atomic Absorption and ICP Emission Spectroscopy, and Mercury Cold Vapor Analysis
c. Follow proper QA/QC methods as described within the QA/QC Manual

3.10.2 The metals analyst must meet at least the minimum of following requirements:

a. B.A. or B.S. in chemistry or related science
b. One year relevant laboratory experience
c. Completed in-house training course which is indicated by the use of a checklist for each metals analysis method.
d. Exhibit competency (see S.O.P. for Employee Training)
- If less than three years experience, the analyst/technician must work under the direct supervision of the Laboratory Director or of an proficient analyst/chemist for a period of three months.
- Completion of 4 runs of 5 samples of lead certified reference material analysis for each matrix.
- The analyst must complete, every 6 months, 4 runs of 5 sets of lead certified reference material analyses for each matrix to continue to show proficiency.

e. Approval letter and date will be documented in the employee's file.

3.10.3 In the event of the absence of the Quality Manager, Laboratory Administrator and the Laboratory Director, the Metals Analyst(s) will accept full responsibility for all events within their department.

3.11 Metals Technician

3.11.1 A metals technician responsibilities include, but are not limited to:

a. Preparation of metals samples of varying media
b. Preparation of metals raw data worksheets using information provided by the client
c. Cleaning and maintenance of equipment within the metals laboratory

3.11.2 The metals technician must meet at least the minimum of the following requirements:

a. Completion of an In-house Training Program which indicated compliance through the use of checklist for each method.
b. Exhibited proficiency in all areas included on the Metals

Technician Training Checklists

c. Exhibit competency (see S.O.P. for Employee Training
- The technician must work under the direct supervision of an analyst for a period of three months.
- Preparation of 4 runs of 5 sets of lead certified reference material analyses for each matrix. This set of runs is to be performed every 6 months to show continued proficiency.

d. Approval letter and date will be documented in the employee's file.

3.12 IAQ Analyst

3.12.1 An IAQ Analyst responsibilities include, but are not limited to:

a. Maintenance of all equipment related to their analytical Assignments

b. Preparation and analysis of IAQ samples

c. Follow proper QA/QC methods as described within the QA/QC Manual

3.12.2 The IAQ analyst must meet at least the minimum of the following requirements:

a. B.A. or B.S. in microbiology, biology or a related life science

b. One year relevant IAQ experience

c. Completion of an In-house Training Program which indicates proficiency using a checklist for each method. Training covers an introduction to Fungi, with their structures and processes. Understanding the characteristics of the different divisions. Identification of spore types, with the ability to sketch the genera. Capability with sampling methodology, preparation, counting methods, detection limits and theory involved with analysis. (See S.O.P. for Employee Training)

d. Exhibit competency by the analysis of samples, counting slides, and reading spore reference samples.

e. Exhibit continued competency by the analysis of a minimum of 30 reference samples annually.

f. Analysts that have shown their proficiency but are not continually analyzing samples, must also complete one reference slide per week to demonstrate their continued proficiency.

3.12.3 In the event of the absence of the IAQ Laboratory Director, Laboratory Administrator and the Quality Manager, the IAQ Analyst will accept full responsibility for all events within their department.

3.13 IAQ Technician

3.13.1 The IAQ technician's responsibilities include but are not limited to:

a. Preparation of IAQ samples for analysis
b. Preparation of raw data worksheets using information supplied by the client.
c. Cleaning and maintenance of equipment within the IAQ Laboratory
d. Other duties as necessary

3.13.2 The IAQ technician must meet at least the minimum of the following requirements:

a. Completion of an IAQ course either outside of the laboratory or an In-house training course using a checklist for each method.

(See S.O.P. for Employee Training)

b. Checklist covers an introduction to Fungi, with their structures and processes. Understanding the characteristics of the different divisions. Compliance with sampling methodology and preparation.
c. Exhibited competency in necessary areas of the IAQ technician course.
d. Three (3) months IAQ experience

4. COC/SAMPLE RECEIVING / HANDLING / DOCUMENT CONTROL

4.1 Chain-of-Custody and Sample Receiving

Samples are received at EHS by US Mail, courier, or hand delivery. For specific information, see the SOP. for Log-in Procedures. EHS does not perform any sample collection, but if a client calls and request instructions see the SOP for Sample Collection.

4.1.1 Chain-of-Custody (COC) forms are supplied by EHS or clients may choose to utilize their own internal COC forms.

4.1.1.1 EHS recommends the following minimum information be provided on COC forms:

a. Project Name
b. Name and Signature of collection personnel
c. Sample identifiers
d. Date and time of collection
e. Grab or Composite designation
f. Signatures of persons involved in sample transfer
g. Date and time of sample transfers

h. Analysis requested
i. Sample condition is noted on the COC

4.1.2 At the time of sample receipt, all initial information requested by the COC is completed by the employee performing sample log-in duties. The date and time sample was received is noted on the COC, with the signature or initials of the receiver. The condition of the sample is noted in Wavefront as the samples are received into the LIMS system. Samples deemed unacceptable are marked unacceptable in Wavefront. The client is called about the samples and a note is placed in Goldmine. The samples are then placed in the hold bin. The samples are held for 90 days and then discarded unless the client authorizes analysis in written form or request that the samples be sent back to the client.

4.1.3 During receipt, samples are individually checked for leaks or contamination (i.e., samples opened in transport) and that information provided on COC matches samples (i.e., correct number of samples, correct analysis requested, correct sampling containers and/or correct sampling media, sample number on containers matches sample number on COC form, etc.). Any inconsistencies, leaks (leaking multiphasic samples cannot be considered representative), or contamination may be cause for sample rejection.

4.1.3.1 Temperature-, time-, and preservative-sensitive samples are additionally examined at this time for:

a. Temperature - temperature of the sample cooler is recorded on the COC.
b. Sample holding times - if the allowed sample holding time will expire before the analysis can be completed, the client is notified immediately. (Holding times can be found in the table 4.1.3.3)
c. Preservatives - the presence or absence of preservative information is recorded on the COC. The addition of any necessary preservatives occurs in the metals laboratory. (See table 4.1.3.3 for preservative information)

4.1.3.2 Containers

EHS does not provide any containers to clients for sampling except for centrifuge tubes and pre-weighed cassettes. EHS recommends the use of glass or plastic containers. In the event of the incorrect sampling, the samples are held and the client is notified of the problem.

Table for containers, preservation techniques,
and holding times for aqueous and solid matrices:

Sample	Container	Preservative	Holding Time
Metals			
Total (except mercury and Chromium VI)			
Aqueous	P, G *	HNO3 to pH<2	6 months
Solid	P, G *	None	6 months
Mercury			
Aqueous	P, G *	HNO3 to pH<2	28 days
Solid	P, G *	None	28 days store at 4 ± 2°C
ChromiumVI	EHS does not analyze for this metal.		
	* P – Plastic, G – Glass		

4.1.3.3 Sample Shipping and Handling

No special protocol for transport is necessary for all samples at EHS except for culturable IAQ samples. Regular mail and shipping times are acceptable. The only requirement is that samples be well sealed in order to control the homogeneity of the sample, to insure that no cross-contamination occurs and that no sample loss transpires during shipping.

All culturable IAQ samples must be shipped in an insulated container, protected from moisture, and refrigerated with an ice pack. Samples must be received within 24 hours of collection. The laboratory holds culturable samples that do not meet these requirements and the client is notified of the non-conformance. The samples are held in the refrigerated Hold Bin until the client notifies EHS of their needs. If the client instructs EHS to analyze the samples a disclaimer is placed on the report stating that due to the fact that the samples were not received in the proper manner the results may be affected.

4.1.4 Documentation of Acceptability

Upon examination of the samples, if the samples are found unacceptable due to lack of paperwork and/or incorrect COC or

other problems, the samples are received into the lab but marked unacceptable in LIMS. The samples are then placed on Hold and the client is notified. The samples are held until the problems are corrected or the client request disposal of the samples. Notes are put in Goldmine as to the reason they are on hold. The following statement shall be included on every final report. "The condition of the samples analyzed was acceptable upon receipt per laboratory protocol unless otherwise noted on this report."

4.1.4.1 If any samples are determined to be unacceptable and analysis is performed a notation must appear on the report with an appropriate explanation.

4.1.4.2 If problems are found with the sample or part of a group of samples, then the samples are unacceptable and a note is placed in Goldmine. Examples of problem samples would be missing samples, no COC, insufficient sample amount, composite wipes, non- refrigerated culturable IAQ sample, etc. If samples are missing from a group of samples the client is called and notified of the problem and the samples are sent to the lab for analysis. In the case of composite wipes, EHS has a written policy which is faxed to the client. For California samples sampling location, date and time must be noted on the COC; if not client must be notified and either the missing information is given by the client and recorded on the COC or the client must give approval for the samples to be analyzed even though sampling information is incomplete.

4.1.4.3 The problem sample or the problem part of a group of samples are held in a special bin until the client can be reached and the problem resolved. The client is made aware of the problems with the sample by a phone call and/or a fax. If after a three month period, the client has not contacted EHS with a remedy for the problem samples, the samples are disposed of in an appropriate manner.

4.2 Sample Receipt and Log-in

4.2.1 Samples are received into a Laboratory Information Management System (LIMS) and a job number is assigned. A label is printed with the job number and the due date. This job numbered is added to each individual sample when they are numbered. The sample receipt should include the following:

a. Customer Name and Number
b. Date received
c. Project/Test Address
d. Turn Around Time
e. Shipping Type

4.2.2 After samples are received they are logged into the LIMS system. The Log In information may consists of the following:

a. Customer Sample ID
b. Collection location
c. Surface type
d. Area dimensions
e. Air volumes or start and end times with flow rates

4.3 Sample Handling

4.3.1 Samples are then moved to sample preparation/analysis areas. Samples are placed in holding bins in each appropriate laboratory area until prep/analysis is conducted.

4.3.2

4.3.2.1 IAQ samples requiring refrigeration are placed in the appropriate refrigerated sample holding area. Daily checks of the refrigerator temperature are kept in the refrigerator temperature log. The acceptable temperature for the refrigerator is 4 $\pm$ 2°C.

4.3.1.1 Samples requiring preservation are preserved as shown in Table 4.1.3.3 on the previous page.

4.3.2 Sample Numbers are assigned by the LIMS number plus an additional number. This number always begins with one and increases by increments of one throughout the job. Sample numbers are assigned by personal within the specific departments. (Example the 1st sample for LIMS number 09-09-00123 is labeled 09-09-00123-1)

4.3.3 Prior to analysis of samples for metals a calibration curve is establish for with the use at least three calibration standards for FAA and two calibration standards for ICP. The calibration curves are checked with the use of a reporting limit verification standard and with a calibration check sample. As sample analysis is conducted, a batch number is assigned to each separate analysis. For example, the first analysis of wipe samples on June 3, 2010, will have a batch number of 060310W. The 06 stands for June, 03 the day of the month, 10 stands for the year and W refers to wipes. Soil samples would be shown by an S, Paints by a P, Airs by an A, and so on. If another group of wipes are run later on that same day the W would be followed by a one (1) to differentiate it from the 1st analysis run (060310W1).

4.3.4 The analyst records the batch number on the QC sheets for each run as well as on the raw data work sheets of each metals sample.

4.3.5 Batch numbers, which are based by date, can be traced to the standards purchased by referencing the Standards Preparation Log Book which list the purchased certified standards used to prepare the standards and the dates prepared.

4.3.6 Samples are maintained on-site for at least thirty days after analysis in dated containers. They are then either disposed of in accordance with all regulations or returned to the client. EHS contracts with a local contractor for hazardous waste disposal.

4.3.6.1 Lead paint, soil and TCLP samples are combined and a TCLP sample is collected and analyzed. If this sample is below regulatory limits, the waste is disposed of as normal waste. If the result is above a regulatory limit, the waste is disposed of in accordance with regulation as a hazardous waste.

4.3.6.2 All viable IAQ samples will be autoclaved at 121^{o}C/15 PSI for 30 minutes with a fast exhaust before disposal. Once samples have been autoclaved they may be disposed of with the normal laboratory waste.

4.4 Reviews

4.4.1 All raw data work sheets from the Asbestos, Metals, and IAQ departments are checked by the analyst and double-checked by a second analyst and/or qualified reviewer for completeness and accuracy prior to submission to administration for reporting. Any errors are marked with a single line, initialed and dated. Once checked, approval will be noted at the bottom of each worksheet by the initials of the reviewers in the appropriate blanks:

Checked By: _____ or Reviewed by: _____

This notation signifies that the worksheet has been checked and all data and calculations are correct.

4.4.2 QA/QC samples are completed and reviewed by the Quality Manager or Laboratory Administrator prior to reporting of results to clients. (See individual analyte S.O.P. for QA/QC Requirements.)

4.5 Data Reporting

Reports are reviewed by a trained reviewer for completeness and, after approval by the appropriate signatory or designate, released to the client. All reports whether electronic or paper are controlled and monitored to insure client confidentiality. For EHS clients a copy of the chain-of-custody and any raw data are kept in files by numerical report number. These files are kept in file cabinets for a minimum of two months, for easy response to

possible client questions. Every two to three months files are archived in the warehouse. Files are maintained for a minimum of five (5) years.

The Authorized Signatories are chosen by their training, education and/or technical experience. Each signatory is competent to review and sign off on the report that corresponds to their knowledge and training.

4.6 Client Confidentiality, Conflict of Interest and Ethical Responsibilities

All information supplied by the client shall remain confidential. All employees are given an employee handbook, which states that absolutely no COC information or client results will be released to third parties without written permission from the client. Employees are prohibited from engaging in any activities, which conflict with the interest of the Company, or its customers. Employees are trained in the ethical and legal responsibilities of the laboratory and that the potential punishment and penalties for improper, unethical or illegal actions can range from the termination of employment to the taking of legal action against said employee. Further information can be found in the employee handbook and a statement of the employee's knowledge of the information within the handbook is signed and dated by said employee. This signed statement is kept within the employee's personal file.

Employees only perform duties within the areas of their competence and quality analysis is paramount and never sacrificed to meet a turn around time. Clients are aware that our turn around time is a good faith estimate and EHS is not liable for delays in turn around time. Clients understand that we do not charge any additional fees for rush or Saturday analysis in exchange for the understanding that on occasion delays may occur due to excess sample receipt, instrument downtime, and any other problems. In the event of the before mentioned occurrences every attempt is made to communicate with the clients and prioritize samples based on client need.

Employees are made aware of these policies to ensure that there is no undue pressure or influences that may adversely affect the quality of work. In the event an employee feels undue pressure or stress which many adversely affect the quality of their work they are instructed to contact their supervisor or the quality assurance coordinator.

4.7 Corrective/Preventative Actions Policies

4.7.1 Corrective Action Policies

EHS, in compliance with ISO/IEC 17025 requirements, has established a program to take corrective action whenever quality control data are outside acceptance limits or any other nonconforming event has occurred. The Quality Manager has been designated to be the focal point of all corrective actions. Once a

corrective action has been initiated the form is given to the Quality Manager who distributes the form to those involved with the nonconformance. Procedures have been established that show the process involved in identifying the non-conformance, documenting the root cause analysis, tracking the correction process determined by the analysis and reviewing the process in order to insure that the corrective actions are effective. (See SOP F-6, SOP for Corrective/Preventive Actions)

4.7.2 Preventive Action Policies

EHS has implemented a Preventive Action Plan to reduce the potential of nonconformance. Through the use of internal audits, management review and input from laboratory personnel potential sources of nonconformance and necessary areas of improvement will be identified. (See SOP F-6, SOP for Corrective/Preventive Actions)

4.8 Sampling Materials and Procedures

Environmental Hazards Services L.L.C. has made a commitment not to be in the business of sample collection, in order to not compete with our clients. A brief discussion of sampling materials, containers, preservatives, shipping requirements and procedures for each test method offered by EHS is provided upon client request. This can be found in the SOP A-2. If samples are received which are determined to deviate from the correct sampling requirements, the sample is placed on hold until the client can be notified of the problems. Samples deemed unacceptable are held in a hold bin, clients are contacted to inform them of the problem and the samples are held for 90 days and are then discarded unless the client authorizes analysis in written form or request that samples be sent back.

4.9 Procurement

All suppliers of critical consumables, supplies and services that may affect the quality of testing must be evaluated to assure they meet the requirements of EHS. This evaluation procedure can be found in SOP F-7, The Evaluation and Use of Outside Vendors.

5. QUALITY ASSURANCE / QUALITY CONTROL

5.1 Internal Quality Control (QC)

5.1.1 Asbestos Bulk Samples

5.1.1.1 Intra-Laboratory Asbestos Bulk Sample QC

At least ten percent (10%) of all asbestos bulk samples analyzed at EHS are reanalyzed as part of a daily QC

Program. The reanalysis are performed “blind” (the QC analyst is unaware of the initial result) and must be 5% duplicate and 5% replicate analysis (by the original analyst or a different analyst, respectively).

5.1.1.2 Reference Bulk Asbestos QC

Each analyst will analyze at least one Reference Samples (past NVLAP proficiency samples, NIST-traceable reference materials, samples verified by other methods (TEM), etc.) daily. The Quality Manager verifies all reference sample results for accuracy. This functions as a measure of accuracy and ensures continued precision of the individual analyst.

5.1.1.3 Record keeping

All documents regarding internal QC of Asbestos bulk samples are maintained in a weekly QC file. Summaries for individual analysts are compiled and overall precision and accuracy are determined.

5.1.1.4 See S.O.P. for Bulk Asbestos QA/QC Program for additional information.

5.1.2 Airborne Fiber Counts

5.1.2.1 Intra-Laboratory QC

At least ten percent (10%) of all samples analyzed at EHS are reanalyzed as part of a daily QC program. The reanalysis are performed “blind” (the QC analyst is unaware of the initial result) and may be a duplicate or replicate analysis (by the original analyst or a different analyst, respectively).

5.1.2.2 Reference Fiber Count QC

EHS maintains a bank of air reference samples generated by regulatory programs (PAT, etc.) and other laboratories. At least one of these reference samples are analyzed by each EHS analyst daily. The Quality Manager verifies all reference sample results for accuracy. This functions as a measure of accuracy and ensures continued precision of the individual analyst.

5.1.2.3 Record keeping

All documents regarding internal QC of Airborne Fiber Counts are maintained in a weekly QC file. Summaries for individual

analysts are compiled and overall precision and accuracy are determined.

5.1.2.4 See S.O.P. for Airborne Fiber Count QA/QC Program for additional information.

5.1.3 Metals/Inorganics

5.1.3.1 Intra-Laboratory QC

EHS ensures accuracy and precision of metals analysis through the use of calibration verifications, internal blind samples, laboratory control samples, spiked matrix and blank samples, duplicate analyses, and the comparison of the generated QC data with specific information regarding individual QC procedures. Quality Control data is analyzed and, when found to be outside acceptance criteria, action is taken to correct the problem and to prevent incorrect results from being reported to the client.

5.1.3.2 See S.O.P for Metals QA/QC for additional information.

5.1.3.3 Record keeping

All documents regarding internal QC of metals analysis are maintained in a weekly QC file for lead samples and a quarterly QC file for multi-metal analysis. Summaries for individual analysts are compiled and overall precision and accuracy are determined.

5.1.4 IAQ

5.1.4.1 Laboratory QC

At least ten percent (10%) of all samples analyzed at EHS are reanalyzed as part of a daily QC program. The reanalysis are performed “blind” (the QC analyst is unaware of the initial result) and 5% is a intra analysis (same analyst) and 5% is the inter analysis (different analyst).

5.1.4.2 Reference IAQ QC

EHS maintains a library of air reference slides generated from round robin samples and in-house samples. At least one of these reference samples is analyzed by each EHS analyst each day before analyzing samples. All reference sample results are verified for accuracy by the Quality Manager.

5.1.4.3 See S.O.P for Indoor Air Quality Analysis for additional information.

5.1.4.4 Recordkeeping

All documents regarding internal QC of IAQ samples are maintained in a monthly QC file.

5.2 Inter-Laboratory QC

Although EHS is a participant in several proficiency programs and is accredited by several accrediting agencies, it does not use the logos of these agencies in any aspect of its operations except for its web site and ads.

5.2.1 Round Robin

EHS participates in Round Robin sample exchanges for PLM, PCM and sporetrap analysis on a semi-annual basis with at least two other laboratories. Records of all round robin activities are maintained in files specific to each analysis. The Round Robin program functions as an on-going external QC measure of samples received on a regular basis.

5.2.1.1 Asbestos Bulk Samples

EHS participates semi-annually in sample exchanges with other accredited laboratories. Sample exchanges are analyzed by the initial laboratory prior to being circulated to other laboratories in the program. Responsibility for issuing samples and summarizing results rotates between participating laboratories.

5.2.1.2 Airborne Fiber Counts

EHS participates semi-annually in sample exchanges with other accredited laboratories. Samples exchanged are analyzed by the initial laboratory prior to being circulated to other laboratories in the program. Responsibility for issuing samples and summarizing results rotates between participating laboratories.

5.2.1.3 Sporetrap Counts

EHS participates semi-annually in sample exchanges with other accredited laboratories. Samples exchanged are analyzed by the initial laboratory prior to being circulated to other laboratories in the program. Responsibility for issuing samples and summarizing results rotates between participating laboratories.

5.2.2 Proficiency

EHS is a participant in the following External Proficiency Programs:

5.2.2.1 Airborne Fiber Counts

- NIOSH/AIHA Proficiency Analytical Testing Program (PAT), Quarterly
- New York PCM Proficiency – Semi-Annually

5.2.2.2 Asbestos Bulk Samples

- National Voluntary Laboratory Accreditation Program (NVLAP), Semi-annually
- New York PLM Proficiency – Semi-Annually

5.2.2.3 Metals

- NIOSH/AIHA PAT Program, 3 Metals, Quarterly
- AIHA Environmental Lead Proficiency Testing Program (ELPAT),
- Lead samples in paint, soil, wipes, Quarterly
- AIHA Beryllium Proficiency (BEPAT) – Be in air, Tri-Annually
- ERA Multi-Metals Proficiency – Semi-Annually (California & South Carolina)
- New York Multi-Metals Proficiency – Semi-Annually

5.2.2.4 IAQ

- AIHA EMPAT Program, Bacterial and Fungal Identification, Tri-Quarterly

5.2.3 All materials pertinent to EHS participation in proficiency testing are maintained for future reference and training purposes. All records are maintained in specific files.

5.3 Control of Non-Conformances

Conformance to all aspects of EHS procedures and policies is essential to the successful implementation of our Quality System. The Laboratory Director, Laboratory Administrator, and/or Quality Manager, irrespective of their other responsibilities, have the authority to implement, maintain and improve the management system. They are also able to identify any departures from the management system and initiate actions to prevent or minimize such departures.

The Laboratory Director, Laboratory Administrator, and/or Quality Manager, irrespective of their other responsibilities, also have the authority to implement, maintain and improve all testing and calibration procedures. They are able to identify any departures from these procedures and initiate

actions to prevent or minimize such departures.

The following procedures must be followed if any aspect of management, testing or the results of the testing do not conform to EHS procedures or the agreed requirements of the client.

Quality Control data is analyzed and, when found to be outside acceptance criteria, action is taken to correct the problem and to prevent incorrect results from being reported to the client. Any departures (accidental or otherwise) from established EHS procedure trigger an immediate stop work action and withholding of test reports.

5.3.1 The Quality Manager, Laboratory Administrator or the Laboratory Director must be notified as soon as a nonconforming work has been noted and are responsible for examining the incident. A thorough investigation of all the possible causes for the non-conformance must be conducted.

5.3.2 Potential causes and consequences of the non-conformance are explored. The causes could include sample collection, client requirements, methods and procedures, standards and reagents, equipment and calibrations. The consequences range from improper analysis to faulty results.

5.3.3 Once the investigation is concluded all necessary corrective actions are taken to ensure that the problem has been corrected and controls must be put in effect to guarantee that the problem can be prevented from reoccurring.

5.3.4 A solution to bring any non-conforming aspect back into conformance must be reached and monitored before work can resume. Any samples affected during the period of non-conformance shall be re-analyzed if possible. If for whatever reason, a sample cannot be reanalyzed (ex. No additional sample available), then an explanation written by either the Quality Manager, Laboratory Administrator or Laboratory Director will be added to the final report. The client is notified of the non-conformance if necessary.

5.3.5 After any nonconformance incident, work may not resume until all log book entries are complete and approval by the Quality Manager, Laboratory Administrator or Laboratory Director is documented.

5.3.6 All departures shall be documented in the Nonconformance Log Book and on the worksheet of any affected samples.

The log book entry at a minimum shall include:

a. Date
b. Type of analysis
c. Analyst/Technician involved
d. An explanation of departure
e. Time of work stoppage
f. ID Numbers of samples affected and a note to distinguish if samples were reanalyzed or released with explanation of non-conformance on report
g. Results of cause analysis
h. Corrective action taken
i. Return to work approval signed by the Quality Manager or Laboratory Director
j. Date & Time of return to work approval
k. Notation which will appear on final reports, if applicable

5.4 Audits/Reviews/Inspections

5.4.1 Quarterly Review

Each quarter a review of laboratory procedures, practices will be performed. The purpose of this audit is to identify and evaluate trends and ensure that key elements of the quality plan are up to date.

This audit review will be completed during the first month of each quarter. The Quality Manager is responsible for ensuring this review is completed.

The Quality Manager will use a laboratory review checklist specific to each laboratory and will review the following during the audit:

a. On-Site Assessments by outside agencies
b. Previous internal audits
c. Proficiency testing results
d. Nonconformities
e. Review of Corrective/Preventive actions and follow-ups procedures

Once the quarterly review is finished a copy of the audit is given to the corresponding laboratory supervisor with a date by which the deficiencies must be corrected. Documentation of the corrective actions showing the type of correction, by whom and when the correction was performed or will be finalized will be signed by the Quality Manager and filed in the respective laboratory binder. Each quarterly review is also submitted to the management review team as a part of the Annual Management Audit (see 5.4.1.4). Any deficiencies found by a quarterly review must be addressed immediately. The next quarterly review will detail all corrective actions arising from any prior quarterly, management and internal

reviews. If it is found that deficiencies may have affected sample results, those clients involved will be immediately notified in writing.

5.4.2 Internal QA Audit

The purpose of the Internal QA Audit is to (1) determine if the quality system contains all the policies and procedures required under ISO 17025 and the accreditations held by the laboratory and (2) determine that those policies and procedures are being followed. This audit will be performed by the Quality Manager and reviewed and by the General Manager. This audit will be performed and completed by end of the 2nd quarter of the year. All deficiencies found by this audit will be addressed and corrections documented showing the type of correction, by whom and when the correction was performed or will be finalized will be signed by the Quality Manager and filed in the respective laboratory binder

The Internal QA Audit will include but is not limited to the following:

a. Analysis of Quarterly Reviews
b. Detailed review of AIHA Assessor Checklist
c. Detailed review of NVLAP Assessor Checklist
d. Detailed review of any state Assessor Checklist
e. A narrative summary of findings
f. Deficiencies, corrective/preventive actions and responses
g. Recommendations for improvement

5.4.3 Annual Management Audit

An annual audit is performed by the Laboratory Management Review Team. The purpose of this audit is to examine the entire laboratory management system and testing activities to ensure their continuing suitability and effectiveness and to introduce necessary changes or improvements. The Laboratory Management Review Team will include at a minimum; the General Manager, Laboratory Administrator, Laboratory Director, Quality Manager, and all section supervisors.

The Annual Management Audit will be accomplished through a series of meetings of the Management Review Team. The first meeting will take place during the first quarter of the year. At the first meeting, each team member will be assigned different segments of the review, which they will be required to perform and report their findings to the entire team. A time frame to complete the assigned tasks will also be determined at that meeting. Subsequent meetings will consist of presentations by the individual members, and questions and discussions by the team. These meetings will continue until all review categories have been fully addressed. This

audit shall be completed by the end of the second quarter.

The key areas to be reviewed are:

- **a.** Suitability of policies and procedures in Quality Manual
- **b.** Review of the overall objectives found in Quality Manual
- **c.** Previous Annual Management Audit
- **d.** Previous Internal QA Audit reports
- **e.** Previous Quarterly Audit reports
- **f.** Corrective/Preventive actions
- **g.** Onsite assessments by external bodies
- **h.** Status of Accreditations
- **i.** Proficiency testing programs and results
- **j.** Changes in the volume and type of work
- **k.** Customer feedback and complaints
- **l.** Quality Control activities
- **m.** Personnel resources and training
- **h.** Recommendations for Improvement
- **n.** One Year Plan
- **o.** General Status

Findings from the management review and the actions that arise from them shall be documented. Documentation will include what is to be done, by whom and by when it will be completed. Management shall ensure that those actions are carried out within an appropriate and agreed timeframe. Progress and follow-up of these actions will be reported in the quarterly QA reports.

5.4.4 Client Services Calls

Every day clients are asked on the service which is provided. The feedback from clients is analyzed and used to improve the management system, testing services and customer service. Customer calls are documented by notes on Goldmine, a computer customer base program. If a client has a significant complaint, a Corrective/Preventive Action form will be generated by Customer Service and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. The Accounting, Customer Service and Marketing Departments review Goldmine customer notes. Goldmine notes are reviewed in the Yearly Management Audit to assess customer feedback.

5.4.5 External Audits/Reviews/Inspections

EHS is occasionally audited, reviewed, or inspected by all accrediting agencies under which it performs analyses.

5.5 Review Of New Methods / Approval Of New Work

5.5.1 The Laboratory Director, Quality Manager, and any key technical personnel prior to approval for use must review all prospective new work, new methodologies or new analytical processes. (See SOP F-13; S.O.P. of Requests, Tenders, and Contracts) This review includes, but is not limited to:

a) Reagents (Are the required chemicals on-hand or readily available?)
b) Instrumentation (Are the required instruments on hand and fully operational?)
c) Personnel (Does the lab have trained, experienced personnel capable of performing the method without direct supervision?)
d) SOP development (Has the required SOP been developed and approved?)
e) Development of Instrument Detection Limits (Has the instrument's detection limit(s) been determined and documented?)
f) Documentation of analyst accuracy and precision (Have the necessary accuracy and precision checks for each analyst been performed and documented?)
g) Approval of Laboratory Director and Quality Manager (Has the approval of the appropriate Lab. Director and the Quality Manager been given?)

5.6 Data Integrity Plan

An integral part of a Quality System is the Data Integrity Plan. The Data Integrity Plan consists of procedures that provide assurance that a highly ethical approach to testing is a key component of all laboratory planning, training and implementation of methods. Environmental Hazards Services data integrity system emphasizes the paramount importance of ethics in the performance of all analytical work. EHS will ensure that laboratory staff consistently meet the specific ethical requirements defined in the Data Integrity Plan and will obtain the commitment of all laboratory staff to the principle that all analyses shall be performed in a controlled and documented manner.

EHS has established data integrity procedures that can be found in the SOP for Data Integrity. There are four required elements within the data integrity system. These are 1) data Integrity training, 2) signed data integrity documentation for all laboratory employees, 3) in-depth, periodic monitoring of data integrity, and 4) data integrity procedure documentation. These procedures and the associated implementation records shall be properly maintained and made available for assessor review. The data

integrity procedures shall be annually reviewed and updated by management.

EHS as part of their overall internal auditing program shall insure a review is conducted with respect to any evidence of inappropriate actions or vulnerabilities related to data integrity. Discovery of potential issues shall be handled in a confidential manner until such time as a follow up evaluation, full investigation, or other appropriate actions have been completed and the issues clarified. All investigations that result in finding of inappropriate activity shall be documented and shall include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. All documentation of these investigation and actions taken shall be maintained for at least ten years.

6. EQUIPMENT/MATERIALS/METHODS

6.1 Phase Contrast Microscopy

6.1.1 PCM Equipment List

- **6.1.1.1** 2 - Nikon Alphaphot-2 VS2 Phase Contrast Microscope
- **6.1.1.2** 1 - Nikon Labophot-2 Phase Contrast Microscope
- **6.1.1.3** 1 - "Quick Fix" Acetone Vaporizer
- **6.1.1.4** 1 - SKC Acetone Vaporizer
- **6.1.1.5** 1 - VWR Dylatherm hot plate

6.1.2 PCM Analytical Method

NIOSH 7400, Revision 3

6.1.3 PCM Calibration & Maintenance Policy

6.1.3.1 Daily calibration and other periodic checks are required to ensure proper functioning . See "S. O. P. C2, Section 3, Calibration of Phase Contrast Microscope" for all requirements.

6.2 Polarized Light Microscopy

6.2.1 Polarized Light Microscope Equipment List

- **6.2.1.1** 4 - Olympus BH-2 Polarized Light Microscope with accessories
- **6.2.1.2** 2 - Nikon Labophot-2 Polarized Light Microscope with accessories
- **6.2.1.3** 2 - NUAIRE Class II, Type A/B3 Biohazard negative pressurehood 6.2.1.3.1 HEPA Filtration
- **6.2.1.4** 2 - AirFiltronix 7400S negative pressure hood

6.2.1.4.1 HEPA Filtration

6.2.1.5 2 - GermFree Labs., Inc. BioPharm negative pressure hood

6.2.1.5.1 HEPA Filtration

6.2.1.6 4 - Thermolyne Nuova II hot plate

6.2.1.7 2 - Thermolyne Cimarec 2 hot plate

6.2.1.8 1 - Nikon SMZ-1 Stereomicroscope

6.2.1.9 1 - Meiji EMT Stereomicroscope

6.2.1.10 4 - Olympus SZ-30 Stereomicroscope

6.2.1.11 1 - Fisher Scientific Refractometer

6.2.2 Polarized Light Microscopy (PLM) Analytical Method E.P.A. Method 600/R-93/116

6.2.3 Polarized Light Microscopy (PLM) Calibration and Maintenance Policy

6.2.3.1 Daily calibration and other periodic checks are required to ensure proper functioning. See "S.O.P. for Polarized Light Microscope Alignment/Calibration" and "S.O.P. for Calibration of Refractive Index Liquids" for requirements.

6.3 Metals/Inorganics

6.3.1 Equipment

6.3.1.1 Varian 220FS Atomic Absorption Spectrophtometer with Spectra AA220 FS Version 3.10FS

6.3.1.2 Varian Vista MPX CCP Simultaneous ICP-OES Spectrophotometer

6.3.1.4 NIST traceable Brass Calibration Weights

6.3.1.5 Hamilton Vectaire Fume Hood

6.3.1.6 Thermolyne Nuova II Hot Plate

6.3.1.7 Eppendorf adjustable pipettes

6.3.1.8 Class A Volumetric Glassware

6.3.1.9 Corning 430 pH Meter

6.3.1.10 Barnstead NANOpure II water deionization system

6.3.1.11 Analytical Design 1.5 liter pressure filtration system

6.3.1.12 Analytical Design 12-vessel Rotary Extractor

6.3.1.13 Waring blender

6.3.1.14 Corning hot plate/stirrer

6.3.1.15 Oakton 110 Series Digital Conductivity Meter

6.3.1.16 3 - Sonicator, Model FS220H

6.3.1.17 Buck Scientific 410A Mercury Cold Vapor Analyzer

6.3.1.18 Precision heated water bath

6.3.1.19 Damon/IEC Division International Centrifuge

6.3.1.20 2 - Norge Refrigerator

6.3.1.21 Mettler B154 Balance
6.3.1.22 Mettler PB303-S Balance

6.3.2 Metals/Inorganics Methods

6.3.2.1 NIOSH 7082 (Lead by FAA)
6.3.2.2 NIOSH 7300 (Metals by ICP)
6.3.2.3 NIOSH 6009 (Mercury Vapor in air)
6.3.2.3 NIOSH 0500 (Total Particulates Not Otherwise Regulated)
6.3.2.4 NIOSH 0600 (Respirable Particulates Not Otherwise Regulated
6.3.2.5 OSHA ID-25 (Welding Fumes in air)
6.3.2.6 OSHA ID-145 (Particulate Mercury in air)
6.3.2.7 EPA SW846/7000B/7420 (Metals by FAA)
6.3.2.8 EPA SW846/1311 (Toxicity Characteristic Leaching Procedure, TCLP)
6.3.2.9 EPA SW846/3010A (Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Flame Atomic Absorption (FLAA) or Inductively Coupled Plasma (ICP) Spectroscopy)
6.3.2.10 EPA SW846/3050B (Acid Digestion of Sediments, Sludges, and Soils)
6.3.2.11 EPA SW846/6010C (Inductively Coupled Plasma - Atomic Absorption Spectroscopy)
6.3.2.12 EPA SW846/7470A (Mercury in Liquid Waste (Manual Cold Vapor Technique))
6.3.2.13 EPA SW846/7471B (Mercury in Semi-/Solid Waste (Manual Cold Vapor Technique))
6.3.2.14 EPA 600/R-93/200 (SOP for the Field Analysis of Lead in Air, TSP Air, Paint, Bulk Dust, and Soil by Ultrasonic, Acid Digestion).
6.3.2.15 ASTM E1979-04 (Ultrasonic Extraction of Dust Samples for Subsequent Determination of Lead).

6.3.3 Calibration and Maintenance

6.3.3.1 Daily calibration and other periodic checks are required to ensure proper functioning. See "SOP for the Set Up and Use of the Varian Vista MPX CCP Simultaneous ICP-OES Spectrophotometer ", "S.O.P. for the Set-up and Use of the Varian 220FS Atomic Absorption Spectrophotometer with Spectra AA220 FS Version 3.10FS ", "S.O.P. for the Maintenance and Calibration of Laboratory Balances", "S.O.P. for the Maintenance and Calibration of Adjustable Pipettes", "S.O.P. for the Calibration and Use of the Electronic pH Meter", "S.O.P. for the Use and Calibration of Digital Conductivity Meters", "SOP for the Set Up and Use of the Perkin Elmer 3100 Flame Atomic Absorption

Spectrophotometer/Perkin Elmer AA Winlab, Version 6.1Software “,”Set up and Use of the Varian 220Z AA spectrophotometer with VGA Assembly” and “SOP for the Set-Up and Use of the Buck Scientific 400A Mercury Cold Vapor Analyzer”.

6.4 IAQ Department

6.4.1 Equipment

6.4.1.1 Biological Microscope (Nikon Alphaphot-2), binocular, Khöler-type illumination with accessories:

6.4.1.1.1 Reticles
6.4.1.1.2 20X, 40X and 100X (oil immersion type) objectives
6.4.1.1.3 On board incandescent light source
6.4.1.1.4 Substage condenser with iris diaphragm

6.4.1.2 Microscope Slides (3” x 1” x 1mm)
6.4.1.3 Coverslips (18mm x 18mm or 22mm x 22mm)
6.4.1.4 Type-A immersion oil ($n_D = 1.5150 \pm 0.0002$)
6.4.1.5 Forceps (Fisherbrand – Jewelers Forceps)
6.4.1.6 Scotch™ Transparent Tape
6.4.1.7 Fast Drying Nail Enamel
6.4.1.8 Acetone Vaporizer
6.4.1.9 Stereomicroscope
6.4.1.10 Sterile transfer pipets (6” blood bank, 25 drops/mL)
6.4.1.11 Sterile inoculating loops (1ul, 10ul)
6.4.1.12 16 x 100mm test tubes
6.4.1.13 Bio-Safety Cabinet
6.4.1.14 Sterile specimen containers (4 oz.)
6.4.1.15 Vortex mixer
6.4.1.16 Culture Media

6.4.1.16.1 Malt Extract Agar with 0.01% Chloramphenicol
6.4.1.16.2 Dichloran Glycerol 18 Agar
6.4.1.16.3 Czapek Yeast Agar
6.4.1.16.4 Cellulose Agar

6.5.2 S.O.P. for Indoor Air Quality Analysis

6.6 Reagents and Standards

6.6.1 All reagents and standards will be certified standards which are of a quality specified by the analytical method used. Reagents and standards are stored in the proper manner according to manufacturer’s specifications.

6.6.2 Reagents and standards will be inspected, dated and initialed at the time of receipt. All reagents and standards will be checked for impurities or nonconformance before being placed into service.

6.6.3 The source, name, lot number, catalog number, date of receipt and the expiration date of each reagent and standard shall be written down in the Standard Lot Book and given a specific number such as SLB-20. This SLB number is to be used whenever the standards or reagents are used for any preparations or analysis.

6.6.4 Documentation of standard and solution preparations shall include the date of preparation, final volume and concentration, SLB number of parent material, concentration and expiration date of parent material, assigned expiration date and the preparer's initials. Each preparations is given a unique label (xx-xxxx), which is used to identify the standards or solutions when used in the preparation or analysis of samples.

6.6.5 Each standard and reagent used in the analysis of samples are listed on the worksheet by their unique identification (xx-xxxx). This ensures the traceability of all standards and reagents from purchase to final sample analysis.

6.6.6 Strict controls and documentation of any reagent solutions and calibrations standards shall be maintained.

6.6.7 Reagents and standards, and any prepared solutions are not to be used beyond their assigned expiration date. Materials specified for reevaluation, and which are concluded to have adequate purity upon reevaluation, shall be given a new expiration date.

6.6.8 Purchased calibration standards and Laboratory Control Standards shall be traceable to National Institute of Standards and Technology or an equivalent national or international standard. All certificates are kept in a binder in the QA/AC Office.

7. TRACEABILITY OF MEASUREMENTS

7.1 Reference standards and testing equipment shall be subject to in-service checks between calibration and verifications as needed. Yearly calibrations are performed by qualified technicians to insure that the instrumentation have been tested and certified to insure traceability to national standards of measurement. All certificates are kept in the QA/QC file cabinet.

7.2 Reference standards shall be calibrated by a source that is ISO/IEC17025 certified.

7.3 Reference standards shall be used only for calibration unless it can be shown that their performance as reference samples has not been invalidated.

8. EMPLOYEE TRAINING

EHS employees are made aware of the importance they play in ensuring that the objectives of the Quality Management System are achieved. Each employee is taught that the Quality Management System as detailed in the QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. The adherence to these standards will ensure

that EHS is able to provide and maintain a reliable and consistently accurate system of analytical work in compliance with ISO/IEC17025 and with NELAC standards.

These standards establish the QA/QC systems throughout the laboratory, which allow the analytical system to be constantly monitored and indicate where adjustments or corrections may be necessary. Communication between management and laboratory personnel will ensure the effectiveness of the management system. All employees are made aware that any questions, concerns or problems can be brought to management at any time. Any changes in laboratory policy are brought to the attention of all employees at the time of the change through departmental meetings.

All EHS employees must read the QA/QC manual and the SOPs that pertain to their position. All employees undergo a training period in which they will be provided with the necessary instruction in order to perform their anticipated tasks. During this training period the new employee will be supervised by a member of the staff competent in the area of instruction. Once the employee has demonstrated proficiency in the area of training they will be allowed to work without supervision.

Technical employees have specific requirements that must be fulfilled in order to demonstrate proficiency. A checklist is used to follow the progress of the training program. For PLM, PCM and IAQ analyst, initial competence is shown through the analysis of 50 reference samples. For Metals analysts a series of analytical runs must be completed and passed to complete the initial training process. PCM and metals technicians must demonstrate their competence in the preparation of samples, before being allowed to prepare client samples unsupervised. Only trained employees are authorized to use equipment and to prepare and analyze samples.

Every year technicians and analyst must re-demonstrate their competence in order to continue to prepare and analyze samples. This re-demonstration evaluates the effectiveness of the training program. For specific technical laboratory training see the SOP for Employee Training.

9. SUBCONTRACTORS

Clients are aware that EHS subcontracts for TEM analysis, Radon analysis and drinking water analysis. This information is listed in the EHS New Client Handbook which is given to all EHS clients. When the need arises for samples normally analyzed by EHS to be analyzed by another laboratory, the client is informed and written permission is received prior to sending out the samples. Samples are sent to competent laboratories that are accredited by the appropriate agencies. Asbestos laboratories must be NVLAP accredited and in compliance with the NVLAP handbook. Every subcontractor must be compliant with the necessary accrediting bodies and ISO/IEC 17025 prior to receipt of samples from EHS. EHS maintains a file for each lab that is

subcontracted. This file contains all applicable accreditations for samples that are analyzed for EHS. The results (reports) from the subcontracted lab are submitted directly to the client in the original format provided to EHS. A copy of EHS's sub-contractors can be found in Appendix 1.

10. POLLUTION PREVENTION

Pollution prevention encompasses any technique that reduces or eliminates the quantity or the toxicity of waste at the point of generation. Many opportunities for pollution prevention exist in laboratory operation. EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address waste generation. The Pollution Prevention Act of 1990, Congress established a national policy that: pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

SOP REVISION LOG
DATE AND ACTIONS

8/14/00

Section Revised:

1.1 Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples, primarily the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and other parameters as needed. EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service and a 24-hour turnaround for PCM, PLM and Lead analysis. EHS is committed to providing quality services to its clients through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

Revision:

1.1 Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples, primarily the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and other parameters as needed. EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service and a 24-hour turnaround for PCM, PLM and Lead analysis. EHS is committed to providing quality services to its clients through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

In 1998 EHS was acquired by Foxboro Capitol Ltd. Under this ownership EHS is a part of the National Testing Laboratories Network. The other laboratories in this network are:

- National Testing Laboratories, Ltd. – A drinking water laboratory located in Ypsilanti, Michigan.
- Broward Testing Laboratory, Ltd. – A drinking water laboratory located in Ft. Lauderdale, Florida.
- Free-Col Laboratories, Ltd. – A full service Environmental and Industrial Hygiene laboratory located in Meadville, Pennsylvania. The corporate headquarters is in Cleveland, Ohio.

8/14/00

Section Revised:

1.2 Purpose of EHS Quality Assurance/Quality Control (QA/QC) Manual

The QA/QC Manual documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies. The QA/QC Manual is to be adhered to explicitly, except in case of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary to permit any departure from documented procedures.

Revision:

1.2 Purpose and Authority of EHS Quality Assurance/Quality Control (QA/QC) Manual

The QA/QC Manual is issued under the authority of the President of Foxboro Capitol, Ltd. and documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work in compliance with ISO/IEC 17025. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies. The QA/QC Manual is to be adhered to explicitly, except in case of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary to permit any departure from documented procedures.

8/14/00

Section Revised:

1.4 Maintenance of EHS S.O.Ps (Standard Operating Procedures)

Laboratory SOPs are reviewed at least annually by the Laboratory Director and Quality Manager. They are revised as necessary to reflect any changes in laboratory practices. All revisions/reviews are documented in the S.O.P. Revisions/Review log found at the end of the Laboratory General Operations Manual. The General Operations Manual is maintained in the Laboratory Technical Library. Copies of the latest revisions for pertinent SOPs are located in each laboratory section Operations Manual. Copies of all laboratory SOPs are located in the General Operations Manual. Invalid and/or obsolete SOP's and documents are promptly removed from use and disposed to insure that the only documents or SOP in use are current.

Revision:

1.4 Maintenance of EHS S.O.Ps (Standard Operating Procedures)

Laboratory SOPs are reviewed at least annually by the Laboratory Director and Quality Manager. They are revised as necessary to reflect any changes in laboratory practices and/or any updates to the reference methods. All revisions/reviews are documented in the S.O.P. Revisions/Review log found at the end of the Laboratory General Operations Manual. The General Operations Manual is maintained in the Laboratory Technical Library. Copies of the latest revisions for pertinent SOPs are located in each laboratory section Operations Manual. Copies of all laboratory SOPs are located in the General Operations Manual. Invalid and/or obsolete SOP's and documents are promptly removed from use and disposed to insure that the only documents or SOP in use are current. The generation of any analytical data is based in strict accordance to the pertinent EHS S.O.P. All analytical SOPs are based on established reference methods. The SOPs may contain slight modifications to the reference method. Whenever a reference method is modified, this will be acknowledged by placing an M after the method number. All SOPs which contain a modification from the reference method shall be validated for compliance.

8/14/00

Section Revised:
Organizational Chart

Revision:
The President of Foxboro Capitol and the Vice President of Operations of NTL Network was added to the Organizational Chart ahead of the General Manager of EHS.

8/14/00

Section Revised:

3. Personnel/Organization/Responsibilities/Qualifications

Revision:

The following Personnel was added to the beginning of this section with the corresponding change to the numbering system of this section.

3.1 President – (Foxboro Capital Ltd.)

The President has the ultimate responsibility for all aspects of every laboratory in the National Testing Laboratories Network.

3.2 Vice President of Operations – National Testing Laboratories Network, Cleveland, OH.

The Vice President of Operations answers directly to the president of Foxboro Capital, Ltd. The General Managers of each laboratory report directly to the Vice President.

Responsibilities of the Vice President include, but are not limited to:

a. Budget Approvals
b. Approval of Staffing
c. Capitol Equipment Expenditures
d. Market Strategies

3.3 General Manager

The General Manager reports directly to Vice President of Operations and is responsible for the day to day operations of Environmental Hazards Services, L.L.C.

8/14/00

Section Revised:

5.4 Corrective/Preventative Actions Policies

EHS has established a protocol for the identification of complaints and the documentation of their resolution. Complaints may be external (i.e. from clients, vendors, etc.) or internal (i.e. staff members, fellow employees, etc.) in origin. EHS, in compliance with ISO Guide 25 requirements, has established a program to identify the complaint, document the rectification, and track the process of these actions. This program can be found documented in S.O.P. F-6, for Complaint Identification, Resolution, and Tracking.

Revision:

5.5 Corrective/Preventative Actions Policies

EHS has established a protocol for the identification of complaints and the documentation of their resolution. Complaints may be external (i.e. from clients, vendors, etc.) or internal (i.e. staff members, fellow employees, etc.) in origin. EHS, in compliance with ISO/IEC 17025 requirements, has established a program to identify the complaint, document the rectification, track the process of these actions and review the process in order to establish or amend policies to prevent problem reoccurrences. This program can be found

documented in S.O.P. F-6, for Complaint Identification, Resolution, and Tracking.

8/14/00

Section Revised:
5.3 Departures From EHS Procedures

All departures (accidental or otherwise) from established EHS procedures are quickly dealt with and are documented by the technician or analyst and approved by the Laboratory Director and/or Quality Manager prior to continuing with further preparation and analysis or any notifications to the client occur.

Revision:
5.3 Departures From EHS Procedures

Conformance to all aspects of EHS procedures and policies is integral to the successful implementation of our Quality System. Any departures (accidental or otherwise) from established EHS procedures trigger an immediate stop work action. Whenever a stop work action has occurred either the Quality Manager or the Laboratory Director must be notified to review the incident. A solution to bring any non-conforming aspect back into conformance must be reached and monitored before work can resume. Any samples affected during the period of non-conformance shall be re-analyzed. If for whatever reason, a sample cannot be reanalyzed (ex. No additional sample available), then an explanation written by either the Quality Manager of Laboratory Director will be added to the final report. All departures shall be documented in the Non-Conformance Log Book and on the worksheet of any affected samples.
The log book entry at a minimum shall include:

1. Date
2. Type of analysis
3. Analyst/Technician involved
4. An explanation of departure
5. Time of work stoppage
6. ID Numbers of samples affected and a note to distinguish if samples were reanalyzed or released with explanation of non-conformance on report
7. Corrective action taken
8. Return to work approval signed by the Quality Manager or Laboratory Director
9. Date & time of return to work approval
10. Notation which will appear on final reports, if applicable

After any stop work action, work may not resume until all log book entries are complete and approval by the Quality Manager or Lab Director is documented.
8/14/00

Section Revised:
Section 5 Quality Assurance/Quality Control

Revision:
The addition of the following with corresponding numbering adjustments

5.4.2 Internal QA Audit

The purpose of the audit is to determine if and make sure that all of the aspects of the quality system are being followed and are up to date. This audit will be performed by a representative from each department under the guidance of the Quality Manager and reviewed by the General Manager. This audit will be performed at least quarterly, however all deficiencies must be re-reviewed within 15 days. A copy of this audit outline can be found at the end of this section.

8/14/00

Section Revised:
6.5.1 All reagents and standards will be certified standards which are of a quality specified by the analytical method used.

Revision:

6.5.1 All reagents and standards will be certified standards which are of a quality specified by the analytical method used. Reagents and standards are stored in the proper manner according to manufacturer's specifications.

8/14/00

Section Revised:

6.5.2 Reagents and standards will be inspected, dated and initialed at the time of receipt. All reagents. Reagents and standards are stored in the proper manner according to manufacturer's specifications.

Revision:
6.5.2 Reagents and standards will be inspected, dated and initialed at the time of receipt. All reagents and standards will be checked for impurities or nonconformance before being placed into service.

8/14/00

Section Revised:
6.5.3 The source, name, lot number, catalog number, and the expiration date of each reagent and standard shall be written down in the Standard Lot Book and given a specific number such as SLB-20. This SLB number is to be used whenever the standards or reagents are used for any preparations or analysis.

Revision:
6.5.3 The source, name, lot number, catalog number, date of receipt and the expiration date of each reagent and standard shall be written down in the Standard Lot Book and given a specific number such as SLB-20. This SLB number is to be used whenever the standards or reagents are used for any preparations or analysis.

8/14/00

Section Revised:
6.5.7 Documentation of standard and solution preparations shall include the date of preparation, concentration, SLB number of parent material, assigned expiration date and the preparer's initials.

Revision:
6.5.7 Documentation of standard and solution preparations shall include the date of preparation, final volume and concentration, SLB number, concentration and expiration date of parent material, assigned expiration date and the preparer's initials.

8/18/00

Section Revised:
Section 3.2 Laboratory Director
Revision:
Addition of:
i. Report opinions and interpretations of the test data when necessary. (This may only be done by the Lab Director or the Quality Manager.)

Renumbering as necessary.
Section Revised:
Section 3.3 Quality Manager
Revision:
Addition of:
j. Report opinions and interpretations of the test data when necessary. (This may only be done by the Lab Director or the Quality Manager.)

8/21/00
Section Revised:
6.5.4 Strict controls and documentation of any reagent solutions and calibrations standards shall be maintained.

Revision:

Changed numbering to 6.5.6

8/21/00

Section Revised:
6.5.7 Documentation of standard and solution preparations shall include the date of preparation, final volume and concentration, SLB number, concentration and expiration date of parent material, assigned expiration date and the preparer's initials.
Revision: (Changed numbering and content)
6.5.4 Documentation of standard and solution preparations shall include the date of preparation, final volume and concentration, SLB number of parent material, concentration and expiration date of parent material, assigned expiration date and the preparer's initials. Each preparations is given a unique label (xx-xxxx), which is used to identify the standards or solutions when used in the preparation or analysis of samples.

8/21/00

Section Revised:
Sections 6.5.5 and 6.5.6

Revision:
Sections were renumbered to be 6.5.7 and 6.5.8

8/21/00

Section Revised:
Addition of the following paragraph in section 6.5.5. taking place of what was previously there.

6.5.5 Each standard and reagent used in the analysis of samples are listed on the worksheet by their unique identification (xx-xxxx). This ensures the traceability of all standards and reagents from purchase to final sample analysis.

10/19/00

Section Revised:
Removal of the following forms from the end of Section A1: Employee Yearly Review, Annual Management Audit, Laboratory Quarterly Review, EHS Internal QA Audit, Daily Follow Up Call Form, EHS Sample Log Sheet, Refrigerator Temperature Log, and Hold Sample Form.
12/11/00

Section Revised:
Removal of the following from the end of Section A1:

- Free-Col Laboratories, Ltd. – A full service Environmental and Industrial Hygiene laboratory located in Meadville, Pennsylvania.

03/14/01

Sections Revised:
Revised the Organizational Chart to include the QA Manager and the removal of the Office Manager.
Revised the Building Layout Chart to show the change in office areas and the addition of the Micro-Balance room.
05/09/01

Addition of following section:
9. Subcontractors
Prior to any samples being subcontracted, the client is notified of the need for their samples to be analyzed by another laboratory and written approval is obtained from the client to allow the samples to be transferred. If this written approval is not received by EHS, samples will be returned to the client. When the need arises for samples to be analyzed by laboratories other than EHS, the samples are sent to laboratories that are accredited by the appropriate agencies. This would include all sample matrices that are listed under the scope of accreditations held by EHS as well as those matrices not covered by any EHS accreditations. When subcontracted, samples that are listed under EHS's scope of accreditation are to be sent to an accredited laboratory whose scope of accreditation includes at least the same scope of accreditation as EHS. When subcontracted, a laboratory that is accredited to analyze a specific matrix (if applicable) will analyze sample matrices that are not covered under EHS's scope of accreditation. EHS maintains a file for each lab that is subcontracted. This file contains all applicable accreditations for samples that are analyzed for EHS. The results (reports) from the subcontracted lab are submitted directly to the client in the original format provided to EHS. A copy of EHS list of contractors can be found in Appendix 1.

01/15/03

Section Revised:

1.1 Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples, primarily the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and other parameters as needed. EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service and a 24 hour turnaround for PCM, PLM and Lead analysis. EHS is committed to providing quality services to its clients through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

Revision:

1.1 Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia has been in business since 1984. EHS is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples. Sample analysis includes the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and fungal spore/pollen grain count and identification of common genera. EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service to its clients through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

02/27/04

Section Revised:
9. Subcontractors
Prior to any samples being subcontracted, the client is notified of the need for their samples to be analyzed by another laboratory and

written approval is obtained from the client to allow the samples to be transferred. If this written approval is not received by EHS, samples will be returned to the client. When the need arises for samples to be analyzed by laboratories other than EHS, the samples are sent to laboratories that are accredited by the appropriate agencies. This would include all sample matrices that are listed under the scope of accreditations held by EHS as well as those matrices not covered by any EHS accreditations. When subcontracted, samples that are listed under EHS's scope of accreditation are to be sent to an accredited laboratory whose scope of accreditation includes at least the same scope of accreditation as EHS. When subcontracted, a laboratory that is accredited to analyze a specific matrix (if applicable) will analyze sample matrices that are not covered under EHS's scope of accreditation. EHS maintains a file for each lab that is subcontracted. This file contains all applicable accreditations for samples that are analyzed for EHS. The results (reports) from the subcontracted lab are submitted directly to the client in the original format provided to EHS. A copy of EHS's sub-contractors can be found in Appendix 1.

Revision:

9. Subcontractors

Prior to any samples being subcontracted, the client is notified of the need for their samples to be analyzed by another laboratory and written approval is obtained from the client to allow the samples to be transferred. If this written approval is not received by EHS, samples will be returned to the client. When the need arises for samples to be analyzed by laboratories other than EHS, the samples are sent to competent laboratories that are accredited by the appropriate agencies. Asbestos laboratories must be NVLAP accredited and in compliance with the NVLAP handbook. Every subcontractor must be compliant with the necessary accreditating bodies prior to receipt of samples from EHS. When subcontracted, samples that are listed under EHS's scope of accreditation are to be sent to an accredited laboratory whose scope of accreditation includes at least the same scope of accreditation as EHS. EHS maintains a file for each lab that is subcontracted. This file contains all applicable accreditations for samples that are analyzed for EHS. The results (reports) from the subcontracted lab are submitted directly to the client in the original format provided to EHS. A copy of EHS's sub-contractors can be found in Appendix 1.

08/27/04

Section Revised:

3. PERSONNEL / ORGANIZATION / RESPONSIBILITIES / QUALIFICATIONS

Revision:

Addition of the following information to the section:

3.13 Environmental Laboratory Technician

3.13.1 The environmental laboratory technician's responsibilities include but are not limited to:

- **a.** Preparation of environmental samples for analysis
- **b.** Preparation of raw data worksheets using information supplied by the client
- **c.** Cleaning and maintenance of equipment within the Environmental Chemistry Laboratory
- d. Other duties as necessary

3.13.2 The environmental laboratory technician must meet at least the minimum of the following requirements:

- **a.** Completion of the Environmental Chemistry Laboratory Technician Checklist
- **b.** Exhibited competency in all areas included on the Environmental Chemistry Laboratory Technician Checklist

3.14 IAQ Analyst

3.14.1 An IAQ Analyst responsibilities include, but are not limited to:

- **a.** Maintenance of all equipment related to their analytical assignments
- b. Preparation and analysis of IAQ samples
- c. Follow proper QA/QC methods as described within the QA/QC Manual

3.14.2 The IAQ analyst must meet at least the minimum of the following requirements:

- **a.** B.A. or B.S. in a life science with strong emphasis on microbiological classwork.
- **b.** One year relevant IAQ experience
- **c.** Exhibit competency

3.14.3 In the event of the absence of the IAQ Laboratory Director and the Quality Manager, the IAQ Analyst will accept full responsibility for all events within their department.

3.15 IAQ Technician

3.15.1 The IAQ technician's responsibilities include but are not limited to:

a. Preparation of IAQ samples for analysis
b. Preparation of raw data worksheets using information supplied by the client.
c. Cleaning and maintenance of equipment within the IAQ Laboratory

d. Other duties as necessary

3.15.2 The IAQ technician must meet at least the minimum of the following requirements:

a. Completion of an IAQ course either outside of the laboratory or an In-house training course.
b. Exhibited competency in necessary areas of the IAQ technician course.
c. Three (3) months IAQ experience

Section Revised:

4.3.6 Samples are maintained on-site for at least thirty days after analysis in dated containers. They are then either disposed of in accordance with all regulations or returned to the client. EHS contracts with a local contractor for hazardous waste disposal.

4.3.6.1 Lead paint, soil and TCLP samples are combined and a TCLP sample is collected and analyzed. If this sample is below regulatory limits, the waste is disposed of as normal waste. If the result is above a regulatory limit, the waste is disposed of in accordance with regulation as a hazardous waste.

Revision:

4.3.6 Samples are maintained on-site for at least thirty days after analysis in dated containers. They are then either disposed of in accordance with all regulations or returned to the client. EHS contracts with a local contractor for hazardous waste disposal.

4.3.6.1 Lead paint, soil and TCLP samples are combined and a TCLP sample is collected and analyzed. If this sample is below regulatory limits, the waste is disposed of as normal waste. If the result is above a regulatory limit, the waste is disposed of in accordance with regulation as a hazardous waste.

4.3.6.2 All viable IAQ samples will be autoclaved at 121°C/15 PSI for 30 minutes with a fast exhaust before disposal.

Addition of following to Section :

6.5 IAQ

6.5.1 Equipment
6.5.1.1 Biological Microscope (Nikon Alphaphot-2), binocular, Khöler-type illumination with accessories:
6.5.1.1.1 Reticle
6.5.1.1.2 20x, 40x and 100X (oil immersion type)objectives
6.5.1.1.3 On board incandescent light source
6.5.1.1.4 Substage condenser with iris diaphragm
6.5.1.2 Microscope Slides (3" x 1" x 1mm)
6.5.1.3 Coverslips (18mm x 18mm or 22mm x 22mm)
6.5.1.4 Type-A immersion oil ($n_D = 1.5150 \pm 0.0002$)
6.5.1.5 Forceps (Fisherbrand – Jewelers Forceps)
6.5.1.6 Scotch™ Transparent Tape
6.5.1.7 Fast Drying Nail Enamel
6.5.1.8 Acetone Vaporizer
6.5.1.9 Stereomicroscope
6.5.1.10 Sterile transfer pipets (6" blood bank, 25 drops/mL)
6.5.1.11 Sterile inoculating loops (1ul, 10ul)
6.5.1.12 16 x 100mm test tubes
6.5.1.13 Bio-Safety Cabinet
6.5.1.14 Sterile specimen containers (4 oz.)
6.5.1.15 Vortex mixer
6.5.1.16 Trypticase Soy Broth (Soybean Casein Digest)
6.5.1.17 Culture Media
6.5.1.17.1 Malt Extract Agar with 0.01% Chloramphenicol

6.5.1.17.2 Dichloran Glycerol 18 Agar
6.5.1.17.3 Czapek Yeast Agar
6.5.1.17.4 Cellulose Agar

6.5.2 IAQ Methods

6.5.2.1 S.O.P. For the preparation of Trypticase Soy Broth
6.5.2.1 S.O.P for the Sterilization of Distilled Water
6.5.2.2 S.O.P. for Indoor Air Quality Analysis

11/05/04

Revision of the following sections:
Table of Contents
Parts: 1.3, 1.5, 2.1, 3.0, 4.1.4.3, 4.4, 4.5, 4.6, 4.7, 5.4, 6.3, and 8.0

Addition of new parts: 5.1.4, 5.2.1.3, 4.8, 4.9 and 6.5

12/5/05

Revision of the Chain of Command Chart to different format

Revision of the following Section:

4.2.2 The EHS Job Number is generated as follows. A first set of four numbers indicate the year the samples were received. A second set of two numbers indicates the month the samples were received. A third set of four numbers indicates the sequential job number. (The first job of each month is assigned job XX-19XX-0001.) Each new job number is increased by a factor of one. All number sets are separated by hyphens.

EXAMPLE: 11-1998 -0123
Month received - Nov (11)
Year received - 1998
EHS Job Number - 0123 (123rd job in Nov.)

Revision:

4.2.2 The EHS Job Number is generated as follows. A first set of four numbers indicate the year the samples were received. A second set of two numbers indicates the month the samples were received. A third set of four numbers indicates the sequential job number. (The first job of each month is assigned job 20XX – XX - 0001.) Each new job number is increased by a factor of one. All number sets are separated by hyphens.

EXAMPLE: 2006 -01-0123
Year received - 2006
Month received - Jan (01)
EHS Job Number - 0123 (123rd job in Jan.)

03/16/06

Revision of the following Section:

1.6 Accreditation Logos

EHS, at the present time, does not use any of their accreditating bodies logos in advertisements, reports, letters or any other documents associated with the laboratory.

Revision:

1.6 Accreditation Logos

EHS uses the NVLAP, AIHA and NELAP logos only in advertising. The logo being used has been pre-approved by the appropriate accrediting body. EHS does not use any of their accreditating bodies logos in reports, letters or any other documents associated with the laboratory.

1.6.1 NVLAP
1.6.1.1 The NVLAP logo stands by itself and is not combined with any other logo, symbol or graphic

1.6.1.2 The ratio of height to width is 1 to 2.25.
1.6.1.3 The NVLAP logo is accompanied by the NVLAP Lab Code in an approved caption. The caption will appear below and in close proximity to the logo.
1.6.1.4 The logo and caption is of a size that allows the caption to be easily read. The size of the caption shall not exceed the size of the logo.
1.6.1.5 The logo shall appear in black, blue or other color approved by NVLAP, and may be filled or unfilled. If the logo is filled then the same color is used for the outline and the fill.

1.6.2 AIHA
1.6.2.1 EHS will only use the AIHA logos for testing within the laboratory's scope of accreditation.
1.6.2.2 EHS will only use the approved logo provided by AIHA to the laboratory.

1.6.3 NELAC
1.6.3.1 EHS will only use the NELAC logos for testing within the laboratory's scope of accreditation.
1.6.3.2 The NELAC logo is accompanied by the phrase "NELAP accredited" and the laboratory's accreditation number or other identifier with their accrediting authorities name.

07/20/06

Revision of the following Section:

1.2 Objectives, Policies and Authority of EHS Quality Assurance/Quality Control (QA/QC) Manual

The QA/QC Manual is issued under the authority of the President of Foxboro Capitol, Ltd. and documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work in compliance with ISO/IEC17025. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies. The QA/QC Manual is to be adhered to explicitly, except in case of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary to permit any departure from documented procedures.

Revision:

1.2 Objectives, Policies and Authority of EHS Quality Assurance/Quality Control (QA/QC) Manual

The QA/QC Manual is issued under the authority of the President of Foxboro Capitol, Ltd. and documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work in compliance with ISO/IEC17025 and with NELAC standards. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies. The QA/QC Manual is to be adhered to explicitly, except in case of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary to permit any departure from documented procedures.

Section Revised:

Part of Section 5.4.5:

The key areas to be reviewed are:

a. Previous Annual Management Audit
b. Internal QA Audit
c. Status of Accreditations
d. Proficiency Testing Programs
e. Quality Assurance Manual Review
f. Operations Manual Review
g. New Methods Offered
h. Pre-existing Methods
i. Personnel
j. One Year Plan
k. General Status

Revision:

The key areas to be reviewed are:

a. Previous Annual Management Audit
b. Internal QA Audit

c. Status of Accreditations
d. Proficiency Testing Programs
e. Quality Assurance Manual Review
f. Operations Manual Review
g. Corrective/Preventive Actions
h. New Methods Offered
i. Pre-existing Methods
j. Personnel
k. One Year Plan
l. General Status

Addition of following sections:

5.6 Data Integrity Plan

An integral part of a Quality System is the data integrity procedures. The data integrity procedures provide assurance that a highly ethical approach to testing is a key component of all laboratory planning, training and implementation of methods. Environmental Hazards Services Data Integrity System emphasizes the paramount importance of ethics in the performance of all analytical work. EHS will ensure that laboratory staff consistently meet the specific ethical requirements defined in the data integrity plan and will obtain the commitment of all laboratory staff to the principle that all analyses shall be performed in a controlled and documented manner.

EHS has established data integrity procedures that can be found in the SOP for Data Integrity. There are four required elements within the data integrity system. These are 1) data Integrity training, 2) signed data integrity documentation for all laboratory employees, 3) in-depth, periodic monitoring of data integrity, and 4) data integrity procedure documentation. These procedures and the associated implementation records shall be properly maintained and made available for assessor review. The data integrity procedures shall be annually reviewed and updated by management.

EHS as part of their overall internal auditing program shall insure a review is conducted with respect to any evidence of inappropriate actions or vulnerabilities related to data integrity. Discovery of potential issues shall be handled in a confidential manner until such time as a follow up evaluation, full investigation, or other appropriate actions have been completed and the issues clarified. All investigations that result in finding of inappropriate activity shall be documented and shall include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. All documentation of these investigation and actions taken shall be maintained for at least ten years.

10. POLLUTION PREVENTION

Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Many opportunities for pollution prevention exist in laboratory operation. EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address waste generation. When it is not feasible to reduce wastes at the source, the Agency recommends recycling as the next best option. The acids used in this Method should be reused as practicable by purifying by electrochemical techniques. The only other chemicals used in this Method are the neat materials used in preparing standards. These standards are used in extremely small amounts and pose little threat to the environment when managed properly. Standards should be prepared in volumes consistent with laboratory use to minimize the disposal of excess volumes of expired standards.

Revision to the title page:

ENVIRONMENTAL HAZARDS SERVICES, L.L.C.

QUALITY ASSURANCE/QUALITY CONTROL

MANUAL

Revision:

QUALITY ASSURANCE/QUALITY CONTROL

MANUAL

ENVIRONMENTAL HAZARDS SERVICES, L.L.C.
7469 Whitepine Road
Richmond, VA 23237
(804) 275-4788

Howard Varner
General Manager

Michael Mueller
Laboratory Director

Irma Faszewski
Quality Manager

09/17/07

Removal of the following Section:

Weekly Summary

A summary of all laboratory QC data, discrepancies, corrective actions, and any relevant information is provided by the Quality Manager to the Laboratory Director each week. Examples of these weekly summary forms are located at the end of this section. A copy of weekly summaries is also stored in dedicated files in the QA/QC Library. Exceptions are made in the case of certain analyses which are run too infrequent for weekly summaries. In that case, monthly or quarterly summaries of these analysis are provided (i.e., Mercury Analysis).

Examples of items which will be part of the weekly summary include but are not limited to the following:

dentification of all outliers and corrective/preventive
action taken for each.
A summary of the Client Services
A summary of corrective/preventive actions procedures

Section Revision:

5.3 Control of Nonconforming Testing

Conformance to all aspects of EHS procedures and policies is essential to the successful implementation of our Quality System. The following procedures must be followed if any aspect of the testing or the results of the testing do not conform to EHS procedures or the agreed requirements of the client.

Any departures (accidental or otherwise) from established EHS procedure trigger an immediate stop work action and withholding of test reports.

Revision:

5.3 Control of Non-Conformances

Conformance to all aspects of EHS procedures and policies is essential to the successful implementation of our Quality System. The Laboratory Director, Laboratory Administrator, and/or Quality Manager, irrespective of their other responsibilities, have the authority to implement, maintain and improve the management system. They are also able to identify any departures from the management system and initiate actions to prevent or minimize such departures.

The Laboratory Director, Laboratory Administrator, and/or Quality Manager, irrespective of their other responsibilities, also have the authority to implement, maintain and improve all testing and calibration procedures. They are able to identify any departures from these procedures and initiate actions to prevent or minimize such departures.

The following procedures must be followed if any aspect of management, testing or the results of the testing do not conform to EHS procedures or the agreed requirements of the client.

Any departures (accidental or otherwise) from established EHS procedure trigger an immediate stop work action and withholding of test reports.

Section Revised:

1.1 Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples, primarily the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and other parameters as needed. EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service and a 24-hour turnaround for PCM, PLM and Lead analysis. EHS is committed to providing quality services to its clients through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

In 1998 EHS was acquired by Foxboro Capitol Ltd. Under this ownership EHS is a part of the National Testing Laboratories Network. The other laboratories in this network are:

- National Testing Laboratories, Ltd. – A drinking water laboratory located in Ypsilanti, Michigan.
- Broward Testing Laboratory, Ltd. – A drinking water laboratory located in Ft. Lauderdale, Florida.

The corporate headquarters is in Cleveland, Ohio.

Revision:

Environmental Hazards Services, L.L.C., (EHS) of Richmond, Virginia has
been in business since 1984. EHS is an analytical testing laboratory specializing in the analysis of environmental and industrial hygiene samples. Sample analysis includes the detection of asbestos in bulk samples (PLM), quantification of airborne fiber concentrations (PCM), detection and quantification of metals in various media (paint chips, wipes, air, building debris, soil), and fungal spore/pollen grain count and identificaion of common genera.

In July 2007, EHS purchased BTS laboratories and moved the entire laboratory down to Richmond. BTS Laboratories was a mold, lead and drinking water testing laboratory. EHS is able to continue to offer these same services for BTS clients as well as EHS clients.

EHS provides its services to government, private, business and residential clients. EHS prides itself on providing its clients with excellent service through the application of a knowledgeable staff to good laboratory practices and strict adherence to the QA/QC Program. All information pertaining to safety and chemical hygiene can be found in the Safety and Chemical Hygiene Plan.

In 1998 EHS was acquired by Foxboro Capitol Ltd. Under this ownership EHS is a part of the National Testing Laboratories Network. The other laboratories in this network are:

- National Testing Laboratories, Ltd. – A drinking water laboratory located in Ypsilanti, Michigan.
- Broward Testing Laboratory, Ltd. – A drinking water laboratory located in Ft. Lauderdale, Florida.

The corporate headquarters is in Cleveland, Ohio

Section Revised:

EMPLOYEE TRAINING

All EHS employees must read the QA/QC manual and the SOPs that pertain to their position. All employees undergo a training period in which they will be provided with the necessary instruction in order to perform their anticipated tasks. During this training period the new employee will be supervised by a member of the staff competent in the area of instruction. Once the employee has demonstrated proficiency in the area of training they will be allowed to work without supervision.

Technical employees have specific requirements that must be fulfilled in order to demonstrate proficiency. A checklist is used to follow the progress of the training program. For PLM, PCM and IAQ analyst, initial competence is shown through the analysis of 50 reference samples. For Metals analysts a series of analytical runs must be completed and passed to complete the initial training process. PCM and metals technicians must demonstrate their competence in the preparation of samples, before being allowed to prepare client samples unsupervised. Only trained employees are authorized to use equipment and to prepare and analyze samples.

Every year technicians and analyst must re-demonstrate their competence in order to continue to prepare and analyze samples. For specific technical laboratory training see the SOP for Employee Training.

Revision:

EMPLOYEE TRAINING

EHS employees are made aware of the importance they play in ensuring that the objectives of the Quality Management System are achieved. Each employee is taught that the Quality Management System as detailed in the QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. The adherence to these standards will ensure that EHS is able to provide and maintain a reliable and consistently accurate system of analytical work in compliance with ISO/IEC17025 and with NELAC standards.

These standards establish the QA/QC systems throughout the laboratory, which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. Communication between management and laboratory personnel will ensure the effectiveness of the management system. All employees are made aware that any questions, concerns or problems can be brought to management at any time. Any changes in laboratory policy are brought to the attention of all employees at the time of the change through departmental meetings.

All EHS employees must read the QA/QC manual and the SOPs that pertainto their position. All employees undergo a training period in which they will be provided with the necessary instruction in order to perform their anticipated tasks. During this training period the new employee will be supervised by a member of the staff competent in the area of instruction. Once the employee has demonstrated proficiency in the area of training they will be allowed to work without supervision.

Technical employees have specific requirements that must be fulfilled in order to demonstrate proficiency. A checklist is used to follow the progress of the training program. For PLM, PCM and IAQ analyst, initial competence is shown through the analysis of 50 reference samples. For Metals analysts a series of analytical runs must be completed and passed to complete the initial training process. PCM and metals technicians must demonstrate their competence in the preparation of samples, before being allowed to prepare client samples unsupervised. Only trained employees are authorized to use equipment and to prepare and analyze samples.

Every year technicians and analyst must re-demonstrate their competence in order to continue to prepare and analyze samples. This re-demonstration evaluates the effectiveness of the training program. For specific technical laboratory training see the SOP for Employee Training.

Section Revised:

Objectives, Policies and Authority of EHS Quality Assurance/Quality Control (QA/QC) Manual

The QA/QC Manual is issued under the authority of the President of Foxboro Capitol, Ltd. and documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work in compliance with ISO/IEC17025 and with NELAC standards. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies. The QA/QC Manual is to be adhered to explicitly, except in case of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary to permit any departure from documented procedures.

Revision:

The Quality Management System as detailed in the QA/QC Manual is issued under the authority of the President of Foxboro Capitol, Ltd. The QA/QC Manual documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work that meet customer requirements and are in compliance with ISO/IEC17025 and with NELAC standards.

EHS will continually improve the effectiveness of its QA/QC Manual and its management system through the use of the quality policy and objectives, management reviews, audit results, analysis of data, corrective and preventive actions. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies.

The QA/QC Manual is to be adhered to explicitly, except in cases of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary. Any changes made to the QA/QC Manual or departures from documented procedures must be approved in order to ensure the integrity of the management system is maintained.

Section Revised:

Client Services Daily Follow-up Review

Every day a minimum of three (3) clients are selected at random for a telephone survey. If a client is unavailable for comments then an additional client is selected. Any one client will not be selected for an interview more than once every three weeks, unless it is to follow-up on corrective actions resulting from complaints. If a client has a concern or complaint, a complaint documentation form will be generated by client services, and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. Each client survey is reviewed by the Accounting and Marketing Departments.

Revision:

Client Services Daily Follow-up Review

Every day a minimum of three (3) clients are selected at random for a telephone survey. If a client is unavailable for comments then an additional client is selected. Any one client will not be selected for the survey more than once every three weeks, unless it is to follow-up on corrective actions resulting from complaints. The feedback from clients is analyzed and used to improve the management system, testing services, and customer service. If a client has a concern or complaint, a complaint documentation form will be generated by client services, and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. The Accounting, Customer Service and Marketing Departments review client surveys.

Section Revised:

The key areas to be reviewed are:

a. Previous Annual Management Audit
b. Internal QA Audit

c. Status of Accreditations
d. Proficiency Testing Programs
e. Quality Assurance Manual Review
f. Operations Manual Review
g. Corrective/Preventive Actions
h. New Methods Offered
i. Pre-existing Methods
j. Personnel
k. One Year Plan
l. General Status

Revision:

The key areas to be reviewed are:

a. Previous Annual Management Audit
b. Internal QA Audit
c. Status of Accreditations
d. Proficiency Testing Programs
e. Quality Assurance Manual Review
f. Operations Manual Review
g. Corrective/Preventive Actions
h. New Methods Offered
i. Pre-existing Methods
j. Personnel
k. Recommendations for Improvement
l. One Year Plan
m. General Status

02/08/08
Revision:

Replace QA/QC Coordinator with Quality Manager

Section Revised

6.3.2 Metals/Inorganics Methods

6.3.2.1	NIOSH 7082 (Lead in Paint Chips, Wipes, Air Samples)
6.3.2.2	NIOSH 7048-M (Cadmium in air)
6.3.2.3	NIOSH 7024-M (Chromium in air)
6.3.2.4	NIOSH 7030-M (Zinc in air)
6.3.2.5	OSHA ID-25 (Welding Fumes in air)
6.3.2.6	NIOSH 0500 (Total Particulates Not Otherwise Regulated)
6.3.2.7	NIOSH 0600 (Respirable Particulates Not otherwise Regulated)
6.3.2.8	9 (Mercury Vapor in air)
6.3.2.9	OSHA ID-145 (Particulate Mercury in air)
6.3.2.10	EPA SW846/1311 (Toxicity Characteristic Leaching Procedure, TCLP)
6.3.2.11	EPA SW846/3010A (Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Flame Atomic Absorption (FLAA) or Inductively Coupled Plasma (ICP) Spectroscopy)
6.3.2.12	EPA SW846/3050B (Acid Digestion of Sediments, Sludges, and Soils)
6.3.2.13	EPA SW846/6010B (Inductively Coupled Plasma - Atomic Absorption Spectroscopy)
6.3.2.14	EPA SW846/7470A (Mercury in Liquid Waste (Manual Cold Vapor Technique))
6.3.2.15	EPA SW846/7471A (Mercury in Semi-/Solid Waste (Manual Cold Vapor Technique))
6.3.2.16	EPA 600/R-93/200 (SOP for the Field Analysis of Lead in Air, TSP Air, Paint, Bulk Dust, and Soil by Ultrasonic, Acid Digestion).
6.3.2.17	ASTM E1979-98 (Ultrasonic Extraction of Dust Samples for Subsequent Determination of Lead).

Revised With:

6.3.2 Metals/Inorganics Methods

6.3.2.16 NIOSH 7082 (Lead by FAA)
6.3.2.17 NIOSH 7300 (Metals by ICP)
6.3.2.3 NIOSH 6009 (Mercury Vapor in air)
6.3.2.18 NIOSH 0500 (Total Particulates Not Otherwise Regulated)
6.3.2.19 NIOSH 0600 (Respirable Particulates Not Otherwise Regulated
6.3.2.20 OSHA ID-25 (Welding Fumes in air)
6.3.2.21 OSHA ID-145 (Particulate Mercury in air)
6.3.2.22 EPA SW846/7000 (Metals by FAA)
6.3.2.23 EPA SW846/1311 (Toxicity Characteristic Leaching Procedure, TCLP)
6.3.2.24 EPA SW846/3010A (Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Flame Atomic Absorption (FLAA) or Inductively Coupled Plasma (ICP) Spectroscopy)
6.3.2.25 EPA SW846/3050B (Acid Digestion of Sediments, Sludges, and Soils)
6.3.2.26 EPA SW846/6010C (Inductively Coupled Plasma - Atomic Absorption Spectroscopy)
6.3.2.27 EPA SW846/7470A (Mercury in Liquid Waste (Manual Cold Vapor Technique))
6.3.2.28 EPA SW846/7471B (Mercury in Semi-/Solid Waste (Manual Cold Vapor Technique))
6.3.2.29 EPA 600/R-93/200 (SOP for the Field Analysis of Lead in Air, TSP Air, Paint, Bulk Dust, and Soil by Ultrasonic, Acid Digestion).
6.3.2.30 ASTM E1979-98 (Ultrasonic Extraction of Dust Samples for Subsequent Determination of Lead).

06/0809

SECTIONS REVISED:

Sample Log-in

4.2.1 EHS Samples

4.2.1.1 Samples are logged into a computer spreadsheet program and a job number is assigned. The computer spreadsheet contains the following for each job number:

a. Date Received
b. EHS Job Number
c. Client Name
d. Client Project Name
e. Sample Acceptability
f. Sample Type/Number of samples received
g. Notes (Includes Sample Rejection Information)

4.2.1.1.1 "Logbook" spreadsheet information is printed daily and stored in a notebook binder. The information is also downloaded onto a computer "floppy" disk and stored in the computer "hard drive". At any time, one software copy and two "hard" copies of the log-in information exist, one "hard" copy is found in the Log-in Department and the other copy is found in the accounting department.

4.2.1.2 The EHS Job Number is generated as follows. A first set of four numbers indicate the year the samples were received. A second set of two numbers indicates the month the samples were received. A third set of four numbers indicates the sequential job number. (The first job of each month is assigned job 20XX – XX - 0001.) Each new job number is increased by a factor of one. All number sets are separated by hyphens.

EXAMPLE: 2008 -01-0123
Year received - 2008
Month received - Jan (01)
EHS Job Number - 0123 (123rd job in Jan.)

4.2.2 BTS Samples

4.2.2.1 After a sample is received by BTS, it is received into the BTS LIMS system and assigned a BTS sample number. The number is recorded on the chain of custody and also labeled on the container. For example, the fifth sample of the second batch received on April 1, 2008 would be assigned a BTS sample number of 08040100002-0005.

4.2.2.2 All samples received should be recorded on the sample login sheet in the BTS LIMS system. The sample login sheet contains, at a minimum, the following:

a. BTS batch number and sample number
b. Date/time received
c. Customer and project information
d. Sample acceptability
e. Initials of the individual receiving samples

4.3.2 Sample Numbers are assigned by the job number plus an additional number. This number always begins with one and increases by increments of one throughout the job. Sample numbers are assigned by analysts within the specific department. Example, the first sample of the job number used would be assigned EHS number 2006-01- 0123-1.

REVISIONS:

4.2 Sample Receipt and Log-in

4.2.2 Samples are received into a Laboratory Information Management System (LIMS) and a job number is assigned. The number is recorded on the chain of custody and also labeled on the individual samples when they are numbered. The sample receipt should include the following:

a. Customer Name and Number
f. Date received
g. Project/Test Address
h. Turn Around Time
i. Shipping Type

4.2.2 After samples are received they are logged into the LIMS system. The Log In information may consists of the following:

a. Customer Sample ID
b. Collection location
c. Surface type
d. Area dimensions
e. Air volumes or start and end times with flow rates

4.3.2 Sample Numbers are assigned by the LIMS number plus an additional number. This number always begins with one and increases by increments of one throughout the job. Sample numbers are assigned by personal within the specific departments. (Example the 1st sample for LIMS number 09-09-00123 is labeled 09-09-00123-1)

Section Revised:

5.4.4 Client Services Daily Follow-up Review

Every day a minimum of three (3) clients are selected at random for a telephone survey. If a client is unavailable for comments then an additional client is selected. Any one client will not be selected for the survey more than once every three weeks, unless it is to follow-up on corrective actions resulting from complaints. The feedback from clients is analyzed and used to improve the management system, testing services, and customer service. If a client has a concern or complaint, a complaint documentation form will be generated by client services, and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. The Accounting, Customer Service and Marketing Departments review client surveys.

Revision:

5.4.4 Client Services Calls

Every day clients are asked on the service which is provided. The feedback from clients is analyzed and used to improve the management system, testing services and customer service. Customer calls are documented by notes on Goldmine, a computer customer base program. If a client has a significant complaint, a Corrective/Preventive Action form will be generated by Customer Service and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. The Accounting, Customer Service and Marketing Departments review Goldmine customer notes. Goldmine notes are reviewed in the Yearly Management Audit to assess customer feedback.

12/16/09

Section Revised:
Amended Organizational Chart to show new employees and to remove old employees.

02/01/10

Section Revised:

7.2 Reference standards shall be calibrated by a source that can provide traceability to a national standard of measurement.

Revision:

7.2 Reference standards shall be calibrated by a source that is ISO/IEC17025 certified.

Section Revised:

6.2.1.11 1 - Fisher Price Refractometer

Revision:

6.2.1.11 1 - Fisher Scientific Refractometer

Section Revised:

6.3.1.5 NIST certified Brass Calibration Weights

Revision:

6.3.1.5 NIST traceable Brass Calibration Weights

Section Revised:

4.1.2 At the time of sample receipt, all initial information requested by the COC is completed by the employee performing sample log-in duties. The date and time sample was received is noted on the COC, with the signature or initials of the receiver.

4.1.3 During the log-in phase, samples are individually checked for leaks or contamination (i.e., samples opened in transport) and that information provided on COC matches samples (i.e., correct number of samples, correct analysis requested, correct sampling containers and/or correct sampling media, sample number on containers matches sample number on COC form, etc.). Any inconsistencies, leaks (leaking multiphasic samples cannot be considered representative), or contamination may be cause for sample rejection. The condition of the sample is noted on the COC with a stamp that states whether the samples are acceptable or unacceptable. Samples deemed unacceptable are placed in the Hold bin and documented in the Hold Log. The samples are held for 90 days and then discarded unless the client authorizes analysis in written form or request that the samples be sent back to the client.

Revision:

4.1.2 At the time of sample receipt, all initial information requested by the COC is completed by the employee performing sample log-in duties. The date and time sample was received is noted on the COC, with the signature or initials of the receiver. The condition of the sample is noted in Wavefront as the samples are received into the LIMS system. Samples deemed unacceptable are marked unacceptable in Wavefront. The client is called about the samples and a note is placed in Goldmine. The samples are then placed in the hold bin. The samples are held for 90 days and then discarded unless the client authorizes analysis in written form or request that the samples be sent back to the client.

4.1.3 During receipt, samples are individually checked for leaks or contamination (i.e., samples opened in transport) and that information provided on COC matches samples (i.e., correct number of samples, correct analysis requested, correct sampling containers and/or correct sampling media, sample number on containers matches sample number on COC form, etc.). Any inconsistencies, leaks (leaking multiphasic samples cannot be considered representative), or contamination may be cause for sample rejection.

Section Revised:

9. SUBCONTRACTORS

Prior to any samples being subcontracted, the client is notified of the need for their samples to be analyzed by another laboratory and written approval is obtained from the client to allow the samples to be transferred. If this written approval is not received by EHS, samples will be returned to the client. When the need arises for samples to be analyzed by laboratories other than EHS, the samples are sent to competent laboratories that are accredited by the appropriate agencies. Asbestos laboratories must be NVLAP accredited and in compliance with the NVLAP handbook. Every subcontractor must be compliant with the necessary accrediting bodies prior to receipt of samples from EHS. When subcontracted, samples that are listed under EHS's scope of accreditation are to be sent to an accredited laboratory whose scope of accreditation includes at least the same scope of accreditation as EHS. EHS maintains a file for each lab that is subcontracted. This file contains all applicable accreditations for samples that are analyzed for EHS. The results (reports) from the subcontracted lab are submitted directly to the client in the original format provided to EHS. A copy of EHS's sub-contractors can be found in Appendix 1.

10. POLLUTION PREVENTION

Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Many opportunities for pollution prevention exist in laboratory operation. EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address waste generation. When it is not feasible to reduce wastes at the source, the Agency recommends recycling as the next best option. The acids used in this Method should be reused as practicable by purifying by electrochemical techniques. The only other chemicals used in this Method are the neat materials used in preparing standards. These standards are used in extremely small amounts and pose little threat to the environment when managed properly. Standards should be prepared in volumes consistent with laboratory use to minimize the disposal of excess volumes of expired standards.

Revision:

9. SUBCONTRACTORS

Clients are aware that EHS subcontracts for TEM analysis, Radon analysis and drinking water analysis. This information is listed in the EHS New Client Handbook which is given to all EHS clients. When the need arises for samples normally analyzed by EHS to be analyzed by another laboratory, the client is informed and written permission is received prior to sending out the samples. Samples are sent to competent laboratories that are accredited by the appropriate agencies. Asbestos laboratories must be NVLAP accredited and in compliance with the NVLAP handbook. Every subcontractor must be compliant with the necessary accrediting bodies and ISO/IEC 17025 prior to receipt of samples from EHS. EHS maintains a file for each lab that is subcontracted. This file contains all applicable accreditations for samples that are analyzed for EHS. The results (reports) from the subcontracted lab are submitted directly to the client in the original format provided to EHS. A copy of EHS's sub-contractors can be found in Appendix 1.

10. POLLUTION PREVENTION

Pollution prevention encompasses any technique that reduces or eliminates the quantity or the toxicity of waste at the point of generation. Many opportunities for pollution prevention exist in laboratory operation. EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address waste generation. The Pollution Prevention Act of 1990, Congress established a national policy that: pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

Section Revised:

1.2 Objectives, Policies and Authority of EHS Quality Assurance/Quality Control (QA/QC) Manual

The Quality Management System as detailed in the QA/QC Manual is issued under the authority of the President of Foxboro Capitol, Ltd. The QA/QC Manual documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work that meet customer requirements and are in compliance with ISO/IEC17025 and with NELAC standards.

EHS will continually improve the effectiveness of its QA/QC Manual and its management system through the use of the quality policy and objectives, management reviews, audit results, analysis of data, corrective and preventive actions. This QA/QC Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies.

The QA/QC Manual is to be adhered to explicitly, except in cases of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary. Any changes made to the QA/QC Manual or departures from documented procedures must be approved in order to ensure the integrity of the management system is maintained.

1.3 Maintenance and Update Procedures of EHS QA/QC Manual

The QA/QC Manual and SOPs are maintained in the QA/QC Office. Additionally, in each department copies of the QA/QC Manual and the SOPs which relate to that department can be found. The Laboratory Director and Quality Manager review the QA/QC manual at least annually to ensure that the management system and SOPs are meeting customer requirements as well as statutory and regulatory requirements. The QA/QC Manual is revised as necessary to reflect any changes in laboratory practices. All revisions/reviews are documented in the Revisions/Review log found at the beginning of the QA/QC Manual. Each revision is brought to the attention of the corresponding department and a review log is kept to insure that each individual has read and understood the revision. Obsolete documents are removed from the manual, marked as obsolete, and placed in secure locations to insure that laboratory personnel only use current documentation. It is available at all times to EHS personnel and others including accrediting agencies. All personnel must review the QA/QC Manual and the

SOPs which relate to their department at least annually.

1.4 Maintenance of EHS SOPs (Standard Operating Procedures)

Laboratory SOPs are reviewed at least annually by the Laboratory Director and Quality Manager. They are revised as necessary to reflect any changes in laboratory practices and/or any updates to the reference methods. All revisions/reviews are documented in the S.O.P. Revisions/Review log found at the end of the Laboratory General Operations Manual. The General Operations Manual is maintained in the QA/QC Office. Copies of the latest revisions for pertinent SOPs are located in each laboratory section Operations Manual. Copies of all laboratory SOPs are located in the General Operations Manual. Invalid and/or obsolete SOP's and documents are promptly removed from use, marked as obsolete, and archived to insure that the only documents or SOP in use are current. The generation of any analytical data is based in strict accordance to the pertinent EHS S.O.P. All analytical SOPs are based on established reference methods. The SOPs may contain slight modifications to the reference method. Whenever a reference method is modified, this will be acknowledged by placing an M after the method number. All SOPs which contain a modification from the reference method shall be validated for compliance.

Revision:

1.2 Objectives, Policies and Authority of EHS Quality Assurance/Quality Control (QA/QC) Operations Manual

The Quality Management System as detailed in the QA/QC Operations Manual is issued under the authority of the President of Foxboro Capitol, Ltd. The QA/QC Operations Manual consists of the QA/QC Manual and the SOPs. The QA/QC Manual documents the facilities, personnel, and procedures utilized by EHS to provide and maintain a reliable and consistently accurate system of analytical work that meet customer requirements and are in compliance with ISO/IEC17025 and with NELAC standards.

EHS will continually improve the effectiveness of its QA/QC Operations Manual and its management system through the use of the quality policy statement and objectives, management reviews, audit results, analysis of data, corrective and preventive actions. This QA/QC Operations Manual provides working standards for personnel on all aspects of work conducted at this facility. It establishes QA/QC systems throughout the laboratory which allow the analytical system to be constantly monitored and indicates where adjustments or corrections may be necessary. It also permits the evaluation of performance and reliability by outside agencies.

The QA/QC Operations Manual is to be adhered to explicitly, except in cases of extraordinary circumstances or accident, in which case the approval of the Laboratory Director and the Quality Manager is necessary. Any changes made to the QA/QC Operations Manual or departures from documented procedures must be approved in order to ensure the integrity of the management system is maintained. The QA/QC Operations Manual is maintained in the QA/QC Office. Additionally, in each department copies of the QA/QC Manual and the SOPs which relate to that department can be found.

1.3 Maintenance and Update Procedures of EHS QA/QC Manual

The Laboratory Director and Quality Manager review the QA/QC manual at least annually to ensure that the management system is meeting customer requirements as well as statutory and regulatory requirements. All revisions/reviews are documented at the end of the QA/QC Manual. Each revision is brought to the attention of the corresponding department and a review log is kept to insure that each individual has read and understood the revision. Obsolete documents are removed from the manual, marked as obsolete, and placed in secure locations to insure that laboratory personnel only use current documentation. It is available at all times to EHS personnel and others including accrediting agencies. All personnel must review the QA/QC Manual at least annually.

1.4 Maintenance of EHS SOPs (Standard Operating Procedures)

Laboratory SOPs are revised as needed by the Laboratory Director and Quality Manager. They are revised to reflect any changes in laboratory practices and/or any updates to the reference methods. All revisions are documented in the Revision log found at the end of the each SOP. Copies of the latest revisions for pertinent SOPs are located in each laboratory section Operations Manual. Laboratory SOPs are located with the QA/QC Manual in the QA/QC Operations Manual. Invalid and/or obsolete SOP's and documents are promptly removed from use, marked as obsolete, and archived to insure that the only documents or SOPs in use are current. The generation of any analytical data is based in strict accordance to the pertinent EHS SOP. All analytical SOPs are based on established reference methods. The SOPs may contain slight modifications to the reference method. Whenever a reference method is modified, this will be acknowledged by placing an M after the method number. All SOPs which contain a modification from the reference method shall be validated for compliance.

Section Revised:

4.1.4 Documentation of Acceptability

Upon examination of the sample, if the sample is found unacceptable due to lack of paperwork and/or incorrect COC or other problems, the samples are placed on Hold and the client is notified. The

samples are held until the problems are corrected or the client request disposal of the samples. Notes are put in Goldmine as to the reason they are on hold. The following statement shall be included on every final report. "The condition of the samples analyzed was acceptable upon receipt per laboratory protocol unless otherwise noted on this report."

Revision:

4.1.4 Documentation of Acceptability

Upon examination of the samples, if the samples are found unacceptable due to lack of paperwork and/or incorrect COC or other problems, the samples are received into the lab but marked unacceptable in LIMS. The samples are then placed on Hold and the client is notified. The samples are held until the problems are corrected or the client request disposal of the samples. Notes are put in Goldmine as to the reason they are on hold. The following statement shall be included on every final report. "The condition of the samples analyzed was acceptable upon receipt per laboratory protocol unless otherwise noted on this report."

Section Revised:

4.5 Data Reporting

Reports are reviewed by a trained reviewer for completeness and, after approval by the appropriate signatory or designate, released to the client. All reports whether electronic or paper are controlled and monitored to insure client confidentiality. For EHS clients a copy of the report, data worksheets, and chain-of-custody are kept in the client file. For BTS clients a copy of the chain-of-custody and any raw data are kept in files by date of receipt. These files are kept in file cabinets for a minimum of two months, for easy response to possible client questions. Every two to three months files are archived in the warehouse. Files are maintained for a minimum of ten (10) years.

Revision:

4.5 Data Reporting

Reports are reviewed by a trained reviewer for completeness and, after approval by the appropriate signatory or designate, released to the client. All reports whether electronic or paper are controlled and monitored to insure client confidentiality. For EHS clients a copy of the chain-of-custody and any raw data are kept in files by numerical report number. These files are kept in file cabinets for a minimum of two months, for easy response to possible client questions. Every two to three months files are archived in the warehouse. Files are maintained for a minimum of five (5) years.

Section Revised:

5.4 Audits/Reviews/Inspections

5.4.6 Quarterly Review

Each quarter a thorough review of laboratory procedures, practices and weekly summaries will be performed. The purpose of this audit is to identify and evaluate trends and ensure that key elements of the quality plan are up to date.

This audit review will be completed during the first month of each quarter. The Quality Manager is responsible for ensuring this review is completed, however parts of the review may be delegated to other persons who possess the technical training necessary for this review and are independent of the areas being reviewed.

This review shall include but is not limited to:

- **a.** Trend analysis for each test area
- **b.** Corrective/Preventive Actions
- **c.** Client Services
- **d.** On-Site Assessments by outside agencies
- **e.** Proficiency testing results
- **j.** Personnel updates
- **k.** Training
- **i.** Equipment/Instrumentation
- **j.** Review of corrective actions taken in response to previous Quarterly Review.

The quarterly review is reviewed by the laboratory Director and is on file in the QA/QC Library. Each quarterly review is also submitted to the management review team as a part of the Annual Management Audit (see 5.4.1.4). Any deficiencies found by a quarterly review must be addressed

immediately. Documentation of corrective actions will be signed by the Laboratory Director and the Quality Manager and filed in the QA/QC Library. The next quarterly review will detail all corrective actions arising from the prior review. If it is found that deficiencies may have affected sample results, those clients involved will be immediately notified in writing.

5.4.7 Internal QA Audit

The purpose of the Internal QA Audit is to (1) determine if the quality system contains all the policies and procedures required under ISO 17025 and the accreditations held by the laboratory and (2) determine that those policies and procedures are being followed. This audit will be performed by a representative from each department under the guidance of the Laboratory Administrator and the Quality Manager and reviewed and signed by the General Manager. This audit will be performed and completed each January. All deficiencies found by this audit will be addressed and responses documented no later than the end of the 1st quarter of the year.

The Internal QA Audit will include but is not limited to the following:

- **i.** Analysis of Quarterly Reviews
- **j.** Detailed review of AIHA Assessor Checklist
- **k.** Detailed review of NVLAP Assessor Checklist
- **l.** Detailed review of any state Assessor Checklist
- **m.** A narrative summary of findings
- **n.** Deficiencies, corrective/preventive actions and responses
- **o.** Recommendations for improvement

5.4.8 Annual Management Audit

An annual audit is performed by the Laboratory Management Review Team. The purpose of this audit is to examine the entire laboratory system and to ensure adequacy for the achievement of the laboratory quality objectives. The Laboratory Management Review Team will include at a minimum; the General Manager, Laboratory Administrator, Laboratory Director, Quality Manager, and all section supervisors.

The Annual Management Audit will be accomplished through a series of meetings of the Management Review Team. The first meeting will take place during the first week of February. At the first meeting, each team member will be assigned different segments of the review, which they will be required to perform and report their findings to the entire team. A time frame to complete the assigned tasks will also be determined at that meeting. Subsequent meetings will consist of presentations by the individual members, and questions and discussions by the team. These meetings will continue until all review categories have been fully addressed.

The key areas to be reviewed are:

- **p.** Previous Annual Management Audit
- **q.** Internal QA Audit
- **r.** Status of Accreditations
- **s.** Proficiency Testing Programs
- **t.** Quality Assurance Manual Review
- **u.** Operations Manual Review
- **v.** Corrective/Preventive Actions
- **w.** New Methods Offered
- **x.** Pre-existing Methods
- **y.** Personnel
- **p.** Recommendations for Improvement
- **z.** One Year Plan
- **aa.** General Status

This audit shall be completed by the end of the first quarter.

5.4.9 Client Services Calls

Every day clients are asked on the service which is provided. The feedback from clients is analyzed and used to improve the management system, testing services, and customer service. If a client has a concern or complaint, a complaint documentation form will be generated by client services, and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. The Accounting, Customer Service and Marketing Departments review client surveys. Customer calls are documented on Goldmine.

Revision:

5.4 Audits/Reviews/Inspections

5.4.10 Quarterly Review

Each quarter a review of laboratory procedures, practices will be performed. The purpose of this audit is to identify and evaluate trends and ensure that key elements of the quality plan are up to date.

This audit review will be completed during the first month of each quarter. The Quality Manager is responsible for ensuring this review is completed.

The Quality Manager will use a laboratory review checklist specific to each laboratory and will review the following during the audit:

f. On-Site Assessments by outside agencies
g. Previous internal audits
h. Proficiency testing results
i. Nonconformities
j. Review of Corrective/Preventive actions and follow-ups procedures

Once the quarterly review is finished a copy of the audit is given to the corresponding laboratory supervisor with a date by which the deficiencies must be corrected. Documentation of the corrective actions showing the type of correction, by whom and when the correction was performed or will be finalized will be signed by the Quality Manager and filed in the respective laboratory binder. Each quarterly review is also submitted to the management review team as a part of the Annual Management Audit (see 5.4.1.4). Any deficiencies found by a quarterly review must be addressed immediately. The next quarterly review will detail all corrective actions arising from any prior quarterly, management and internal reviews. If it is found that deficiencies may have affected sample results, those clients involved will be immediately notified in writing.

5.4.11 Internal QA Audit

The purpose of the Internal QA Audit is to (1) determine if the quality system contains all the policies and procedures required under ISO 17025 and the accreditations held by the laboratory and (2) determine that those policies and procedures are being followed. This audit will be performed by the Quality Manager and reviewed and by the General Manager. This audit will be performed and completed by end of the 2nd quarter of the year. All deficiencies found by this audit will be addressed and corrections documented showing the type of correction, by whom and when the correction was performed or will be finalized will be signed by the Quality Manager and filed in the respective laboratory binder

The Internal QA Audit will include but is not limited to the following:

q. Analysis of Quarterly Reviews
r. Detailed review of AIHA Assessor Checklist
s. Detailed review of NVLAP Assessor Checklist
t. Detailed review of any state Assessor Checklist
u. A narrative summary of findings
v. Deficiencies, corrective/preventive actions and responses
w. Recommendations for improvement

5.4.12 Annual Management Audit

An annual audit is performed by the Laboratory Management Review Team. The purpose of this audit is to examine the entire laboratory management system and testing activities to ensure their continuing suitability and effectiveness and to introduce necessary changes or improvements. The Laboratory Management Review Team will include at a minimum; the General Manager, Laboratory Administrator, Laboratory Director, Quality Manager, and all section supervisors.

The Annual Management Audit will be accomplished through a series of meetings of the Management Review Team. The first meeting will take place during the first quarter of the year. At the first meeting, each team member will be assigned different segments of the review, which they will be required to perform and report their findings to the entire team. A time frame to complete the assigned tasks will also be determined at that meeting. Subsequent meetings will consist of presentations by the individual members, and questions and discussions by the team. These meetings will continue until all review categories have been fully addressed. This audit shall be completed by the end of the second quarter.

The key areas to be reviewed are:

a. Suitability of policies and procedures in Quality Manual
b. Review of the overall objectives found in Quality Manual
c. Previous Annual Management Audit
d. Previous Internal QA Audit reports
e. Previous Quarterly Audit reports
f. Corrective/Preventive actions
g. Onsite assessments by external bodies
h. Status of Accreditations
i. Proficiency testing programs and results

j. Changes in the volume and type of work
k. Customer feedback and complaints
l. Quality Control activities
m. Personnel resources and training
n. Recommendations for Improvement
o. One Year Plan
p. General Status

Findings from the management review and the actions that arise from them shall be documented. Documentation will include what is to be done, by whom and by when it will be completed. Management shall ensure that those actions are carried out within an appropriate and agreed timeframe. Progress and follow-up of these actions will be reported in the quarterly QA reports.

5.4.13 Client Services Calls

Every day clients are asked on the service which is provided. The feedback from clients is analyzed and used to improve the management system, testing services and customer service. Customer calls are documented by notes on Goldmine, a computer customer base program. If a client has a significant complaint, a Corrective/Preventive Action form will be generated by Customer Service and addressed per the S.O.P. For Complaint Identification, Resolution and Tracking. The Accounting, Customer Service and Marketing Departments review Goldmine customer notes. Goldmine notes are reviewed in the Yearly Management Audit to assess customer feedback.

11/08/10

Section Revised:

Section 4.3.3: Changed year on analytical run description to 2010. (ex. 060310W)

Section 5.5: Added reference to SOP F-13

Section 6:3.2.15: Changed method number from ASTM E1979-98 to ASTM E1979-04

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ #29; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10 c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User's Guide); s = Concentration may exceed Csat (See User's Guide); SSL values are based on DAF=1

Contaminant		Toxicity and Chemical-specific information														Screening Levels												Protection of Groundwater Soil	
		SFO	k e y	IUR	k e y	RfDo	k e y	RfCi	k e y	v o c	muta-gen	GIABS	ABS	Csat	Residential Soil		Industrial Soil		Residential Air		Industrial Air		Tapwater		MCL	Risk-based SSL	MCL-based SSL
Analyte	CAS No.	(mg/kg-day)$^{-1}$		(ug/m^3)$^{-1}$		(mg/kg-day)		(mg/m^3)						mg/kg	mg/kg	key	mg/kg	key	ug/m^3	key	ug/m^3	key	ug/L	key	ug/L	mg/kg	mg/kg
ALAR	1596-84-5	1.8E-02	C	5.1E-06	C	1.5E-01	I					1	0.1		2.7E+01	c	9.6E+01	c	4.8E-01	c	2.4E+00	c	3.7E+00	c		8.2E-04	
Acephate	30560-19-1	8.7E-03	I			4.0E-03	I					1	0.1		5.6E+01	c**	2.0E+02	c*					7.7E+00	c*		1.7E-03	
Acetaldehyde	75-07-0			2.2E-06	I			9.0E-03	I	V		1		1.1E+05	1.0E+01	c**	5.2E+01	c**	1.1E+00	c**	5.6E+00	c**	2.2E+00	c**		4.5E-04	
Acetochlor	34256-82-1					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		5.8E-01	
Acetone	67-64-1					9.0E-01	I	3.1E+01	A	V		1		1.1E+05	6.1E+04	n	6.3E+05	nms	3.2E+04	n	1.4E+05	n	2.2E+04	n		4.5E+00	
Acetone Cyanohydrin	75-86-5					3.0E-03	P	6.0E-02	P	V		1		1.1E+05	2.0E+02	n	2.1E+03	n	6.3E+01	n	2.6E+02	n	5.8E+01	n		1.2E-02	
Acetonitrile	75-05-8							6.0E-02	I	V		1		1.3E+05	8.7E+02	n	3.7E+03	n	6.3E+01	n	2.6E+02	n	1.3E+02	n		2.6E-02	
Acetophenone	98-86-2					1.0E-01	I			V		1		2.5E+03	7.8E+03	ns	1.0E+05	nms					3.7E+03	n		1.1E+00	
Acetylaminofluorene, 2-	53-96-3	3.8E+00	C	1.3E-03	C							1	0.1		1.3E-01	c	4.5E-01	c	1.9E-03	c	9.4E-03	c	1.6E-02	c		8.2E-05	
Acrolein	107-02-8					5.0E-04	I	2.0E-05	I	V		1		2.3E+04	1.5E-01	n	6.5E-01	n	2.1E-02	n	8.6E-02	n	4.2E-02	n		8.4E-06	
Acrylamide	79-06-1	4.5E+00	I	1.3E-03	I	2.0E-04	I					1	0.1		1.1E-01	c	3.8E-01	c	1.9E-03	c	9.4E-03	c	1.5E-02	c		3.2E-06	
Acrylic Acid	79-10-7					5.0E-01	I	1.0E-03	I			1	0.1		3.0E+04	n	2.9E+05	nm	1.0E+00	n	4.4E+00	n	1.8E+04	n		3.7E+00	
Acrylonitrile	107-13-1	5.4E-01	I	6.8E-05	I	4.0E-02	A	2.0E-03	I	V		1		1.1E+04	2.4E-01	c*	1.2E+00	c*	3.6E-02	c*	1.6E-01	c*	4.5E-02	c*		9.9E-06	
Adiponitrile	111-69-3							6.0E-03	P			1	0.1		6.5E+06	nm	3.6E+07	nm	6.3E+00	n	2.6E+01	n					
Alachlor	15972-60-8	5.6E-02	C			1.0E-02	I					1	0.1		8.7E+00	c*	3.1E+01	c					1.2E+00	c	2.0E+00	9.9E-04	1.6E-03
Aldicarb	116-06-3					1.0E-03	I					1	0.1		6.1E+01	n	6.2E+02	n					3.7E+01	n		9.1E-03	
Aldicarb Sulfone	1646-88-4					1.0E-03	I					1	0.1		6.1E+01	n	6.2E+02	n					3.7E+01	n		8.0E-03	
Aldrin	309-00-2	1.7E+01	I	4.9E-03	I	3.0E-05	I					1	0.1		2.9E-02	c*	1.0E-01	c	5.0E-04	c	2.5E-03	c	4.0E-03	c		6.5E-04	
Ally	74223-64-6					2.5E-01	I					1	0.1		1.5E+04	n	1.5E+05	nm					9.1E+03	n		3.5E+00	
Allyl Alcohol	107-18-6					5.0E-03	I	1.0E-04	X			1	0.1		3.0E+02	n	3.1E+03	n	1.0E-01	n	4.4E-01	n	1.8E+02	n		3.7E-02	
Allyl Chloride	107-05-1	2.1E-02	C	6.0E-06	C			1.0E-03	I	V		1		1.4E+03	6.8E-01	c**	3.4E+00	c**	4.1E-01	c**	2.0E+00	c**	6.5E-01	c**		2.1E-04	
Aluminum	7429-90-5					1.0E+00	P	5.0E-03	P			1			7.7E+04	n	9.9E+05	nm	5.2E+00	n	2.2E+01	n	3.7E+04	n		5.5E+04	
Aluminum Phosphide	20859-73-8					4.0E-04	I					1			3.1E+01	n	4.1E+02	n					1.5E+01	n			
Amdro	67485-29-4					3.0E-04	I					1	0.1		1.8E+01	n	1.8E+02	n					1.1E+01	n		3.9E+03	
Ametryn	834-12-8					9.0E-03	I					1	0.1		5.5E+02	n	5.5E+03	n					3.3E+02	n		3.5E-01	
Aminobiphenyl, 4-	92-67-1	2.1E+01	C	6.0E-03	C							1	0.1		2.3E-02	c	8.2E-02	c	4.1E-04	c	2.0E-03	c	3.2E-03	c		1.6E-05	
Aminophenol, m-	591-27-5					8.0E-02	P					1	0.1		4.9E+03	n	4.9E+04	n					2.9E+03	n		1.1E+00	
Aminophenol, p-	123-30-8					2.0E-02	P					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		2.8E-01	
Amitraz	33089-61-1					2.5E-03	I					1	0.1		1.5E+02	n	1.5E+03	n					9.1E+01	n		4.7E+01	
Ammonia	7664-41-7							1.0E-01	I			1									1.0E+02	n	4.4E+02	n			
Ammonium Perchlorate	7790-98-9					7.0E-04	I					1			5.5E+01	n	7.2E+02	n					2.6E+01	n			
Ammonium Sulfamate	7773-06-0					2.0E-01	I					1			1.6E+04	n	2.0E+05	nm					7.3E+03	n			
Aniline	62-53-3	5.7E-03	I	1.6E-06	C	7.0E-03	P	1.0E-03	I			1	0.1		8.5E+01	c**	3.0E+02	c*	1.0E+00	n	4.4E+00	n	1.2E+01	c*		4.0E-03	
Antimony (metallic)	7440-36-0					4.0E-04	I					0.15			3.1E+01	n	4.1E+02	n					1.5E+01	n	6.0E+00	6.6E-01	2.7E-01
Antimony Pentoxide	1314-60-9					5.0E-04	H					0.15			3.9E+01	n	5.1E+02	n					1.8E+01	n			
Antimony Potassium Tartrate	11071-15-1					9.0E-04	H					0.15			7.0E+01	n	9.2E+02	n					3.3E+01	n			
Antimony Tetroxide	1332-81-6					4.0E-04	H					0.15			3.1E+01	n	4.1E+02	n					1.5E+01	n			
Antimony Trioxide	1309-64-4							2.0E-04	I			0.15			2.8E+05	nm	1.2E+06	nm	2.1E-01	n	8.8E-01	n					
Apollo	74115-24-5					1.3E-02	I					1	0.1		7.9E+02	n	8.0E+03	n					4.7E+02	n		2.9E+01	
Aramite	140-57-8	2.5E-02	I	7.1E-06	I	5.0E-02	H					1	0.1		1.9E+01	c	6.9E+01	c	3.4E-01	c	1.7E+00	c	2.7E+00	c		3.0E-02	
Arsenic, Inorganic	7440-38-2	1.5E+00	I	4.3E-03	I	3.0E-04	I	1.5E-05	C			1	0.03		3.9E-01	c*	1.6E+00	c	5.7E-04	c*	2.9E-03	c*	4.5E-02	c	1.0E+01	1.3E-03	2.9E-01
Arsine	7784-42-1					3.5E-06	C	5.0E-05	I			1			2.7E-01	n	3.6E+00	n	5.2E-02	n	2.2E-01	n	1.3E-01	n			
Assure	76578-14-8					9.0E-03	I					1	0.1		5.5E+02	n	5.5E+03	n					3.3E+02	n		5.1E+00	
Asulam	3337-71-1					5.0E-02	I					1	0.1		3.1E+03	n	3.1E+04	n					1.8E+03	n		4.7E-01	
Atrazine	1912-24-9	2.3E-01	C			3.5E-02	I					1	0.1		2.1E+00	c	7.5E+00	c					2.9E-01	c	3.0E+00	1.9E-04	1.9E-03
Auramine	492-80-8	8.8E-01	C	2.5E-04	C							1			7.3E-01	c	3.3E+00	c	9.7E-03	c	4.9E-02	c	7.6E-02	c		7.0E-04	
Avermectin B1	65195-55-3					4.0E-04	I					1	0.1		2.4E+01	n	2.5E+02	n					1.5E+01	n		2.6E+01	
Azobenzene	103-33-3	1.1E-01	I	3.1E-05	I					V		1			5.1E+00	c	2.3E+01	c	7.8E-02	c	4.0E-01	c	1.2E-01	c		9.6E-04	
Barium	7440-39-3					2.0E-01	I	5.0E-04	H			0.07			1.5E+04	n	1.9E+05	nm	5.2E-01	n	2.2E+00	n	7.3E+03	n	2.0E+03	3.0E+02	8.2E+01
Baygon	114-26-1					4.0E-03	I					1	0.1		2.4E+02	n	2.5E+03	n					1.5E+02	n		4.7E-02	
Bayleton	43121-43-3					3.0E-02	I					1	0.1		1.8E+03	n	1.8E+04	n					1.1E+03	n		8.7E-01	
Baythroid	68359-37-5					2.5E-02	I					1	0.1		1.5E+03	n	1.5E+04	n					9.1E+02	n		2.4E+02	
Benefin	1861-40-1					3.0E-01	I					1	0.1		1.8E+04	n	1.8E+05	nm					1.1E+04	n		3.6E+02	
Benomyl	17804-35-2					5.0E-02	I					1	0.1		3.1E+03	n	3.1E+04	n					1.8E+03	n		1.6E+00	
Bentazon	25057-89-0					3.0E-02	I					1	0.1		1.8E+03	n	1.8E+04	n					1.1E+03	n		2.4E-01	
Benzaldehyde	100-52-7					1.0E-01	I			V		1		1.2E+03	7.8E+03	ns	1.0E+05	nms					3.7E+03	n		8.1E-01	
Benzene	71-43-2	5.5E-02	I	7.8E-06	I	4.0E-03	I	3.0E-02	I	V		1		1.8E+03	1.1E+00	c*	5.4E+00	c*	3.1E-01	c	1.6E+00	c*	4.1E-01	c	5.0E+00	2.1E-04	2.6E-03
Benzenethiol	108-98-5					1.0E-05	H			V		1		1.3E+03	7.8E-01	n	1.0E+01	n					3.7E-01	n		2.4E-04	
Benzidine	92-87-5	2.3E+02	I	6.7E-02	I	3.0E-03	I				M	1	0.1		5.0E-04	c	7.5E-03	c	1.4E-05	c	1.8E-04	c	9.4E-05	c		2.4E-07	
Benzoic Acid	65-85-0					4.0E+00	I					1	0.1		2.4E+05	nm	2.5E+06	nm					1.5E+05	n		3.4E+01	
Benzotrichloride	98-07-7	1.3E+01	I							V		1		3.2E+02	4.9E-02	c	2.2E-01	c					5.2E-03	c		1.1E-05	
Benzyl Alcohol	100-51-6					1.0E-01	P					1	0.1		6.1E+03	n	6.2E+04	n					3.7E+03	n		8.9E-01	
Benzyl Chloride	100-44-7	1.7E-01	I	4.9E-05	C	2.0E-03	P	1.0E-03	P	V		1		1.5E+03	1.0E+00	c*	4.9E+00	c*	5.0E-02	c*	2.5E-01	c*	7.9E-02	c*		8.7E-05	
Beryllium and compounds	7440-41-7			2.4E-03	I	2.0E-03	I	2.0E-05	I			0.007			1.6E+02	n	2.0E+03	n	1.0E-03	c*	5.1E-03	c*	7.3E+01	n	4.0E+00	5.8E+01	3.2E+00
Bidrin	141-66-2					1.0E-04	I					1	0.1		6.1E+00	n	6.2E+01	n					3.7E+00	n		8.5E-04	
Bifenox	42576-02-3					9.0E-03	P					1	0.1		5.5E+02	n	5.5E+03	n					3.3E+02	n		2.5E+00	
Biphenthrin	82657-04-3					1.5E-02	I					1	0.1		9.2E+02	n	9.2E+03	n					5.5E+02	n		2.5E+03	
Biphenyl, 1,1'-	92-52-4					5.0E-02	I			V		1		2.1E+02	3.9E+03	ns	5.1E+04	ns					1.8E+03	n		1.9E+01	
Bis(2-chloro-1-methylethyl) ether	108-60-1	7.0E-02	H	1.0E-05	H	4.0E-02	I			V		1		1.0E+03	4.6E+00	c	2.2E+01	c	2.4E-01	c	1.2E+00	c	3.2E-01	c		1.2E-04	
Bis(2-chloroethoxy)methane	111-91-1					3.0E-03	P					1	0.1		1.8E+02	n	1.8E+03	n					1.1E+02	n		2.5E-02	
Bis(2-chloroethyl)ether	111-44-4	1.1E+00	I	3.3E-04	I					V		1		5.1E+03	2.1E-01	c	1.0E+00	c	7.4E-03	c	3.7E-02	c	1.2E-02	c		3.1E-06	
Bis(2-ethylhexyl)phthalate	117-81-7	1.4E-02	I	2.4E-06	C	2.0E-02	I					1	0.1		3.5E+01	c*	1.2E+02	c	1.0E+00	c	5.1E+00	c	4.8E+00	c	6.0E+00	1.1E+00	1.4E+00
Bis(chloromethyl)ether	542-88-1	2.2E+02	I	6.2E-02	I					V		1		4.2E+03	7.7E-05	c	3.9E-04	c	3.9E-05	c	2.0E-04	c	6.2E-05	c		1.5E-06	
Bisphenol A	80-05-7					5.0E-02	I					1	0.1		3.1E+03	n	3.1E+04	n					1.8E+03	n		1.4E+02	
Boron And Borates Only	7440-42-8					2.0E-01	I	2.0E-02	H			1			1.6E+04	n	2.0E+05	nm	2.1E+01	n	8.8E+01	n	7.3E+03	n		2.3E+01	
Boron Trifluoride	7637-07-2					4.0E-02	C	1.3E-02	C			1			3.1E+03	n	4.1E+04	n	1.4E+01	n	5.7E+01	n	1.5E+03	n			
Bromate	15541-45-4	7.0E-01	I			4.0E-03	I					1			9.1E-01	c	4.1E+00	c					9.6E-02	c	1.0E+01	7.4E-04	7.7E-02
Bromo-2-chloroethane, 1-	107-04-0	2.0E+00	X	6.0E-04	X					V		1		2.4E+03	2.4E-02	c	1.2E-01	c	4.1E-03	c	2.0E-02	c	6.5E-03	c		1.8E-06	
Bromobenzene	108-86-1					8.0E-03	I	6.0E-02	I	V		1		6.8E+02	3.0E+02	n	1.8E+03	ns	6.3E+01	n	2.6E+02	n	8.8E+01	n		5.9E-02	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ #29; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User's Guide); s = Concentration may exceed Csat (See User's Guide); SSL values are based on DAF=1

Contaminant		Toxicity and Chemical-specific Information																Screening Levels												Protection of Groundwater Soil	
		SFO	k e y	IUR	k e y	RfDo	k e y	RfCi	k e y	v o c	muta-gen	GIABS	ABS	Csat	Residential Soil		Industrial Soil		Residential Air		Industrial Air		Tapwater		MCL	Risk-based SSL	MCL-based SSL
Analyte	CAS No.	(mg/kg-day)$^{-1}$		(ug/m^3)$^{-1}$		(mg/kg-day)		(mg/m^3)						mg/kg	mg/kg	key	mg/kg	key	ug/m^3	key	ug/m^3	key	ug/L	key	ug/L	mg/kg	mg/kg
Bromodichloromethane	75-27-4	6.2E-02	I	3.7E-05	C	2.0E-02	I			V		1		9.3E+02	2.7E-01	c	1.4E+00	c	6.6E-02	c	3.3E-01	c	1.2E-01	c		3.2E-05	
Bromoform	75-25-2	7.9E-03	I	1.1E-06	I	2.0E-02	I					1	0.1		6.1E+01	c*	2.2E+02	c*	2.2E+00	c	1.1E+01	c	8.5E+00	c*		2.3E-03	
Bromomethane	74-83-9					1.4E-03	I	5.0E-03	I	V		1		3.6E+03	7.3E+00	n	3.2E+01	n	5.2E+00	n	2.2E+01	n	8.7E+00	n		2.2E-03	
Bromophos	2104-96-3					5.0E-03	H					1	0.1		3.1E+02	n	3.1E+03	n					1.8E+02	n		7.7E-01	
Bromoxynil	1689-84-5					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		6.3E-01	
Bromoxynil Octanoate	1689-99-2					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		6.4E+00	
Butadiene, 1,3-	106-99-0	3.4E+00	C	3.0E-05	I			2.0E-03	I	V		1		6.7E+02	5.4E-02	c*	2.6E-01	c*	8.1E-02	c*	4.1E-01	c*	1.8E-02	c		9.7E-06	
Butanol, N-	71-36-3					1.0E-01	I					1	0.1		6.1E+03	n	6.2E+04	n					3.7E+03	n		7.6E-01	
Butyl Benzyl Phthlate	85-68-7	1.9E-03	P			2.0E-01	I					1	0.1		2.6E+02	c*	9.1E+02	c					3.5E+01	c		5.1E-01	
Butyl alcohol, sec-	78-92-2					2.0E+00	P	3.0E+01	P						1.6E+05	nm	2.0E+06	nm	3.1E+04	n	1.3E+05	n	7.3E+04	n		1.5E+01	
Butylate	2008-41-5					5.0E-02	I					1	0.1		3.1E+03	n	3.1E+04	n					1.8E+03	n		1.8E+00	
Butylated hydroxyanisole	25013-16-5	2.0E-04	C	5.7E-08	C										3.2E+03	c	1.4E+04	c	4.3E+01	c	2.2E+02	c	3.4E+02	c		6.3E-01	
Butylphthalyl Butylglycolate	85-70-1					1.0E+00	I					1	0.1		6.1E+04	n	6.2E+05	nm					3.7E+04	n		8.3E+02	
Cacodylic Acid	75-60-5					2.0E-02	A					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n			
Cadmium (Diet)	7440-43-9			1.8E-03	I	1.0E-03	I	1.0E-05	A			0.025	0.001		7.0E+01	n	8.0E+02	n									
Cadmium (Water)	7440-43-9			1.8E-03	I	5.0E-04	I	1.0E-05	A			0.05	0.001						1.4E-03	c**	6.8E-03	c**	1.8E+01	n	5.0E+00	1.4E+00	3.8E-01
Caprolactam	105-60-2					5.0E-01	I					1	0.1		3.1E+04	n	3.1E+05	nm					1.8E+04	n		4.5E+00	
Captafol	2425-06-1	1.5E-01	C	4.3E-05	C	2.0E-03	I					1	0.1		3.2E+00	c*	1.1E+01	c	5.7E-02	c	2.9E-01	c	4.5E-01	c		7.9E-04	
Captan	133-06-2	2.3E-03	C	6.6E-07	C	1.3E-01	I					1	0.1		2.1E+02	c*	7.5E+02	c	3.7E+00	c	1.9E+01	c	2.9E+01	c		2.1E-02	
Carbaryl	63-25-2					1.0E-01	I					1	0.1		6.1E+03	n	6.2E+04	n					3.7E+03	n		3.3E+00	
Carbofuran	1563-66-2					5.0E-03	I					1	0.1		3.1E+02	n	3.1E+03	n					1.8E+02	n	4.0E+01	7.1E-02	1.6E-02
Carbon Disulfide	75-15-0					1.0E-01	I	7.0E-01	I	V		1		7.4E+02	8.2E+02	ns	3.7E+03	ns	7.3E+02	n	3.1E+03	n	1.0E+03	n		3.1E-01	
Carbon Tetrachloride	56-23-5	1.3E-01	I	1.5E-05	I	7.0E-04	I	1.9E-01	A	V		1		4.6E+02	2.5E-01	c	1.2E+00	c	1.6E-01	c	8.2E-01	c	2.0E-01	c	5.0E+00	7.7E-05	1.9E-03
Carbosulfan	55285-14-8					1.0E-02	I					1	0.1		6.1E+02	n	6.2E+03	n					3.7E+02	n		8.8E+00	
Carboxin	5234-68-4					1.0E-01	I					1	0.1		6.1E+03	n	6.2E+04	n					3.7E+03	n		2.0E+00	
Ceric oxide	1306-38-3							9.0E-04	I			1			1.3E+06	nm	5.4E+06	nm	9.4E-01	n	3.9E+00	n					
Chloral Hydrate	302-17-0					1.0E-01	I					1	0.1		6.1E+03	n	6.2E+04	n					3.7E+03	n		7.4E-01	
Chloramben	133-90-4					1.5E-02	I					1	0.1		9.2E+02	n	9.2E+03	n					5.5E+02	n		1.3E-01	
Chloranil	118-75-2	4.0E-01	H									1	0.1		1.2E+00	c	4.3E+00	c					1.7E-01	c		1.4E-04	
Chlordane	12789-03-6	3.5E-01	I	1.0E-04	I	5.0E-04	I	7.0E-04	I			1	0.04		1.6E+00	c*	6.5E+00	c*	2.4E-02	c*	1.2E-01	c*	1.9E-01	c*	2.0E+00	1.3E-02	1.4E-01
Chlordecone (Kepone)	143-50-0	1.0E+01	I	4.6E-03	C	3.0E-04	I					1	0.1		4.9E-02	c	1.7E-01	c	5.3E-04	c	2.7E-03	c	6.7E-03	c		2.4E-04	
Chlorfenvinphos	470-90-6					7.0E-04	A					1	0.1		4.3E+01	n	4.3E+02	n					2.6E+01	n		7.0E-02	
Chlorimuron, Ethyl-	90982-32-4					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		2.5E-01	
Chlorine	7782-50-5					1.0E-01	I	1.5E-04	A			1			7.5E+03	n	9.1E+04	n	1.5E-01	n	6.4E-01	n	3.7E+03	n		1.6E+00	
Chlorine Dioxide	10049-04-4					3.0E-02	I	2.0E-04	I			1			2.3E+03	n	3.0E+04	n	2.1E-01	n	8.8E-01	n	1.1E+03	n			
Chlorite (Sodium Salt)	7758-19-2					3.0E-02	I					1			2.3E+03	n	3.1E+04	n					1.1E+03	n			
Chloro-1,1-difluoroethane, 1-	75-68-3							5.0E+01	I	V		1		1.2E+03	5.8E+04	ns	2.4E+05	nms	5.2E+04	n	2.2E+05	n	1.0E+05	n		5.2E+01	
Chloro-1,3-butadiene, 2-	126-99-8					2.0E-02	H	7.0E-03	H	V		1		7.5E+02	8.4E+00	n	3.6E+01	n	7.3E+00	n	3.1E+01	n	1.4E+01	n		7.5E-03	
Chloro-2-methylaniline HCl, 4-	3165-93-3	4.6E-01	H									1	0.1		1.1E+00	c	3.7E+00	c					1.5E-01	c		8.3E-05	
Chloroacetic Acid	79-11-8					2.0E-03	H					1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		1.5E-02	
Chloroacetophenone, 2-	532-27-4							3.0E-05	I			1	0.1		4.3E+04	n	1.8E+05	nm	3.1E-02	n	1.3E-01	n					
Chloroaniline, p-	106-47-8	2.0E-01	P			4.0E-03	I					1	0.1		2.4E+00	c	8.6E+00	c					3.4E-01	c		1.4E-04	
Chlorobenzene	108-90-7					2.0E-02	I	5.0E-02	P	V		1		7.6E+02	2.9E+02	n	1.4E+03	ns	5.2E+01	n	2.2E+02	n	9.1E+01	n	1.0E+02	6.2E-02	6.8E-02
Chlorobenzilate	510-15-6	1.1E-01	C	3.1E-05	C	2.0E-02	I					1	0.1		4.4E+00	c	1.6E+01	c	7.8E-02	c	4.0E-01	c	6.1E-01	c		2.0E-03	
Chlorobenzoic Acid, p-	74-11-3					3.0E-02	X					1	0.1		1.8E+03	n	1.8E+04	n					1.1E+03	n		2.8E-01	
Chlorobenzotrifluoride, 4-	98-56-6					3.0E-03	P	3.0E-01	P	V		1		1.2E+02	2.1E+02	ns	2.3E+03	ns	3.1E+02	n	1.3E+03	n	9.3E+01	n		3.3E-01	
Chlorobutane, 1-	109-69-3					4.0E-02	P			V		1		7.3E+02	3.1E+03	ns	4.1E+04	ns					1.5E+03	n		5.9E-01	
Chlorodifluoromethane	75-45-6							5.0E+01	I	V		1		1.7E+03	5.3E+04	ns	2.2E+05	nms	5.2E+04	n	2.2E+05	n	1.0E+05	n		4.3E+01	
Chloroform	67-66-3	3.1E-02	C	2.3E-05	I	1.0E-02	I	9.8E-02	A	V		1		2.5E+03	2.9E-01	c	1.5E+00	c	1.1E-01	c	5.3E-01	c	1.9E-01	c		5.3E-05	
Chloromethane	74-87-3							9.0E-02	I	V		1		1.3E+03	1.2E+02	n	5.0E+02	n	9.4E+01	n	3.9E+02	n	1.9E+02	n		4.9E-02	
Chloromethyl Methyl Ether	107-30-2	2.4E+00	C	6.9E-04	C					V		1		2.6E+04	1.9E-02	c	9.4E-02	c	3.5E-03	c	1.8E-02	c	5.6E-03	c		1.2E-06	
Chloronaphthalene, Beta-	91-58-7					8.0E-02	I			V		1		1.8E+02	6.3E+03	ns	8.2E+04	ns					2.9E+03	n		1.5E+01	
Chloronitrobenzene, o-	88-73-3	3.0E-01	P			3.0E-03	P	1.0E-05	X			1	0.1		1.6E+00	c	5.7E+00	c	1.0E-02	n	4.4E-02	n	2.2E-01	c		2.1E-04	
Chloronitrobenzene, p-	100-00-5	6.3E-03	P			1.0E-03	P	6.0E-04	P			1	0.1		6.1E+01	n	2.7E+02	c**	6.3E-01	n	2.6E+00	n	1.1E+01	c**		9.9E-03	
Chlorophenol, 2-	95-57-8					5.0E-03	I			V		1		2.2E+04	3.9E+02	n	5.1E+03	n					1.8E+02	n		1.5E-01	
Chloropicrin	76-06-2							4.0E-04	C						5.7E+05	nm	2.4E+06	nm	4.2E-01	n	1.8E+00	n					
Chlorothalonil	1897-45-6	3.1E-03	C	8.9E-07	C	1.5E-02	I					1	0.1		1.6E+02	c**	5.6E+02	c*	2.7E+00	c	1.4E+01	c	2.2E+01	c*		4.9E-02	
Chlorotoluene, o-	95-49-8					2.0E-02	I			V		1		9.1E+02	1.6E+03	ns	2.0E+04	ns					7.3E+02	n		7.1E-01	
Chlorotoluene, p-	106-43-4					7.0E-02	P			V		1		2.5E+02	5.5E+03	ns	7.2E+04	ns					2.6E+03	n		2.5E+00	
Chlorozotocin	54749-90-5	2.4E+02	C	6.9E-02	C										2.7E-03	c	1.2E-02	c	3.5E-05	c	1.8E-04	c	2.8E-04	c		6.2E-06	
Chlorpropham	101-21-3					2.0E-01	I					1	0.1		1.2E+04	n	1.2E+05	nm					7.3E+03	n		6.6E+00	
Chlorpyrifos	2921-88-2					3.0E-03	I					1	0.1		1.8E+02	n	1.8E+03	n					1.1E+02	n		1.6E+00	
Chlorpyrifos Methyl	5598-13-0					1.0E-02	H					1	0.1		6.1E+02	n	6.2E+03	n					3.7E+02	n		1.7E+00	
Chlorsulfuron	64902-72-3					5.0E-02	I					1	0.1		3.1E+03	n	3.1E+04	n					1.8E+03	n		1.5E+00	
Chlorthiophos	60238-56-4					8.0E-04	H					1	0.1		4.9E+01	n	4.9E+02	n					2.9E+01	n		7.5E-01	
Chromium(III), Insoluble Salts	16065-83-1					1.5E+00	I					0.013			1.2E+05	nm	1.5E+06	nm					5.5E+04	n		9.9E+07	
Chromium(VI)	18540-29-9	5.0E-01	J	8.4E-02	I	3.0E-03	I	1.0E-04	I		M	0.025			2.9E-01	c	5.6E+00	c	1.1E-05	c	1.5E-04	c	4.3E-02	c		8.3E-04	
Chromium, Total	7440-47-3											0.013													1.0E+02		1.8E+05
Cobalt	7440-48-4			9.0E-03	P	3.0E-04	P	6.0E-06	P			1			2.3E+01	n	3.0E+02	n	2.7E-04	c*	1.4E-03	c*	1.1E+01	n		4.9E-01	
Coke Oven Emissions	8007-45-2			6.2E-04	I						M	1	0.1						1.5E-03	c	2.0E-02	c					
Copper	7440-50-8					4.0E-02	H					1			3.1E+03	n	4.1E+04	n					1.5E+03	n	1.3E+03	5.1E+01	4.6E+01
Cresol, m-	108-39-4					5.0E-02	I	6.0E-01	C			1	0.1		3.1E+03	n	3.1E+04	n	6.3E+02	n	2.6E+03	n	1.8E+03	n		1.5E+00	
Cresol, o-	95-48-7					5.0E-02	I	6.0E-01	C			1	0.1		3.1E+03	n	3.1E+04	n	6.3E+02	n	2.6E+03	n	1.8E+03	n		1.5E+00	
Cresol, p-	106-44-5					5.0E-03	H	6.0E-01	C			1	0.1		3.1E+02	n	3.1E+03	n	6.3E+02	n	2.6E+03	n	1.8E+02	n		1.5E-01	
Cresol, p-chloro-m-	59-50-7					1.0E-01	X					1	0.1		6.1E+03	n	6.2E+04	n					3.7E+03	n		4.3E+00	
Cresols	1319-77-3					1.0E-01	A	6.0E-01	C	V		1		5.0E+04	7.5E+03	n	9.1E+04	ns	6.3E+02	n	2.6E+03	n	9.3E+02	n		7.6E-01	
Crotonaldehyde, trans-	123-73-9	1.9E+00	H							V		1		1.7E+04	3.4E-01	c	1.5E+00	c					3.5E-02	c		7.2E-06	
Cumene	98-82-8					1.0E-01	I	4.0E-01	I	V		1		2.7E+02	2.1E+03	ns	1.1E+04	ns	4.2E+02	n	1.8E+03	n	6.8E+02	n		1.1E+00	
Cupferron	135-20-6	2.2E-01	C	6.3E-05	C										2.9E+00	c	1.3E+01	c	3.9E-02	c	1.9E-01	c	3.1E-01	c		5.3E-04	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ #29; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10. c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User's Guide); s = Concentration may exceed Csat (See User's Guide); SSL values are based on DAF=1

Contaminant		Toxicity and Chemical-specific Information												Screening Levels												Protection of Groundwater Soil	
		SFO	k e y	IUR	k e y	RfDo	k e y	RfCi	k e y	v o c	muta-gen	GIABS	ABS	Csat	Residential Soil		Industrial Soil		Residential Air		Industrial Air		Tapwater		MCL	Risk-based SSL	MCL-based SSL
Analyte	CAS No.	(mg/kg-day)$^{-1}$		(ug/m^3)$^{-1}$		(mg/kg-day)		(mg/m^3)						mg/kg	mg/kg	key	mg/kg	key	ug/m^3	key	ug/m^3	key	ug/L	key	ug/L	mg/kg	mg/kg
Cyanazine	21725-46-2	8.4E-01	H			2.0E-03	H					1	0.1		5.8E-01	c	2.1E+00	c					8.0E-02	c		3.7E-05	
Cyanides																											
~Calcium Cyanide	592-01-8					4.0E-02	I					1			3.1E+03	n	4.1E+04	n					1.5E+03	n			
~Copper Cyanide	544-92-3					5.0E-03	I					1			3.9E+02	n	5.1E+03	n					1.9E+02	n			
~Cyanide (CN-)	57-12-5					2.0E-02	I			V		1		1.0E+07	1.6E+03	n	2.0E+04	n					7.3E+02	n	2.0E+02	7.4E+00	2.0E+00
~Cyanogen	460-19-5					4.0E-02	I			V		1		1.5E+03	3.1E+03	ns	4.1E+04	ns					1.5E+03	n		3.0E-01	
~Cyanogen Bromide	506-68-3					9.0E-02	I			V		1		1.0E+05	7.0E+03	n	9.2E+04	n					3.3E+03	n		6.9E-01	
~Cyanogen Chloride	506-77-4					5.0E-02	I			V		1		4.3E+03	3.9E+03	n	5.1E+04	ns					1.8E+03	n		3.8E-01	
~Hydrogen Cyanide	74-90-8					2.0E-02	I	3.0E-03	I	V		1		1.2E+05	1.9E+01	n	8.0E+01	n	3.1E+00	n	1.3E+01	n	6.2E+00	n		1.3E-03	
~Potassium Cyanide	151-50-8					5.0E-02	I					1			3.9E+03	n	5.1E+04	n					1.8E+03	n			
~Potassium Silver Cyanide	506-61-6					2.0E-01	I					0.04			1.6E+04	n	2.0E+05	nm					7.3E+03	n			
~Silver Cyanide	506-64-9					1.0E-01	I					0.04			7.8E+03	n	1.0E+05	nm					3.7E+03	n			
~Sodium Cyanide	143-33-9					4.0E-02	I					1			3.1E+03	n	4.1E+04	n					1.5E+03	n			
~Thiocyanate	463-56-9					2.0E-04	P			V		1		4.6E+03	1.6E+01	n	2.0E+02	n					7.3E+00	n		1.5E-03	
~Zinc Cyanide	557-21-1					5.0E-02	I					1			3.9E+03	n	5.1E+04	n					1.8E+03	n			
Cyclohexane	110-82-7							6.0E+00	I	V		1		1.2E+02	7.0E+03	ns	2.9E+04	ns	6.3E+03	n	2.6E+04	n	1.3E+04	n		1.3E+01	
Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	2.3E-02	H									1	0.1		2.1E+01	c	7.5E+01	c					2.9E+00	c		1.7E-02	
Cyclohexanone	108-94-1					5.0E+00	I					1	0.1		3.1E+05	nm	3.1E+06	nm					1.8E+05	n		4.3E+01	
Cyclohexylamine	108-91-8					2.0E-01	I					1	0.1		1.2E+04	n	1.2E+05	nm					7.3E+03	n		1.9E+00	
Cyhalothrin/karate	68085-85-8					5.0E-03	I					1	0.1		3.1E+02	n	3.1E+03	n					1.8E+02	n		1.2E+02	
Cypermethrin	52315-07-8					1.0E-02	I					1	0.1		6.1E+02	n	6.2E+03	n					3.7E+02	n		5.8E+01	
Cyromazine	66215-27-8					7.5E-03	I					1	0.1		4.6E+02	n	4.6E+03	n					2.7E+02	n		7.0E-02	
DDD	72-54-8	2.4E-01	I	6.9E-05	C							1	0.1		2.0E+00	c	7.2E+00	c	3.5E-02	c	1.8E-01	c	2.8E-01	c		6.6E-02	
DDE, p,p'-	72-55-9	3.4E-01	I	9.7E-05	C							1	0.1		1.4E+00	c	5.1E+00	c	2.5E-02	c	1.3E-01	c	2.0E-01	c		4.7E-02	
DDT	50-29-3	3.4E-01	I	9.7E-05	I	5.0E-04	I					1	0.03		1.7E+00	c*	7.0E+00	c*	2.5E-02	c	1.3E-01	c	2.0E-01	c*		6.7E-02	
Dacthal	1861-32-1					1.0E-02	I					1	0.1		6.1E+02	n	6.2E+03	n					3.7E+02	n		4.5E-01	
Dalapon	75-99-0					3.0E-02	I					1	0.1		1.8E+03	n	1.8E+04	n					1.1E+03	n	2.0E+02	2.3E-01	4.1E-02
Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	7.0E-04	I			7.0E-03	I					1	0.1		4.3E+02	n	2.5E+03	c**					9.6E+01	c**		5.3E+01	
Demeton	8065-48-3					4.0E-05	I					1	0.1		2.4E+00	n	2.5E+01	n					1.5E+00	n			
Di(2-ethylhexyl)adipate	103-23-1	1.2E-03	I			6.0E-01	I					1	0.1		4.0E+02	c*	1.4E+03	c					5.6E+01	c	4.0E+02	4.0E+00	2.9E+01
Diallate	2303-16-4	6.1E-02	H									1	0.1		8.0E+00	c	2.8E+01	c					1.1E+00	c		1.6E-03	
Diazinon	333-41-5					7.0E-04	A					1	0.1		4.3E+01	n	4.3E+02	n					2.6E+01	n		1.6E-01	
Dibromo-3-chloropropane, 1,2-	96-12-8	8.0E-01	P	6.0E-03	P	2.0E-04	P	2.0E-04	I	V	M	1		9.8E+02	5.4E-03	c	6.9E-02	c	1.6E-04	c	2.0E-03	c	3.2E-04	c	2.0E-01	1.4E-07	8.6E-05
Dibromobenzene, 1,4-	106-37-6					1.0E-02	I					1	0.1		6.1E+02	n	6.2E+03	n					3.7E+02	n		3.5E-01	
Dibromochloromethane	124-48-1	8.4E-02	I	2.7E-05	C	2.0E-02	I			V		1	0.1	8.0E+02	6.8E-01	c	3.3E+00	c	9.0E-02	c	4.5E-01	c	1.5E-01	c		3.9E-05	
Dibromoethane, 1,2-	106-93-4	2.0E+00	I	6.0E-04	I	9.0E-03	I	9.0E-03	I	V		1		1.3E+03	3.4E-02	c	1.7E-01	c	4.1E-03	c	2.0E-02	c	6.5E-03	c	5.0E-02	1.8E-06	1.4E-05
Dibromomethane (Methylene Bromide)	74-95-3					1.0E-02	H	4.0E-03	X	V		1		2.8E+03	2.5E+01	n	1.1E+02	n	4.2E+00	n	1.8E+01	n	8.2E+00	n		2.0E-03	
Dibutyl Phthalate	84-74-2					1.0E-01	I					1	0.1		6.1E+03	n	8.2E+04	n					3.7E+03	n		9.2E+00	
Dibutyltin Compounds	NA					3.0E-04	P					1	0.1		1.8E+01	n	1.8E+02	n					1.1E+01	n			
Dicamba	1918-00-9					3.0E-02	I					1	0.1		1.8E+03	n	1.8E+04	n					1.1E+03	n		2.8E-01	
Dichloro-2-butene, 1,4-	764-41-0			4.2E-03	P					V		1		5.2E+02	6.5E-03	c	3.3E-02	c	5.8E-04	c	2.9E-03	c	1.2E-03	c		5.4E-07	
Dichloro-2-butene, cis-1,4-	1476-11-5			4.2E-03	P					V		1	0.1	5.2E+02	6.9E-03	c	3.5E-02	c	5.8E-04	c	2.9E-03	c	1.2E-03	c		5.4E-07	
Dichloro-2-butene, trans-1,4-	110-57-6			4.2E-03	P					V		1	0.1	7.6E+02	6.9E-03	c	3.5E-02	c	5.8E-04	c	2.9E-03	c	1.2E-03	c		5.4E-07	
Dichloroacetic Acid	79-43-6	5.0E-02	I			4.0E-03	I					1	0.1		9.7E+00	c*	3.4E+01	c*					1.3E+00	c		2.8E-04	
Dichlorobenzene, 1,2-	95-50-1					9.0E-02	I	2.0E-01	H	V		1		3.8E+02	1.9E+03	ns	9.8E+03	ns	2.1E+02	n	8.8E+02	n	3.7E+02	n	6.0E+02	3.6E-01	5.8E-01
Dichlorobenzene, 1,4-	106-46-7	5.4E-03	C	1.1E-05	C	7.0E-02	A	8.0E-01	I	V		1			2.4E+00	c	1.2E+01	c	2.2E-01	c	1.1E+00	c	4.3E-01	c	7.5E+01	4.1E-04	7.2E-02
Dichlorobenzidine, 3,3'-	91-94-1	4.5E-01	I	3.4E-04	C							1	0.1		1.1E+00	c	3.8E+00	c	7.2E-03	c	3.6E-02	c	1.5E-01	c		9.8E-04	
Dichlorobenzophenone, 4,4'-	90-98-2					9.0E-03	X					1	0.1		5.5E+02	n	5.5E+03	n					3.3E+02	n		2.0E+00	
Dichlorodifluoromethane	75-71-8					2.0E-01	I	2.0E-01	H	V		1		8.5E+02	1.8E+02	n	7.8E+02	n	2.1E+02	n	8.8E+02	n	3.9E+02	n		6.1E-01	
Dichloroethane, 1,1-	75-34-3	5.7E-03	C	1.6E-06	C	2.0E-01	P			V		1		1.7E+03	3.3E+00	c	1.7E+01	c	1.5E+00	c	7.7E+00	c	2.4E+00	c		6.9E-04	
Dichloroethane, 1,2-	107-06-2	9.1E-02	I	2.6E-05	I	2.0E-02	P	2.4E+00	A	V		1		3.0E+03	4.3E-01	c	2.2E+00	c	9.4E-02	c	4.7E-01	c	1.5E-01	c	5.0E+00	4.2E-05	1.4E-03
Dichloroethylene, 1,1-	75-35-4					5.0E-02	I	2.0E-01	I	V		1		1.2E+03	2.4E+02	n	1.1E+03	n	2.1E+02	n	8.8E+02	n	3.4E+02	n	7.0E+00	1.2E-01	2.5E-03
Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0					9.0E-03	H			V		1		1.3E+03	7.0E+02	n	9.2E+03	ns					3.3E+02	n		9.7E-02	
Dichloroethylene, 1,2-cis-	156-59-2					1.0E-02	P			V		1		2.4E+03	7.8E+02	n	1.0E+04	ns					3.7E+02	n	7.0E+01	1.1E-01	2.1E-02
Dichloroethylene, 1,2-trans-	156-60-5					2.0E-02	I	6.0E-02	P	V		1		1.7E+03	1.5E+02	n	6.9E+02	n	6.3E+01	n	2.6E+02	n	1.1E+02	n	1.0E+02	3.1E-02	2.9E-02
Dichlorophenol, 2,4-	120-83-2					3.0E-03	I					1	0.1		1.8E+02	n	1.8E+03	n					1.1E+02	n		1.3E-01	
Dichlorophenoxy Acetic Acid, 2,4-	94-75-7					1.0E-02	I					1	0.05		6.9E+02	n	7.7E+03	n					3.7E+02	n	7.0E+01	9.5E-02	1.8E-02
Dichlorophenoxy)butyric Acid, 4-(2,4-	94-82-6					8.0E-03	I					1	0.1		4.9E+02	n	4.9E+03	n					2.9E+02	n		1.2E-01	
Dichloropropane, 1,2-	78-87-5	3.6E-02	C	1.0E-05	C	9.0E-02	A	4.0E-03	I	V		1		1.4E+03	8.9E-01	c*	4.5E+00	c*	2.4E-01	c*	1.2E+00	c*	3.9E-01	c*	5.0E+00	1.3E-04	1.7E-03
Dichloropropane, 1,3-	142-28-9					2.0E-02	P			V		1		1.5E+03	1.6E+03	ns	2.0E+04	ns					7.3E+02	n		2.5E-01	
Dichloropropanol, 2,3-	616-23-9					3.0E-03	I					1	0.1		1.8E+02	n	1.8E+03	n					1.1E+02	n		2.3E-02	
Dichloropropene, 1,3-	542-75-6	1.0E-01	I	4.0E-06	I	3.0E-02	I	2.0E-02	I	V		1		1.6E+03	1.7E+00	c*	8.1E+00	c*	6.1E-01	c*	3.1E+00	c*	4.3E-01	c*		1.5E-04	
Dichlorvos	62-73-7	2.9E-01	I	8.3E-05	C	5.0E-04	I	5.0E-04	I			1	0.1		1.7E+00	c*	5.9E+00	c*	2.9E-02	c*	1.5E-01	c*	2.3E-01	c*		7.1E-05	
Dicyclopentadiene	77-73-6					8.0E-03	P	7.0E-03	P	V		1		1.3E+02	2.7E+01	n	1.2E+02	n	7.3E+00	n	3.1E+01	n	1.4E+01	n		4.8E-02	
Dieldrin	60-57-1	1.6E+01	I	4.6E-03	I	5.0E-05	I					1	0.1		3.0E-02	c	1.1E-01	c	5.3E-04	c	2.7E-03	c	4.2E-03	c		1.7E-04	
Diesel Engine Exhaust	NA			3.0E-04	C			5.0E-03	I			1	0.1						8.1E-03	c	4.1E-02	c					
Diethanolamine	111-42-2							3.0E-03	C						4.3E+06	nm	1.8E+07	nm	3.1E+00	n	1.3E+01	n					
Diethyl Phthalate	84-66-2					8.0E-01	I					1	0.1		4.9E+04	n	4.9E+05	nm					2.9E+04	n		1.2E+01	
Diethylene Glycol Monobutyl Ether	112-34-5					3.0E-02	P	1.0E-04	P			1	0.1		1.8E+03	n	1.8E+04	n	1.0E-01	n	4.4E-01	n	1.1E+03	n		2.4E-01	
Diethylene Glycol Monoethyl Ether	111-90-0					6.0E-02	P	3.0E-04	P			1	0.1		3.6E+03	n	3.6E+04	n	3.1E-01	n	1.3E+00	n	2.2E+03	n		4.4E-01	
Diethylformamide	617-84-5					1.0E-03	P					1	0.1		6.1E+01	n	6.2E+02	n					3.7E+01	n		7.5E-03	
Diethylstilbestrol	56-53-1	3.5E+02	C	1.0E-01	C							1	0.1		1.4E-03	c	4.9E-03	c	2.4E-05	c	1.2E-04	c	1.9E-04	c		1.1E-04	
Difenzoquat	43222-48-6					8.0E-02	I					1	0.1		4.9E+03	n	4.9E+04	n					2.9E+03	n			
Diflubenzuron	35367-38-5					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		8.2E-01	
Difluoroethane, 1,1-	75-37-6							4.0E+01	I	V		1		1.4E+03	5.2E+04	ns	2.2E+05	nms	4.2E+04	n	1.8E+05	n	8.3E+04	n		2.8E+01	
Dihydrosafrole	94-58-6	4.4E-02	C	1.3E-05	C										1.5E+01	c	6.5E+01	c	1.9E-01	c	9.4E-01	c	1.5E+00	c		1.9E-03	
Diisopropyl Ether	108-20-3							4.0E-01	P	V		1		2.3E+03	1.4E+03	n	5.8E+03	ns	4.2E+02	n	1.8E+03	n	8.3E+02	n		2.1E-01	
Diisopropyl Methylphosphonate	1445-75-6					8.0E-02	I			V		1		5.3E+02	6.3E+03	ns	8.2E+04	ns					2.9E+03	n		8.3E-01	
Dimethipin	55290-64-7					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		1.6E-01	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ #29; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10 c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User's Guide); s = Concentration may exceed Csat (See User's Guide); SSL values are based on DAF=1

Contaminant		Toxicity and Chemical-specific information														Screening Levels												Protection of Groundwater Soil	
		SFO	k e y	IUR	k e y	RfDo	k e y	RfCi	k e y	v o c	muta-gen	GIABS	ABS	Csat	Residential Soil		Industrial Soil		Residential Air		Industrial Air		Tapwater		MCL	Risk-based SSL	MCL-based SSL
Analyte	CAS No.	(mg/kg-day)$^{-1}$		(ug/m^3)$^{-1}$		(mg/kg-day)		(mg/m^3)						mg/kg	mg/kg	key	mg/kg	key	ug/m^3	key	ug/m^3	key	ug/L	key	ug/L	mg/kg	mg/kg
Dimethoate	60-51-5					2.0E-04	I					1	0.1		1.2E+01	n	1.2E+02	n					7.3E+00	n		1.6E-03	
Dimethoxybenzidine, 3,3'-	119-90-4	1.4E-02	H									1	0.1		3.5E+01	c	1.2E+02	c					4.8E+00	c		5.8E-03	
Dimethyl methylphosphonate	756-79-6	1.7E-03	P			6.0E-02	P					1	0.1		2.9E+02	c*	1.0E+03	c*					4.0E+01	c*		8.3E-03	
Dimethylamino azobenzene [p-]	60-11-7	4.6E+00	C	1.3E-03	C							1	0.1		1.1E-01	c	3.7E-01	c	1.9E-03	c	9.4E-03	c	1.5E-02	c		6.2E-05	
Dimethylaniline HCl, 2,4-	21436-96-4	5.8E-01	H									1	0.1		8.4E-01	c	3.0E+00	c					1.2E-01	c		6.6E-05	
Dimethylaniline, 2,4-	95-68-1	7.5E-01	H									1	0.1		6.5E-01	c	2.3E+00	c					9.0E-02	c		5.1E-05	
Dimethylaniline, N,N-	121-69-7					2.0E-03	I			V		1		8.3E+02	1.6E+02	n	2.0E+03	ns					7.3E+01	n		2.6E-02	
Dimethylbenzidine, 3,3'-	119-93-7	1.1E+01	P									1	0.1		4.4E-02	c	1.6E-01	c					6.1E-03	c		4.0E-05	
Dimethylformamide	68-12-2					1.0E-01	P	3.0E-02	I			1	0.1		6.1E+03	n	6.2E+04	n	3.1E+01	n	1.3E+02	n	3.7E+03	n		7.4E-01	
Dimethylhydrazine, 1,1-	57-14-7					1.0E-04	X	2.0E-06	X			1	0.1		6.1E+00	n	6.1E+01	n	2.1E-03	n	8.8E-03	n	3.7E+00	n		8.2E-04	
Dimethylhydrazine, 1,2-	540-73-8	5.5E+02	C	1.6E-01	C							1	0.1		8.8E-04	c	3.1E-03	c	1.5E-05	c	7.7E-05	c	1.2E-04	c		2.6E-08	
Dimethylphenol, 2,4-	105-67-9					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		8.6E-01	
Dimethylphenol, 2,6-	576-26-1					6.0E-04	I					1	0.1		3.7E+01	n	3.7E+02	n					2.2E+01	n		2.6E-02	
Dimethylphenol, 3,4-	95-65-8					1.0E-03	I					1	0.1		6.1E+01	n	6.2E+02	n					3.7E+01	n		4.3E-02	
Dimethylterephthalate	120-61-6					1.0E-01	I			V		1		5.5E+00	7.8E+03	ns	1.0E+05	nms					3.7E+03	n		9.6E-01	
Dimethylvinylchloride	513-37-1	4.5E-02	C	1.3E-05	C										1.4E+01	c	6.4E+01	c	1.9E-01	c	9.4E-01	c	1.5E+00	c		9.2E-04	
Dinitro-o-cresol, 4,6-	534-52-1					1.0E-04	P					1	0.1		6.1E+00	n	6.2E+01	n					3.7E+00	n		6.2E-03	
Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5					2.0E-03	I					1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		2.4E+00	
Dinitrobenzene, 1,2-	528-29-0					1.0E-04	P					1	0.1		6.1E+00	n	6.2E+01	n					3.7E+00	n		3.3E-03	
Dinitrobenzene, 1,3-	99-65-0					1.0E-04	I					1	0.1		6.1E+00	n	6.2E+01	n					3.7E+00	n		3.3E-03	
Dinitrobenzene, 1,4-	100-25-4					1.0E-04	P					1	0.1		6.1E+00	n	6.2E+01	n					3.7E+00	n		3.3E-03	
Dinitrophenol, 2,4-	51-28-5					2.0E-03	I					1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		8.2E-02	
Dinitrotoluene Mixture, 2,4/2,6-	25321-14-6	6.8E-01	I									1	0.1		7.1E-01	c	2.5E+00	c					9.9E-02	c		1.4E-04	
Dinitrotoluene, 2,4-	121-14-2	3.1E-01	C	8.9E-05	C	2.0E-03	I					1	0.102		1.6E+00	c*	5.5E+00	c	2.7E-02	c	1.4E-01	c	2.2E-01	c		2.9E-04	
Dinitrotoluene, 2,6-	606-20-2					1.0E-03	P					1	0.099		6.1E+01	n	6.2E+02	n					3.7E+01	n		5.0E-02	
Dinitrotoluene, 2-Amino-4,6-	35572-78-2					2.0E-03	S					1	0.006		1.5E+02	n	2.0E+03	n					7.3E+01	n		5.6E-02	
Dinitrotoluene, 4-Amino-2,6-	19406-51-0					2.0E-03	S					1	0.009		1.5E+02	n	1.9E+03	n					7.3E+01	n		5.6E-02	
Dinoseb	88-85-7					1.0E-03	I					1	0.1		6.1E+01	n	6.2E+02	n					3.7E+01	n	7.0E+00	3.2E-01	6.2E-02
Dioxane, 1,4-	123-91-1	1.1E-02	I	7.7E-06	C	1.0E-01	A	3.6E+00	A			1	0.1		4.4E+01	c	1.8E+02	c	3.2E-01	c	1.6E+00	c	6.1E+00	c		1.3E-03	
Dioxins																													
~Hexachlorodibenzo-p-dioxin, Mixture	NA	6.2E+03	I	1.3E+00	I							1	0.03		9.4E-05	c	3.9E-04	c	1.9E-06	c	9.4E-06	c	1.1E-05	c		9.0E-06	
~TCDD, 2,3,7,8-	1746-01-6	1.3E+05	C	3.8E+01	C	1.0E-09	A	4.0E-08	C			1	0.03		4.5E-06	c*	1.8E-05	c*	6.4E-08	c	3.2E-07	c	5.2E-07	c*	3.0E-05	2.6E-07	1.5E-05
Diphenamid	957-51-7					3.0E-02	I					1	0.1		1.8E+03	n	1.8E+04	n					1.1E+03	n		1.1E+01	
Diphenyl Sulfone	127-63-9					8.0E-04	X					1	0.1		4.9E+01	n	4.9E+02	n					2.9E+01	n		7.1E-02	
Diphenylamine	122-39-4					2.5E-02	I					1	0.1		1.5E+03	n	1.5E+04	n					9.1E+02	n		1.7E+00	
Diphenylhydrazine, 1,2-	122-66-7	8.0E-01	I	2.2E-04	I							1	0.1		6.1E-01	c	2.2E+00	c	1.1E-02	c	5.6E-02	c	8.4E-02	c		2.7E-04	
Diquat	85-00-7					2.2E-03	I					1	0.1		1.3E+02	n	1.4E+03	n					8.0E+01	n	2.0E+01	1.5E+00	3.7E-01
Direct Black 38	1937-37-7	7.4E+00	C	2.1E-03	C							1	0.1		6.6E-02	c	2.3E-01	c	1.2E-03	c	5.8E-03	c	9.1E-03	c		4.4E+00	
Direct Blue 6	2602-46-2	7.4E+00	C	2.1E-03	C							1	0.1		6.6E-02	c	2.3E-01	c	1.2E-03	c	5.8E-03	c	9.1E-03	c		1.4E+01	
Direct Brown 95	16071-86-6	6.7E+00	C	1.9E-03	C							1	0.1		7.2E-02	c	2.6E-01	c	1.3E-03	c	6.5E-03	c	1.0E-02	c			
Disulfoton	298-04-4					4.0E-05	I					1	0.1		2.4E+00	n	2.5E+01	n					1.5E+00	n		2.7E-03	
Dithiane, 1,4-	505-29-3					1.0E-02	I					1	0.1		6.1E+02	n	6.2E+03	n					3.7E+02	n		1.6E-01	
Diuron	330-54-1					2.0E-03	I					1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		3.1E-02	
Dodine	2439-10-3					4.0E-03	I					1	0.1		2.4E+02	n	2.5E+03	n					1.5E+02	n		7.5E-01	
EPTC	759-94-4					2.5E-02	I			V		1		4.1E+02	2.0E+03	ns	2.6E+04	ns					9.1E+02	n		4.8E-01	
Endosulfan	115-29-7					6.0E-03	I					1	0.1		3.7E+02	n	3.7E+03	n					2.2E+02	n		3.0E+00	
Endothall	145-73-3					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n	1.0E+02	1.7E-01	2.4E-02
Endrin	72-20-8					3.0E-04	I					1	0.1		1.8E+01	n	1.8E+02	n					1.1E+01	n	2.0E+00	4.4E-01	8.1E-02
Epichlorohydrin	106-89-8	9.9E-03	I	1.2E-06	I	6.0E-03	P	1.0E-03	I	V		1		1.1E+04	2.0E+01	n	8.8E+01	n	1.0E+00	n	4.4E+00	n	2.1E+00	n		4.5E-04	
Epoxybutane, 1,2-	106-88-7							2.0E-02	I	V		1		1.5E+04	1.7E+02	n	7.2E+02	n	2.1E+01	n	8.8E+01	n	4.2E+01	n		9.2E-03	
Ethephon	16672-87-0					5.0E-03	I					1	0.1		3.1E+02	n	3.1E+03	n					1.8E+02	n		3.8E-02	
Ethion	563-12-2					5.0E-04	I					1	0.1		3.1E+01	n	3.1E+02	n					1.8E+01	n		3.6E-02	
Ethoxyethanol Acetate, 2-	111-15-9					3.0E-01	H	3.0E-01	C			1	0.1		1.8E+04	n	1.8E+05	nm	3.1E+02	n	1.3E+03	n	1.1E+04	n		2.3E+00	
Ethoxyethanol, 2-	110-80-5					4.0E-01	H	2.0E-01	I			1	0.1		2.4E+04	n	2.5E+05	nm	2.1E+02	n	8.8E+02	n	1.5E+04	n		2.9E+00	
Ethyl Acetate	141-78-6					9.0E-01	I			V		1		1.1E+04	7.0E+04	ns	9.2E+05	nms					3.3E+04	n		7.0E+00	
Ethyl Acrylate	140-88-5	4.8E-02	H							V		1		2.5E+03	1.3E+01	c	8.0E+01	c					1.4E+00	c		3.1E-04	
Ethyl Chloride	75-00-3							1.0E+01	I	V		1		2.1E+03	1.5E+04	ns	6.1E+04	ns	1.0E+04	n	4.4E+04	n	2.1E+04	n		5.9E+00	
Ethyl Ether	60-29-7					2.0E-01	I			V		1		1.0E+04	1.6E+04	ns	2.0E+05	nms					7.3E+03	n		1.6E+00	
Ethyl Methacrylate	97-63-2					9.0E-02	H			V		1		1.1E+03	7.0E+03	ns	9.2E+04	ns					3.3E+03	n		7.7E-01	
Ethyl-p-nitrophenyl Phosphonate	2104-64-5					1.0E-05	I					1	0.1		6.1E-01	n	6.2E+00	n					3.7E-01	n		1.1E-02	
Ethylbenzene	100-41-4	1.1E-02	C	2.5E-06	C	1.0E-01	I	1.0E+00	I	V		1		4.8E+02	5.4E+00	c	2.7E+01	c	9.7E-01	c	4.9E+00	c	1.5E+00	c	7.0E+02	1.7E-03	7.8E-01
Ethylene Cyanohydrin	109-78-4					3.0E-02	P					1	0.1		1.8E+03	n	1.8E+04	n					1.1E+03	n		2.2E-01	
Ethylene Diamine	107-15-3					9.0E-02	P					1	0.1		5.5E+03	n	5.5E+04	n					3.3E+03	n		7.5E-01	
Ethylene Glycol	107-21-1					2.0E+00	I	4.0E-01	C			1	0.1		1.2E+05	nm	1.2E+06	nm	4.2E+02	n	1.8E+03	n	7.3E+04	n		1.5E+01	
Ethylene Glycol Monobutyl Ether	111-76-2					5.0E-01	I	1.3E+01	I			1	0.1		3.1E+04	n	3.1E+05	nm	1.4E+04	n	5.7E+04	n	1.8E+04	n		3.8E+00	
Ethylene Oxide	75-21-8	3.1E-01	C	8.8E-05	C			3.0E-02	C	V		1		1.2E+05	1.7E-01	c	8.3E-01	c	2.8E-02	c	1.4E-01	c	4.4E-02	c		9.1E-06	
Ethylene Thiourea	96-45-7	4.5E-02	C	1.3E-05	C	8.0E-05	I					1	0.1		4.9E+00	n	3.8E+01	c**	1.9E-01	c	9.4E-01	c	1.5E+00	c**		3.4E-04	
Ethyleneimine	151-56-4	6.5E+01	C	1.9E-02	C										9.8E-03	c	4.4E-02	c	1.3E-04	c	6.5E-04	c	1.0E-03	c		2.3E-07	
Ethylphthalyl Ethyl Glycolate	84-72-0					3.0E+00	I					1	0.1		1.8E+05	nm	1.8E+06	nm					1.1E+05	n		2.5E+02	
Express	101200-48-0					8.0E-03	I					1	0.1		4.9E+02	n	4.9E+03	n					2.9E+02	n		1.1E-01	
Fenamiphos	22224-92-6					2.5E-04	I					1	0.1		1.5E+01	n	1.5E+02	n					9.1E+00	n		9.1E-03	
Fenpropathrin	39515-41-8					2.5E-02	I					1	0.1		1.5E+03	n	1.5E+04	n					9.1E+02	n		4.1E+01	
Fluometuron	2164-17-2					1.3E-02	I					1	0.1		7.9E+02	n	8.0E+03	n					4.7E+02	n		3.7E-01	
Fluoride	16984-48-8					4.0E-02	C	1.3E-02	C						3.1E+03	n	4.1E+04	n	1.4E+01	n	5.7E+01	n	1.5E+03	n			
Fluorine (Soluble Fluoride)	7782-41-4					6.0E-02	I	1.3E-02	C			1			4.7E+03	n	6.1E+04	n	1.4E+01	n	5.7E+01	n	2.2E+03	n	4.0E+03	3.3E+02	6.0E+02
Fluridone	59756-60-4					8.0E-02	I					1	0.1		4.9E+03	n	4.9E+04	n					2.9E+03	n		3.3E+02	
Flurprimidol	56425-91-3					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		3.3E+00	
Flutolanil	66332-96-5					6.0E-02	I					1	0.1		3.7E+03	n	3.7E+04	n					2.2E+03	n		1.2E+01	
Fluvalinate	69409-94-5					1.0E-02	I					1	0.1		6.1E+02	n	6.2E+03	n					3.7E+02	n		5.3E+02	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ #29; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User's Guide); s = Concentration may exceed Csat (See User's Guide); SSL values are based on DAF=1

Contaminant		Toxicity and Chemical-specific Information													Screening Levels											Protection of Groundwater Soil	
		SFO	k e y	IUR	k e y	RfDo	k e y	RfCi	k e y	v o c	muta-gen	GIABS	ABS	Csat	Residential Soil		Industrial Soil		Residential Air		Industrial Air		Tapwater		MCL	Risk-based SSL	MCL-based SSL
Analyte	CAS No.	(mg/kg-day)$^{-1}$		(ug/m^3)$^{-1}$		(mg/kg-day)		(mg/m^3)						mg/kg	mg/kg	key	mg/kg	key	ug/m^3	key	ug/m^3	key	ug/L	key	ug/L	mg/kg	mg/kg
Folpet	133-07-3	3.5E-03	I			1.0E-01	I					1	0.1		1.4E+02	c*	4.9E+02	c					1.9E+01	c		4.5E-03	
Fomesafen	72178-02-0	1.9E-01	I									1	0.1		2.6E+00	c	9.1E+00	c					3.5E-01	c		1.2E-03	
Fonofos	944-22-9					2.0E-03	I					1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		1.4E-01	
Formaldehyde	50-00-0			1.3E-05	I	2.0E-01	I	9.8E-03	A			1	0.1		1.2E+04	n	1.2E+05	nm	1.9E-01	c*	9.4E-01	c*	7.3E+03	n		1.5E+00	
Formic Acid	64-18-6					2.0E+00	H	3.0E-03	P			1	0.1		1.2E+05	nm	1.2E+06	nm	3.1E+00	n	1.3E+01	n	7.3E+04	n		1.5E+01	
Fosetyl-AL	39148-24-8					3.0E+00	I					1	0.1		1.8E+05	nm	1.8E+06	nm					1.1E+05	n			
Furans																											
~Dibenzofuran	132-64-9					1.0E-03	X			V		1		1.7E+02	7.8E+01	n	1.0E+03	ns					3.7E+01	n		6.8E-01	
~Furan	110-00-9					1.0E-03	I			V		1		6.2E+03	7.8E+01	n	1.0E+03	n					3.7E+01	n		1.4E-02	
Furazolidone	67-45-8	3.8E+00	H									1	0.1		1.3E-01	c	4.5E-01	c					1.8E-02	c		3.4E-05	
Furfural	98-01-1					3.0E-03	I	5.0E-02	H			1	0.1		1.8E+02	n	1.8E+03	n	5.2E+01	n	2.2E+02	n	1.1E+02	n		2.3E-02	
Furium	531-82-8	1.5E+00	C	4.3E-04	C							1	0.1		3.2E-01	c	1.1E+00	c	5.7E-03	c	2.9E-02	c	4.5E-02	c		6.1E-05	
Furmecyclox	60568-05-0	3.0E-02	I	8.6E-06	C							1	0.1		1.6E+01	c	5.7E+01	c	2.8E-01	c	1.4E+00	c	2.2E+00	c		2.4E-03	
Glufosinate, Ammonium	77182-82-2					4.0E-04	I					1	0.1		2.4E+01	n	2.5E+02	n					1.5E+01	n		3.2E-03	
Glutaraldehyde	111-30-8							8.0E-05	C						1.1E+05	nm	4.8E+05	nm	8.3E-02	n	3.5E-01	n					
Glycidyl	765-34-4					4.0E-04	I	1.0E-03	H			1	0.1		2.4E+01	n	2.5E+02	n	1.0E+00	n	4.4E+00	n	1.5E+01	n		2.9E-03	
Glyphosate	1071-83-6					1.0E-01	I					1	0.1		6.1E+03	n	6.2E+04	n					3.7E+03	n	7.0E+02	7.4E-01	1.4E-01
Goal	42874-03-3					3.0E-03	I					1	0.1		1.8E+02	n	1.8E+03	n					1.1E+02	n		8.8E+00	
Guthion	86-50-0					3.0E-03	A	1.0E-02	A			1	0.1		1.8E+02	n	1.8E+03	n	1.0E+01	n	4.4E+01	n	1.1E+02	n		3.3E-02	
Haloxyfop, Methyl	69806-40-2					5.0E-05	I					1	0.1		3.1E+00	n	3.1E+01	n					1.8E+00	n		2.0E-02	
Harmony	79277-27-3					1.3E-02	I					1	0.1		7.9E+02	n	8.0E+03	n					4.7E+02	n		1.4E-01	
Heptachlor	76-44-8	4.5E+00	I	1.3E-03	I	5.0E-04	I					1	0.1		1.1E-01	c	3.8E-01	c	1.9E-03	c	9.4E-03	c	1.5E-02	c	4.0E-01	1.2E-03	3.3E-02
Heptachlor Epoxide	1024-57-3	9.1E+00	I	2.6E-03	I	1.3E-05	I					1	0.1		5.3E-02	c*	1.9E-01	c*	9.4E-04	c	4.7E-03	c	7.4E-03	c*	2.0E-01	1.5E-04	4.1E-03
Hexabromobenzene	87-82-1					2.0E-03	I					1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		4.2E-01	
Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2					2.0E-04	I								1.6E+01	n	2.0E+02	n					7.3E+00	n			
Hexachlorobenzene	118-74-1	1.6E+00	I	4.6E-04	I	8.0E-04	I					1	0.1		3.0E-01	c	1.1E+00	c	5.3E-03	c	2.7E-02	c	4.2E-02	c	1.0E+00	5.3E-04	1.3E-02
Hexachlorobutadiene	87-68-3	7.8E-02	I	2.2E-05	I	1.0E-03	P					1	0.1		6.2E+00	c**	2.2E+01	c*	1.1E-01	c	5.6E-01	c	8.6E-01	c*		1.7E-03	
Hexachlorocyclohexane, Alpha-	319-84-6	6.3E+00	I	1.8E-03	I	8.0E-03	A					1	0.1		7.7E-02	c	2.7E-01	c	1.4E-03	c	6.8E-03	c	1.1E-02	c		6.2E-05	
Hexachlorocyclohexane, Beta-	319-85-7	1.8E+00	I	5.3E-04	I							1	0.1		2.7E-01	c	9.6E-01	c	4.6E-03	c	2.3E-02	c	3.7E-02	c		2.2E-04	
Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	1.1E+00	C	3.1E-04	C	3.0E-04	I					1	0.04		5.2E-01	c*	2.1E+00	c	7.8E-03	c	4.0E-02	c	6.1E-02	c	2.0E-01	3.6E-04	1.2E-03
Hexachlorocyclohexane, Technical	608-73-1	1.8E+00	I	5.1E-04	I							1	0.1		2.7E-01	c	9.6E-01	c	4.8E-03	c	2.4E-02	c	3.7E-02	c		2.2E-04	
Hexachlorocyclopentadiene	77-47-4					6.0E-03	I	2.0E-04	I			1	0.1		3.7E+02	n	3.7E+03	n	2.1E-01	n	8.8E-01	n	2.2E+02	n	5.0E+01	6.8E-01	1.6E-01
Hexachloroethane	67-72-1	1.4E-02	I	4.0E-06	I	1.0E-03	I					1	0.1		3.5E+01	c**	1.2E+02	c**	6.1E-01	c	3.1E+00	c	4.8E+00	c**		2.9E-03	
Hexachlorophene	70-30-4					3.0E-04	I					1	0.1		1.8E+01	n	1.8E+02	n					1.1E+01	n		1.5E+01	
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	1.1E-01	I			3.0E-03	I					1	0.015		5.5E+00	c*	2.4E+01	c					6.1E-01	c		2.3E-04	
Hexamethylene Diisocyanate, 1,6-	822-06-0							1.0E-05	I	V		1		5.2E+03	3.4E+00	n	1.4E+01	n	1.0E-02	n	4.4E-02	n	2.1E-02	n		2.1E-04	
Hexane, N-	110-54-3					6.0E-02	H	7.0E-01	I	V		1		1.4E+02	5.7E+02	ns	2.6E+03	ns	7.3E+02	n	3.1E+03	n	8.8E+02	n		6.2E+00	
Hexanedioic Acid	124-04-9					2.0E+00	P					1	0.1		1.2E+05	nm	1.2E+06	nm					7.3E+04	n		1.6E+01	
Hexanone, 2-	591-78-6					5.0E-03	I	3.0E-02	I	V		1		3.3E+03	2.1E+02	n	1.4E+03	n	3.1E+01	n	1.3E+02	n	4.7E+01	n		1.1E-02	
Hexazinone	51235-04-2					3.3E-02	I					1	0.1		2.0E+03	n	2.0E+04	n					1.2E+03	n		5.5E-01	
Hydrazine	302-01-2	3.0E+00	I	4.9E-03	I			3.0E-05	P			1			2.1E-01	c	9.5E-01	c	5.0E-04	c*	2.5E-03	c*	2.2E-02	c			
Hydrazine Sulfate	10034-93-2	3.0E+00	I	4.9E-03	I							1			2.1E-01	c	9.5E-01	c	5.0E-04	c	2.5E-03	c	2.2E-02	c			
Hydrogen Chloride	7647-01-0							2.0E-02	I			1			2.8E+07	nm	1.2E+08	nm	2.1E+01	n	8.8E+01	n					
Hydrogen Fluoride	7664-39-3					4.0E-02	C	1.4E-02	C			1			3.1E+03	n	4.1E+04	n	1.5E+01	n	6.1E+01	n	1.5E+03	n			
Hydrogen Sulfide	7783-06-4							2.0E-03	I			1			2.8E+06	nm	1.2E+07	nm	2.1E+00	n	8.8E+00	n					
Hydroquinone	123-31-9	6.0E-02	P			4.0E-02	P					1	0.1		8.1E+00	c	2.9E+01	c					1.1E+00	c		7.6E-04	
Imazalil	35554-44-0					1.3E-02	I					1	0.1		7.9E+02	n	8.0E+03	n					4.7E+02	n		8.2E+00	
Imazaquin	81335-37-7					2.5E-01	I					1	0.1		1.5E+04	n	1.5E+05	nm					9.1E+03	n		4.5E+01	
Iodine	7553-56-2					1.0E-02	A								7.8E+02	n	1.0E+04	n					3.7E+02	n			
Iprodione	36734-19-7					4.0E-02	I					1	0.1		2.4E+03	n	2.5E+04	n					1.5E+03	n		4.5E-01	
Iron	7439-89-6					7.0E-01	P					1			5.5E+04	n	7.2E+05	nm					2.6E+04	n		6.4E+02	
Isobutyl Alcohol	78-83-1					3.0E-01	I			V		1		1.0E+04	2.3E+04	ns	3.1E+05	nms					1.1E+04	n		2.3E+00	
Isophorone	78-59-1	9.5E-04	I			2.0E-01	I	2.0E+00	C			1	0.1		5.1E+02	c*	1.8E+03	c*	2.1E+03	n	8.8E+03	n	7.1E+01	c		2.3E-02	
Isopropalin	33820-53-0					1.5E-02	I					1	0.1		9.2E+02	n	9.2E+03	n					5.5E+02	n		1.3E+01	
Isopropanol	67-63-0							7.0E+00	C			1	0.1		9.9E+09	nm	4.2E+10	nm	7.3E+03	n	3.1E+04	n					
Isopropyl Methyl Phosphonic Acid	1832-54-8					1.0E-01	I					1	0.1		6.1E+03	n	6.2E+04	n					3.7E+03	n		7.9E-01	
Isoxaben	82558-50-7					5.0E-02	I					1	0.1		3.1E+03	n	3.1E+04	n					1.8E+03	n		5.0E+00	
JP-7	NA							3.0E-01	A	V		1			4.3E+08	nm	1.8E+09	nm	3.1E+02	n	1.3E+03	n	6.3E+02	n			
Kerb	23950-58-5					7.5E-02	I					1	0.1		4.6E+03	n	4.6E+04	n					2.7E+03	n		2.8E+00	
Lactofen	77501-63-4					2.0E-03	I					1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		3.4E+00	
Lead Compounds																											
~Lead and Compounds	7439-92-1											1			4.0E+02	nL	8.0E+02	nL							1.5E+01		1.4E+01
~Tetraethyl Lead	78-00-2					1.0E-07	I					1	0.1		6.1E-03	n	6.2E-02	n					3.7E-03	n		1.3E-05	
Lead acetate	301-04-2	2.8E-01	C	8.0E-05	C										2.3E+00	c	1.0E+01	c	3.0E-02	c	1.5E-01	c	2.4E-01	c			
Lead subacetate	1335-32-6	3.8E-02	C	1.1E-05	C										1.7E+01	c	7.5E+01	c	2.2E-01	c	1.1E+00	c	1.8E+00	c			
Linuron	330-55-2					2.0E-03	I					1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		6.4E-02	
Lithium	7439-93-2					2.0E-03	P					1			1.6E+02	n	2.0E+03	n					7.3E+01	n		2.2E+01	
Lithium Perchlorate	7791-03-9					7.0E-04	I					1			5.5E+01	n	7.2E+02	n					2.6E+01	n			
Londax	83055-99-6					2.0E-01	I					1	0.1		1.2E+04	n	1.2E+05	nm					7.3E+03	n		1.9E+00	
MCPA	94-74-6					5.0E-04	I					1	0.1		3.1E+01	n	3.1E+02	n					1.8E+01	n		4.7E-03	
MCPB	94-81-5					1.0E-02	I					1	0.1		6.1E+02	n	6.2E+03	n					3.7E+02	n		1.4E-01	
MCPP	93-65-2					1.0E-03	I					1	0.1		6.1E+01	n	6.2E+02	n					3.7E+01	n		1.1E-02	
Malathion	121-75-5					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		1.9E-01	
Maleic Anhydride	108-31-6					1.0E-01	I	7.0E-04	C			1	0.1		6.1E+03	n	6.1E+04	n	7.3E-01	n	3.1E+00	n	3.7E+03	n		7.4E-01	
Maleic Hydrazide	123-33-1					5.0E-01	I					1	0.1		3.1E+04	n	3.1E+05	nm					1.8E+04	n		3.8E+00	
Malononitrile	109-77-3					1.0E-04	P					1	0.1		6.1E+00	n	6.2E+01	n					3.7E+00	n		7.5E-04	
Mancozeb	8018-01-7					3.0E-02	H					1	0.1		1.8E+03	n	1.8E+04	n					1.1E+03	n		1.5E+00	
Maneb	12427-38-2					5.0E-03	I					1	0.1		3.1E+02	n	3.1E+03	n					1.8E+02	n		2.6E-01	
Manganese (Diet)	7439-96-5					1.4E-01	I	5.0E-05	I			1															

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ #29; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10 c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User's Guide); s = Concentration may exceed Csat (See User's Guide); SSL values are based on DAF=1

Contaminant		Toxicity and Chemical-specific Information														Screening Levels												Protection of Groundwater Soil	
		SFO	k e y	IUR	k e y	RfDo	k e y	RfCi	k e y	muta-gen	GIABS	ABS	Csat	Residential Soil		Industrial Soil		Residential Air		Industrial Air		Tapwater		MCL	Risk-based SSL	MCL-based SSL
Analyte	CAS No.	(mg/kg-day)$^{-1}$		(ug/m^3)$^{-1}$		(mg/kg-day)		(mg/m^3)					mg/kg	mg/kg	key	mg/kg	key	ug/m^3	key	ug/m^3	key	ug/L	key	ug/L	mg/kg	mg/kg
Manganese (Water)	7439-96-5					2.4E-02	I	5.0E-05	I		0.04			1.8E+03	n	2.3E+04	n	5.2E-02	n	2.2E-01	n	8.8E+02	n		5.7E+01	
Mephosfolan	950-10-7					9.0E-05	H				1	0.1		5.5E+00	n	5.5E+01	n					3.3E+00	n		4.8E-03	
Mepiquat Chloride	24307-26-4					3.0E-02	I				1	0.1		1.8E+03	n	1.8E+04	n					1.1E+03	n		3.6E-01	
Mercury Compounds																													
~Mercuric Chloride	7487-94-7					3.0E-04	I	3.0E-05	C		0.07			2.3E+01	n	3.1E+02	n	3.1E-02	n	1.3E-01	n	1.1E+01	n			
~Mercuric Sulfide	1344-48-5					3.0E-04	S				1			2.3E+01	n	3.1E+02	n					1.1E+01	n			
~Mercury (elemental)	7439-97-6					1.6E-04	C	3.0E-04	I	V	1		3.1E+00	5.6E+00	ns	3.4E+01	ns	3.1E-01	n	1.3E+00	n	5.7E-01	n	2.0E+00	3.0E-02	1.0E-01
~Mercury, Inorganic Salts	NA					3.0E-04	S				0.07			2.3E+01	n	3.1E+02	n					1.1E+01	n		5.7E-01	
~Methyl Mercury	22967-92-6					1.0E-04	I				1			7.8E+00	n	1.0E+02	n					3.7E+00	n			
~Phenylmercuric Acetate	62-38-4					8.0E-05	I				1	0.1		4.9E+00	n	4.9E+01	n					2.9E+00	n		9.1E-04	
Merphos	150-50-5					3.0E-05	I				1	0.1		1.8E+00	n	1.8E+01	n					1.1E+00	n		1.1E-01	
Merphos Oxide	78-48-8					3.0E-05	I				1	0.1		1.8E+00	n	1.8E+01	n					1.1E+00	n		5.4E-03	
Metalaxyl	57837-19-1					8.0E-02	I				1	0.1		3.7E+03	n	3.7E+04	n					2.2E+03	n		6.1E-01	
Methacrylonitrile	126-98-7					1.0E-04	I	7.0E-04	H	V	1		4.6E+03	3.2E+00	n	1.6E+01	n	7.3E-01	n	3.1E+00	n	1.0E+00	n		2.4E-04	
Methamidophos	10265-92-6					5.0E-05	I				1	0.1		3.1E+00	n	3.1E+01	n					1.8E+00	n		3.8E-04	
Methanol	67-56-1					5.0E-01	I	4.0E+00	C		1	0.1		3.1E+04	n	3.1E+05	nm	4.2E+03	n	1.8E+04	n	1.8E+04	n		3.7E+00	
Methidathion	950-37-8					1.0E-03	I				1	0.1		6.1E+01	n	6.2E+02	n					3.7E+01	n		8.9E-03	
Methomyl	16752-77-5					2.5E-02	I				1	0.1		1.5E+03	n	1.5E+04	n					9.1E+02	n		2.0E-01	
Methoxy-5-nitroaniline, 2-	99-59-2	4.9E-02	C	1.4E-05	C						1	0.1		9.9E+00	c	3.5E+01	c	1.7E-01	c	8.8E-01	c	1.4E+00	c		4.7E-04	
Methoxychlor	72-43-5					5.0E-03	I				1	0.1		3.1E+02	n	3.1E+03	n					1.8E+02	n	4.0E+01	9.9E+00	2.2E+00
Methoxyethanol Acetate, 2-	110-49-6					2.0E-03	H	9.0E-02	C		1	0.1		1.2E+02	n	1.2E+03	n	9.4E+01	n	3.9E+02	n	7.3E+01	n		1.5E-02	
Methoxyethanol, 2-	109-86-4					3.0E-03	P	2.0E-02	I		1	0.1		1.8E+02	n	1.8E+03	n	2.1E+01	n	8.8E+01	n	1.1E+02	n		2.2E-02	
Methyl Acetate	79-20-9					1.0E+00	H			V	1		2.9E+04	7.8E+04	ns	1.0E+06	nms					3.7E+04	n		7.5E+00	
Methyl Acrylate	96-33-3					3.0E-02	H			V	1		6.8E+03	2.3E+03	n	3.1E+04	ns					1.1E+03	n		2.3E-01	
Methyl Ethyl Ketone (2-Butanone)	78-93-3					6.0E-01	I	5.0E+00	I	V	1		2.8E+04	2.8E+04	n	2.0E+05	nms	5.2E+03	n	2.2E+04	n	7.1E+03	n		1.5E+00	
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1					8.0E-02	H	3.0E+00	I	V	1		3.4E+03	5.3E+03	ns	5.3E+04	ns	3.1E+03	n	1.3E+04	n	2.0E+03	n		4.5E-01	
Methyl Isocyanate	624-83-9							1.0E-03	C					1.4E+05	nm	6.0E+06	nm	1.0E+00	n	4.4E+00	n						
Methyl Methacrylate	80-62-6					1.4E+00	I	7.0E-01	I	V	1		2.4E+03	4.8E+03	ns	2.1E+04	ns	7.3E+02	n	3.1E+03	n	1.4E+03	n		3.1E-01	
Methyl Parathion	298-00-0					2.5E-04	I				1	0.1		1.5E+01	n	1.5E+02	n					9.1E+00	n		1.5E-02	
Methyl Phosphonic Acid	993-13-5					6.0E-02	X				1	0.1		3.7E+03	n	3.7E+04	n					2.2E+03	n		4.4E-01	
Methyl Styrene (Mixed Isomers)	25013-15-4					6.0E-03	H	4.0E-02	H	V	1		3.8E+02	2.5E+02	n	1.6E+03	ns	4.2E+01	n	1.8E+02	n	6.0E+01	n		9.7E-02	
Methyl methanesulfonate	66-27-3	9.9E-02	C	2.8E-05	C						1	0.1		4.9E+00	c	1.7E+01	c	8.7E-02	c	4.4E-01	c	6.8E-01	c		1.4E-04	
Methyl tert-Butyl Ether (MTBE)	1634-04-4	1.8E-03	C	2.6E-07	C			3.0E+00	I	V	1		8.9E+03	4.3E+01	c	2.2E+02	c	9.4E+00	c	4.7E+01	c	1.2E+01	c		2.8E-03	
Methyl-5-Nitroaniline, 2-	99-55-8	3.3E-02	H								1	0.1		1.5E+01	c	5.2E+01	c					2.0E+00	c		1.1E-03	
Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	8.3E+00	C	2.4E-03	C									7.7E-02	c	3.4E-01	c	1.0E-03	c	5.1E-03	c	8.1E-03	c		2.8E-06	
Methylaniline Hydrochloride, 2-	636-21-5	1.3E-01	C	3.7E-05	C						1	0.1		3.7E+00	c	1.3E+01	c	6.6E-02	c	3.3E-01	c	5.2E-01	c		2.2E-04	
Methylarsonic acid	124-58-3					1.0E-02	A				1	0.1		6.1E+02	n	6.2E+03	n					3.7E+02	n			
Methylcholanthrene, 3-	56-49-5	2.2E+01	C	6.3E-03	C						1	0.1		2.2E-02	c	7.8E-02	c	3.9E-04	c	1.9E-03	c	3.1E-03	c		5.9E-03	
Methylene Chloride	75-09-2	7.5E-03	I	4.7E-07	I	6.0E-02	I	1.0E+00	A	V	1		3.3E+03	1.1E+01	c	5.3E+01	c	5.2E+00	c	2.6E+01	c	4.8E+00	c	5.0E+00	1.2E-03	1.3E-03
Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	1.0E-01	P	4.3E-04	C	2.0E-03	P			M	1	0.1		1.2E+00	c	1.7E+01	c*	2.2E-03	c	2.9E-02	c	2.2E-01	c		2.5E-03	
Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	4.6E-02	I	1.3E-05	C						1	0.1		1.1E+01	c	3.7E+01	c	1.9E-01	c	9.4E-01	c	1.5E+00	c		8.1E-03	
Methylenebisbenzenamine, 4,4'-	101-77-9	1.6E+00	C	4.6E-04	C			2.0E-02	C		1	0.1		3.0E-01	c	1.1E+00	c	5.3E-03	c	2.7E-02	c	4.2E-02	c		1.9E-04	
Methylenediphenyl Diisocyanate	101-68-8							6.0E-04	I		1	0.1		8.5E+05	nm	3.6E+06	nm	6.3E-01	n	2.6E+00	n				
Methylstyrene, Alpha-	98-83-9					7.0E-02	H			V	1		5.0E+02	5.5E+03	ns	7.2E+04	ns					2.6E+03	n		4.1E+00	
Metolachlor	51218-45-2					1.5E-01	I				1	0.1		9.2E+03	n	9.2E+04	n					5.5E+03	n		6.4E+00	
Metribuzin	21087-64-9					2.5E-02	I				1	0.1		1.5E+03	n	1.5E+04	n					9.1E+02	n		2.8E-01	
Mineral oils	8012-95-1					3.0E+00	P							2.3E+05	nm	3.1E+06	nm					1.1E+05	n		4.3E+03	
Mirex	2385-85-5	1.8E+01	C	5.1E-03	C	2.0E-04	I				1	0.1		2.7E-02	c	9.6E-02	c	4.8E-04	c	2.4E-03	c	3.7E-03	c		2.7E-03	
Molinate	2212-67-1					2.0E-03	I				1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		4.1E-02	
Molybdenum	7439-98-7					5.0E-03	I				1			3.9E+02	n	5.1E+03	n					1.8E+02	n		3.7E+00	
Monochloramine	10599-90-3					1.0E-01	I				1			7.8E+03	n	1.0E+05	nm					3.7E+03	n			
Monomethylaniline	100-61-8					2.0E-03	P				1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		2.7E-02	
N,N'-Diphenyl-1,4-benzenediamine	74-31-7					3.0E-04	X				1	0.1		1.8E+01	n	1.8E+02	n					1.1E+01	n		1.1E+00	
Naled	300-76-5					2.0E-03	I				1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		3.3E-02	
Naphtha, High Flash Aromatic (HFAN)	64724-95-6					3.0E-02	X	1.0E-01	P	V				2.3E+03	n	3.1E+04	n	1.0E+02	n	4.4E+02	n	1.8E+02	n			
Naphthylamine, 2-	91-59-8	1.8E+00	C	0.0E+00	C						1	0.1		2.7E-01	c	9.6E-01	c					3.7E-02	c		1.9E-04	
Napropamide	15299-99-7					1.0E-01	I				1	0.1		6.1E+03	n	6.2E+04	n					3.7E+03	n		2.4E+01	
Nickel Carbonyl	13463-39-3					5.0E-02	C	5.0E-05	C		0.04			3.7E+03	n	4.4E+04	n	5.2E-02	n	2.2E-01	n	1.8E+03	n			
Nickel Oxide	1313-99-1					5.0E-02	C	1.0E-04	C					3.6E+03	n	4.7E+04	n	1.0E-01	n	4.4E-01	n	1.8E+03	n			
Nickel Refinery Dust	NA			2.4E-04	I	5.0E-02	C	5.0E-05	C		0.04			3.7E+03	n	4.4E+04	n	1.0E-02	c**	5.1E-02	c**	1.8E+03	n			
Nickel Soluble Salts	7440-02-0			2.6E-04	C	2.0E-02	I	9.0E-05	A		0.04			1.5E+03	n	2.0E+04	n	9.4E-03	c*	4.7E-02	c**	7.3E+02	n		4.8E+01	
Nickel Subsulfide	12035-72-2	1.7E+00	C	4.8E-04	I	5.0E-02	C	5.0E-05	C		0.04			3.8E-01	c	1.7E+00	c	5.1E-03	c*	2.6E-02	c**	4.0E-02	c			
Nitrate	14797-55-8					1.6E+00	I				1			1.3E+05	nm	1.6E+06	nm					5.8E+04	n	1.0E+04		
Nitrite	14797-65-0					1.0E-01	I				1			7.8E+03	n	1.0E+05	nm					3.7E+03	n	1.0E+03		
Nitroaniline, 2-	88-74-4					1.0E-02	X	5.0E-05	X		1	0.1		6.1E+02	n	6.0E+03	n	5.2E-02	n	2.2E-01	n	3.7E+02	n		1.5E-01	
Nitroaniline, 4-	100-01-6	2.0E-02	P			4.0E-03	P	6.0E-03	P		1	0.1		2.4E+01	c*	8.6E+01	c*	6.3E+00	n	2.6E+01	n	3.4E+00	c*		1.4E-03	
Nitrobenzene	98-95-3			4.0E-05	I	2.0E-03	I	9.0E-03	I	V	1		3.1E+03	4.8E+00	c*	2.4E+01	c*	6.1E-02	c	3.1E-01	c	1.2E-01	c		7.9E-05	
Nitrocellulose	9004-70-0					3.0E+03	P							2.3E+08	nm	3.1E+09	nm					1.1E+08	n		2.4E+04	
Nitrofurantoin	67-20-9					7.0E-02	H							4.3E+03	n	4.3E+04	n					2.6E+03	n		1.1E+00	
Nitrofurazone	59-87-0	1.3E+00	C	3.7E-04	C						1	0.1		3.7E-01	c	1.3E+00	c	6.6E-03	c	3.3E-02	c	5.2E-02	c		4.7E-05	
Nitroglycerin	55-63-0	1.7E-02	P			1.0E-04	P				1	0.1		6.1E+00	n	6.2E+01	n					3.7E+00	n		1.6E-03	
Nitroguanidine	556-88-7					1.0E-01	I				1	0.1		6.1E+03	n	6.2E+04	n					3.7E+03	n		8.8E-01	
Nitromethane	75-52-5			9.0E-06	P			2.0E-02	P	V	1		1.8E+04	4.9E+00	c*	2.5E+01	c*	2.7E-01	c*	1.4E+00	c*	5.4E-01	c*		1.2E-04	
Nitropropane, 2-	79-46-9			2.7E-03	H			2.0E-02	I	V	1		4.9E+03	1.3E-02	c	6.4E-02	c	9.0E-04	c	4.5E-03	c	1.8E-03	c		4.7E-07	
Nitroso-N-ethylurea, N-	759-73-9	2.7E+01	C	7.7E-03	C						1	0.1		1.8E-02	c	6.4E-02	c	3.2E-04	c	1.6E-03	c	2.5E-03	c		6.0E-07	
Nitroso-N-methylurea, N-	684-93-5	1.2E+02	C	3.4E-02	C						1	0.1		4.0E-03	c	1.4E-02	c	7.2E-05	c	3.6E-04	c	5.6E-04	c		1.2E-07	
Nitroso-di-N-butylamine, N-	924-16-3	5.4E+00	I	1.6E-03	I					V	1		7.1E+03	8.7E-02	c	4.0E-01	c	1.5E-03	c	7.7E-03	c	2.4E-03	c		5.0E-06	
Nitroso-di-N-propylamine, N-	621-64-7	7.0E+00	I	2.0E-03	C						1	0.1		6.9E-02	c	2.5E-01	c	1.2E-03	c	6.1E-03	c	9.6E-03	c		7.2E-06	
Nitrosodiethanolamine, N-	1116-54-7	2.8E+00	I	8.0E-04	C						1	0.1		1.7E-01	c	6.2E-01	c	3.0E-03	c	1.5E-02	c	2.4E-02	c		4.9E-06	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ #29; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10 c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User's Guide); s = Concentration may exceed Csat (See User's Guide); SSL values are based on DAF=1

Contaminant		Toxicity and Chemical-specific Information												Screening Levels												Protection of Groundwater Soil	
		SFO	k e y	IUR	k e y	RfDo	k e y	RfCi	k e y	v o c	muta-gen	GIABS	ABS	Csat	Residential Soil		Industrial Soil		Residential Air		Industrial Air		Tapwater		MCL	Risk-based SSL	MCL-based SSL
Analyte	CAS No.	(mg/kg-day)$^{-1}$		(ug/m^3)$^{-1}$		(mg/kg-day)		(mg/m^3)						mg/kg	mg/kg	key	mg/kg	key	ug/m^3	key	ug/m^3	key	ug/L	key	ug/L	mg/kg	mg/kg
Nitrosodiethylamine, N-	55-18-5	1.5E+02	I	4.3E-02	I						M	1	0.1		7.7E-04	c	1.1E-02	c	2.2E-05	c	2.9E-04	c	1.4E-04	c		5.3E-08	
Nitrosodimethylamine, N-	62-75-9	5.1E+01	I	1.4E-02	I	8.0E-06	P	4.0E-05	X		M	1	0.1		2.3E-03	c	3.4E-02	c	6.9E-05	c	8.8E-04	c	4.2E-04	c		1.0E-07	
Nitrosodiphenylamine, N-	86-30-6	4.9E-03	I	2.6E-06	C							1	0.1		9.9E+01	c	3.5E+02	c	9.4E-01	c	4.7E+00	c	1.4E+01	c		7.5E-02	
Nitrosomethylethylamine, N-	10595-95-6	2.2E+01	I	6.3E-03	C							1	0.1		2.2E-02	c	7.8E-02	c	3.9E-04	c	1.9E-03	c	3.1E-03	c		8.8E-07	
Nitrosomorpholine [N-]	59-89-2	6.7E+00	C	1.9E-03	C							1	0.1		7.2E-02	c	2.6E-01	c	1.3E-03	c	6.5E-03	c	1.0E-02	c		2.5E-06	
Nitrosopiperidine [N-]	100-75-4	9.4E+00	C	2.7E-03	C							1	0.1		5.2E-02	c	1.8E-01	c	9.0E-04	c	4.5E-03	c	7.2E-03	c		3.8E-06	
Nitrosopyrrolidine, N-	930-55-2	2.1E+00	I	6.1E-04	I							1	0.1		2.3E-01	c	8.2E-01	c	4.0E-03	c	2.0E-02	c	3.2E-02	c		1.2E-05	
Nitrotoluene, m-	99-08-1					1.0E-04	X					1	0.1		6.1E+00	n	6.2E+01	n					3.7E+00	n		3.4E-03	
Nitrotoluene, o-	88-72-2	2.2E-01	P			9.0E-04	P			V		1		1.5E+03	2.9E+00	c*	1.3E+01	c*					3.1E-01	c		2.9E-04	
Nitrotoluene, p-	99-99-0	1.6E-02	P			4.0E-03	P					1	0.1		3.0E+01	c**	1.1E+02	c*					4.2E+00	c*		3.9E-03	
Nonane, n-	111-84-2					3.0E-04	X	2.0E-01	P	V				6.9E+00	2.1E+01	ns	2.3E+02	ns	2.1E+02	n	8.8E+02	n	1.1E+01	n		1.5E-01	
Norflurazon	27314-13-2					4.0E-02	I					1	0.1		2.4E+03	n	2.5E+04	n					1.5E+03	n		9.4E+00	
Nustar	85509-19-9					7.0E-04	I					1	0.1		4.3E+01	n	4.3E+02	n					2.6E+01	n		4.1E+00	
Octabromodiphenyl Ether	32536-52-0					3.0E-03	I					1	0.1		1.8E+02	n	1.8E+03	n					1.1E+02	n		2.2E+01	
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0					5.0E-02	I					1	0.006		3.8E+03	n	4.9E+04	n					1.8E+03	n		2.3E+00	
Octamethylpyrophosphoramide	152-16-9					2.0E-03	H					1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		1.8E-02	
Oryzalin	19044-88-3					5.0E-02	I					1	0.1		3.1E+03	n	3.1E+04	n					1.8E+03	n		3.4E+00	
Oxadiazon	19666-30-9					5.0E-03	I					1	0.1		3.1E+02	n	3.1E+03	n					1.8E+02	n		1.9E+00	
Oxamyl	23135-22-0					2.5E-02	I					1	0.1		1.5E+03	n	1.5E+04	n					9.1E+02	n	2.0E+02	2.0E-01	4.4E-02
Paclobutrazol	76738-62-0					1.3E-02	I					1	0.1		7.9E+02	n	8.0E+03	n					4.7E+02	n		9.7E-01	
Paraquat Dichloride	1910-42-5					4.5E-03	I					1	0.1		2.7E+02	n	2.8E+03	n					1.6E+02	n		2.3E+00	
Parathion	56-38-2					6.0E-03	H					1	0.1		3.7E+02	n	3.7E+03	n					2.2E+02	n		1.1E+00	
Pebulate	1114-71-2					5.0E-02	H					1	0.1		3.1E+03	n	3.1E+04	n					1.8E+03	n		1.5E+00	
Pendimethalin	40487-42-1					4.0E-02	I					1	0.1		2.4E+03	n	2.5E+04	n					1.5E+03	n		1.7E+01	
Pentabromodiphenyl Ether	32534-81-9					2.0E-03	I					1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		3.2E+00	
Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9					1.0E-04	I								7.8E+00	n	1.0E+02	n					3.7E+00	n		1.6E-01	
Pentachlorobenzene	608-93-5					8.0E-04	I					1	0.1		4.9E+01	n	4.9E+02	n					2.9E+01	n		2.2E-01	
Pentachloroethane	76-01-7	9.0E-02	P									1	0.1		5.4E+00	c	1.9E+01	c					7.5E-01	c		3.6E-04	
Pentachloronitrobenzene	82-68-8	2.6E-01	H			3.0E-03	I					1	0.1		1.9E+00	c*	6.6E+00	c					2.6E-01	c		3.2E-03	
Pentachlorophenol	87-86-5	1.2E-01	I	5.1E-06	C	3.0E-02	I					1	0.25		3.0E+00	c	9.0E+00	c	4.8E-01	c	2.4E+00	c	5.6E-01	c	1.0E+00	5.7E-03	1.0E-02
Pentane, n-	109-66-0							1.0E+00	P	V				3.9E+02	8.7E+02	ns	3.7E+03	ns	1.0E+03	n	4.4E+03	n	2.1E+03	n		1.0E+01	
Perchlorate and Perchlorate Salts	14797-73-0					7.0E-04	I					1			5.5E+01	n	7.2E+02	n					2.6E+01	n	15 (F)		
Permethrin	52645-53-1					5.0E-02	I					1	0.1		3.1E+03	n	3.1E+04	n					1.8E+03	n		4.3E+02	
Phenacetin	62-44-2	2.2E-03	C	6.3E-07	C							1	0.1		2.2E+02	c	7.8E+02	c	3.9E+00	c	1.9E+01	c	3.1E+01	c		8.6E-03	
Phenmedipham	13684-63-4					2.5E-01	I					1	0.1		1.5E+04	n	1.5E+05	nm					9.1E+03	n		4.9E+01	
Phenol	108-95-2					3.0E-01	I	2.0E-01	C			1	0.1		1.8E+04	n	1.8E+05	nm	2.1E+02	n	8.8E+02	n	1.1E+04	n		6.3E+00	
Phenylenediamine, m-	108-45-2					6.0E-03	I					1	0.1		3.7E+02	n	3.7E+03	n					2.2E+02	n		5.9E-02	
Phenylenediamine, o-	95-54-5	4.7E-02	H									1	0.1		1.0E+01	c	3.7E+01	c					1.4E+00	c		3.8E-04	
Phenylenediamine, p-	106-50-3					1.9E-01	H					1	0.1		1.2E+04	n	1.2E+05	nm					6.9E+03	n		1.9E+00	
Phenylphenol, 2-	90-43-7	1.9E-03	H									1	0.1		2.5E+02	c	8.9E+02	c					3.5E+01	c		4.7E-01	
Phorate	298-02-2					2.0E-04	H					1	0.1		1.2E+01	n	1.2E+02	n					7.3E+00	n		8.2E-03	
Phosgene	75-44-5							3.0E-04	I	V		1		1.6E+03	3.3E-01	n	1.4E+00	n	3.1E-01	n	1.3E+00	n					
Phosmet	732-11-6					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		1.6E-01	
Phosphine	7803-51-2					3.0E-04	I	3.0E-04	I			1			2.3E+01	n	3.1E+02	n	3.1E+01	n	1.3E+00	n	1.1E+01	n			
Phosphoric Acid	7664-38-2							1.0E-02	I			1			1.4E+07	nm	6.0E+07	nm	1.0E+01	n	4.4E+01	n					
Phosphorus, White	7723-14-0					2.0E-05	I					1			1.6E+00	n	2.0E+01	n					7.3E-01	n		2.7E-03	
Phthalic Acid, P-	100-21-0					1.0E+00	H					1	0.1		6.1E+04	n	6.2E+05	nm					3.7E+04	n		1.3E+01	
Phthalic Anhydride	85-44-9					2.0E+00	I	2.0E-02	C			1	0.1		1.2E+05	nm	1.2E+06	nm	2.1E+01	n	8.8E+01	n	7.3E+04	n		1.6E+01	
Picloram	1918-02-1					7.0E-02	I					1	0.1		4.3E+03	n	4.3E+04	n					2.6E+03	n	5.0E+02	7.1E-01	1.4E-01
Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3					1.0E-04	X					1	0.1		6.1E+00	n	6.2E+01	n					3.7E+00	n		2.4E-03	
Pirimiphos, Methyl	29232-93-7					1.0E-02	I					1	0.1		6.1E+02	n	6.2E+03	n					3.7E+02	n		3.5E-01	
Polybrominated Biphenyls	59536-65-1	3.0E+01	C	8.6E-03	C	7.0E-06	H					1	0.1		1.6E-02	c*	5.7E-02	c*	2.8E-04	c	1.4E-03	c	2.2E-03	c			
Polychlorinated Biphenyls (PCBs)																											
~Aroclor 1016	12674-11-2	7.0E-02	I	2.0E-05	I	7.0E-05	I					1	0.14		3.9E+00	n	2.1E+01	c**	1.2E-01	c	6.1E-01	c	9.6E-01	c**		9.2E-02	
~Aroclor 1221	11104-28-2	2.0E+00	I	5.7E-04	I					V		1	0.14	7.6E+02	1.4E-01	c	5.4E-01	c	4.3E-03	c	2.1E-02	c	6.8E-03	c		1.2E-04	
~Aroclor 1232	11141-16-5	2.0E+00	I	5.7E-04	I					V		1	0.14	7.3E+01	1.4E-01	c	5.4E-01	c	4.3E-03	c	2.1E-02	c	6.8E-03	c		1.2E-04	
~Aroclor 1242	53469-21-9	2.0E+00	I	5.7E-04	I							1	0.14		2.2E-01	c	7.4E-01	c	4.3E-03	c	2.1E-02	c	3.4E-02	c		5.3E-03	
~Aroclor 1248	12672-29-6	2.0E+00	I	5.7E-04	I							1	0.14		2.2E-01	c	7.4E-01	c	4.3E-03	c	2.1E-02	c	3.4E-02	c		5.2E-03	
~Aroclor 1254	11097-69-1	2.0E+00	I	5.7E-04	I	2.0E-05	I					1	0.14		2.2E-01	c**	7.4E-01	c*	4.3E-03	c	2.1E-02	c	3.4E-02	c*		8.8E-03	
~Aroclor 1260	11096-82-5	2.0E+00	I	5.7E-04	I							1	0.14		2.2E-01	c	7.4E-01	c	4.3E-03	c	2.1E-02	c	3.4E-02	c		2.4E-02	
~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	1.3E+01	C	3.8E-03	C							1	0.14		3.4E-02	c	1.1E-01	c	6.4E-04	c	3.2E-03	c	5.2E-03	c		3.6E-03	
~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	1.3E+00	C	3.8E-04	C							1	0.14		3.4E-01	c	1.1E+00	c	6.4E-03	c	3.2E-02	c	5.2E-02	c		2.2E-02	
~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	6.5E+01	C	1.9E-02	C							1	0.14		6.8E-03	c	2.3E-02	c	1.3E-04	c	6.5E-04	c	1.0E-03	c		4.4E-04	
~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	6.5E+01	C	1.9E-02	C							1	0.14		6.8E-03	c	2.3E-02	c	1.3E-04	c	6.5E-04	c	1.0E-03	c		4.4E-04	
~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	1.3E+03	C	3.8E-01	C							1	0.14		3.4E-04	c	1.1E-03	c	6.4E-06	c	3.2E-05	c	5.2E-05	c		2.2E-05	
~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	1.3E+01	C	3.8E-03	C							1	0.14		3.4E-02	c	1.1E-01	c	6.4E-04	c	3.2E-03	c	5.2E-03	c		1.4E-03	
~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	1.3E+01	C	3.8E-03	C							1	0.14		3.4E-02	c	1.1E-01	c	6.4E-04	c	3.2E-03	c	5.2E-03	c		1.3E-03	
~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	1.3E+01	C	3.8E-03	C							1	0.14		3.4E-02	c	1.1E-01	c	6.4E-04	c	3.2E-03	c	5.2E-03	c		1.4E-03	
~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	6.5E+02	C	1.9E-02	C							1	0.14		6.8E-04	c	2.3E-03	c	1.3E-04	c	6.5E-04	c	1.0E-04	c		2.7E-05	
~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	1.3E+04	C	3.8E+00	C							1	0.14		3.4E-05	c	1.1E-04	c	6.4E-07	c	3.2E-06	c	5.2E-06	c		1.3E-06	
~Polychlorinated Biphenyls (high risk)	1336-36-3	2.0E+00	I	5.7E-04	C							1	0.14		2.2E-01	c	7.4E-01	c	4.3E-03	c	2.2E-02	c					
~Polychlorinated Biphenyls (low risk)	1336-36-3	4.0E-01	I	1.0E-04	I							1	0.14								2.4E-02	c	1.7E-01	c	5.0E-01	2.6E-02	7.8E-02
~Polychlorinated Biphenyls (lowest risk)	1336-36-3	7.0E-02	I	2.0E-05	C							1	0.14								1.2E-01	c	6.1E-01	c			
~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	1.3E+01	C	3.8E-03	C							1	0.14		3.4E-02	c	1.1E-01	c	6.4E-04	c	3.2E-03	c	5.2E-03	c		8.1E-04	
~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	1.3E+01	C	3.8E-03	C							1	0.14		3.4E-02	c	1.1E-01	c	6.4E-04	c	3.2E-03	c	5.2E-03	c		8.1E-04	
Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9							6.0E-04	I			1	0.1		8.5E+05	nm	3.6E+06	nm	6.3E-01	n	2.6E+00	n					
Polynuclear Aromatic Hydrocarbons (PAHs)																											
~Acenaphthene	83-32-9					6.0E-02	I			V		1	0.13		3.4E+03	n	3.3E+04	n					2.2E+03	n		2.2E+01	
~Anthracene	120-12-7					3.0E-01	I			V		1	0.13		1.7E+04	n	1.7E+05	nm					1.1E+04	n		3.6E+02	

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Contaminant		Toxicity and Chemical-specific Information													Screening Levels											Protection of Groundwater Soil	
		SFO	k e y	IUR	k e y	RfDo	k e y	RfCi	k e y	v o c	muta-gen	GIABS	ABS	Csat	Residential Soil		Industrial Soil		Residential Air		Industrial Air		Tapwater		MCL	Risk-based SSL	MCL-based SSL
Analyte	CAS No.	(mg/kg-day)$^{-1}$		(ug/m^3)$^{-1}$		(mg/kg-day)		(mg/m^3)						mg/kg	mg/kg	key	mg/kg	key	ug/m^3	key	ug/m^3	key	ug/L	key	ug/L	mg/kg	mg/kg
~Benz[a]anthracene	56-55-3	7.3E-01	E	1.1E-04	C						M	1	0.13		1.5E-01	c	2.1E+00	c	8.7E-03	c	1.1E-01	c	2.9E-02	c		1.0E-02	
~Benzo(j)fluoranthene	205-82-3	1.2E+00	C	1.1E-04	C										5.3E-01	c	2.4E+00	c	2.2E-02	c	1.1E-01	c	5.6E-02	c		6.7E-02	
~Benzo[a]pyrene	50-32-8	7.3E+00	I	1.1E-03	C						M	1	0.13		1.5E-02	c	2.1E-01	c	8.7E-04	c	1.1E-02	c	2.9E-03	c	2.0E-01	3.5E-03	2.4E-01
~Benzo[b]fluoranthene	205-99-2	7.3E-01	E	1.1E-04	C						M	1	0.13		1.5E-01	c	2.1E+00	c	8.7E-03	c	1.1E-01	c	2.9E-02	c		3.5E-02	
~Benzo[k]fluoranthene	207-08-9	7.3E-02	E	1.1E-04	C						M	1	0.13		1.5E+00	c	2.1E+01	c	8.7E-03	c	1.1E-01	c	2.9E-01	c		3.5E-01	
~Chrysene	218-01-9	7.3E-03	E	1.1E-05	C						M	1	0.13		1.5E+01	c	2.1E+02	c	8.7E-02	c	1.1E+00	c	2.9E+00	c		1.1E+00	
~Dibenz[a,h]anthracene	53-70-3	7.3E+00	E	1.2E-03	C						M	1	0.13		1.5E-02	c	2.1E-01	c	8.0E-04	c	1.0E-02	c	2.9E-03	c		1.1E-02	
~Dibenzo(a,e)pyrene	192-65-4	1.2E+01	C	1.1E-03	C										5.3E-02	c	2.4E-01	c	2.2E-03	c	1.1E-02	c	5.6E-03	c		7.3E-02	
~Dimethylbenz(a)anthracene, 7,12-	57-97-6	2.5E+02	C	7.1E-02	C							1	0.13		1.8E-03	c	6.2E-03	c	3.4E-05	c	1.7E-04	c	2.7E-04	c		2.7E-04	
~Fluoranthene	206-44-0					4.0E-02	I					1	0.13		2.3E+03	n	2.2E+04	n					1.5E+03	n		1.6E+02	
~Fluorene	86-73-7					4.0E-02	I			V		1	0.13		2.3E+03	n	2.2E+04	n					1.5E+03	n		2.7E+01	
~Indeno[1,2,3-cd]pyrene	193-39-5	7.3E-01	E	1.1E-04	C						M	1	0.13		1.5E-01	c	2.1E+00	c	8.7E-03	c	1.1E-01	c	2.9E-02	c		1.2E-01	
~Methylnaphthalene, 1-	90-12-0	2.9E-02	P			7.0E-02	A			V		1		3.9E+02	2.2E+01	c	9.9E+01	c					2.3E+00	c		1.2E-02	
~Methylnaphthalene, 2-	91-57-6					4.0E-03	I			V		1		3.7E+02	3.1E+02	n	4.1E+03	ns					1.5E+02	n		7.5E-01	
~Naphthalene	91-20-3			3.4E-05	C	2.0E-02	I	3.0E-03	I	V		1	0.13		3.6E+00	c*	1.8E+01	c*	7.2E-02	c*	3.6E-01	c*	1.4E-01	c*		4.7E-04	
~Nitropyrene, 4-	57835-92-4	1.2E+00	C	1.1E-04	C										5.3E-01	c	2.4E+00	c	2.2E-02	c	1.1E-01	c	5.6E-02	c		9.7E-03	
~Pyrene	129-00-0					3.0E-02	I			V		1	0.13		1.7E+03	n	1.7E+04	n					1.1E+03	n		1.2E+02	
Potassium Perchlorate	7778-74-7					7.0E-04	I					1			5.5E+01	n	7.2E+02	n					2.6E+01	n			
Prochloraz	67747-09-5	1.5E-01	I			9.0E-03	I					1	0.1		3.2E+00	c	1.1E+01	c					4.5E-01	c		2.3E-03	
Profluralin	26399-36-0					6.0E-03	H					1	0.1		3.7E+02	n	3.7E+03	n					2.2E+02	n		1.3E+01	
Prometon	1610-18-0					1.5E-02	I					1	0.1		9.2E+02	n	9.2E+03	n					5.5E+02	n		2.6E-01	
Prometryn	7287-19-6					4.0E-03	I					1	0.1		2.4E+02	n	2.5E+03	n					1.5E+02	n		2.2E-01	
Propachlor	1918-16-7					1.3E-02	I					1	0.1		7.9E+02	n	8.0E+03	n					4.7E+02	n		2.9E-01	
Propanil	709-98-8					5.0E-03	I					1	0.1		3.1E+02	n	3.1E+03	n					1.8E+02	n		1.0E-01	
Propargite	2312-35-8					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		5.4E+01	
Propargyl Alcohol	107-19-7					2.0E-03	I					1	0.1		1.2E+02	n	1.2E+03	n					7.3E+01	n		1.5E-02	
Propazine	139-40-2					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		6.5E-01	
Propham	122-42-9					2.0E-02	I					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		4.7E-01	
Propiconazole	60207-90-1					1.3E-02	I					1	0.1		7.9E+02	n	8.0E+03	n					4.7E+02	n		1.6E+00	
Propionaldehyde	123-38-6							8.0E-03	I	V				3.3E+04	8.0E+01	n	3.4E+02	n	8.3E+00	n	3.5E+01	n	1.7E+01	n		3.4E-03	
Propyl benzene	103-65-1					1.0E-01	X	1.0E+00	X	V		1	0.1	2.6E+02	3.4E+03	ns	2.1E+04	ns	1.0E+03	n	4.4E+03	n	1.3E+03	n		2.5E+00	
Propylene	115-07-1							3.0E+00	C						4.3E+09	nm	1.8E+10	nm	3.1E+03	n	1.3E+04	n					
Propylene Glycol	57-55-6					2.0E+01	P					1	0.1		1.2E+08	nm	1.2E+07	nm					7.3E+05	n		1.5E+02	
Propylene Glycol Dinitrate	6423-43-4							2.7E-04	A	V		1		1.5E+03	5.7E+01	n	2.4E+02	n	2.8E-01	n	1.2E+00	n	5.7E-01	n		1.8E-04	
Propylene Glycol Monoethyl Ether	1569-02-4					7.0E-01	H					1	0.1		4.3E+04	n	4.3E+05	nm					2.6E+04	n		5.2E+00	
Propylene Glycol Monomethyl Ether	107-98-2					7.0E-01	H	2.0E+00	I			1	0.1		4.3E+04	n	4.3E+05	nm	2.1E+03	n	8.8E+03	n	2.6E+04	n		5.2E+00	
Propylene Oxide	75-56-9	2.4E-01	I	3.7E-06	I			3.0E-02	I	V		1		7.8E+04	1.9E+00	c	8.8E+00	c	6.6E-01	c*	3.3E+00	c*	2.3E-01	c		4.9E-05	
Pursuit	81335-77-5					2.5E-01	I					1	0.1		1.5E+04	n	1.5E+05	nm					9.1E+03	n		8.0E+00	
Pydrin	51630-58-1					2.5E-02	I					1	0.1		1.5E+03	n	1.5E+04	n					9.1E+02	n		5.8E+02	
Pyridine	110-86-1					1.0E-03	I			V		1		5.3E+05	7.8E+01	n	1.0E+03	n					3.7E+01	n		1.3E-02	
Quinalphos	13593-03-8					5.0E-04	I					1	0.1		3.1E+01	n	3.1E+02	n					1.8E+01	n		1.6E-01	
Quinoline	91-22-5	3.0E+00	I									1	0.1		1.6E-01	c	5.7E-01	c					2.2E-02	c		7.4E-05	
Refractory Ceramic Fibers	NA							3.0E-02	A			1			4.3E+07	nm	1.8E+08	nm	3.1E+01	n	1.3E+02	n					
Resmethrin	10453-86-8					3.0E-02	I					1	0.1		1.8E+03	n	1.8E+04	n					1.1E+03	n		6.8E+02	
Ronnel	299-84-3					5.0E-02	H					1	0.1		3.1E+03	n	3.1E+04	n					1.8E+03	n		1.7E+01	
Rotenone	83-79-4					4.0E-03	I					1	0.1		2.4E+02	n	2.5E+03	n					1.5E+02	n		7.6E+01	
Safrole	94-59-7	2.2E-01	C	6.3E-05	C							1	0.1		2.2E+00	c	7.8E+00	c	3.9E-02	c	1.9E-01	c	3.1E-01	c		1.9E-04	
Savey	78587-05-0					2.5E-02	I					1	0.1		1.5E+03	n	1.5E+04	n					9.1E+02	n		4.1E+00	
Selenious Acid	7783-00-8					5.0E-03	I					1			3.9E+02	n	5.1E+03	n					1.8E+02	n			
Selenium	7782-49-2					5.0E-03	I	2.0E-02	C			1			3.9E+02	n	5.1E+03	n	2.1E+01	n	8.8E+01	n	1.8E+02	n	5.0E+01	9.5E-01	2.6E-01
Selenium Sulfide	7446-34-6					5.0E-03	C	2.0E-02	C			1			3.9E+02	n	5.1E+03	n	2.1E+01	n	8.8E+01	n	1.8E+02	n			
Sethoxydim	74051-80-2					9.0E-02	I					1	0.1		5.5E+03	n	5.5E+04	n					3.3E+03	n		2.9E+01	
Silica (crystalline, respirable)	7631-86-9							3.0E-03	C						4.3E+06	nm	1.8E+07	nm	3.1E+00	n	1.3E+01	n					
Silver	7440-22-4					5.0E-03	I					0.04			3.9E+02	n	5.1E+03	n					1.8E+02	n		1.6E+00	
Simazine	122-34-9	1.2E-01	H			5.0E-03	I					1	0.1		4.0E+00	c*	1.4E+01	c					5.6E-01	c	4.0E+00	2.8E-04	2.0E-03
Sodium Acifluorfen	62476-59-9					1.3E-02	I					1	0.1		7.9E+02	n	8.0E+03	n					4.7E+02	n		3.8E+00	
Sodium Azide	26628-22-8					4.0E-03	I					1			3.1E+02	n	4.1E+03	n					1.5E+02	n			
Sodium Diethyldithiocarbamate	148-18-5	2.7E-01	H			3.0E-02	I					1	0.1		1.6E+00	c	6.4E+00	c					2.5E-01	c			
Sodium Fluoride	7681-49-4					5.0E-02	A	1.3E-02	C			1			3.9E+03	n	5.1E+04	n	1.4E+01	n	5.7E+01	n	1.8E+03	n			
Sodium Fluoroacetate	62-74-8					2.0E-05	I					1	0.1		1.2E+00	n	1.2E+01	n					7.3E-01	n		1.5E-04	
Sodium Metavanadate	13718-26-8					1.0E-03	H					1			7.8E+01	n	1.0E+03	n					3.7E+01	n			
Sodium Perchlorate	7601-89-0					7.0E-04	I					1			5.5E+01	n	7.2E+02	n					2.6E+01	n			
Stirofos (Tetrachlorovinphos)	961-11-5	2.4E-02	H			3.0E-02	I					1	0.1		2.0E+01	c*	7.2E+01	c					2.8E+00	c		8.3E-03	
Strontium, Stable	7440-24-6					6.0E-01	I					1			4.7E+04	n	6.1E+05	nm					2.2E+04	n		7.7E+02	
Strychnine	57-24-9					3.0E-04	I					1	0.1		1.8E+01	n	1.8E+02	n					1.1E+01	n		1.2E-01	
Styrene	100-42-5					2.0E-01	I	1.0E+00	I	V		1		8.7E+02	6.3E+03	ns	3.6E+04	ns	1.0E+03	n	4.4E+03	n	1.6E+03	n	1.0E+02	1.8E+00	1.1E-01
Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9					8.0E-04	P					1	0.1		4.9E+01	n	4.9E+02	n					2.9E+01	n		1.7E-01	
Sulfuric Acid	7664-93-9							1.0E-03	C						1.4E+06	nm	6.0E+06	nm	1.0E+00	n	4.4E+00	n					
Systhane	88671-89-0					2.5E-02	I					1	0.1		1.5E+03	n	1.5E+04	n					9.1E+02	n		1.1E+01	
TCMTB	21564-17-0					3.0E-02	H					1	0.1		1.8E+03	n	1.8E+04	n					1.1E+03	n		7.6E+00	
Tebuthiuron	34014-18-1					7.0E-02	I					1	0.1		4.3E+03	n	4.3E+04	n					2.6E+03	n		7.3E-01	
Temephos	3383-96-8					2.0E-02	H					1	0.1		1.2E+03	n	1.2E+04	n					7.3E+02	n		1.4E+02	
Terbacil	5902-51-2					1.3E-02	I					1	0.1		7.9E+02	n	8.0E+03	n					4.7E+02	n		1.4E-01	
Terbufos	13071-79-9					2.5E-05	H					1	0.1		1.5E+00	n	1.5E+01	n					9.1E-01	n		2.0E-03	
Terbutryn	886-50-0					1.0E-03	I					1	0.1		6.1E+01	n	6.2E+02	n					3.7E+01	n		5.2E-02	
Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1					1.0E-04	I								7.8E+00	n	1.0E+02	n					3.7E+00	n		9.7E-02	
Tetrachlorobenzene, 1,2,4,5-	95-94-3					3.0E-04	I					1	0.1		1.8E+01	n	1.8E+02	n					1.1E+01	n		5.1E-02	
Tetrachloroethane, 1,1,1,2-	630-20-6	2.6E-02	I	7.4E-06	I	3.0E-02	I			V		1		6.8E+02	1.9E+00	c	9.3E+00	c	3.3E-01	c	1.7E+00	c	5.2E-01	c		2.0E-04	
Tetrachloroethane, 1,1,2,2-	79-34-5	2.0E-01	I	5.8E-05	I	4.0E-03	P			V		1		1.9E+03	5.6E-01	c	2.8E+00	c	4.2E-02	c	2.1E-01	c	6.7E-02	c		2.6E-05	

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X = PPRTV Appendix; H = HEAST; J = New Jersey; E = Environmental Criteria and Assessment Office; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; F = See FAQ #29; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10 c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User's Guide); s = Concentration may exceed Csat (See User's Guide); SSL values are based on DAF=1

Contaminant		Toxicity and Chemical-specific Information														Screening Levels												Protection of Groundwater Soil	
		SFO	k e y	IUR	k e y	RfDo	k e y	RfCi	k e y	v o c	muta-gen	GIABS	ABS	Csat		Residential Soil		Industrial Soil		Residential Air		Industrial Air		Tapwater		MCL		Risk-based SSL	MCL-based SSL
Analyte	CAS No.	(mg/kg-day)$^{-1}$		(ug/m^3)$^{-1}$		(mg/kg-day)		(mg/m^3)						mg/kg		mg/kg	key	mg/kg	key	ug/m^3	key	ug/m^3	key	ug/L	key	ug/L		mg/kg	mg/kg
Tetrachloroethylene	127-18-4	5.4E-01	C	5.9E-06	C	1.0E-02	I	2.7E-01	A	V		1		1.7E+02		5.5E+01	c	2.6E+00	c	4.1E-01	c	2.1E+00	c	1.1E-01	c	5.0E+00		4.9E-05	2.3E-03
Tetrachlorophenol, 2,3,4,6-	58-90-2					3.0E-02	I					1	0.1			1.8E+03	n	1.8E+04	n					1.1E+03	n			6.7E+00	
Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	2.0E+01	H									1	0.1			2.4E-02	c	8.6E-02	c					3.4E-03	c			1.1E-05	
Tetraethyl Dithiopyrophosphate	3689-24-5					5.0E-04	I					1	0.1			3.1E+01	n	3.1E+02	n					1.8E+01	n			1.3E-02	
Tetrafluoroethane, 1,1,1,2-	811-97-2							8.0E+01	I	V		1		1.1E+03		1.1E+05	nms	4.6E+05	nms	8.3E+04	n	3.5E+05	n	1.7E+05	n			9.3E+01	
Tetryl (Trinitrophenylmethylnitramine)	479-45-8					4.0E-03	P					1	0.1			2.4E+02	n	2.5E+03	n					1.5E+02	n			1.4E+00	
Thallium (Soluble Salts)	7440-28-0											1														2.0E+00			1.4E-01
Thiobencarb	28249-77-6					1.0E-02	I					1	0.1			6.1E+02	n	6.2E+03	n					3.7E+02	n			1.3E+00	
Thiodiglycol	111-48-8					7.0E-02	X					1	0.008			5.4E+03	n	6.8E+04	n					2.6E+03	n			5.2E-01	
Thiofanox	39196-18-4					3.0E-04	H					1	0.1			1.8E+01	n	1.8E+02	n					1.1E+01	n			3.8E-03	
Thiophanate, Methyl	23564-05-8					8.0E-02	I					1	0.1			4.9E+03	n	4.9E+04	n					2.9E+03	n			2.5E+00	
Thiram	137-26-8					5.0E-03	I					1	0.1			3.1E+02	n	3.1E+03	n					1.8E+02	n			2.6E-01	
Tin	7440-31-5					6.0E-01	H					1				4.7E+04	n	6.1E+05	nm					2.2E+04	n			5.5E+03	
Titanium Tetrachloride	7550-45-0							1.0E-04	A			1				1.4E+05	nm	6.0E+05	nm	1.0E-01	n	4.4E-01	n						
Toluene	108-88-3					8.0E-02	I	5.0E+00	I	V		1		8.2E+02		5.0E+03	ns	4.5E+04	ns	5.2E+03	n	2.2E+04	n	2.3E+03	n	1.0E+03		1.6E+00	6.9E-01
Toluidine, p-	106-49-0	1.9E-01	H									1	0.1			2.6E+00	c	9.1E+00	c					3.5E-01	c			1.5E-04	
Toxaphene	8001-35-2	1.1E+00	I	3.2E-04	I							1	0.1			4.4E-01	c	1.6E+00	c	7.6E-03	c	3.8E-02	c	6.1E-02	c	3.0E+00		9.4E-03	4.6E-01
Tralomethrin	66841-25-6					7.5E-03	I					1	0.1			4.6E+02	n	4.6E+03	n					2.7E+02	n			1.0E+02	
Tri-n-butyltin	688-73-3					3.0E-04	A					1	0.1			1.8E+01	n	1.8E+02	n					1.1E+01	n			2.4E-01	
Triallate	2303-17-5					1.3E-02	I					1	0.1			7.9E+02	n	8.0E+03	n					4.7E+02	n			1.1E+00	
Triasulfuron	82097-50-5					1.0E-02	I					1	0.1			6.1E+02	n	6.2E+03	n					3.7E+02	n			3.8E-01	
Tribromobenzene, 1,2,4-	615-54-3					5.0E-03	I					1	0.1			3.1E+02	n	3.1E+03	n					1.8E+02	n			2.6E-01	
Tributyl Phosphate	126-73-8	9.2E-03	P			2.0E-01	P					1	0.1			5.3E+01	c	1.9E+02	c					7.3E+00	c			3.6E-02	
Tributyltin Compounds	NA					3.0E-04	P					1	0.1			1.8E+01	n	1.8E+02	n					1.1E+01	n				
Tributyltin Oxide	56-35-9					3.0E-04	I					1	0.1			1.8E+01	n	1.8E+02	n					1.1E+01	n			5.7E+02	
Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1					3.0E+01	I	3.0E+01	H	V		1		9.1E+02		4.3E+04	ns	1.8E+05	nms	3.1E+04	n	1.3E+05	n	5.9E+04	n			1.5E+02	
Trichloroaniline HCl, 2,4,6-	33663-50-2	2.9E-02	H									1	0.1			1.7E+01	c	5.9E+01	c					2.3E+00	c			6.4E-03	
Trichloroaniline, 2,4,6-	634-93-5	3.4E-02	H									1	0.1			1.4E+01	c	5.1E+01	c					2.0E+00	c			1.8E-02	
Trichlorobenzene, 1,2,3-	87-61-6					8.0E-04	X			V		1	0.1	1.5E+02		4.9E+01	n	4.9E+02	ns					2.9E+01	n			8.7E-02	
Trichlorobenzene, 1,2,4-	120-82-1	2.9E-02	P			1.0E-02	I	2.0E-03	P	V		1		4.0E+02		2.2E+01	c**	9.9E+01	c**	2.1E+00	n	8.8E+00	n	2.3E+00	c**	7.0E+01		6.8E-03	2.0E-01
Trichloroethane, 1,1,1-	71-55-6					2.0E+00	I	5.0E+00	I	V		1		6.4E+02		8.7E+03	ns	3.8E+04	ns	5.2E+03	n	2.2E+04	n	9.1E+03	n	2.0E+02		3.2E+00	7.0E-02
Trichloroethane, 1,1,2-	79-00-5	5.7E-02	I	1.6E-05	I	4.0E-03	I			V		1		2.2E+03		1.1E+00	c	5.3E+00	c	1.5E-01	c	7.7E-01	c	2.4E-01	c	5.0E+00		7.8E-05	1.6E-03
Trichloroethylene	79-01-6	5.9E-03	C	2.0E-06	C					V		1		6.9E+02		2.8E+00	c	1.4E+01	c	1.2E+00	c	6.1E+00	c	2.0E+00	c	5.0E+00		7.2E-04	1.8E-03
Trichlorofluoromethane	75-69-4					3.0E-01	I	7.0E-01	H	V		1		1.2E+03		7.9E+02	n	3.4E+03	ns	7.3E+02	n	3.1E+03	n	1.3E+03	n			8.3E-01	
Trichlorophenol, 2,4,5-	95-95-4					1.0E-01	I					1	0.1			6.1E+03	n	6.2E+04	n					3.7E+03	n			1.4E+01	
Trichlorophenol, 2,4,6-	88-06-2	1.1E-02	I	3.1E-06	I	1.0E-03	P					1	0.1			4.4E+01	c**	1.6E+02	c**	7.8E-01	c	4.0E+00	c	6.1E+00	c**			2.3E-02	
Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5					1.0E-02	I					1	0.1			6.1E+02	n	6.2E+03	n					3.7E+02	n			1.5E-01	
Trichlorophenoxypropionic acid, -2,4,5	93-72-1					8.0E-03	I					1	0.1			4.9E+02	n	4.9E+03	n					2.9E+02	n	5.0E+01		1.6E-01	2.8E-02
Trichloropropane, 1,1,2-	598-77-6					5.0E-03	I			V		1		1.3E+03		3.9E+02	n	5.1E+03	ns					1.8E+02	n			7.1E-02	
Trichloropropane, 1,2,3-	96-18-4	3.0E+01	I			4.0E-03	I	3.0E-04	I	V	M	1		1.4E+03		5.0E-03	c	9.5E-02	c	3.1E-01	n	1.3E+00	n	7.2E-04	c			3.1E-07	
Trichloropropene, 1,2,3-	96-19-5					3.0E-03	X	3.0E-04	P	V		1		4.5E+02		7.8E-01	n	3.3E+00	n	3.1E-01	n	1.3E+00	n	6.2E-01	n			3.1E-04	
Tridiphane	58138-08-2					3.0E-03	I					1	0.1			1.8E+02	n	1.8E+03	n					1.1E+02	n			7.8E-01	
Triethylamine	121-44-8							7.0E-03	I	V		1		2.8E+04		1.2E+02	n	5.2E+02	n	7.3E+00	n	3.1E+01	n	1.5E+01	n			4.4E-03	
Trifluralin	1582-09-8	7.7E-03	I			7.5E-03	I					1	0.1			6.3E+01	c**	2.2E+02	c*					8.7E+00	c*			2.9E-01	
Trimethyl Phosphate	512-56-1	3.7E-02	H									1	0.1			1.3E+01	c	4.7E+01	c					1.8E+00	c			4.0E-04	
Trimethylbenzene, 1,2,4-	95-63-6							7.0E-03	P	V		1		2.2E+02		6.2E+01	n	2.6E+02	ns	7.3E+00	n	3.1E+01	n	1.5E+01	n			2.1E-02	
Trimethylbenzene, 1,3,5-	108-67-8					1.0E-02	X			V		1		1.8E+02		7.8E+02	ns	1.0E+04	ns					3.7E+02	n			5.2E-01	
Trinitrobenzene, 1,3,5-	99-35-4					3.0E-02	I					1	0.019			2.2E+03	n	2.7E+04	n					1.1E+03	n			3.9E+00	
Trinitrotoluene, 2,4,6-	118-96-7	3.0E-02	I			5.0E-04	I					1	0.032			1.9E+01	c**	7.9E+01	c**					2.2E+00	c**			1.3E-02	
Triphenylphosphine Oxide	791-28-6					2.0E-02	P					1	0.1			1.2E+03	n	1.2E+04	n					7.3E+02	n			3.0E+00	
Tris(2-chloroethyl)phosphate	115-96-8	2.0E-02	P			7.0E-03	P					1	0.1			2.4E+01	c*	8.6E+01	c*					3.4E+00	c*			3.3E-03	
Tris(2-ethylhexyl)phosphate	78-42-2	3.2E-03	P			1.0E-01	P					1	0.1			1.5E+02	c*	5.4E+02	c					2.1E+01	c			1.0E+02	
Uranium (Soluble Salts)	NA					3.0E-03	I	3.0E-04	A			1				2.3E+02	n	3.1E+03	n	3.1E-01	n	1.3E+00	n	1.1E+02	n			4.9E+01	
Urethane	51-79-6	1.0E+00	C	2.9E-04	C											6.4E-01	c	2.9E+00	c	4.2E-03	c	4.2E-02	c	6.7E-02	c			1.5E-05	
Vanadium Pentoxide	1314-62-1			8.3E-03	P	9.0E-03	I	7.0E-06	P			0.026				4.0E+02	c**	2.0E+03	c**	2.9E-04	c*	1.5E-03	c*	3.3E+02	n				
Vanadium Sulfate	36907-42-3					2.0E-02	H					0.026				1.6E+03	n	2.0E+04	n					7.3E+02	n				
Vanadium and Compounds	NA					5.0E-03	S					1				3.9E+02	n	5.2E+03	n					1.8E+02	n			1.8E+02	
Vanadium, Metallic	7440-62-2					7.0E-05	P					0.026				5.5E+00	n	7.2E+01	n					2.6E+00	n			2.6E+00	
Vernolate	1929-77-7					1.0E-03	I					1	0.1			6.1E+01	n	6.2E+02	n					3.7E+01	n			2.9E-02	
Vinclozolin	50471-44-8					2.5E-02	I					1	0.1			1.5E+03	n	1.5E+04	n					9.1E+02	n			7.0E-01	
Vinyl Acetate	108-05-4					1.0E+00	H	2.0E-01	I	V		1		2.8E+03		9.7E+02	n	4.1E+03	ns	2.1E+02	n	8.8E+02	n	4.1E+02	n			8.8E-02	
Vinyl Bromide	593-60-2			3.2E-05	H			3.0E-03	I	V		1		3.4E+03		1.1E-01	c*	5.6E-01	c*	7.6E-02	c*	3.8E-01	c*	1.5E-01	c*			4.4E-05	
Vinyl Chloride	75-01-4	7.2E-01	I	4.4E-06	I	3.0E-03	I	1.0E-01	I	V	M	1		3.9E+03		6.0E-02	c	1.7E+00	c	1.6E-01	c	2.8E+00	c	1.6E-02	c	2.0E+00		5.6E-06	6.9E-04
Warfarin	81-81-2					3.0E-04	I					1	0.1			1.8E+01	n	1.8E+02	n					1.1E+01	n			1.2E-02	
Xylene, Mixture	1330-20-7					2.0E-01	I	1.0E-01	I	V		1		2.6E+02		6.3E+02	ns	2.7E+03	ns	1.0E+02	n	4.4E+02	n	2.0E+02	n	1.0E+04		2.0E-01	9.8E+00
Xylene, P-	106-42-3					2.0E-01	I	7.0E-01	C	V		1		3.9E+02		3.4E+03	ns	1.7E+04	ns	7.3E+02	n	3.1E+03	n	1.2E+03	n			1.2E+00	
Xylene, m-	108-38-3					2.0E-01	I	7.0E-01	C	V		1		3.9E+02		3.4E+03	ns	1.7E+04	ns	7.3E+02	n	3.1E+03	n	1.2E+03	n			1.2E+00	
Xylene, o-	95-47-6					2.0E-01	I	7.0E-01	C	V		1		4.3E+02		3.8E+03	ns	1.9E+04	ns	7.3E+02	n	3.1E+03	n	1.2E+03	n			1.2E+00	
Zinc (Metallic)	7440-66-6					3.0E-01	I					1				2.3E+04	n	3.1E+05	nm					1.1E+04	n			6.8E+02	
Zinc Phosphide	1314-84-7					3.0E-04	I					1				2.3E+01	n	3.1E+02	n					1.1E+01	n				
Zineb	12122-67-7					5.0E-02	I					1	0.1			3.1E+03	n	3.1E+04	n					1.8E+03	n			5.3E+00	
Xylene, Mixture	1330-20-7					2.0E-01	I	1.0E-01	I	V		1		2.6E+02		6.3E+02	ns	2.7E+03	ns	1.0E+02	n	4.4E+02	n	2.0E+02	n	1.0E+04		2.0E-01	9.8E+00
Xylene, P-	106-42-3					2.0E-01	I	7.0E-01	C	V		1		3.9E+02		3.4E+03	ns	1.7E+04	ns	7.3E+02	n	3.1E+03	n	1.2E+03	n			1.2E+00	
Xylene, m-	108-38-3					2.0E-01	I	7.0E-01	C	V		1		3.9E+02		3.4E+03	ns	1.7E+04	ns	7.3E+02	n	3.1E+03	n	1.2E+03	n			1.2E+00	
Xylene, o-	95-47-6					2.0E-01	I	7.0E-01	C	V		1		4.3E+02		3.8E+03	ns	1.9E+04	ns	7.3E+02	n	3.1E+03	n	1.2E+03	n			1.2E+00	
Zinc (Metallic)	7440-66-6					3.0E-01	I					1				2.3E+04	n	3.1E+05	nm					1.1E+04	n			6.8E+02	
Zinc Phosphide	1314-84-7					3.0E-04	I					1				2.3E+01	n	3.1E+02	n					1.1E+01	n				
Zineb	12122-67-7					5.0E-02	I					1	0.1			3.1E+03	n	3.1E+04	n					1.8E+03	n			5.3E+00	

EPA National Primary Drinking Water Standards

	Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal
OC	Acrylamide	TT[8]	Nervous system or blood problems;	Added to water during sewage/wastewater increased risk of cancer treatment	zero
OC	Alachlor	0.002	Eye, liver, kidney or spleen problems; anemia; increased risk of cancer	Runoff from herbicide used on row crops	zero
R	Alpha particles	15 picocuries per Liter (pCi/L)	Increased risk of cancer	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation	zero
IOC	Antimony	0.006	Increase in blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder	0.006
IOC	Arsenic	0.010 as of 1/23/06	Skin damage or problems with circulatory systems, and may have increased risk of getting cancer	Erosion of natural deposits; runoff from orchards, runoff from glass & electronics production wastes	0
IOC	Asbestos (fibers >10 micrometers)	7 million fibers per Liter (MFL)	Increased risk of developing benign intestinal polyps	Decay of asbestos cement in water mains; erosion of natural deposits	7 MFL
OC	Atrazine	0.003	Cardiovascular system or reproductive problems	Runoff from herbicide used on row crops	0.003
IOC	Barium	2	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits	2
OC	Benzene	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Discharge from factories; leaching from gas storage tanks and landfills	zero
OC	Benzo(a)pyrene (PAHs)	0.0002	Reproductive difficulties; increased risk of cancer	Leaching from linings of water storage tanks and distribution lines	zero
IOC	Beryllium	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries	0.004
R	Beta particles and photon emitters	4 millirems per year	Increased risk of cancer	Decay of natural and man-made deposits of certain minerals that are radioactive and may emit forms of radiation known as photons and beta radiation	zero
DBP	Bromate	0.010	Increased risk of cancer	Byproduct of drinking water disinfection	zero
IOC	Cadmium	0.005	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints	0.005
OC	Carbofuran	0.04	Problems with blood, nervous system, or reproductive system	Leaching of soil fumigant used on rice and alfalfa	0.04
OC	Carbon tetrachloride	0.005	Liver problems; increased risk of cancer	Discharge from chemical plants and other industrial activities	zero
D	Chloramines (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort, anemia	Water additive used to control microbes	MRDLG=4[1]

LEGEND

D Dinsinfectant
DBP Disinfection Byproduct
IOC Inorganic Chemical
M Microorganism
OC Organic Chemical
R Radionuclides

	Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal
OC	Chlordane	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide	zero
D	Chlorine (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort	Water additive used to control microbes	MRDLG=4[1]
D	Chlorine dioxide (as ClO_2)	MRDL=0.8[1]	Anemia; infants & young children: nervous system effects	Water additive used to control microbes	MRDLG=0.8[1]
DBP	Chlorite	1.0	Anemia; infants & young children: nervous system effects	Byproduct of drinking water disinfection	0.8
OC	Chlorobenzene	0.1	Liver or kidney problems	Discharge from chemical and agricultural chemical factories	0.1
IOC	Chromium (total)	0.1	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits	0.1
IOC	Copper	TT[7]; Action Level = 1.3	Short term exposure: Gastrointestinal distress. Long term exposure: Liver or kidney damage. People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level	Corrosion of household plumbing systems; erosion of natural deposits	1.3
M	*Cryptosporidium*	TT[3]	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero
IOC	Cyanide (as free cyanide)	0.2	Nerve damage or thyroid problems	Discharge from steel/metal factories; discharge from plastic and fertilizer factories	0.2
OC	2,4-D	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops	0.07
OC	Dalapon	0.2	Minor kidney changes	Runoff from herbicide used on rights of way	0.2
OC	1,2-Dibromo-3-chloropropane (DBCP)	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards	zero
OC	o-Dichlorobenzene	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories	0.6
OC	p-Dichlorobenzene	0.075	Anemia; liver, kidney or spleen damage; changes in blood	Discharge from industrial chemical factories	0.075
OC	1,2-Dichloroethane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	zero
OC	1,1-Dichloroethylene	0.007	Liver problems	Discharge from industrial chemical factories	0.007
OC	cis-1,2-Dichloroethylene	0.07	Liver problems	Discharge from industrial chemical factories	0.07
OC	trans-1,2-Dichloroethylene	0.1	Liver problems	Discharge from industrial chemical factories	0.1
OC	Dichloromethane	0.005	Liver problems; increased risk of cancer	Discharge from drug and chemical factories	zero
OC	1,2-Dichloropropane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	zero
OC	Di(2-ethylhexyl) adipate	0.4	Weight loss, live problems, or possible reproductive difficulties	Discharge from chemical factories	0.4
OC	Di(2-ethylhexyl) phthalate	0.006	Reproductive difficulties; liver problems; increased risk of cancer	Discharge from rubber and chemical factories	zero
OC	Dinoseb	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables	0.007
OC	Dioxin (2,3,7,8-TCDD)	0.00000003	Reproductive difficulties; increased risk of cancer	Emissions from waste incineration and other combustion; discharge from chemical factories	zero
OC	Diquat	0.02	Cataracts	Runoff from herbicide use	0.02
OC	Endothall	0.1	Stomach and intestinal problems	Runoff from herbicide use	0.1

LEGEND

D Dinsinfectant
DBP Disinfection Byproduct
IOC Inorganic Chemical
M Microorganism
OC Organic Chemical
R Radionuclides

	Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal
OC	Endrin	0.002	Liver problems	Residue of banned insecticide	0.002
OC	Epichlorohydrin	TT[8]	Increased cancer risk, and over a long period of time, stomach problems	Discharge from industrial chemical factories; an impurity of some water treatment chemicals	zero
OC	Ethylbenzene	0.7	Liver or kidneys problems	Discharge from petroleum refineries	0.7
OC	Ethylene dibromide	0.00005	Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer	Discharge from petroleum refineries	zero
IOC	Fluoride	4.0	Bone disease (pain and tenderness of the bones); Children may get mottled teeth	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories	4.0
M	*Giardia lamblia*	TT[3]	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero
OC	Glyphosate	0.7	Kidney problems; reproductive difficulties	Runoff from herbicide use	0.7
DBP	Haloacetic acids (HAA5)	0.060	Increased risk of cancer	Byproduct of drinking water disinfection	n/a[6]
OC	Heptachlor	0.0004	Liver damage; increased risk of cancer	Residue of banned termiticide	zero
OC	Heptachlor epoxide	0.0002	Liver damage; increased risk of cancer	Breakdown of heptachlor	zero
M	Heterotrophic plate count (HPC)	TT[3]	HPC has no health effects; it is an analytic method used to measure the variety of bacteria that are common in water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.	HPC measures a range of bacteria that are naturally present in the environment	n/a
OC	Hexachlorobenzene	0.001	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Discharge from metal refineries and agricultural chemical factories	zero
OC	Hexachlorocyclopentadiene	0.05	Kidney or stomach problems	Discharge from chemical factories	0.05
IOC	Lead	TT[7]; Action Level = 0.015	Infants and children: Delays in physical or mental development; children could show slight deficits in attention span and learning abilities; Adults: Kidney problems; high blood pressure	Corrosion of household plumbing systems; erosion of natural deposits	zero
M	*Legionella*	TT[3]	Legionnaire's Disease, a type of pneumonia	Found naturally in water; multiplies in heating systems	zero
OC	Lindane	0.0002	Liver or kidney problems	Runoff/leaching from insecticide used on cattle, lumber, gardens	0.0002
IOC	Mercury (inorganic)	0.002	Kidney damage	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands	0.002
OC	Methoxychlor	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock	0.04
IOC	Nitrate (measured as Nitrogen)	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	10
IOC	Nitrite (measured as Nitrogen)	1	Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	1

LEGEND

D Dinsinfectant
DBP Disinfection Byproduct
IOC Inorganic Chemical
M Microorganism
OC Organic Chemical
R Radionuclides

	Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal
OC	Oxamyl (Vydate)	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, and tomatoes	0.2
OC	Pentachlorophenol	0.001	Liver or kidney problems; increased cancer risk	Discharge from wood preserving factories	zero
OC	Picloram	0.5	Liver problems	Herbicide runoff	0.5
OC	Polychlorinated biphenyls (PCBs)	0.0005	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Runoff from landfills; discharge of waste chemicals	zero
R	Radium 226 and Radium 228 (combined)	5 pCi/L	Increased risk of cancer	Erosion of natural deposits	zero
IOC	Selenium	0.05	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	Discharge from petroleum refineries; erosion of natural deposits; discharge from mines	0.05
OC	Simazine	0.004	Problems with blood	Herbicide runoff	0.004
OC	Styrene	0.1	Liver, kidney, or circulatory system problems	Discharge from rubber and plastic factories; leaching from landfills	0.1
OC	Tetrachloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from factories and dry cleaners	zero
IOC	Thallium	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories	0.0005
OC	Toluene	1	Nervous system, kidney, or liver problems	Discharge from petroleum factories	1
M	Total Coliforms (including fecal coliform and *E. coli*)	5.0%[4]	Not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present[5]	Coliforms are naturally present in the environment as well as feces; fecal coliforms and *E. coli* only come from human and animal fecal waste.	zero
DBP	Total Trihalomethanes (TTHMs)	0.10 0.080 after 12/31/03	Liver, kidney or central nervous system problems; increased risk of cancer	Byproduct of drinking water disinfection	n/a[6]
OC	Toxaphene	0.003	Kidney, liver, or thyroid problems; increased risk of cancer	Runoff/leaching from insecticide used on cotton and cattle	zero
OC	2,4,5-TP (Silvex)	0.05	Liver problems	Residue of banned herbicide	0.05
OC	1,2,4-Trichlorobenzene	0.07	Changes in adrenal glands	Discharge from textile finishing factories	0.07
OC	1,1,1-Trichloroethane	0.2	Liver, nervous system, or circulatory problems	Discharge from metal degreasing sites and other factories	0.20
OC	1,1,2-Trichloroethane	0.005	Liver, kidney, or immune system problems	Discharge from industrial chemical factories	0.003
OC	Trichloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from metal degreasing sites and other factories	zero
M	Turbidity	TT[3]	Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing micro-organisms such as viruses, parasites and some bacteria. These organisms can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.	Soil runoff	n/a
R	Uranium	30 ug/L as of 12/08/03	Increased risk of cancer, kidney toxicity	Erosion of natural deposits	zero

LEGEND

D Dinsinfectant

DBP Disinfection Byproduct

IOC Inorganic Chemical

M Microorganism

OC Organic Chemical

R Radionuclides

	Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal
OC	Vinyl chloride	0.002	Increased risk of cancer	Leaching from PVC pipes; discharge from plastic factories	zero
M	Viruses (enteric)	TT3	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero
OC	Xylenes (total)	10	Nervous system damage	Discharge from petroleum factories; discharge from chemical factories	10

NOTES

1 Definitions

- Maximum Contaminant Level Goal (MCLG)—The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.
- Maximum Contaminant Level (MCL)—The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.
- Maximum Residual Disinfectant Level Goal (MRDLG)—The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
- Maximum Residual Disinfectant Level (MRDL)—The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- Treatment Technique (TT)—A required process intended to reduce the level of a contaminant in drinking water.

2 Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter are equivalent to parts per million (ppm).

3 EPA's surface water treatment rules require systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

- *Cryptosporidium* (as of 1/1/02 for systems serving >10,000 and 1/14/05 for systems serving <10,000) 99% removal.
- *Giardia lamblia*: 99.9% removal/inactivation
- Viruses: 99.99% removal/inactivation
- *Legionella:* No limit, but EPA believes that if *Giardia* and viruses are removed/inactivated, *Legionella* will also be controlled.
- Turbidity: At no time can turbidity (cloudiness of water) go above 5 nephelolometric turbidity units (NTU); systems that filter must ensure that the turbidity go no higher than 1 NTU (0.5 NTU for conventional or direct filtration) in at least 95% of the daily samples in any month. As of January 1, 2002, for systems servicing >10,000, and January 14, 2005, for systems servicing <10,000, turbidity may never exceed 1 NTU, and must not exceed 0.3 NTU in 95% of daily samples in any month.
- HPC: No more than 500 bacterial colonies per milliliter
- Long Term 1 Enhanced Surface Water Treatment (Effective Date: January 14, 2005); Surface water systems or (GWUDI) systems serving fewer than 10,000 people must comply with the applicable Long Term 1 Enhanced Surface Water Treatment Rule provisions (e.g. turbidity standards, individual filter monitoring, *Cryptosporidium* removal requirements, updated watershed control requirements for unfiltered systems).
- Filter Backwash Recycling: The Filter Backwash Recycling Rule requires systems that recycle to return specific recycle flows through all processes of the system's existing conventional or direct filtration system or at an alternate location approved by the state.

4 No more than 5.0% samples total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive per month.) Every sample that has total coliform must be analyzed for either fecal coliforms or *E. coli* if two consecutive TC-positive samples, and one is also positive for *E. coli* fecal coliforms, system has an acute MCL violation.

5 Fecal coliform and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Disease-causing microbes (pathogens) in these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms. These pathogens may pose a special health risk for infants, young children, and people with severely compromised immune systems.

6 Although there is no collective MCLG for this contaminant group, there are individual MCLGs for some of the individual contaminants:

- Haloacetic acids: dichloroacetic acid (zero); trichloroacetic acid (0.3 mg/L)
- Trihalomethanes: bromodichloromethane (zero); bromoform (zero); dibromochloromethane (0.06 mg/L)

7 Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.

8 Each water system must certify, in writing, to the state (using third-party or manufacturers certification) that when it uses acrylamide and/or epichlorohydrin to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows: Acrylamide = 0.05% dosed at 1 mg/L (or equivalent); Epichlorohydrin = 0.01% dosed at 20 mg/L (or equivalent).

LEGEND

D Dinsinfectant
DBP Disinfection Byproduct
IOC Inorganic Chemical
M Microorganism
OC Organic Chemical
R Radionuclides

National Secondary Drinking Water Standards

National Secondary Drinking Water Standards are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, states may choose to adopt them as enforceable standards.

Contaminant	Secondary Standard
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	noncorrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5-8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

Office of Water (4606M)
EPA 816-F-03-016
www.epa.gov/safewater
June 2003

S&ME

UNIFORM PROTOCOLS

FOR USE BY ALL LOCATIONS

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S&ME

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

DECONTAMINATION: Soil Sampling Equipment

OBJECTIVE

The integrity of collected soil samples can be compromised by sampling equipment that is not properly decontaminated. Chemical constituents on the sampling equipment as a result of contaminated soil at a previous sampling location or from spurious sources can be introduced into the collected sample, resulting in analytical testing results not representative of the soil at the collection point. The objective of this procedure is to remove any contamination from soil sampling tools prior to the collection of the sample to the extent practical, so that the sample collected in not compromised by the sampling equipment.

APPLICABILITY

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of soil samples.

GENERAL

Cleaning and decontamination procedures for all environmental field sampling equipment will be conducted in a thorough and stepwise manner as indicated by the methods described below for each medium to be sampled. If necessary, specific areas to be utilized as contaminant reduction zones will be designated in a site specific health and safety plan. Deionized water, isopropyl alcohol, acid solutions, and other decon fluids will be technical grade at a minimum. All rinse water and other fluids from decontamination of sampling equipment will be collected and stored for proper disposal or otherwise handled in such a way as to not spread contamination. Clean, new disposable latex gloves will be worn during decon of sampling equipment, with the exception of drilling rigs and other heavy equipment. All health and safety procedures must be followed during decon of sampling equipment.

Decon of sampling equipment must be documented. Decontamination procedures must be reviewed for applicability for each site, based on the contaminants and media involved. *Variations from these decon protocols are authorized by the project manager only, with approval of the department manager. Any deviation of standard decon protocols must be documented.*

Personnel will take care to protect decontaminated sampling tools from recontamination. Decontaminated tools will not be allowed to contact soil, unprotected hands, or other potential sources of recontamination. When decontaminating several tools at one time, personnel shall replace latex gloves as frequently as necessary to prevent transferring contamination from one tool onto another one.

EQUIPMENT

Hand Augers, trowels, stainless steel spoons, spades, shovels, etc.

PREPARATION FOR DECON

Remove all heavily contaminated materials, large clumps of soil, and other such materials from the last use. It is best to do this at the previous sampling site, so as not to spread contaminated materials from their original site. Prepare all decontamination fluids. Lay down clean plastic sheet for decon procedures, providing for collection of spent fluids. Lay down a separate sheet in a clean area on which to place decontaminated tools for drying and wrapping. Deionized water, isopropyl alcohol, acid solutions, and other decon fluids will be technical grade at a minimum.

DECONTAMINATION PROCEDURE

1. Clean soil free sample equipment with potable water and phosphate-free laboratory detergent (Alconox or equivalent), using a brush, if necessary, to remove particulate matter and surface films.

2. Rinse thoroughly with potable water.

3. Rinse thoroughly with deionized water.

4. Rinse thoroughly with isopropyl alcohol rinse.

5. Triple rinse with deionized water.

6. Allow to air dry, taking care to protect sampling equipment from dusty conditions.

7. Wrap with aluminum foil, shiny side out, to prevent contamination of stored or transported sampling equipment

(For field sampling equipment utilized at sites with potential metals contamination, optionally insert the following steps after step 5 above:

5a. Rinse with 0.5-1.0 N nitric acid solution

5b. Rinse thoroughly with deionized water.

5c. Rinse with 0.5-1.0 N hydrochloric acid solution)

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

COLLECTION OF SOIL SAMPLES: Surface and Shallow Depths

OBJECTIVE

The integrity of collected soil samples can be affected by many factors, including the methods and procedures by which a sampling site is selected and the actual collection of the soil sample. The objective of this protocol is to provide for uniform methods by which samples are collected by S&ME personnel which have minimum impact on the nature of the sample and for the documentation of those methods used in the collection of the samples.

APPLICABILITY

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of soil samples.

GENERAL

This protocol describes standard procedures for the collection of representative soil samples at spot locations from the surface or shallow excavations (shallow sampling). The purpose of the sampling is to collect representative samples for submission to an analytical laboratory or other testing for chemical contamination.

All sampling equipment will be deconned according to S&ME's Sampling Equipment Decon Protocol or other approved means prior to sampling and deconned sampling equipment will be protected from contaminated sources (including airborne sources) until used to collect the sample. Sampling equipment will be handled only while wearing clean latex gloves which may be covered by other clean gloves if required by the health and safety plan or for mechanical protection. All health and safety procedures from the general or site health and safety plan will be followed at all times.

All soil sampling procedures will be logged in the site field sampling logbook or approved forms. *Variations from this protocol are authorized only by the project manager, with approval by the department manager. Any deviation from this protocol must be clearly documented.*

EQUIPMENT

Stainless steel spoons, spatulas, trowels, hand augers, spades, shovels, split spoon samplers, shelby tube samplers.

Clean sample containers, either laboratory supplied for the purpose of sample collection or decontaminated according to the Sampling Equipment Decon Protocol. All decon and preservation fluids must be technical grade at a minimum.

PREPARATION FOR SAMPLING

Identify and mark the sample location and document in the site field logbook to sufficient extent that location can be identified at a later time. Photographs of the sample location are very helpful. Prepare the location for sampling.

If the sample is to be collected from the surface, brush all leaves, roots, sticks, and other debris away from the sampling location a sufficient distance that they will not interfere with sampling or possibly get included into the sample. If the sample is to be collected from below the ground, dig down to the sampling depth in a diameter sufficient to allow a discrete sample to be collected. All excavation tools should be clean. The last few inches of soil should be removed using decontaminated tools so that the top portion of the sample will not be contaminated by digging tools.

SURFACE AND SHALLOW SOIL SAMPLING PROCEDURE

1. Brush all loose dirt and any remaining debris away from the sampling location. Using a decontaminated tool, remove a thin layer of soil from the sampling surface. The sampling surface must be undisturbed by digging tools to assure that contamination has not been introduced to the sampling location from above. Do not collect the sample at or near any visible roots or other vegetative matter. If this is not possible due to the prevalence of roots and the sample location cannot be moved, minimize any roots and root hairs in the sample and note these field conditions in the site field logbook.

2. Using another decontaminated sampling tool (usually a stainless steel spoon or spatula), dig out a plug of soil and transfer directly to the sampling container. Make sure that an adequate volume of soil is placed in the container for the laboratory analysis to be performed. If VOC's are to be analyzed, the sampling should be done as quickly as possible and the sample container should be filled as full as possible.

3. Place cap tightly onto container. It is recommended that the sample identification label be placed on the container before the sample is collected. If it has not been, the container must be labelled immediately after closing the container.

4. Enter the sample information in the site field logbook.

5. Place the sample in a cool dry place. Fill out the chain-of-custody form. The sample must be kept in personal possession of the sampler or sample custodian, or otherwise secured in order to maintain chain-of-custody and sample integrity.

TO: S&ME BRANCH MANAGERS
FROM: S&ME TECHNICAL STEERING COMMITTEE
Ernie Parker, Chairman
SUBJECT: S&ME UNIFORM ENVIRONMENTAL PROTOCOLS
DATE: JUNE 11, 1993

Most environmental projects involve various types of field testing and the collection of environmental media samples of air, soil, and water. The samples are generally tested by an analytical laboratory for the presence and quantification of contaminants. The field and laboratory test results are used to characterize the subject sites and are relied on heavily by ourselves, our clients, regulators, and others as the basis for many regulatory and environmental decisions. Therefore, the accuracy and validity of the data are critical.

The results of field testing are affected by such factors as the knowledge and capability of field personnel, the condition of the test equipment, the applicability of the test to the site conditions, and skillful data interpretation and analysis. Environmental contamination samples can also be greatly affected by the selection of sampling locations, the sampling equipment used and the condition of that equipment, the procedures used to collect the sample, and the handling and transportation of the sample to the testing laboratory. Proper Chain-of-Custody procedures are also required to assure the validity of the sample results.

Since the accuracy and validity of field and analytical test data are so critical to environmental projects and consistent procedures are required for consistent results, the Technical Steering Committee has recommended to management that uniform environmental protocols be established by S&ME. Management agrees with this concept. <u>These protocols are to be used on a mandatory basis by all locations except where there are substantial and documented reasons for not doing so</u>. Some reasons for varying from standard protocols could include:

-specific direction from clients or regulators;
-inappropriateness to specific site conditions; and,
-collection of special purpose samples requiring special collection and handling.

It is important that actual field procedures not vary from standard protocols without approval. <u>Any variations from standard protocols **must** be approved in advance by the project manager, with the concurrence of the department manager. Any variations from standard protocols and any alternative protocols used must be documented in the files showing the reasons for such variations and the approvals of the project and department managers</u>.

Training programs should be held for field personnel to demonstrate the protocols, and to emphasize the importance of carefully following the protocols and of documenting and notifying the project manager of any variations from standard protocols.

S&ME UNIFORM ENVIRONMENTAL PROTOCOLS

CONTENTS

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

Objective:

The integrity of collected soil samples can be compromised by sampling equipment that is not properly decontaminated. Chemical constituents on the sampling equipment as a result of contaminated soil at a previous sampling location or from spurious sources can be introduced into the collected sample, resulting in analytical testing results not representative of the soil at the collection point. The objective of this procedure is remove any contamination from soil sampling tools prior to the collection of the sample to the extent practical, so that the sample collected is not compromised by the sampling equipment.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of soil samples.

General:

Cleaning and decontamination procedures for all environmental field sampling equipment will be conducted in a thorough and stepwise manner as indicated by the methods described below for each medium to be sampled. If necessary, specific areas to be utilized as contaminant reduction zones will be designated in a site specific health and safety plan. Deionized water, isopropyl alcohol, acid solutions, and other decon fluids will be technical grade at a minimum. All rinse water and other fluids from decontamination of sampling equipment will be collected and stored for proper disposal or otherwise handled in such a way as to not spread contamination. Clean, new disposable latex gloves will be worn during decon of sampling equipment, with the exception of drilling rigs and other heavy equipment. All health and safety procedures must be followed during decon of sampling equipment.

Decon of sampling equipment must be documented. Decontamination procedures must be reviewed for applicability for each site, based on the contaminants and media involved. Variations from these decon protocols are authorized by the project manager only, with approval of the department manager. Any deviation of standard decon protocols must be documented.

Personnel will take care to protect decontaminated sampling tools from recontamination. Decontaminated tools will not be allowed to contact soil, unprotected hands, or other potential sources of recontamination. When decontaminating several tools at one time, personnel shall replace latex gloves as frequently as necessary to prevent transferring contamination from one tool onto another one.

Equipment:

Hand Augers, trowels, stainless steel spoons, spades, shovels, etc.

Preparation for Decon:

Remove all heavily contaminated materials, large clumps of soil, and other such materials from the last use. It is best to do this at the previous sampling site, so as not to spread contaminated materials from their original site. Prepare all decontamination fluids. Lay down clean plastic sheet for decon procedures, providing for the collection of spent fluids. Lay down a separate sheet in a clean area on which to place decontaminated tools for drying and wrapping. Deionized water, isopropyl alcohol, acid solutions, and other decon fluids will be technical grade at a minimum.

Decontamination Procedure:

1.Clean soil free sample equipment with potable water and phosphate-free laboratory detergent (Alconox or equivalent), using a brush, if necessary, to remove particulate matter and surface films.

2.Rinse thoroughly with potable water.

3.Rinse thoroughly with deionized water.

4.Rinse thoroughly with isopropyl alcohol rinse.

5.Triple rinse with deionized water.

6.Allow to air dry, taking care to protect sampling equipment from dusty conditions.

7.Wrap with aluminum foil, shiny side out, to prevent contamination of stored or transported sampling equipment.

(For field sampling equipment utilized at sites with potential metals contamination, optionally insert the following steps after step 5 above:

5a.Rinse with 0.5-1.0 N nitric acid solution.

5b.Rinse thoroughly with deionized water.

5c.Rinse with 0.5-1.0 N hydrochloric acid solution.)

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

Objective:

The integrity of collected water samples can be compromised by sampling equipment that is not properly decontaminated. Chemical constituents on the sampling equipment as a result of contamination from a previous sampling location or from spurious sources can be introduced into the collected sample, resulting in analytical testing results not representative of the water at the collection point. The objective of this procedure is remove any contamination from sampling tools prior to the collection of the sample to the extent practical, so that the sample collected is not compromised by the sampling equipment.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in collecting groundwater samples.

General:

Cleaning and decontamination procedures for all environmental field sampling equipment will be conducted in a thorough and stepwise manner as indicated by the methods described below for each medium to be sampled. If necessary, specific areas to be utilized as contaminant reduction zones will be designated in a site specific health and safety plan. Deionized water, isopropyl alcohol, acid solutions, and other decon fluids will be technical grade at a minimum. All rinse water and other fluids from decontamination of sampling equipment will be collected and stored for proper disposal or otherwise handled in such a way as to not spread contamination. Clean, new disposable latex gloves will be worn during decon of sampling equipment, with the exception of drilling rigs and other heavy equipment. All health and safety procedures must be followed during decon of sampling equipment.

Decon of sampling equipment must be documented. Decontamination procedures must be reviewed for applicability for each site, based on the contaminants and media involved. Variations from these decon protocols are authorized by the project manager only, with approval of the department manager. Any deviation of standard decon protocols must be documented.

Personnel will take care to protect decontaminated sampling tools from recontamination. Decontaminated tools will not be allowed to contact soil, unprotected hands, or other potential sources of recontamination. When decontaminating several tools at one time, personnel shall replace latex gloves as frequently as necessary to prevent transferring contamination from one tool onto another one.

Equipment: bailers, pumps

Preparation for Decon:

Prepare all decontamination fluids. Lay down clean plastic sheet for decon procedures, providing for the collection of spent fluids. Lay down a separate sheet in a clean area on which to place decontaminated tools for drying and wrapping. Deionized water, isopropyl alcohol, acid solutions, and other decon fluids will be technical grade at a minimum.

Decontamination Procedure:

1.Rinse thoroughly with potable water.

2.Wash inside and outside thoroughly with phosphate-free laboratory detergent (Alconox or equivalent).

3.Rinse thoroughly (inside and outside) with deionized water.

4.Rinse thoroughly (inside and outside) with isopropyl alcohol rinse.

5.Triple rinse (inside and outside) with deionized water.

6.Allow to air dry, taking care to protect sampling equipment from dusty conditions.

7.Wrap with aluminum foil, shiny side out, to prevent contamination of stored or transported sampling equipment.

(For field sampling equipment utilized at sites with potential metals contamination, optionally insert the following steps after step 5 above:

5a.Rinse (inside and outside) with 0.5-1.0 N nitric acid solution.

5b.Rinse thoroughly (inside and outside) with deionized water.

5c.Rinse (inside and outside) with 0.5-1.0 N hydrochloric acid solution.)

Note: Decontamination of inside of pumps may not be technically feasible due to pump construction. Perform to the extent appropriate as determined by the project manager.

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

DECONTAMINATION: Drilling Equipment/Well Construction Materials

Objective:

The integrity of collected soil and water samples can be compromised by sampling equipment that is not properly decontaminated. Chemical constituents on the sampling equipment as a result of contaminated soil and water at a previous sampling location or from spurious sources can be introduced into the collected sample, resulting in analytical testing results not representative of the conditions at the collection point. The objective of this procedure is remove any contamination from sampling tools prior to the collection of the sample to the extent practical, so that the sample collected is not compromised by the sampling equipment.

Applicability:

Project managers, geologists, environmental technicians, and other technical / professional personnel involved in collecting environmental samples from borings and wells.

General:

Cleaning and decontamination procedures for all environmental field equipment will be conducted in a thorough and stepwise manner as indicated by the methods described below for each medium to be sampled. If necessary, specific areas to be utilized as contaminant reduction zones will be designated in a site specific health and safety plan. All rinse water and other fluids from decontamination of equipment will be collected and stored for proper disposal or otherwise handled in such a way as to not spread contamination. All health and safety procedures must be followed during decon of equipment.

Decon of equipment must be documented. Decontamination procedures must be reviewed for applicability for each site, based on the contaminants and media involved. Variations from these decon protocols are authorized by the project manager only, with approval of the department manager. Any deviation of standard decon protocols must be documented.

Equipment:

Truck, skid, or trailer mounted drill rigs, drill bits, drill rods, stabilizers, mud pans, wrenches, hammers, cheater bars, pumps, hoses, grout mixing equipment, split spoon samplers, shelby tube samplers, packers, well casing. well screen, well caps and couplings, etc.

Preparation for Decon:

All drilling equipment shall be free of caked-on soil and heavy contamination prior to decon procedures. Wherever possible, these materials should be removed at the site of the equipment's prior use to minimize transporting the contamination from that location. Well construction materials should be stored at all times in a manner and location to minimize their coming into contact with contaminated materials. A decontamination pad will be prepared, large enough to collect and contain all soil and fluids resulting from decontamination of equipment. Provisions will be made to use a membrane of sufficient strength as not to be torn or punctured by the drilling equipment moving onto and off of the decon pad. Auger, drill rod, etc. shall be mounted on trailers or racks wherever possible to facilitate effective decon and to minimize recontamination of these tools by contact with soil.

Decontamination Procedure:

1.The equipment will be free of excess grease, oils, and caked-on soils from previous work prior to arrival at the site.

2.Equipment which has been determined to leak fuel, cooling fluids, crankcase oil, transmission fluids, hydraulic oils, and lubricants shall be repaired prior to use at the site. Should leaks occur during use at the site, the equipment will be repaired at the soonest possible opportunity, in no case later than the next time it is to be deconned.

3.All other equipment which has the potential of introducing contamination into the borehole will be flushed with potable water or other wise cleaned prior to use.

4.Steam-cleaning with a high pressure system will be used to conduct decontamination as outlined below. NOTE: Steam cleaning will volatilize VOC's on drilling equipment and may create a significant potential threat to personnel exposure to inhalation of VOC's. The site health and safety plan must address the potential need for respiratory protection during this activity or any other use of steam cleaning.

5.Clean thoroughly (both inside orifices and outside areas) with a steam cleaning unit (water at 200 degrees F and 1500 psi).

6.Allow to drip dry on the decon pad until minimal fluids drip from the equipment. If the equipment is not to used immediately after decon, sampling tools should be wrapped in aluminum foil (shiny side out). All auger, drill rod, and other tools which will enter the borehole will be covered with a clean tarp to prevent recontamination by dust.

7.Well casing, screen, caps, couplings, etc. will be steam cleaned inside and out immediately prior to use. These well construction materials will be suspended on racks, pallets, trailers, saw-bucks, or other supports. They will not be laid directly onto the decon pad membrane to avoid contact with heavily contaminated materials that have been removed from the drilling equipment.

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

DECONTAMINATION: Sediment Sampling Equipment

Objective:

The integrity of collected soil samples can be compromised by sampling equipment that is not properly decontaminated. Chemical constituents on the sampling equipment as a result of contaminated soil at a previous sampling location or from spurious sources can be introduced into the collected sample, resulting in analytical testing results not representative of the soil at the collection point. The objective of this procedure is remove any contamination from sampling tools prior to sample collection to the extent practical, so that the sample collected is not compromised by the sampling equipment.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of soil samples.

General:

Cleaning and decontamination procedures for all environmental field sampling equipment will be conducted in a thorough and stepwise manner as indicated by the methods described below for each medium to be sampled. If necessary, specific areas to be utilized as contaminant reduction zones will be designated in a site specific health and safety plan. Deionized water, isopropyl alcohol, acid solutions, and other decon fluids will be technical grade at a minimum. All rinse water and other fluids from decontamination of sampling equipment will be collected and stored for proper disposal or otherwise handled in such a way as to not spread contamination. Clean, new disposable latex gloves will be worn during decon of sampling equipment, with the exception of drilling rigs and other heavy equipment. All health and safety procedures must be followed during decon of sampling equipment.

Decon of sampling equipment must be documented. Decontamination procedures must be reviewed for applicability for each site, based on the contaminants and media involved. Variations from these decon protocols are authorized by the project manager only, with approval of the department manager. Any deviation of standard decon protocols must be documented.

Personnel will take care to protect decontaminated sampling tools from recontamination. Decontaminated tools will not be allowed to contact soil, unprotected hands, or other potential sources of recontamination. When decontaminating several tools at one time, replace latex gloves as frequently as necessary to prevent transferring contamination from one tool onto another one.

Equipment:

Metal beakers, shovels, buckets, trowels, stainless steel spoons, etc.

Preparation for Decon:

Remove all heavily contaminated materials, large clumps of soil, and other materials from the last use. It is best to do this at the previous sampling site so as not to spread contaminated materials from their original site. Insofar as possible, attempt to do so in a manner to minimize the transport of disturbed sediments downstream by surface water. Prepare all decontamination fluids. Lay down clean plastic sheet for decon procedures, providing for the collection of spent fluids. Lay down a separate sheet in a clean area on which to place decontaminated tools for drying and wrapping. Deionized water, isopropyl alcohol, acid solutions, and other decon fluids will be minimum technical grade.

Decontamination Procedure:

1.Clean soil free sample equipment with potable water and phosphate-free laboratory detergent (Alconox or equivalent), using a brush, if necessary, to remove particulate matter and surface films.

2.Rinse thoroughly with potable water.

3.Rinse thoroughly with deionized water.

4.Rinse thoroughly with isopropyl alcohol rinse.

5.Triple rinse with deionized water.

6.Allow to air dry, taking care to protect sampling equipment from dusty conditions.

7.Wrap with aluminum foil, shiny side out, to prevent contamination of stored or transported sampling equipment.

(For field sampling equipment utilized at sites with potential metals contamination, optionally insert the following steps after step 5 above:

5a.Rinse with 0.5-1.0 N nitric acid solution.

5b.Rinse thoroughly with deionized water.

5c.Rinse with 0.5-1.0 N hydrochloric acid solution.)

Hand Augers, trowels, stainless steel spoons, spades, shovels, etc.

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

COLLECTION OF SOIL SAMPLES: Surface and Shallow Depths

Objective:

The integrity of collected soil samples can be affected by many factors, including the methods and procedures by which a sampling site is selected and the actual collection of the soil sample. The objective of this protocol is to provide for uniform methods by which samples are collected by S&ME personnel which have minimum impact on the nature of the sample and for the documentation of those methods used in the collection of the samples.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of soil samples.

General:

This protocol describes standard procedures for the collection of representative soil samples at spot locations from the surface or shallow excavations (shallow sampling). The purpose of the sampling is to collect representative samples for submission to an analytical laboratory or other testing for chemical contamination.

All sampling equipment will be deconned according to S&ME's Sampling Equipment Decon Protocol or other approved means prior to sampling and deconned sampling equipment will be protected from contaminated sources (including airborne sources) until used to collect the sample. Sampling equipment will be handled only while wearing clean latex gloves which may be covered by other clean gloves if required by the health and safety plan or for mechanical protection. All health and safety procedures from the general or site health and safety plan will be followed at all times.

All soil sampling procedures will be logged in the site field sampling logbook or approved forms. Variations from this protocol are authorized only by the project manager, with approval by the department manager. Any deviation from this protocol must be clearly documented.

Equipment:

Stainless steel spoons, spatulas, trowels, hand augers, spades, shovels, split spoon samplers, shelby tube samplers.

Clean sample containers, either laboratory supplied for the purpose of sample collection or decontaminated according to the Sampling Equipment Decon Protocol. All decon and preservation fluids must be technical grade at a minimum.

Preparation for Sampling:

Identify and mark the sample location and document in the site field logbook to sufficient extent that location can be identified at a later time. Photographs of the sample location are very helpful. Prepare the location for sampling.

If the sample is to be collected from the surface, brush all leaves, roots, sticks, and other debris away from the sampling location a sufficient distance that they will not interfere with sampling or possibly get included into the sample. If the sample is to be collected from below the ground, dig down to the sampling depth in a diameter sufficient to allow a discrete sample to be collected. All excavation tools should be clean. The last few inches of soil should be removed using decontaminated tools so that the top portion of the sample will not be contaminated by digging tools.

Surface and Shallow Soil Sampling Procedure:

1. Brush all loose dirt and any remaining debris away from the sampling location. Using a decontaminated tool, remove a thin layer of soil from the sampling surface. The sampling surface must be undisturbed by digging tools to assure that contamination has not been introduced to the sampling location from above. Do not collect the sample at or near any visible roots or other vegetative matter. If this is not possible due to the prevalence of roots and the sample location cannot be moved, minimize any roots and root hairs in the sample and note these field conditions in the site field logbook.
2. Using another decontaminated sampling tool (usually a stainless steel spoon or spatula), dig out a plug of soil and transfer directly to the sampling container. Make sure that an adequate volume of soil is placed in the container for the laboratory analysis to be performed. If VOC's are to be analyzed, the sampling should be done as quickly as possible and the sample container should be filled as full as possible.
3. Place cap tightly onto container. It is recommended that the sample identification label be placed on the container before the sample is collected. If it has not been, the container must be labelled immediately after closing the container.
4. Enter the sample information in the site field logbook.
5. Place the sample in a cool dry place. Fill out the chain-of-custody form. The sample must be kept in personal possession of the sampler or sample custodian, or otherwise secured in order to maintain chain-of-custody and sample integrity.

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

COLLECTION OF SOIL SAMPLES:Intermediate Depths (Test Pits)

Objective:

The integrity of collected soil samples can be affected by many factors, including the methods and procedures by which a sampling site is selected and the actual collection of the soil sample. The objective of this protocol is to provide for uniform methods by which samples are collected by S&ME personnel which have minimum impact on the nature of the sample and for the documentation of those methods used in the collection of the samples.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of soil samples.

General:

This protocol describes standard procedures for the collection of representative soil samples at spot locations from shallow excavations test pits. The purpose of the sampling is to collect representative samples for submission to an analytical laboratory or other testing for chemical contamination.

All sampling equipment will be deconned according to S&ME's Sampling Equipment Decon Protocol or other approved means prior to sampling and deconned sampling equipment will be protected from contaminated sources (including airborne sources) until used to collect the sample. Sampling equipment will be handled only while wearing clean latex gloves which may be covered by other clean gloves if required by the health and safety plan or for mechanical protection. All health and safety procedures from the general or site health and safety plan will be followed at all times.

All soil sampling procedures will be logged in the site field sampling logbook or approved forms. Variations from this protocol are authorized only by the project manager, with approval by the department manager. Any deviation from this protocol must be clearly documented.

Equipment:

Stainless steel spoons, spatulas, trowels, spades, shovels, split spoon samplers, shelby tube samplers, etc.

Clean sample containers, either laboratory supplied for the purpose of sample collection or decontaminated according to the Sampling Equipment Decon Protocol. All decon and preservation fluids must be technical grade at a minimum.

Preparation for Sampling:

Identify and mark the sample location and document in the site field logbook to sufficient extent that location can be identified at a later time. Photographs of the sample location are very helpful.

Intermediate Depth Soil Sampling Procedures (Test Pits):

At intermediate depths, soil samples may be collected either from test pits or from shallow auger holes. For auger hole procedures, see Intermediate Depth Soil Sampling Procedures (Auger Holes).

1.Once the excavation has been staked and flagged, the excavation can be made using a backhoe or other excavating device. If bulldozers or front-end loaders are used for the excavation, no samples can be collected from the bottom of the test pit due to disturbance by the tracks of the machine. Samples in this case must be removed from the pit sidewall.

2.Absolutely no entry is to be made into a test pit greater than 5 feet deep and in many cases much more shallow depths where the soil is potentially weak or unstable. Entering a test pit may also constitute a confined space entry. The Health and Safety Plan must address special health and safety issues for any project which incorporates test pits.

3.Where possible, samples should be collected from the side walls of the test pit. Samples can be collected from different depths from the surface to the bottom of the test pit at the same time after the test pit is completed. Because of loose soil and debris falling downward into the test pit, the deepest sample should be collected first and the sequence move up the sidewall, ending in the most shallow sample.

4.Using a decontaminated spoon, spatula or other sampling tool, dig two to three inches (more if necessary to reach undisturbed soil). Brush all loose dirt and any remaining debris away from the sampling location. Using a decontaminated tool, remove a thin layer of soil from the sampling surface. Do not collect the sample at or near any visible roots or other vegetative matter. If not possible due to the prevalence of roots and the sample location cannot be moved, minimize any roots and root hairs in the sample and note these conditions in the site field logbook.

5.Using another decontaminated sampling tool (usually a stainless steel spoon or spatula), dig out a plug of soil and transfer directly to the sampling container. Make sure that an adequate volume of soil is placed in the container for the laboratory analysis to be performed. If VOC's are to be analyzed, the sampling should be done as quickly as possible and the sample container should be filled as full as possible.

6.Place cap tightly onto container. It is recommended that the sample identification label be placed on the container before the sample is collected. If it has not been, the container must be labelled immediately after closing the container.

7.Enter the sample information in the site field logbook.

8.Place the sample in a cool dry place. Fill out the chain-of-custody form. The sample must be kept in personal possession of the sampler or sample custodian, or otherwise secured in order to maintain chain-of-custody and sample integrity.

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

Objective:

The integrity of collected sediment samples can be affected by many factors, including the methods and procedures by which a sampling site is selected and the actual collection of the sample. The objective of this protocol is to provide for uniform methods by which sediment samples are collected by S&ME personnel which have minimum impact on the nature of the sample and for the documentation of those methods used in the collection of the samples.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of sediment samples.

General:

This protocol describes standard procedures for the collection of representative sediment samples at spot locations from streams, creeks, ponds and other water bodies. The purpose of the sampling is to collect representative samples of the sediment for submission to an analytical laboratory or other testing for chemical contamination.

All sampling equipment will be deconned according to S&ME's Sampling Equipment Decon Protocol or other approved means prior to sampling and deconned sampling equipment will be protected from contaminated sources (including airborne sources) until use to collect the sample. Sampling equipment will be handled only while wearing clean latex gloves which may be covered by other clean gloves if required by the health and safety plan or for mechanical protection. All health and safety procedures from either the general or site specific health and safety plan will be followed at all times.

All sediment sampling procedures will be logged in the site field sampling logbook or approved forms. Variations from this protocol are authorized only by the project manager, with approval by the department manager. Any deviation from this protocol must be clearly documented.

Equipment:

Stainless steel spoons, spatulas, trowels, hand augers, spades, shovels, stainless steel beakers, stainless steel buckets.

Clean sample containers, either laboratory supplied for the purpose of sample collection or decontaminated according to the Sampling Equipment Decon Protocol. All decon and preservation fluids must be technical grade at a minimum.

Preparation for Sampling:

Identify and mark the sample location and document in the site field logbook to sufficient extent that location can be identified at a later time. Photographs of the sample location are very helpful. Select a location free of leaves, organic matter, stones, and gravel. If these materials cover the surface of the sample location, they may be carefully removed without disturbing the in-place sediment.

Sediment Sampling Procedure:

1.Select a sampling location that appears to be representative of the stream or pond bed. Water sorts sediments according to the water velocity and the location must be carefully selected to be representative of the conditions to be studied. Sediments from the bottom of a still backwater area will probably be substantially different than from a sandbar in a swiftly flowing area. Photographs are extremely valuable in documenting the nature of the stream bed where a sample is collected.

2.Where several samples are to be collected along a stream or creek with flowing water, it is important to collect the most downstream sample first and move in sequence upstream. This will prevent the possibility of contaminated sediment stirred up by the sampling a one location moving downstream with the water flow and impacting the next sample, if it were downstream of the first. Brush all loose dirt and any remaining debris away from the sampling location. Using a decontaminated tool, remove a thin layer of soil from the sampling surface. The sampling surface must be undisturbed by digging tools to assure that contamination has not been introduced to the sampling location from above. Do not collect the sample at or near any visible roots or other vegetative matter. If this is not possible due to the prevalence of roots and the sample location cannot be moved, minimize any roots and root hairs in the sample and note these field conditions in the site field logbook.

3.Care should be taken, insofar as possible, to collect a sample of the sediments with as little of the overlying water as possible. Possible contamination of the sediments should be assessed separately from the stream or pond water quality. If the sediments are soft enough, a plug sampler is generally the best for collecting samples in areas covered by water, as it collects very little of the overlying water. If the sample is collected using a beaker, spatula, or other scooping type tool, the water should be drained or decanted as much as possible to remove this water. However, do not squeeze or over dry the sample, as the pore water in the sediments should be retained.

4.All sampling tools must be decontaminated according to the Sampling Equipment Decon Protocol. After collecting the sample, transfer it directly to the sampling container. Make sure that an adequate volume of soil is placed in the container for the laboratory analysis to be performed. If VOC's are to be analyzed, the sampling should be done as quickly as possible and the sample container should be filled as full as possible.

5.Place cap tightly onto container. It is recommended that the sample identification label be placed on the container before the sample is collected. If it has not been, the container must be labelled immediately after closing the container.

6.Enter the sample information in the site field logbook.

7.Place the sample in a cool dry place. Fill out the chain-of-custody form. The sample must be kept in personal possession of the sampler or sample custodian, or otherwise secured in order to maintain chain-of-custody and sample integrity.

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

MONITORING WELL CONSTRUCTION

Objective:

The primary tool used for the assessment of groundwater quality is the groundwater monitor well. A well is installed into the geologic media with the intent, among other uses, of being a collection point for groundwater samples for analytical testing to determine the groundwater quality. The well is constructed to sample a particular point in a specific geologic unit and the water sample is assumed to be representative of the waters occurring within that geologic unit. It is the objective of this protocol to describe uniform methods by which monitor wells are installed, to provide samples of the groundwater that are in fact representative of the conditions at the screened interval of the well.

Applicability:

Project managers, geologists, drillers, environmental technicians, and other technical and professional personnel involved with the installation of wells.

Equipment:

Well drilling rig, well construction materials, water level indicators, well development pumps, containers for collection and disposal of well construction and development waste materials, etc.

General:

Monitor wells have many and varied uses. These uses and the geology and hydrogeology of the specific site at which they are installed determine both the design of the well and the methods by which they are installed. This protocol is not intended to be comprehensive in detail or applicable in all situations. The project manager or project hydrogeologist must design wells at each specific site for the purposes intended. The following are general principles of well construction and installation which are to be followed in all or nearly all situations. Any well to be installed in variance of these principles must be carefully considered, variations clearly specified, and reasons for the variations documented in the project file and site field logbook.

Well Construction Principles:

1.The borehole for the well shall not penetrate to a depth greater than the depth to be monitored or the depth from which water is to be monitored. If it is necessary to collect stratigraphic data below these depths, a test boring should be performed to the depth desired and a separate bolehole installed to the proper depth for installation of the well.

2.The well should not connect hydrologically separate aquifers or hydrologically discrete segments of aquifer systems, without well considered analysis of the effects of the interconnection.

3.Construction materials must be compatible with contaminants to be monitored or recovered. Typically, the materials to be considered will be high strength PVC, teflon, or 316 stainless steel.

4.All wells in soil or weathered rock will be drilled to a minimum diameter of 4 inches greater than the outside diameter of the well screen and casing. The annulus around the well screen will be packed with clean sand, silica beads, or clean gravel, sized according to the well screen slot size and the grain size distribution of the soils to be monitored. The sand or gravel pack should extend from the bottom of the borehole to a height of 1 to 2 feet above the well screen. The sand or gravel pack (not just the well screen) must not connect hydrologically separate aquifers. In the case of rock wells, a sand or gravel pack is not required (but may be used if desired). The well may be installed either open hole with the casing through the overburden grouted into the rock or a well screen may be used if the borehole annulus is properly grouted at the rock/overburden interface.

5.Untreated bentonite pellets should be used in the saturated zone to seal the top of the sand or gravel pack. The bentonite layer should be a minimum of 1 foot thick but may extend to the top of the saturated zone. Expanding neat cement or a neat cement-bentonite mixture containing no more than 10% bentonite by weight. In an open borehole, the grout may be poured from the surface if the depth to the top of the bentonite is 15 feet or less. If the borehole is caving or the depth to the bentonite is greater that 15 feet, the grout must be pumped or tremied to the bottom. Concrete should be used for the upper 5 feet of the borehole and to set a steel protective casing.

6.All wells must be developed to insure minimum turbidity. If a well cannot be developed, it may have to be replaced.

7.The minimum well diameter is 2 inches.

8.Well construction as completed must be clearly documented at the time of construction on the field log and in the site logbook.

9.Water levels should be recorded at the time that the borehole is completed, when the well construction is completed, and frequently thereafter. Although more frequent readings may be required in some cases, well water levels should be recorded on at least a weekly basis or the first time personnel return to the site after a week has passed since the water levels were read. All readings should be recorded in the field site logbook. If it is raining at the time of the reading or the persons collecting the readings knows of recent rain at the site, this should be recorded in the logbook with the water readings.

Objective:

The integrity of collected soil samples can be affected by many factors, including the methods and procedures by which a sampling site is selected and the actual collection of the soil sample. The objective of this protocol is to provide for uniform methods by which samples are collected by S&ME personnel which have minimum impact on the nature of the sample and for the documentation of those methods used in the collection of the samples.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of soil samples.

General:

This protocol describes standard procedures for the collection of representative soil samples at specific locations from test borings (deep sampling). The purpose of the sampling is to collect representative samples for submission to an analytical laboratory or other testing for chemical contamination.

All sampling equipment will be deconned according to S&ME's Sampling Equipment Decon Protocol or other approved means prior to sampling and deconned sampling equipment will be protected from contaminated sources (including airborne sources) until used to collect the sample. Sampling equipment will be handled only while wearing clean latex gloves which may be covered by other clean gloves if required by the health and safety plan or for mechanical protection. All health and safety procedures from the general or site health and safety plan will be followed at all times.

All soil sampling procedures will be logged in the site field sampling logbook or approved forms. Variations from this protocol are authorized only by the project manager, with approval by the department manager. Any deviation from this protocol must be clearly documented.

Equipment:

Split spoons, Shelby tubes, stainless steel spoons, spatulas, trowels, etc.

Clean sample containers, either laboratory supplied for the purpose of sample collection or decontaminated according to the Sampling Equipment Decon Protocol. All decon and preservation fluids must be technical grade at a minimum.

Preparation for Sampling:

Identify and mark the sample location and document in the site field logbook to sufficient extent that location can be identified at a later time. Photographs of the sample location are very helpful. Prepare the location for sampling.

Deep Soil Sampling Procedure

Deep soil samples are collected from drilling rig boreholes using either split spoon samplers or thin wall shelby tube samplers. Generally, analytical samples should not be taken from the auger cuttings or from the auger flights, since the augering mixes soils and it is impossible to tell from what depth(s) the sample collected came. If the decision is made to sample these materials, this fact must be noted and discussed in the site field logbook and the sample testing results interpreted in light of the method of sample collection.

1.Advance to borehole to within a few inches of the top of the sampling interval. Using a clean, decontaminated sampler, drive or push the sampler to the top of the sampling interval. Carefully remove the sampler from the borehole and discard the collected soil with the auger cuttings.

2.Place another decontaminated sampler onto the drill rod and carefully lower the sampler into the hole left by the first sampler. Push or drive the sampler over the sampling interval, being careful to collect sufficient sample for the laboratory analyses to be performed. Remove the sampler from the borehole.

3.Disconnect the sampler from the drill rods. Carefully remove the sample from the sampler directly in to the sample containers, using a decontaminated spoon or spatula.

4.Place cap tightly onto container. It is recommended that the sample identification label be placed on the container before the sample is collected. If it has not been, the container must be labelled immediately after closing the container.

5.Enter the sample information in the site field logbook.

6.Place the sample in a cool dry place. Fill out the chain-of-custody form. The sample must be kept in personal possession of the sampler or sample custodian, or otherwise secured in order to maintain chain-of-custody and sample integrity.

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

SOIL SAMPLE LABELLING

Objective:

In the collection of soil samples to access potential soil contamination, a number of detailed procedures are carefully followed to assure, within reasonable limitations, that the soil sample sent to the analytical laboratory is representative of the soil conditions at the sampling location. Several soil samples are typically collected during a single sampling event. The objective of this protocol is to provide for proper labelling of each sample container, so that there is no doubt by the field or laboratory personnel as to the identity of each soil sample and what test procedures are to be performed on each sample.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of soil samples.

General:

Care will be taken to the extent necessary to accurately label each sample container with the complete information required. All QA samples will be labelled in the same manner as all other collected samples. Some personnel prefer to label all sample containers prior to the sampling event and then, when sampling, place the sample in the previously labelled container. This method is allowed under this protocol but not generally recommended, due to the lack of flexibility in sample collection and the potential for placing soil sample in the incorrect sample container. Throughout all sampling procedures, the sampler will take care to place all samples in their correct containers, and to record all information regarding the sample collection in a complete and systematic fashion.

Equipment:

Sample labels and tags, Chain of Custody forms, custody seals, indelible waterproof marking pens, field logbooks, and suitable containers for storage and transport of the containers and collected samples.

Labelling Procedure:

Once a sample has been collected and placed in the proper container, label the container with the following information:

Sample Identification Number
Project Number
Date
Time of Collection
Analysis to be performed
Preservatives used (if any)
Sampler's Name

Cover the label and seal the sample container with clear plastic tape. Place a custody seal over the container lid and cover with clear plastic tape in such a manner that the container cannot be append with tearing or otherwise damaging the seal. Record all sampling information in the field sampling logbook and complete Chain-of-Custody documents. Store in a cooler or other suitable container to maintain sample temperature and security.

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

WATER SAMPLE LABELLING

Objective:

In the collection of water samples to access potential groundwater or surface water contamination, a number of detailed procedures are carefully followed to assure, within reasonable limitations, that the sample sent to the analytical laboratory is representative of the waters at the sampling location. Several water samples are typically collected during a single sampling event. The objective of this protocol is to provide for proper labelling of each sample container, so that there is no doubt by the field or laboratory personnel as to the identity of each water sample and what test procedures are to be performed on each sample.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of water samples.

General:

Care will be taken to the extent necessary to accurately label each sample container with the complete information required. All QA samples will be labelled in the same manner as all other collected samples. Some personnel prefer to label all sample containers prior to the sampling event and then, when sampling, place the sample in the previously labelled container. This method is allowed under this protocol but not generally recommended, due to the lack of flexibility in sample collection and the potential for placing a water sample in the incorrect sample container. During all sampling procedures, the sampler will take care to place all samples in their correct containers, and to record all information regarding the sample collection in a complete and systematic fashion.

Equipment:

Sample labels and tags, Chain of Custody forms, custody seals, indelible waterproof marking pens, field logbooks, and suitable containers for storage and transport of the containers and collected samples.

Labelling Procedure:

Once a sample has been collected and placed in the proper container, label the container with the following information:

Sample Identification Number
Project Number
Date
Time of Collection
Analysis to be performed
Preservatives used (if any)
Sampler's Name

Cover the label and seal the sample container with clear plastic tape. Place a custody seal over the container lid and cover with clear plastic tape in such a manner that the container cannot be append with tearing or otherwise damaging the seal. Seal the sample container with clear plastic tape or place the container in a sealable plastic bag to prevent leakage. Record all sampling information in the field sampling logbook and complete Chain-of-Custody documents. Store in a cooler or other suitable container to maintain sample temperature and security.

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

COLLECTION OF SOIL SAMPLES: Intermediate Depths (Auger Holes)

Objective:

The integrity of collected soil samples can be affected by many factors, including the methods and procedures by which a sampling site is selected and the actual collection of the soil sample. The objective of this protocol is to provide for uniform methods by which samples are collected by S&ME personnel which have minimum impact on the nature of the sample and for the documentation of those methods used in the collection of the samples.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of soil samples.

General:

This protocol describes standard procedures for the collection of representative soil samples at specific locations from shallow hand auger borings (intermediate sampling). The purpose of the sampling is to collect representative samples for submission to an analytical laboratory or other testing for chemical contamination.

All sampling equipment will be deconned according to S&ME's Sampling Equipment Decon Protocol or other approved means prior to sampling and deconned sampling equipment will be protected from contaminated sources (including airborne sources) until used to collect the sample. Sampling equipment will be handled only while wearing clean latex gloves which may be covered by other clean gloves if required by the health and safety plan or for mechanical protection. All health and safety procedures from the general or site health and safety plan will be followed at all times.

All soil sampling procedures will be logged in the site field sampling logbook or approved forms. Variations from this protocol are authorized only by the project manager, with approval by the department manager. Any deviation from this protocol must be clearly documented.

Equipment:

Hand augers, trays, stainless steel spoons, spatulas, trowels, etc.

Clean sample containers, either laboratory supplied for the purpose of sample collection or decontaminated according to the Sampling Equipment Decon Protocol. All decon and preservation fluids must be technical grade at a minimum.

Preparation for Sampling:

Identify and mark the sample location and document in the site field logbook to sufficient extent that location can be identified at a later time. Photographs of the sample location are very helpful. Prepare the location for sampling.

Brush all leaves, roots, sticks, and other debris away from the sampling location a sufficient distance that they will not interfere with sampling or possibly get included into the samples. All auger heads, extensions, and sampling tools should be clean and properly deconned.

Intermediate Depth Soil Sampling Procedures (Auger Holes)

At intermediate depths, soil samples may be collected either from test pits or from shallow hand auger or power auger holes. For test pit procedures, see Intermediate Depth Soil Sampling Procedures (Test Pit).

1. Clear and brush away all contaminated materials, vegetation, debris, or other materials away from the auger hole location (minimum 1 ft. radius) to prevent these materials from falling into the auger hole during sampling.
2. Attach a clean auger head to the auger drill rod and to either the "T" handle or mechanical power source. Auger to the necessary sample depth.
3. Clean the auger head or attach another clean auger head to the drill rod and clean as much loose dirt and debris from the borehole.
4. Using a decontaminated auger head or thin wall shelby tube, advance the bolehole a sufficient distance to collect enough sample for the analyses to be performed. If possible, all of the sample should be collected in a single entry of the sampling device into the borehole to minimize the intrusion of cave-in or other contamination from other depths.
5. Slowly and carefully remove the sampling device and lay on a clean plastic sheet. Remove sample from the sampling device and place into clean sample containers. The upper two inches (or more if extraneous material appears to be present) should not be used for the analytical sample since this part of the sample may contain cave-in or other material from the upper part of the borehole.
6. Place cap tightly onto container. It is recommended that the sample identification label be placed on the container before the sample is collected. If it has not been, the container must be labelled immediately after closing the container.
7. Enter the sample information in the site field logbook.
8. Place the sample in a cool dry place. Fill out the chain-of-custody form. The sample must be kept in personal possession of the sampler or sample custodian, or otherwise secured in order to maintain chain-of-custody and sample integrity.

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

SOIL SAMPLE SCREENING

Objective:

During any site assessment, the use of analytical testing of collected samples is the primary means by which our personnel identify, quantify, and document the presence of contaminants. Although this testing is necessary, it is also expensive. The means by which we minimize these expenses is to reduce the number of samples that must be tested. However, it is often difficult to decide in the field which samples are the proper ones to submit for sampling. Adequate coverage of the area is necessary for ourselves and the regulators to evaluate the site and to develop remediation designs, if necessary. One means of addressing these factors where volatile contaminants are involved is to use field screening of samples by an organic vapor analyzer or photoionization detector. The objective of this protocol is to provide uniform procedures for the field screening of these samples for general indications of the extent of contamination on a site and for the selection of samples for testing by the analytical laboratory.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved with field sampling.

Organic Vapor Analyzer(OVA)/Photoionization(Hnu) Screening Procedure

1. Place representative samples of soil in new, clean plastic bags or sample jars and seal, to allow any vapors to volatilize for determination of the presence/absence in the soil sample and relative levels of volatile contamination. Make sure samples are labelled sufficiently to track samples.

2. Allow sealed sample to volatilize in a warm but not hot location for 10 to 15 minutes. Bright sunshine during hot weather is not recommended.

3. Make sure instrument is operating properly and is calibrated.

4.Make a small hole in the plastic bag or open the sample jar, just large enough for the probe to be inserted. If a bag is used, take care not to force vapors from the bag during the process.

5. Note reading on the instrument and record in field records for each sample.

6. After recording reading, dispose of sample properly. Since volatiles have been forced from the sample, the screening sample is not valid for submittal to a laboratory. Duplicate samples must be used.

7. This procedure is to be used for field screening purposes only, such as in relative identification of areas of relative volatile contamination or the selection of samples to be submitted to an analytical laboratory. Results are not to be used for determination of the presence or absence of volatile contamination or for definitively determining the extent or nature of any contamination.

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

Objective:

S&ME field teams depend on field instrumentation to collect data on field parameters, screen samples for analytical testing, air quality screening for health and safety purposes, and numerous other purposes. For the collection of reliable data, it is critical that the instrumentation be correctly calibrated and operating properly. During these site activities, the instrumentation is exposed to dust, moisture, and various contaminants. These materials may have either immediate or long term deterioration effects on the instrumentation. They may also represent an exposure pathway to our personnel if the equipment is not properly cleaned. In order to rely on the data produced by the instrumentation, protect personnel health and safety, and extend the useful life of the equipment, it is important that all instrumentation be properly and promptly cleaned and decontaminated after each use.

Applicability:

Project managers, geologists, health and safety officers, environmental technicians, and other technical/professional personnel involved in site activities on environmental sites.

General:

Cleaning and decontamination procedures for all environmental field equipment will be conducted in a thorough and stepwise manner as indicated by the methods described below. If necessary, specific areas to be utilized as contaminant reduction zones will be designated in a site specific health and safety plan. All disposable wipes, fluids, and other materials from decontamination of equipment will be collected and stored for proper disposal or otherwise handled in such a way as to not spread contamination. All health and safety procedures must be followed during decon of equipment.

Decontamination procedures must be reviewed for applicability for each site, based on the contaminants and media involved. Variations from these decon protocols are authorized by the project manager only, with approval of the department manager. Any deviation of standard decon protocols must be documented.

Equipment:

Water level probes, pH meters, conductivity meters, OVA's, HNu's, geophysical equipment, borehole logging equipment, etc.

Preparation for Decon:

Wipe all soil and excess contamination from equipment. Lay down clean plastic sheet large enough to contain equipment to be cleaned.

Decontamination Procedure:

Rinse probes with technical grade deionized water prior to each use. If necessary, gently brush areas of heavy contamination and re-rinse with deionized water, being very careful not to damage the probe. Use clean damp cloth to clean instrument case and other portions of the unit which cannot be immersed or rinsed in water.

S&ME, INC. STANDARD SITE ASSESSMENT PROTOCOL

COLLECTION OF SOIL SAMPLES: Intermediate Depths (Auger Holes)

Objective:

The integrity of collected soil samples can be affected by many factors, including the methods and procedures by which a sampling site is selected and the actual collection of the soil sample. The objective of this protocol is to provide for uniform methods by which samples are collected by S&ME personnel which have minimum impact on the nature of the sample and for the documentation of those methods used in the collection of the samples.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of soil samples.

General:

This protocol describes standard procedures for the collection of representative soil samples at specific locations from shallow hand auger borings (intermediate sampling). The purpose of the sampling is to collect representative samples for submission to an analytical laboratory or other testing for chemical contamination.

All sampling equipment will be deconned according to S&ME's Sampling Equipment Decon Protocol or other approved means prior to sampling and deconned sampling equipment will be protected from contaminated sources (including airborne sources) until used to collect the sample. Sampling equipment will be handled only while wearing clean latex gloves which may be covered by other clean gloves if required by the health and safety plan or for mechanical protection. All health and safety procedures from the general or site health and safety plan will be followed at all times.

All soil sampling procedures will be logged in the site field sampling logbook or approved forms. Variations from this protocol are authorized only by the project manager, with approval by the department manager. Any deviation from this protocol must be clearly documented.

Equipment:

Hand augers, trays, stainless steel spoons, spatulas, trowels, etc.

Clean sample containers, either laboratory supplied for the purpose of sample collection or decontaminated according to the Sampling Equipment Decon Protocol. All decon and preservation fluids must be technical grade at a minimum.

Preparation for Sampling:

Identify and mark the sample location and document in the site field logbook to sufficient extent that location can be identified at a later time. Photographs of the sample location are very helpful. Prepare the location for sampling.

Brush all leaves, roots, sticks, and other debris away from the sampling location a sufficient distance that they will not interfere with sampling or possibly get included into the samples. All auger heads, extensions, and sampling tools should be clean and properly deconned.

Intermediate Depth Soil Sampling Procedures (Auger Holes)

At intermediate depths, soil samples may be collected either from test pits or from shallow hand auger or power auger holes. For test pit procedures, see Intermediate Depth Soil Sampling Procedures (Test Pit).

1.Clear and brush away all contaminated materials, vegetation, debris, or other materials away from the auger hole location (minimum 1 ft. radius) to prevent these materials from falling into the auger hole during sampling.

2.Attach a clean auger head to the auger drill rod and to either the "T" handle or mechanical power source. Auger to the necessary sample depth.

3.Clean the auger head or attach another clean auger head to the drill rod and clean as much loose dirt and debris from the borehole.

4.Using a decontaminated auger head or thin wall shelby tube, advance the bolehole a sufficient distance to collect enough sample for the analyses to be performed. If possible, all of the sample should be collected in a single entry of the sampling device into the borehole to minimize the intrusion of cave-in or other contamination from other depths.

5.Slowly and carefully remove the sampling device and lay on a clean plastic sheet. Remove sample from the sampling device and place into clean sample containers. The upper two inches (or more if extraneous material appears to be present) should not be used for the analytical sample since this part of the sample may contain cave-in or other material from the upper part of the borehole.

6.Place cap tightly onto container. It is recommended that the sample identification label be placed on the container before the sample is collected. If it has not been, the container must be labelled immediately after closing the container.

7.Enter the sample information in the site field logbook.

8.Place the sample in a cool dry place. Fill out the chain-of-custody form. The sample must be kept in personal possession of the sampler or sample custodian, or otherwise secured in order to maintain chain-of-custody and sample integrity.

Objective:

In the assessment of a site for potential contamination, samples are typically collected for chemical analysis by an analytical laboratory. The reported presence or absence of numerous chemical compounds in minute trace amounts can have a significant impact on the assessment of any environmental hazards at the site, on the regulatory issues involved, and financial expenditures by the responsible parties. Therefore, it is important that the collected samples be representative of the actual conditions at the site, within practical limitations. Standard protocols are in place for the systematic collection and packaging of samples. However, it is necessary that quality assurance samples be collected to a degree to statistically support the sampling program and that can identify any areas where inconsistencies occur.

Applicability:

Project managers, geologists, environmental technicians, and other technical and professional personnel involved in the collection of samples.

Types of Quality Assurance Samples:

Field Quality Control samples consist of sample duplicates and field blanks. All field QC samples will be collected in the same sample containers and handled in the same way as all other samples. All field QC samples should not be directly labelled as such but assigned a sample number similar to all other samples.

Duplicate samples provide an indication of consistent field sampling techniques. Sample duplicates, as the name implies, are simply second samples of the sample matrix, taken from the same location, at the same time, and in the same manner as the original sample. The sampler attempts to collect an identical sample in every way.

Trip blanks provide an indication of extraneous contamination introduced by sample container preparation or field exposure. Rinsate blanks provide an indication of the effectiveness of decontamination procedures.

Field trip blanks for water samples consist of deionized water. Trip blanks are normally to be prepared and supplied by the laboratory. In any case, sample containers are filled with technical grade deionized water prior to going to the site, are sealed and transported to the site. Care should be taken that the laboratory uses containers for trip blanks from the same lots as those containers actually used for sample collection. At the site, they are handled in every way as collected samples and returned to the laboratory with the other samples for analysis.

Field blanks for soil samples are diatomaceous earth which has been previously analyzed by the laboratory for the contaminants present at the site. Trip blanks are generally filled by the laboratory prior to leaving for the site and transported to the site. These blanks are handled as all collected samples and returned to the laboratory for analysis.

Rinsate blanks are deionized water passed over decontaminated sampling equipment and collected in a clean sample container. After the sample is collected, the container is sealed and handled as any other sample. Insofar as practicable, the rinsate sample should be collected just prior the use of the sampling equipment for the collection of the sample.

MINIMUM QC SAMPLE FREQUENCY:

Variations from this protocol are authorized only by the project manager, with the approval of the department manager. Any deviation from this protocol must be clearly documented.

Hazardous Waste, Chemical, and Large Hydrocarbon Sites:

A minimum of one duplicate sample is to be taken for each 10 record samples from each matrix. The project manager may direct that where less than 10 record samples are collected from a single matrix on a given day, at least one sample from each matrix will be collected daily.

Water and soil travel blanks are used at the project manager's option and at a rate and frequency specified by the project manager.

Where sampling equipment is decontaminated in the field, a minimum of one rinsate sample should be collected for each decon method for each day's sampling. Where more than 10 samples are collected on a given day by a given decontaminated method, the ratio of rinsate samples to record samples should not fall below 1:10.

Smaller Hydrocarbon Sites (Convenience Store/Gas Station):

It is recognized that where small hydrocarbon releases have occurred, a different level of field QC is required. In such cases, the source and nature of contamination are already known, analyses of samples are performed only for common hydrocarbon constituents and indicators, and the overall number of samples is small. In such cases, full compliance with S&ME QC sampling protocols is not appropriate, due to the limited range of constituents and regulatory requirements on the assessment of these sites. For a small site with limited sampling, full compliance with the program would inflate the total number of samples beyond the intent of the program, resulting in a waste of time and resources. Where projects meet the above criteria, the S&ME project manager may develop a more limited QC sample program, appropriate to the nature of the project. This program should be documented in the file and, once established, followed as thoroughly as the full protocol. All such reduced scope QC sampling programs are restricted to limited scope hydrocarbon investigations and must be approved by the department manager prior to the beginning of work on the site.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Soil Sampling**

Effective Date: November 1, 2007 | **Number:** SESDPROC-300-R1

Authors

Name: Fred Sloan
Title: Environmental Engineer, Regional Expert
Signature: [signature] Date: 11/2/07

Approvals

Name: Antonio Quinones
Title: Chief, Enforcement and Investigations Branch
Signature: [signature] Date: 11/02/07

Name: Laura Ackerman
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Laura Acker Date: 11/01/07

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-300-R1, *Soil Sampling*, replaces SESDPROC-300-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual. **Section 1.5.2, 4th bullet** Added references to the CFR and IATA's Dangerous Goods Regulations. **Section 2.7** Updated referenced operating procedures due to changes in title names.	November 1, 2007
SESDPROC-300-R0, Soil Sampling, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting soil samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling soil samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used to obtain a soil sample, the variant procedure will be documented in the field log book and subsequent investigation report, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Field X-Ray Fluorescence (XRF) Measurement, SESDPROC-107, Most Recent Version

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

Title 49 Code of Federal Regulations, Pts. 171 to 179, Most Recent Version

United States Environmental Protection Agency (US EPA). 1981. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples," Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), April 13, 1981.

US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting soil samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting soil samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could

alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.

- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader in the project files.

2 Special Sampling Considerations

2.1 Soil Samples for Volatile Organic Compounds (VOC) Analysis

If samples are to be analyzed for volatile organic compounds, they should be collected in a manner that minimizes disturbance of the sample. For example, when sampling with a bucket auger, the sample for VOC analysis should be collected directly from the auger bucket (preferred) or from minimally disturbed material immediately after an auger bucket is emptied into the pan. The sample shall be containerized by filling an En Core® Sampler or other Method 5035 compatible container. ***Samples for VOC analysis are not homogenized.*** Preservatives may be required for some samples with certain variations of Method 5035. Consult the method or the principal analytical chemist to determine if preservatives are necessary.

2.2 Soil Sampling (Method 5035)

The following sampling protocol is recommended for site investigators assessing the extent of volatile organic compounds (VOC's) in soils at a project site. Because of the large number of options available, careful coordination between field and laboratory personnel is needed. The specific sampling containers and sampling tools required will depend upon the detection levels and intended data use. Once this information has been established, selection of the appropriate sampling procedure and preservation method best applicable to the investigation can be made.

2.2.1 Equipment

Soil for VOC analyses may be retrieved using any of the SESD soil sampling methods described in Sections 3 through 8 of this procedure. Once the soil has been obtained, the En Core® Sampler, syringes, stainless steel spatula, standard 2-oz. soil VOC container, or pre-prepared 40 ml vials may be used/required for sub-sampling. The specific sample containers and the sampling tools required will depend upon the data quality objectives established for the site or sampling investigation. The various sub-sampling methods are described below.

2.2.2 Sampling Methodology - Low Concentrations (<200 ug/kg)

When the total VOC concentration in the soil is expected to be less than 200 µg/kg, the samples may be collected directly with the En Core® Sampler or syringe. If using the syringes, the sample must be placed in the sample container (40 ml pre-prepared vial) immediately to reduce volatilization losses. The 40 ml vials should contain 10 ml of organic-free water for an un-preserved sample or approximately 10 ml of organic-free water and a preservative. It is recommended that the 40 ml vials be prepared and weighed by the laboratory (commercial

sources are available which supply preserved and tared vials). When sampling directly with the En Core® Sampler, the vial must be immediately capped and locked

A soil sample for VOC analysis may also be collected with conventional sampling equipment. A sample collected in this fashion must either be placed in the final sample container (En Core® Sampler or 40 ml pre-prepared vial) immediately or the sample may be immediately placed into an intermediate sample container with no head space. If an intermediate container (usually 2-oz. soil jar) is used, the sample must be transferred to the final sample container (En Core® Sampler or 40 ml pre-prepared vial) as soon as possible, not to exceed 30 minutes.

NOTE: After collection of the sample into either the En Core® Sampler or other container, the sample must immediately be stored in an ice chest and cooled.

Soil samples may be prepared for shipping and analysis as follows:

En Core® Sampler - the sample shall be capped, locked, and secured in a plastic bag.

Syringe - Add about 3.7 cc (approximately 5 grams) of sample material to 40-ml pre-prepared containers. Secure the containers in a plastic bag. Do not use a custody seal on the container; place the custody seal on the plastic bag. Note: When using the syringes, it is important that no air is allowed to become trapped behind the sample prior to extrusion, as this will adversely affect the sample.

Stainless Steel Laboratory Spatulas - Add between 4.5 and 5.5 grams (approximate) of sample material to 40 ml containers. Secure the containers in a plastic bag. Do not use a custody seal on the container; place the custody seal on the plastic bag.

2.2.3 Sampling Methodology - High Concentrations (>200 ug/kg)

Based upon the data quality objectives and the detection level requirements, this high level method may also be used. Specifically, the sample may be packed into a single 2-oz. glass container with a screw cap and septum seal. The sample container must be filled quickly and completely to eliminate head space. Soils\sediments containing high total VOC concentrations may also be collected as described in Section 2.2.2, Sampling Methodology - Low Concentrations, and preserved using 10 ml methanol.

2.2.4 Special Techniques and Considerations for Method 5035

Effervescence

If low concentration samples effervesce from contact with the acid preservative, then either a test for effervescence must be performed prior to sampling, or the investigators must be prepared to collect each sample both preserved or un-preserved as needed, or all samples must be collected unpreserved.

To check for effervescence, collect a test sample and add to a pre-preserved vial. If preservation (acidification) of the sample results in effervescence (rapid formation of bubbles) then preservation by acidification is not acceptable, and the sample must be collected un-preserved.

If effervescence occurs and only pre-preserved sample vials are available, the preservative solution may be placed into an appropriate hazardous waste container and the vials triple rinsed with organic free water. An appropriate amount of organic free water, equal to the amount of preservative solution, should be placed into the vial. The sample may then be collected as an un-preserved sample. Note that the amount of organic free water placed into the vials will have to be accurately measured.

Sample Size

While this method is an improvement over earlier ones, field investigators must be aware of an inherent limitation. Because of the extremely small sample size and the lack of sample mixing, sample representativeness for VOC's may be reduced compared to samples with larger volumes collected for other constituents. The sampling design and objectives of the investigation should take this into consideration.

Holding Times

Sample holding times are specified in the Analytical Support Branch *Laboratory Operations and Quality Assurance Manual* (ASBLOQAM), Most Recent Version. Field investigators should note that the holding time for an un-preserved VOC soil/sediment sample is 48 hours. Arrangements should be made to ship the soil/sediment VOC samples to the laboratory by overnight delivery the day they are collected so the laboratory may preserve and/or analyze the sample within 48 hours of collection.

Percent Moisture

Samplers must ensure that the laboratory has sufficient material to determine percent moisture in the VOC soil/sediment sample to correct the analytical results to dry weight. If other analyses requiring percent moisture determination are

being performed upon the sample, these results may be used. If not, a separate sample (minimum of 2 oz.) for percent moisture determination will be required. The sample collected for Percent Moisture may also be used by the laboratory to check for preservative compatibility.

Safety

Methanol is a toxic and flammable liquid. Therefore, methanol must be handled with all required safety precautions related to toxic and flammable liquids. Inhalation of methanol vapors must be avoided. Vials should be opened and closed quickly during the sample preservation procedure. Methanol must be handled in a ventilated area. Use protective gloves when handling the methanol vials. Store methanol away from sources of ignition such as extreme heat or open flames. The vials of methanol should be stored in a cooler with ice at all times.

Shipping

Methanol and sodium bisulfate are considered dangerous goods, therefore shipment of samples preserved with these materials by common carrier is regulated by the U.S. Department of Transportation and the International Air Transport Association (IATA). The rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179) and the current edition of the IATA Dangerous Goods Regulations must be followed when shipping methanol and sodium bisulfate. Consult the above documents or the carrier for additional information. Shipment of the quantities of methanol and sodium bisulfate used for sample preservation falls under the exemption for small quantities.

The summary table on the following page lists the options available for compliance with SW846 Method 5035. The advantages and disadvantages are noted for each option. SESD's goal is to minimize the use of hazardous material (methanol and sodium bisulfate) and minimize the generation of hazardous waste during sample collection.

2.3 Dressing Soil Surfaces

Any time a vertical or near vertical surface is sampled, such as achieved when shovels or similar devices are used for subsurface sampling, the surface should be dressed (scraped) to remove smeared soil. This is necessary to minimize the effects of contaminant migration interferences due to smearing of material from other levels.

Table 1: Method 5035 Summary

OPTION	PROCEDURE	ADVANTAGES	DISADVANTAGES
1	Collect 2 - 40 mL vials with ~5 grams of sample and 1 - 2 oz., glass w/septum lid for screening, % moisture and preservative compatibility	Screening conducted by lab	Presently a 48 hour holding time for unpreserved samples Sample containers must be tared
2	Collect 3 En Core® Samplers; and 1- 2 oz., glass w/septum lid for screening, % moisture and preservative compatibility	Lab conducts all preservation/preparation procedures	Presently a 48 hour holding time for preparation of samples
3	Collect 2 - 40 ml vials with 5 grams of sample and preserve w/methanol or sodium bisulfate and 1 - 2-oz., glass w/septum lid for screening, % moisture and preservative compatibility	High level VOC samples may be composited Longer holding time	Hazardous materials used in field Sample containers must be tared
4	Collect 1 - 2-oz., glass w/septum lid for analysis, % moisture and preservative compatibility	Lab conducts all preservation/preparation procedures	May have significant VOC loss

2.4 Special Precautions for Trace Contaminant Soil Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different sample is collected and the gloves should be donned immediately prior to sampling. The gloves should not come in contact with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.
- Sample containers for samples suspected of containing high concentrations of contaminants shall be collected, handled and stored separately.
- All background samples shall be segregated from obvious high concentration or waste samples. Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area if sampling devices are to be reused. Samples of waste or highly contaminated media must not be placed in the same ice chest as environmental (i.e., containing low contaminant levels) or background samples.

- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.
- Samplers must use new, verified certified-clean disposable or non-disposable equipment cleaned according to procedures contained in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205), for collection of samples for trace metals or organic compound analyses.

2.5 Sample Homogenization

1. If sub-sampling of the primary sample is to be performed in the laboratory, transfer the entire primary sample directly into an appropriate, labeled sample container(s). Proceed to step 5.

2. If sub-sampling the primary sample in the field or compositing multiple primary samples in the field, place the sample into a glass or stainless steel homogenization container and mix thoroughly. Each aliquot of a composite sample should be of the same approximate volume.

3. All soil samples must be thoroughly mixed to ensure that the sample is as representative as possible of the sample media. ***Samples for VOC analysis are not homogenized.*** The most common method of mixing is referred to as quartering. The quartering procedure should be performed as follows:

   - The material in the sample pan should be divided into quarters and each quarter should be mixed individually.
   - Two quarters should then be mixed to form halves.
   - The two halves should be mixed to form a homogenous matrix.

   This procedure should be repeated several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion, reversing direction, and occasionally turning the material over.

4. Place the sample into an appropriate, labeled container(s) by using the alternate shoveling method and secure the cap(s) tightly. The alternate shoveling method involves placing a spoonful of soil in each container in sequence and repeating until the containers are full or the sample volume has been exhausted. Threads on the container and lid should be cleaned to ensure a tight seal when closed.

5. Return any unused sample material back to the auger, drill or push hole from which the sample was collected.

2.6 Quality Control

If possible, a control sample should be collected from an area not affected by the possible contaminants of concern and submitted with the other samples. This control sample should be collected as close to the sampled area as possible and from the same soil type. Equipment blanks should be collected if equipment is field cleaned and re-used on-site or if necessary to document that low-level contaminants were not introduced by sampling tools. SESD Operating Procedure for Field Sampling Quality Control (SESDPROC-011) contains other procedures that may be applicable to soil sampling investigations.

2.7 Records

Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation, as described in the SESD Operating Procedure for Logbooks (SESDPROC-010) and the SESD Operating Procedure for Sample and Evidence Management (SESDPROC-005).

3 Manual Soil Sampling Methods

3.1 General

These methods are used primarily to collect surface and shallow subsurface soil samples. Surface soils are generally classified as soils between the ground surface and 6 to 12 inches below ground surface. The most common interval is 0 to 6 inches, however the data quality objectives of the investigation may dictate another interval, such as 0 to 3 inches for risk assessment purposes. The shallow subsurface interval may be considered to extend from approximately 12-inches below ground surface to a site-specific depth at which sample collection using manual collection methods becomes impractical.

3.2 Spoons

Stainless steel spoons may be used for surface soil sampling to depths of approximately 6-inches below ground surface where conditions are generally soft and non-indurated and there is no problematic vegetative layer to penetrate.

3.2.1 Special Considerations When Using Spoons

- When using stainless steel spoons, consideration must be given to the procedure used to collect the volatile organic compound sample. If the soil being sampled is cohesive and holds its in situ texture in the spoon, the En Core® Sampler or syringe used to collect the sub-sample for Method 5035 should be plugged directly from the spoon. If, however, the soil is not cohesive and crumbles when removed from the ground surface for sampling, consideration should be given to plugging the sample for Method 5035 directly from the ground surface at a depth appropriate for the investigation Data Quality Objectives.
- When compositing, make sure that each composite location (aliquot) consist of equal volumes, i.e., same number of equal spoonfuls.
- If a thick, matted root zone is present at or near the surface, it should be removed before the sample is collected

3.3 Hand Augers

Hand augers may be used to advance boreholes and collect soil samples in the surface and shallow subsurface intervals. Typically, 4-inch stainless steel auger buckets with cutting heads are used. The bucket is advanced by simultaneously pushing and turning using an attached handle.

3.3.1 Surface Soil Sampling

When conducting surface soil sampling with hand augers, the auger buckets may be used with a handle alone or with a handle and extensions. The bucket is

advanced to the appropriate depth and the contents are transferred to the homogenization container for processing. Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

3.3.2 Subsurface Soil Sampling

Hand augers are the most common equipment used to collect shallow subsurface soil samples. Auger holes are advanced one bucket at a time until the sample depth is achieved. When the sample depth is reached, the bucket used to advance the hole is removed and a clean bucket is attached. The clean auger bucket is then placed in the hole and filled with soil to make up the sample and removed.

The practical depth of investigation using a hand auger depends upon the soil properties and depth of investigation. In sand, augering is usually easily performed, but the depth of collection is limited to the depth at which the sand begins to flow or collapse. Hand augers may also be of limited use in tight clays or cemented sands. In these soil types, the greater the depth attempted, the more difficult it is to recover a sample due to increased friction and torqueing of the hand auger extensions. At some point these problems become so severe that power equipment must be used.

3.3.3 Special Considerations for Soil Sampling with the Hand Auger

- Because of the tendency for the auger bucket to scrape material from the sides of the auger hole while being extracted, the top several inches of soil in the auger bucket should be discarded prior to placing the bucket contents in the homogenization container for processing.
- Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035. Collect the VOC sample directly from the auger bucket, if possible.
- Power augers, such as the Little Beaver®, and drill rigs may be used to advance boreholes to depths for subsurface soil sampling with the hand auger. They may not be used for sample collection. When power augers are used to advance a borehole to depth for sampling, care must be taken that exhaust fumes, gasoline and/or oil do not contaminate the borehole or area in the immediate vicinity of sampling.
- When a new borehole is advanced, the entire hand auger assembly must be replaced with a properly decontaminated hand auger assembly.

4 Direct Push Soil Sampling Methods

4.1 General

These methods are used primarily to collect shallow and deep subsurface soil samples. Three methods are available for use with either the Geoprobe® or the drill rig adapted with a hydraulic hammer. All methods involve the collection and retrieval of the soil sample within a thin-walled liner. The following sections describe each of the specific sampling methods that can be accomplished using direct push techniques, along with details specific to each method.

4.2 Large Bore® Soil Sampler

The Large Bore® (LB) sampler is a solid barrel direct push sampler equipped with a piston-rod point assembly used primarily for collection of depth-discrete subsurface soil samples. The sample barrel is approximately 30-inches (762 mm) long and has a 1.5-inch (38 mm) outside diameter. The LB® sampler is capable of recovering a discrete sample core 22 inches x 1.0 inch (559 mm x 25 mm) contained inside a removable liner. The resultant sample volume is a maximum of 283 ml.

After the LB® sample barrel is equipped with the cutting shoe and liner, the piston-rod point assembly is inserted, along with the drive head and piston stop assembly. The assembled sampler is driven to the desired sampling depth, at which time the piston stop pin is removed, freeing the push point. The LB® sampler is then pushed into the soil a distance equal to the length of the LB® sample barrel. The probe rod string, with the LB® sampler attached, is then removed from the subsurface. After retrieval, the LB® sampler is then removed from the probe rod string. The drive head is then removed to allow removal of the liner and soil sample.

4.3 Macro-Core® Soil Sampler

The Macro-Core® (MC) sampler is a solid barrel direct push sampler equipped with a piston-rod point assembly used primarily for collection of either continuous or depth-discrete subsurface soil samples. Although other lengths are available, the standard MC® sampler has an assembled length of approximately 52 inches (1321 mm) with an outside diameter of 2.2 inches (56 mm). The MC® sampler is capable of recovering a discrete sample core 45 inches x 1.5 inches (1143 mm x 38 mm) contained inside a removable liner. The resultant sample volume is a maximum of 1300 ml. The MC® sampler may be used in either an open-tube or closed-point configuration. Samples collected for chemical analyses must be collected with the closed-point configuration. If used for collection of soil for stratigraphic descriptions, the open-tubed configuration is acceptable.

4.4 Dual Tube Soil Sampling System

The Dual Tube 21 soil sampling system is a direct push system for collecting continuous core samples of unconsolidated materials from within a sealed outer casing of 2.125-inch (54 mm) OD probe rod. The samples are collected within a liner that is threaded onto the leading end of a string of 1.0-inch diameter probe rod. Collected samples have a volume of up to 800 ml in the form of a 1.125-inch x 48-inch (29 mm x 1219 mm) core. Use of this method allows for collection of continuous core inside a cased hole, minimizing or preventing cross-contamination between different intervals during sample collection. The outer casing is advanced, one core length at a time, with only the inner probe rod and core being removed and replaced between samples. If the sampling zone of interest begins at some depth below ground surface, a solid drive tip must be used to drive the dual tube assembly and core to its initial sample depth.

4.5 Special Considerations When Using Direct Push Sampling Methods

- *Liner Use and Material Selection* – Due to the mode of operation, the samples must be collected with a liner. Liners are available in the following materials: stainless steel, brass, cellulose acetate butyrate (CAB), PETG, polyvinyl chloride (PVC) and Teflon®. For the majority of environmental investigations conducted by EIB, either CAB or Teflon® liners are used. If samples are collected for organic compound analyses, Teflon® liners are required. CAB or PVC liners may be used if metals or other inorganic constituents are the object of the investigation.
- *Sample Orientation* – When the liners and associated sample are removed from the sample tubes, it is important to maintain the proper orientation of the sample. This is particularly important when multiple sample depths are collected from the same push. It is also important to maintain proper orientation to define precisely the depth at which an aliquot was collected. Maintaining proper orientation is typically accomplished using vinyl end caps. Convention is to place red caps on the top of the liner and black caps on the bottom to maintain proper sample orientation. Orientation can also be indicated by marking on the exterior of the liner with a permanent marker.
- *Core Catchers* – Occasionally the material being sampled lacks cohesiveness and is subject to crumbling and falling out of the sample liner. In cases such as these, the use of core catchers on the leading end of the sampler may help retain the sample until it is retrieved to the surface. Materials of construction for core catchers must be consistent with the type of liner used, i.e., if stainless steel liners are required, stainless steel core catchers must be used.
- *VOC Sample Collection* - Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

5 Split Spoon/Drill Rig Methods

5.1 General

Split spoon sampling methods are used primarily to collect shallow and deep subsurface soil samples. All split spoon samplers, regardless of size, are basically split cylindrical barrels that are threaded on each end. The leading end is held together with a beveled threaded collar that functions as a cutting shoe. The other end is held together with a threaded collar that serves as the sub used to attach the spoon to the string of drill rod. Two basic methods are available for use, including the smaller diameter standard split spoon, driven with the drill rig safety hammer, and the larger diameter continuous split spoon, advanced inside and slightly ahead of the lead auger during hollow stem auger drilling. The following sections describe each of the specific sampling methods, along with details specific to each method.

5.2 Standard Split Spoon

A drill rig is used to advance a borehole to the target depth. The drill string is then removed and a standard split spoon is attached to a string of drill rod. Split spoons used for soil sampling must be constructed of stainless steel and are typically 2.0-inches OD (1.5-inches ID) and 18-inches to 24-inches in length. Other diameters and lengths are common and may be used if constructed of the proper material. After the spoon is attached to the string of drill rod it is lowered into the borehole. The drill rig safety hammer is then used to drive the split spoon into the soil at the bottom of the borehole. After the split spoon has been driven into the soil, filling the spoon, it is retrieved to the surface, where it is removed from the drill rod string and opened for sample acquisition.

5.3 Continuous Split Spoon

The continuous split spoon is a large diameter split spoon that is advanced into the soil column inside a hollow stem auger. Continuous split spoons are typically 3-inches to 5-inches in diameter and either 5-feet or 10-feet in length, although the 5-foot long samplers are most common. After the auger string has been advanced into the soil column a distance equal to the length of the sampler being used it is returned to the surface. The sampler is removed from inside the hollow stem auger and the threaded collars are removed. The split spoon is then opened for sampling.

5.4 Special Considerations When Using Split Spoon Sampling Methods

- Always discard the top several inches of material in the spoon before removing any portion for sampling. This material normally consists of borehole wall material that has sloughed off of the borehole wall after removal of the drill string prior to and during inserting the split spoon.
- Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

6 Shelby Tube/Thin-Walled Sampling Methods

6.1 General

Shelby tubes, also referred to generically as thin-walled push tubes or Acker thin-walled samplers, are used to collect subsurface soil samples in cohesive soils and clays during drilling activities. In addition to samples for chemical analyses, Shelby tubes are also used to collect relatively undisturbed soil samples for geotechnical analyses, such as hydraulic conductivity and permeability, to support hydrogeologic characterizations at hazardous waste and other sites.

6.2 Shelby Tube Sampling Method

A typical Shelby tube is 30-inches in length and has a 3.0-inch OD (2.875 ID) and may be constructed of steel, stainless steel, galvanized steel, or brass. They also typically are attached to push heads that are constructed with a ball-check to aid in holding the contained sample during retrieval. If used for collecting samples for chemical analyses, it must be constructed of stainless steel. If used for collecting samples for standard geotechnical parameters, any material is acceptable.

To collect a sample, the tube is attached to a string of drill rod and is lowered into the borehole, where the sampler is then pressed into the undisturbed clay or silts by hydraulic force. After retrieval to the surface, the tube containing the sample is then removed from the sampler head. If samples for chemical analyses are needed, the soil contained inside the tube is then removed for sample acquisition. If the sample is collected for geotechnical parameters, the tube is typically capped, maintaining the sample in its relatively undisturbed state, and shipped to the appropriate geotechnical laboratory.

6.3 Special Considerations When Using Split Spoon Sampling Methods

Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

7 Backhoe Sampling Method

7.1 General

Backhoes may be used in the collection of surface and shallow subsurface soil samples. The trenches created by excavation with a backhoe offer the capability of collecting samples from very specific intervals and allow visual correlation with vertically and horizontally adjacent material. If possible, the sample should be collected without entering the trench. Samples may be obtained from the trench wall or they may be obtained directly from the bucket at the surface. The following sections describe various techniques for safely collecting representative soil samples with the aid of a backhoe.

7.2 Scoop and Bracket Method

If a sample interval is targeted from the surface, it can be sampled using a stainless steel scoop and bracket. First a scoop and bracket are affixed to a length of conduit and is lowered into the backhoe pit. The first step is to take the scoop and scrape away the soil comprising the surface of the excavated wall. This material likely represents soil that has been smeared by the backhoe bucket from adjacent material. After the smeared material has been scraped off, the original stainless steel scoop is removed and a clean stainless steel scoop is placed on the bracket. The clean scoop can then be used to remove sufficient volume of soil from the excavation wall to make up the required sample volume.

7.3 Direct-From-Bucket Method

It is also possible to collect soil samples directly from the backhoe bucket at the surface. Some precision with respect to actual depth or location may be lost with this method but if the soil to be sampled is uniquely distinguishable from the adjacent or nearby soils, it may be possible to characterize the material as to location and depth. In order to ensure representativeness, it is also advisable to dress the surface to be sampled by scraping off any smeared material that may cross-contaminate the sample.

7.4 Special Considerations When Sampling with a Backhoe

- Do not physically enter backhoe excavations to collect a sample. Use either procedure 7.2, Scoop and Bracket Method, or procedure 7.3, Direct-From-Bucket Method to obtain soil for sampling.
- Smearing is an important issue when sampling with a backhoe. Measures must be taken, such as dressing the surfaces to be sampled (see Section 2.3), to mitigate problems with smearing.

- Paint, grease and rust must be removed and the bucket decontaminated prior to sample collection.
- Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Surface Water Sampling**

Effective Date: November 1, 2007 | **Number:** SESDPROC-201-R1

Authors

Name: Joe Compton
Title: Life Scientist
Signature: Joe Compton Date: 11/7/07

Name: Laura Ackerman
Title: Environmental Engineer
Signature: Laura Acker Date: 11/02/07

Approvals

Name: Antonio Quinones
Title: ~~Chief, Enforcement and~~ Investigations Branch
Signature: Date: 11/02/07

Name: Bill Cosgrove
Title: Chief, Ecological Assessment Branch
Signature: Date: 11/2/07

Name: Laura Ackerman
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Laura Acker Date: 11/02/07

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-201-R1, *Surface Water Sampling*, replaces SESDPROC-201-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove's title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. Added two references (49 CFR and SESDPROC-206). **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual. **Section 1.5.2, 4th bullet** Added references to the CFR and IATA's Dangerous Goods Regulations. **Section 2.2, 5th bullet** Added reference to SESDPROC-206. **Section 2.5** Updated referenced operating procedures due to changes in title names.	November 1, 2007
SESDPROC-201-R0, *Surface Water Sampling*, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting surface water samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling surface water samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used to obtain a surface water sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Field pH Measurement, SESDPROC-100, Most Recent Version

SESD Operating Procedure for Field Specific Conductance Measurement, SESDPROC-101, Most Recent Version

SESD Operating Procedure for Field Turbidity Measurement, SESDPROC-103, Most Recent Version

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, Most Recent Version

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

Title 49 Code of Federal Regulations, Pts. 171 to 179, Most Recent Version

United States Environmental Protection Agency (US EPA). 1981. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples," Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), April 13, 1981.

US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting surface water samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting surface water samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader and stored in a secure place.

2 Special Sampling Considerations

2.1 Volatile Organic Compounds (VOC) Analysis

Surface water samples for VOC analysis must be collected in 40 ml glass vials with Teflon® septa. The vial may be either preserved with concentrated hydrochloric acid or they may be unpreserved. Preserved samples have a two week holding time, whereas, unpreserved samples have only a seven day holding time. In the great majority of cases, the preserved vials are used to take advantage of the extended holding time. In some situations, however, it may be necessary to use the unpreserved vials. For example, if the surface water sample contains a high concentration of dissolved calcium carbonate, there may be an effervescent reaction between the hydrochloric acid and the water, producing large numbers of fine bubbles. This will render the sample unacceptable. In this case, unpreserved vials should be used and arrangements must be confirmed with the laboratory to ensure that they can accept the unpreserved vials and meet the shorter sample holding times.

The samples should be collected with as little agitation or disturbance as possible. The vial should be filled so that there is a reverse or convex meniscus at the top of the vial and absolutely no bubbles or headspace should be present in the vial after it is capped. After the cap is securely tightened, the vial should be inverted and tapped on the palm of one hand to see if any undetected bubbles are dislodged. If a bubble or bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus. Care should be taken not to flush any preservative out of the vial during topping off. If, after topping off and capping the vial, bubbles are still present, a new vial should be obtained and the sample re-collected.

Samples for VOC analysis must be collected using either stainless steel or Teflon® equipment.

2.2 Special Precautions for Trace Contaminant Surface Water Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come in contact with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.
- Sample containers for samples suspected of containing high concentrations of contaminants shall be stored separately.
- All background or control samples shall be collected and placed in separate ice chests or shipping containers. Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area. Samples of waste or highly contaminated media must not be placed in the same ice chest as

environmental (i.e., containing low contaminant levels) or background samples.

- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.
- Samplers must use new, verified and certified-clean disposable or non-disposable equipment cleaned according to procedures contained in SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, or SESD Operating Procedure for Field Cleaning and Decontamination at the FEC, SESDPROC-206, for collection of samples for trace metals or organic compound analyses.

2.3 Sample Handling and Preservation Requirements

1. Surface water samples will typically be collected either by directly filling the container from the surface water body being sampled or by decanting the water from a collection device such as a stainless steel scoop or other device.
2. During sample collection, if transferring the sample from a collection device, make sure that the device does not come in contact with the sample containers.
3. Place the sample into appropriate, labeled containers. Samples collected for VOC analysis must not have any headspace (see Section 2.1, Volatile Organic Compound Analysis). All other sample containers must be filled with an allowance for ullage.
4. All samples requiring preservation must be preserved as soon as practically possible, ideally immediately at the time of sample collection. If preserved VOC vials are used, these will be preserved with concentrated hydrochloric acid by ASB personnel prior to departure for the field investigation. All other chemical preservatives required for the remaining suite of analytes will be supplied by ASB personnel and will be added to the samples by SESD field personnel or other authorized persons. The adequacy of sample preservation will be checked after the addition of the preservative for all samples, except for the samples collected for VOC analysis. If it is determined that a sample is not adequately preserved, additional preservative should be added to achieve adequate preservation. Preservation requirements for surface water samples are found in the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version.
5. All samples preserved using a pH adjustment (except VOCs) must be checked, using pH strips, to ensure that they were adequately preserved. This is done by pouring a small volume of sample over the strip. Do not place the strip in the sample. Samples requiring reduced temperature storage should be placed on ice immediately.

2.4 Quality Control

If possible, a control sample should be collected from a location not affected by the possible contaminants of concern and submitted with the other samples. In streams or other bodies of moving water, the control sample should be collected upstream of the sampled area. For impounded bodies of water, particularly small lakes or ponds, it may be difficult or inappropriate to obtain an unbiased control from the same body of water from which the samples are collected. In these cases, it may be appropriate to collect a background sample from a similar impoundment located near the sampled body of water if there is a reasonable certainty that the background location has not been impacted. Equipment blanks should be collected if equipment is field cleaned and re-used on-site or if necessary to document that low-level contaminants were not introduced by pumps, bailers or other sampling equipment.

2.5 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in SESD Operating Procedure for Control of Records, SESDPROC-002. Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation in accordance with SESD Operating Procedure for Logbooks, SESDPROC-010 and SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005.

3 General Considerations

3.1 General

The surface water sampling techniques and equipment described in the following Sections 4, 5 and 6 of this procedure document are designed to minimize effects on the chemical and physical integrity of the sample. If the procedures in this section are followed, a representative sample of the surface water should be obtained.

3.2 Equipment Selection Considerations

The physical location of the investigator when collecting a sample may dictate the equipment to be used. If surface water samples are required, direct dipping of the sample container into the stream is desirable. Collecting samples in this manner is possible when sampling from accessible locations such as stream banks or by wading or from low platforms, such as small boats or piers. Wading or streamside sampling from banks, however, may cause the re-suspension of bottom deposits and bias the sample. Wading is acceptable if the stream has a noticeable current (is not impounded), and the samples are collected while facing upstream. If the stream is too deep to wade, or if the sample must be collected from more than one water depth, or if the sample must be collected from an elevated platform (bridge, pier, etc.), supplemental sampling equipment must be used.

To collect a surface water sample from a water body or other surface water conveyance, a variety of methods can be used:

- Dipping Using Sample Container
- Scoops
- Peristaltic Pumps
- Submersible Pumps
- Discrete Depth Samplers
- Bailers
- Buckets

Regardless of the method used, precautions should be taken to insure that the sample collected is representative of the water body or conveyance. These methods are discussed in the following sections.

4 Dipping Using Sample Container

A sample may be collected directly into the sample container when the surface water source is accessible by wading or other means. The sampler should face upstream if there is a current and collect the sample without disturbing the bottom sediment. The surface water sample should always be collected prior to the collection of a sediment sample at the same location. The sampler should be careful not to displace the preservative from a pre-preserved sample container, such as the 40-ml VOC vial.

5 Scoops

Stainless steel scoops provide a means of collecting surface water samples from surface water bodies that are too deep to access by wading. They have a limited reach of about eight feet and if samples from distances too far to access using this method are needed, a mobile platform, such as a boat may be required.

Stainless steel scoops are useful for reaching out into a body of water to collect a surface water sample. The scoop may be used directly to collect and transfer a surface water sample to the sample container, or it may be attached to an extension in order to access the selected sampling location.

6 Peristaltic Pumps

Another device that can be effectively used to sample a water column, such as a shallow pond or stream, is the peristaltic pump/vacuum jug system. The peristaltic pump can be used to collect a water sample from any depth if the pump is located at or near the surface water elevation. There is no suction limit for these applications. The use of a metal conduit to which the tubing is attached, allows for the collection of a vertical sample (to about a 25 foot depth) which is representative of the water column. The tubing intake is positioned in the water column at the desired depth by means of the conduit. Using this method, discrete samples may be collected by positioning the tubing intake at one depth or a vertical composite may be collected by moving the tubing intake at a constant rate vertically up and down the water column over the interval to be composited.

Samples for VOC analysis cannot be collected directly from the peristaltic pump discharge or from the vacuum jug. If a peristaltic pump is used for sample collection and VOC analysis is required, the VOC sample must be collected using one of the "soda straw" variations. Ideally, the tubing intake will be placed at the depth from which the sample is to be collected and the pump will be ran for several minutes to fill the tubing with water representative of that interval. After several minutes, the pump is turned off and the tubing string is retrieved. The pump speed is then reduced to a slow pumping rate and the pump direction is reversed. After turning the pump back on, the sample stream is collected into the VOC vials as it is pushed from the tubing by the pump. Care must be taken to prevent any water that was in contact with the silastic pump head tubing from being incorporated into the sample.

7 Discrete Depth Samplers

When discrete samples are desired from a specific depth, and the parameters to be measured do not require a Teflon®-coated sampler, a standard Kemmerer or Van Dorn sampler may be used. The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the ends of the sampler open while being lowered in a vertical position, thus allowing free passage of water through the cylinder. The Van Dorn sampler is plastic and is lowered in a horizontal position. In each case, a messenger is sent down a rope when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill respective sample containers. With a rubber tube attached to the valve, dissolved oxygen sample bottles can be properly filled by allowing an overflow of the water being collected. With multiple depth samples, care should be taken not to disturb the bottom sediment, thus biasing the sample.

When metals and organic compounds parameters are of concern, then a double-check valve, stainless steel bailer or Kemmerer sampler should be used to collect the sample.

8 Bailers

Teflon® bailers may also be used for surface water sampling if the study objectives do not necessitate a sample from a discrete interval in the water column. A closed-top bailer with a bottom check-valve is sufficient for many studies. As the bailer is lowered through the water column, water is continually displaced through the bailer until the desired depth is reached, at which point the bailer is retrieved. This technique may not be successful where strong currents are found.

9 Buckets

A plastic bucket can be used to collect samples for measurement of water quality parameters such as pH, temperature, and conductivity. Samples collected for analysis of classical water quality parameters including but not limited to ammonia, nitrate-nitrite, phosphorus, and total organic carbon may also be collected with a bucket. Typically, a bucket is used to collect a sample when the water depth is too great for wading, it is not possible to deploy a boat, or access is not possible (excessive vegetation or steep embankments) and the water column is well mixed. The water body is usually accessed from a bridge. The bucket is normally lowered by rope over the side of the bridge. Upon retrieval, the water is poured into the appropriate sample containers

Caution should be exercised whenever working from a bridge. Appropriate measures should be taken to insure the safety of sampling personnel from traffic hazards.

10 Submersible Pumps

Submersible pumps can be used to collect surface water samples directly into a sample container. The constituents of interest should be taken into consideration when choosing the type of submersible pump and tubing to be used. If trace contaminant sampling of extractable organic compounds and/or inorganic analytes will be conducted, the submersible pump and all of its components should be constructed of inert materials such as stainless steel and Teflon®. The tubing should also be constructed of Teflon®. If re-using the same pump between sample locations, the pump should be decontaminated using SESD Operating Procedure for Field Equipment Cleaning and Decontamination, (SESDPROC-205). New tubing should be used at each sample location.

If the samples will be analyzed for classical parameters such as ammonia, nitrate-nitrite, phosphorus, or total organic carbon, the pump and tubing may be constructed of components other than stainless steel and Teflon®. The same pump and tubing may be re-used at each sampling station after rinsing with deionized water and then purging several volumes of sample water through the pump and tubing prior to filling the sample containers.

Either a grab or composite sample can be collected using a submersible pump. A composite sample can be collected by raising and lowering the pump throughout the water column. If a composite sample is collected, it may be necessary to pump the sample into a compositing vessel for mixing prior to dispensing into the sample containers. If a compositing vessel is required, it should be constructed of materials compatible with the constituents of concern and decontaminated between sample stations according to appropriate procedures, again depending on the constituents of concern.

11 Automatic Samplers

Where unattended sampling is required (e.g., storm-event sampling, time-of-travel studies) an automatic sampler may be used. The automatic sampling device may be used to collect grab samples based on time, in-stream flow or water level or used to collect composite samples as dictated by the study data needs. The automatic sampling device should be calibrated prior to deployment to insure the proper volume is collected. The manufacturer's instruction manual should be consulted for automatic sampler operation.

12 Trace-Level Mercury Sampling

In order to prevent contamination during sample collection, Region 4 has developed this sampling procedure for trace-level mercury analysis (< 1 part per trillion). This procedure is based on EPA Method 1669.

A vacuum chamber assembly is utilized to collect surface water samples for trace-level mercury analyses. The vacuum chamber assembly consists of the following: 1) an airtight acrylic, cylindrical chamber with an o-ring sealed lid to hold the sample bottle, 2) a Teflon® sample tubing that connects to a centered Teflon® compression fitting on top of the chamber. The other end of the tubing passes through a rigid Teflon® pole for stability and has a modified magnetic screen holder at the intake, and a hand vacuum pump. The chamber is designed to hold a 2-liter sample bottle; however, smaller sample containers may be utilized with a spacer inserted into the chamber. A two inch square of 100 □m Nitex® screen is used on the magnetic screen holder at the intake to prevent large pieces of debris from entering the sample. The screen does not prevent the passage of particulate organic matter which is often prevalent in surface water. The vacuum chamber has a second off-center compression fitting with a 4 inch piece of Teflon® tubing inserted in the fitting. A piece of clear Tygon® tubing approximately 18-24 inches long is placed over the small piece of Teflon®. The Teflon® adds stability to the tubing and keeps it from crimping. The Tygon® is attached to the hand pump and the chamber with electrical tape. The Nitex® screen intake is inserted into the water to be sampled and a vacuum is pulled on the chamber by means of the hand vacuum pump, thus drawing a water sample into a sample container placed directly beneath the intake tubing within the chamber.

Teflon® bottles or 300-Series glass bottles with single use Teflon®-lined caps may be used for sample collection. All sample containers used for collection of trace-level mercury water samples must be pre-cleaned in a laboratory as described in EPA Method 1631. Teflon® containers should also be etched on the outside of the bottle with a unique identification number for QA purposes. All bottles for trace-level sampling must be double bagged in re-sealable bags. Water samples collected for total, inorganic, methyl or ethyl mercury analyses are pumped into appropriately cleaned bottles. Preservation should be done in a clean room laboratory that has been specifically prepared for the preparation of trace level samples (positive pressure ventilation, sticky floor mats, etc.). Preservation must occur within 48 hours of sample collection, sooner if possible. Region 4 utilizes laboratory preservation of trace-level mercury samples in order to minimize the potential for contamination, and if split samples are required, they must be split in a trace-level clean room laboratory.

The following quality assurance/quality control (QA/QC) samples are collected in conjunction with low-level mercury samples:

- bottle blanks
- equipment blanks

- air deposition blanks
- trip blanks
- duplicates, and
- splits

A bottle blank is prepared in the lab with reagent-grade water to insure the cleanliness of the bottles prior to use in the field. After decontamination of the Teflon® tubing by pumping and discarding several sample container volumes of reagent-grade water through the tubing, (using the same amount of water used for sample collection in the field) an equipment blank sample is collected into an appropriately pre-cleaned sample container. Equipment blanks are collected at the beginning of each field trip and at the end of each day. The bottle blank and the equipment blank do not go out into the field and are preserved at the end of the day with the regular field samples.

Air deposition blanks are collected to determine if airborne mercury is present at the time of sample collection. The air deposition blanks consist of a pre-cleaned mercury sample container, filled with reagent-grade water by the laboratory that prepared the containers, and is shipped with the containers to the field. The air deposition blank is uncapped using "clean hands"/ "dirty hands" procedures (see below) and set near the sampling location throughout the duration of the mercury sample collection for that particular station. Once the mercury sample is collected, the air deposition blank is recapped and handled and processed with the other mercury samples. One air deposition blank is collected each day by each field crew unless atmospheric conditions or site conditions warrant additional blanks.

Trip blanks are utilized to determine if any contaminants of interest to the study are potentially introduced to the samples during storage and transport to the laboratory. Trip blanks are prepared by the laboratory which supplies the mercury sample containers. The trip blanks consist of cleaned bottles which are filled with reagent-grade water by the laboratory and shipped with the other clean sample containers. A dark plastic bag is placed in each cooler that will hold the trace-level water samples. One trip blank is placed in each trace-level cooler of samples and returned to the laboratory with the ambient trace-level water samples. All trace-level samples should be kept in the dark until they are preserved. The trip blanks are never opened in the field. Trip blanks are preserved in the clean room.

Duplicate samples are discrete samples collected at the same site and time to measure variability of collected samples and to assess sample collection consistency. Sample splits are aliquots of a minimum 500 ml poured from a single ambient sample. They must be split in a trace-level clean room laboratory.

In order to prevent cross contamination in samples analyzed for trace-level mercury in ambient surface waters, clean sampling protocols must be employed throughout the sampling effort. For each sampling event, one sampling team member is designated as "clean hands" and one as "dirty hands" (see below). All operations involving contact

with the sample bottle and transfer of the sample from the sample collection device to the sample bottle are handled by the individual designated as "clean hands". "Dirty hands" is responsible for preparation of the sampling device (except the sample container) and for all other activities that do not involve direct contact with the sample.

Prior to sample collection with the vacuum chamber assembly, the Teflon® line is cleaned at each station by rinsing with ambient water as follows: A 2-liter poly bottle is placed into the chamber and filled half full with ambient water. The bottle is swirled to rinse it and the water is discarded downstream of sampling area. The same 2-liter poly bottle can be used at each station. Additional cleaning measures are not recommended as long as the chamber assembly is only used to collect ambient surface water samples. Detergent washes and acid rinses are not conducted due to potential mercury contamination from these solutions. If applicable, samples for other analyses can be collected in a poly bottle with the vacuum chamber assembly but should be collected before the trace-level sample as an additional means of flushing the sampling line prior to collection of the trace-level samples. It is not necessary to implement the "clean hands"/ "dirty hands" method for collection of non-mercury samples, but latex or vinyl gloves should be worn when any samples are collected.

Following are procedures for cleaning the vacuum chamber tubing and collection of ancillary water quality samples, if applicable:

1. Carefully approach the sampling station from downstream and downwind if possible.

2. While wearing latex or vinyl gloves, place an uncapped 2-liter poly bottle into the chamber and secure the chamber lid by attaching the spring-loaded clamps.

3. Place a new square of 100 µm Nitex® screen in the magnetic screen holder. Place the intake beneath the surface of the water (mid-depth or six inches, which ever is less) and hold firmly in place. Care should be taken not to disturb sediment particles in very shallow waters (< 4 inches deep).

4. Squeeze the hand pump until liquid starts to fill the bottle in the chamber. When the bottle is approximately half full, release the vacuum on the chamber, remove the bottle, swirl the contents and discard the water downstream. Repeat this rinse. If ancillary water quality samples are to be collected, return the 2-liter poly bottle to the chamber and pump the required volume of water to fill the appropriate ancillary sample containers. Remove the 2-liter bottle from the chamber and cap. Fill the ancillary sample bottles upon completion of the mercury sample collection.

Water samples for trace level mercury analyses should be collected immediately after the ancillary water samples have been collected according to the following procedures:

1. "Clean hands" should put on a pair of latex or vinyl gloves, then a pair of shoulder length polyethylene gloves.

2. "Dirty hands" should put on a pair of latex or vinyl gloves, retrieve the double bagged trace level sample bottle from the cooler, and open the outer bag. "Clean hands" should open the inner bag and remove the pre-cleaned Teflon® or glass bottle.

3. "Dirty hands" should open the lid on the chamber. "Clean hands" should place the sample bottle in the chamber, remove the bottle top and place it inside the chamber with the bottle.

4. "Dirty hands" should close and secure the chamber lid and using the hand pump, fill the container. The sample container should be filled to overflowing. "Dirty hands" should then release the vacuum and open the lid on the chamber.

5. "Clean hands" should place the top on the sample bottle, remove it from the chamber and place it in the inner bag and seal the bag. "Dirty hands" should seal the outer bag and place the sample in the black bag in the dark cooler. Only coolers dedicated to storage and transport of trace-level mercury samples should be used.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Groundwater Sampling**

Effective Date: November 1, 2007 | **Number:** SESDPROC-301-R1

Authors

Name: Donald Hunter
Title: Environmental Scientist, Regional Expert
Signature: Donald Hunter Date: 11/02/07

Approvals

Name: Antonio Quinones
Title: ~~Chief, Enforcement and Investigations Branch~~
Signature: Date: 11/02/07

Name: Laura Ackerman
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Laura Acker Date: 11/01/07

Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-301-R1, *Groundwater Sampling*, replaces SESDPROC-301-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual. **Section 1.5.2, 4th bullet** Added references to the CFR and IATA's Dangerous Goods Regulations. **Section 2.5** Updated referenced operating procedures due to changes in title names.	November 1, 2007
SESDPROC-301-R0, Groundwater Sampling, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting groundwater samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling groundwater samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used to obtain a groundwater sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

Puls, Robert W., and Michael J. Barcelona. 1989. Filtration of Ground Water Samples for Metals Analysis. Hazardous Waste and Hazardous Materials 6(4), pp.385-393.

Puls, Robert W., Don A. Clark, and Bert Bledsoe. 1992. Metals in Ground Water: Sampling Artifacts and Reproducibility. Hazardous Waste and Hazardous Materials 9(2), pp. 149-162.

SESD Guidance Document, Design and Installation of Monitoring Wells, SESDGUID-001, Most Recent Version

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Field pH Measurement, SESDPROC-100, Most Recent Version

SESD Operating Procedure for Field Specific Conductance Measurement, SESDPROC-101, Most Recent Version

SESD Operating Procedure for Field Temperature Measurement, SESDPROC-102, Most Recent Version

SESD Operating Procedure for Field Turbidity Measurement, SESDPROC-103, Most Recent Version

SESD Operating Procedure for Groundwater Level and Well Depth Measurement, SESDPROC-105, Most Recent Version

SESD Operating Procedure for Management of Investigation Derived Waste, SESDROC-202, Most Recent Version

SESD Operating Procedure for Pump Operation, SESDPROC-203, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, Most Recent Version

SESD Operating Procedure for Potable Water Supply Sampling, SESDPROC-305, Most Recent Version

United States Environmental Protection Agency (US EPA). 1975. Handbook for Evaluating Water Bacteriological Laboratories. Office of Research and Development (ORD), Municipal Environmental Research Laboratory, Cincinnati, Ohio.

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US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting groundwater samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting groundwater samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Always sample from the anticipated cleanest, i.e., least contaminated location, to the most contaminated location. This minimizes the opportunity for cross-contamination to occur during sampling.

- Collected samples must remain in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader and placed in the project files.

2 Special Sampling Considerations

2.1 Volatile Organic Compounds (VOC) Analysis

Groundwater samples for VOC analysis must be collected in 40 ml glass vials with Teflon® septa. The vial may be either preserved with concentrated hydrochloric acid or they may be unpreserved. Preserved samples have a two week holding time, whereas unpreserved samples have only a seven day holding time. In the great majority of cases, the preserved vials are used to take advantage of the extended holding time. In some situations, however, it may be necessary to use the unpreserved vials. For example, if the groundwater has a high amount of dissolved limestone, i.e., is highly calcareous, there will most likely be an effervescent reaction between the hydrochloric acid and the water, producing large numbers of fine bubbles. This will render the sample unacceptable. In this case, unpreserved vials should be used and arrangements must be confirmed with the laboratory to ensure that they can accept the unpreserved vials and meet the shorter sample holding times.

The samples should be collected with as little agitation or disturbance as possible. The vial should be filled so that there is a meniscus at the top of the vial and absolutely no bubbles or headspace should be present in the vial after it is capped. After the cap is securely tightened, the vial should be inverted and tapped on the palm of one hand to see if any undetected bubbles are dislodged. If a bubble or bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus. Care should be taken not to flush any preservative out of the vial during topping off. If, after topping off and capping the vial, bubbles are still present, a new vial should be obtained and the sample re-collected.

Samples for VOC analysis must be collected using either stainless steel or Teflon® equipment, such as:

- Bailers must be constructed of stainless steel or Teflon®
- RediFlo2® submersible pumps used for sampling should be equipped with Teflon® sample delivery tubing
- Peristaltic pump/vacuum jug assemblies should be outfitted with Teflon® tubing from the water column to the transfer cap, which should also be constructed of Teflon®

2.2 Special Precautions for Trace Contaminant Groundwater Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come in contact

with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.

- Sample containers for samples suspected of containing high concentrations of contaminants shall be stored separately.
- Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area if sampling devices are to be reused. Samples of waste or highly contaminated media must not be placed in the same ice chest as environmental (i.e., containing low contaminant levels) or background samples.
- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.
- Clean plastic sheeting will be placed on the ground at each sample location to prevent or minimize contaminating sampling equipment by accidental contact with the ground surface.
- Samplers must use new, verified certified-clean disposable or non-disposable equipment cleaned according to procedures contained in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205) or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) for collection of samples for trace metals or organic compound analyses.

2.3 Sample Handling and Preservation Requirements

1. Groundwater samples will typically be collected from the discharge line of a pump or from a bailer, either from the pour stream of an up-turned bailer or from the stream from a bottom-emptying device. Efforts should be made to reduce the flow from either the pump discharge line or the bailer during sample collection to minimize sample agitation.

2. During sample collection, make sure that the pump discharge line or the bailer does not contact the sample container.

3. Place the sample into appropriate, labeled containers. Samples collected for VOC analysis must not have any headspace (see Section 2.1, Volatile Organic Compound Analysis). All other sample containers must be filled with an allowance for ullage.

4. All samples requiring preservation must be preserved as soon as practically possible, ideally immediately at the time of sample collection. If preserved VOC vials are used, these will be preserved with concentrated hydrochloric acid by ASB personnel prior to departure for the field investigation. All other chemical preservatives required for the remaining suite of analytes will be supplied by ASB personnel and will be added to the samples by SESD field personnel or other

authorized persons. The adequacy of sample preservation will be checked after the addition of the preservative for all samples except for the samples collected for VOC analysis. Additional preservative should be added to achieve adequate preservation. Preservation requirements for groundwater samples are found in the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version.

2.4 Quality Control

If possible, a control sample should be collected from location not affected by the possible contaminants of concern and submitted with the other samples. This control sample should be collected as close to the sampled area as possible and from the same water-bearing formation. Equipment blanks should be collected if equipment is field cleaned and re-used on-site or if necessary to document that low-level contaminants were not introduced by pumps, bailers or other sampling equipment.

2.5 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in SESD Operating Procedure for Control of Records, SESDPROC-002. Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation in accordance with SESD Operating Procedure for Logbooks, SESDPROC-010 and SESD Procedure for Sample and Evidence Management, SESDPROC-005.

3 Groundwater Sampling Methods - Purging

3.1 General

3.1.1 Purging and Purge Adequacy

Purging is the process of removing stagnant water from a well, immediately prior to sampling, causing its replacement by ground water from the adjacent formation that is representative of actual aquifer conditions. In order to determine when a well has been adequately purged, field investigators should monitor the pH, specific conductance, temperature, and turbidity of the ground water removed during purging and, in the case of permanent monitoring wells, observe and record the volume of water removed.

Prior to initiating the purge, the amount of water standing in the water column (water inside the well riser and screen) should be determined, if possible. To do this, the diameter of the well should be determined and the water level and total depth of the well should be measured and recorded. Specific methodology for obtaining these measurements is found in SESD Operating Procedure for Groundwater Level and Well Depth Measurement (SESDPROC-105). Once this information is obtained, the volume of water to be purged can be determined using one of several methods. One is the equation:

$$V = 0.041\ d^2h$$

Where: h = depth of water in feet
d = diameter of well in inches
V = volume of water in gallons

Alternatively, the volume may be determined using a casing volume per foot factor for the appropriate diameter well, similar to that in Table 3.1.1. The water level is subtracted from the total depth, providing the length of the water column. This length is multiplied by the factor in the Table 3.1.1 which corresponds to the appropriate well diameter, providing the amount of water, in gallons, contained in the well, i.e., one well or water column volume. Other acceptable methods include the use of nomographs or other equations or formulae.

With respect to volume, an adequate purge is normally achieved when three to five well volumes have been removed. The field notes should reflect the single well volume calculations or determinations, according to one of the above methods, and a reference to the appropriate multiplication of that volume, i.e., a minimum three well volumes, clearly identified as a purge volume goal.

With respect to the ground water chemistry, an adequate purge is achieved when the pH, specific conductance, and temperature of the ground water have stabilized

TABLE 3.1.1
WELL CASING DIAMETER vs. VOLUME

WELL CASING DIAMETER (INCHES) vs. VOLUME (GALS.)/FEET of WATER	
CASING	GALLONS/FT
1	0.041
2	0.163
3	0.367
4	0.653
5	1.02
6	1.469
7	1.999
8	2.611
9	3.305
10	4.08
11	4.934
12	5.875

and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs) (twice the Primary Drinking Water Standard of 5 NTUs). Although 10 NTUs is normally considered the minimum goal for most ground water sampling objectives, lower turbidity has been shown to be easily achievable in most situations and reasonable attempts should be made to achieve these lower levels. Stabilization occurs when, for at least three consecutive measurements, the pH remains constant within 0.1 Standard Unit (SU), specific conductance varies no more than approximately 10 percent, and the temperature is constant. There are no set criteria for establishing how many total sets of measurements are adequate to document stability of parameters. If the calculated purge volume is small, the measurements should be taken frequently enough to provide a sufficient number of measurements to evaluate stability. If the purge volume is large, measurements taken every 15 minutes, for example, may be sufficient. See the SESD Operating Procedure for Field pH Measurement (SESDPROC-100), SESD Operating Procedure for Field Specific Conductance Measurement (SESDPROC-101), SESD Operating Procedure for Field Temperature Measurement (SESDPROC-102) and SESD Operating Procedure for Field Turbidity Measurement (SESDPROC-103) for procedures for conducting these purge adequacy measurements.

If, after three well volumes have been removed, the chemical parameters have not stabilized according to the above criteria, additional well volumes (up to five well volumes), should be removed. If the parameters have not stabilized within five volumes, it is at the discretion of the project leader whether or not to collect a sample or to continue purging. If, after five well volumes, pH and conductivity have stabilized and the turbidity is still decreasing and approaching an acceptable level, additional purging should be considered to obtain the best sample possible, with respect to turbidity. The conditions of sampling should be noted in the field log.

In some situations, even with slow purge rates, a well may be pumped or bailed dry (evacuated). In these situations, this generally constitutes an adequate purge and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). ***It is not necessary that the well be evacuated three times before it is sampled.*** The pH, specific conductance, temperature, and turbidity should be measured and recorded, during collection of the sample from the recovered volume, as the measurements of record for the sampling event.

For wells with slow recovery, attempts should be made to avoid purging them to dryness. This can be accomplished, for example, by slowing the purge rate. If a well is purged to dryness, it may result in the sample being comprised partially of water contained in the sand pack, which may be reflective, at least in part, of initial, stagnant conditions. Additionally, as water enters a well that has been purged to dryness, it may cascade down the sand pack and/or the well screen, stripping volatile organic constituents that may be present and/or introducing soil fines into the water column.

It is particularly important that wells be sampled as soon as possible after purging. If adequate volume is available immediately upon completion of purging, the well must be sampled immediately. If not, sampling should occur as soon as adequate volume has recovered. Sampling of wells which have a slow recovery should be scheduled so that they can be purged and sampled in the same day, after adequate volume has recovered. Wells of this type should not be purged at the end of one day and sampled the following day.

3.1.2 Equipment Considerations for Purging

Monitoring well purging is preferably accomplished by using in-place plumbing and dedicated pumps or by using portable pumps/equipment when dedicated systems are not present. The equipment utilized by Branch personnel will usually consist of peristaltic pumps and variable speed electric submersible pumps, but may also include bladder pumps or inertial pumps. The pump of choice is usually a function of the well diameter, the depth to water, the depth of the well and the amount of water that is to be removed during purging. Whenever the head difference between the sampling location and the water level is less than the limit of suction and the volume to be removed is reasonably small, a peristaltic pump

should be used for purging. For wells where the water level is below the limit of suction and/or there is a large volume of water to be purged, the variable speed electric submersible pump would be the pump of choice. SESD Operating Procedure for Pump Operation (SESDPROC-203) contains the use and operating instructions for all pumps commonly used during SESD ground water investigations.

Bailers may also be used for purging in appropriate situations, however, their use is discouraged. Bailers tend to disturb any sediment that may be present in the well, creating or increasing sample turbidity. If a bailer is used, it should be a closed-top Teflon® bailer.

3.2 Wells Without Plumbing or In-Place Pumps

For permanent monitoring wells, the depth to water (water level) and depth of the well (total depth) should be determined before purging. Caution should be exercised during this procedure to prevent cross-contamination between wells. This is a critical concern when samples for trace organic compounds or metals analyses are collected. See SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205) for cleaning procedures for well sounders. After cleaning, the well sounding device should be protected to keep it clean until its next use.

3.2.1 Purging with Pumps

3.2.1.1 Peristaltic Pumps

The following step-by-step procedures describe the process of purging with a peristaltic pump:

1. Cut a length of standard-cleaned (SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) Teflon® tubing, equal to the well depth plus an additional five to ten feet. Enough tubing is needed to run from the ground surface up to the top of the well casing and back down to the bottom of the well. This will allow for operation of the pump at all possible water level conditions in the well.

2. Place one end of the tubing into the vacuum side of the peristaltic pump head. Proper sizing of the Teflon® and Silastic® or Tygon® tubing should allow for a snug fit of the Teflon® tubing inside the flexible tubing mounted in the pump head.

3. Run a short section of tubing (does not have to be Teflon®) from the discharge side of the pump head to a graduated bucket.

4. Place the free end of the Teflon® tubing into the well until the end of the tubing is just below the surface of the water column.

5. Secure the Teflon® tubing to the well casing or other secure object using electrician's tape or other suitable means. This will prevent the tubing from being lost in the well should the tubing detach from the pump head.

6. Turn on the pump to produce a vacuum on the well side of the pump head and begin the purge. Observe pump direction to ensure that a vacuum is being applied to the purge line. If the purge line is being pressurized, either switch the tubing at the pump head or reverse the polarity of the cables on the pump or on the battery.

7. If the pumping rate exceeds the recovery rate of the well, continue to lower the tubing into the well, as needed, until the drawdown stabilizes or the well is evacuated to dryness. If the pump is a variable speed peristaltic pump, and the water level in the well is being drawn down, reduce the speed of the pump in an attempt to stabilize the drawdown. If the well can be purged without evacuating the well to dryness, a sample with greater integrity can be obtained.

8. For wells which are not evacuated to dryness, particularly those with recovery rates equal to or very nearly equal to the purge rate, there may not be a complete exchange and removal of stagnant water in that portion of the water column above the tubing intake. For this reason, it is important that the tubing intake be placed in the very uppermost portion of the water column while purging. Standard field measurements should frequently be taken during this process to verify adequacy of the purge and readiness for sampling, as described in Section 3.

3.2.1.2 Submersible Pumps

When a submersible pump is used for well purging, the pump itself is lowered into the water column. The pump must be cleaned as specified in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).

The pump/hose assembly used in purging should be lowered into the top of the standing water column and not deep into the column. This is done so that the purging will "pull" water from the formation into the screened area of the well and up through the casing so that the entire static volume can be removed. If the pump is placed deep into the water column, the water above the pump may not be removed, and the subsequent samples, particularly if collected with a bailer, may not be representative of the aquifer conditions. It is recommended that no more than three to five feet

of hose be lowered into the water column. If the recovery rate of the well is faster than the pump rate and no observable draw down occurs, the pump should be raised until the intake is within one foot of the top of the water column for the duration of purging. If the pump rate exceeds the recovery rate of the well, the pump will have to be lowered, as needed, to accommodate the drawdown. After the pump is removed from the well, the hose and the pump should be cleaned as outlined in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).

3.2.2 Purging With Bailers

Standard-cleaned (SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205) or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) closed-top Teflon® bailers with Teflon® coated stainless steel leaders and new nylon rope are lowered into the top of the water column, allowed to fill, and removed. It is critical that bailers be slowly and gently immersed into the top of the water column, particularly during final stages of purging, to minimize turbidity and disturbance of volatile organic constituents. The use of bailers for purging and sampling is discouraged because the correct technique is highly operator dependent and improper use may result in an unrepresentative sample.

3.2.3 Field Care of Purging Equipment

New plastic sheeting should be placed on the ground surface around the well casing to prevent contamination of the pumps, hoses, ropes, etc., in the event they accidentally come into contact with the ground surface or, for some reason, they need to be placed on the ground during the purging event. It is preferable that hoses used in purging that come into contact with the ground water be kept on a spool or contained in a large wash tub lined with plastic sheeting, both during transportation and during field use, to further minimize contamination by the transporting vehicle or the ground surface.

Careful consideration shall be given to using submersible pumps to purge wells which are excessively contaminated with oily compounds, because it may be difficult to adequately decontaminate severely contaminated pumps under field conditions. When wells of this type are encountered, alternative purging methods, such as bailers, should be considered.

3.2.4 General Low Flow/Low Stress Method Preference

The device with the lowest pump or water removal rate and the least tendency to stress the well during purging should be selected for use. For example, if a bailer and a peristaltic pump both work in a given situation, the pump should be selected because it will greatly minimize turbidity, providing a higher quality sample (Sec.

3.4.2, Purging When Water Level Is Within Limit of Suction, contains a description of low flow purging and sampling with a peristaltic pump used in a temporary well).

3.2.5 Low Flow/Low Volume Purging Techniques/Procedures

An alternative to the low flow/low stress purging method is the low flow/low volume method, commonly referred to as the "micro-purge" method. The low flow/low volume purging method is a procedure developed and used to minimize purge water volumes. The pump intake is placed within the screened interval at the zone of sampling, preferably, the zone with the highest flow rate. Low flow rate purging is conducted after hydraulic conditions within the well have re-stabilized, usually within 24 to 48 hours. Flow rates should not exceed the recharge rate of the aquifer. This is monitored by measuring the top of the water column with a properly cleaned water level indicator or similar device while pumping. This method is not considered to be a standard method by the Branch and is only acceptable under certain hydraulic conditions. It's use must be evaluated on a case-by-case basis.

3.3 Wells With In-Place Plumbing

Wells with in-place plumbing are commonly found at municipal water treatment plants, industrial water supplies, private residences, etc. Many permanent monitoring wells at active facilities are also equipped with dedicated, in-place pumps. The objective of purging wells with in-place pumps is the same as with monitoring wells without in-place pumps, i.e., to ultimately collect a ground water sample representative of aquifer conditions. Among the types of wells identified in this section, two different approaches are necessary.

A permanent monitoring well with an in-place pump should, in all respects, be treated like a monitoring well without a pump. One limitation is that in most cases the in-place pump is "hard" mounted, that is, the pump is suspended in the well at a pre-selected depth and cannot be moved up or down during purging and sampling. In these cases, well volumes are calculated, parameters are measured and the well is sampled from the pump discharge, after volume removal and parameter conditions have been met.

In the case of the other types of wells, i.e., municipal, industrial and residential supply wells, however, not enough is generally known about the construction aspects of the wells to apply the same criteria as used for monitoring wells, i.e., 3 to 5 well volumes. The volume to be purged in these situations, therefore, depends on several factors: whether the pumps are running continuously or intermittently and whether or not any storage/pressure tanks are located between the sampling point and the pump. The following considerations and procedures should be followed when purging wells with in-place plumbing under the conditions described.

3.3.1 Continuously Running Pumps

If the pump runs more or less continuously, no purge (other than opening a valve and allowing it to flush for a few minutes) is necessary. If a storage tank is present, a spigot, valve or other sampling point should be located between the pump and the storage tank. If not, locate the valve closest to the tank. Measurements of pH, specific conductance, temperature, and turbidity are recorded at the time of sampling.

3.3.2 Intermittently or Infrequently Running Pumps

If the pump runs intermittently or infrequently, best judgment should be utilized to remove enough water from the plumbing to flush standing water from the piping and any storage tanks that might be present. Generally, under these conditions, 15 to 30 minutes will be adequate. Measurements of pH, specific conductance, temperature and turbidity should be made and recorded at intervals during the purge and the final measurements made at the time of sampling should be considered the measurements of record for the event.

3.4 Temporary Monitoring Wells

3.4.1 General Considerations

Procedures used to purge temporary ground water monitoring wells differ from permanent wells because temporary wells are installed for immediate sample acquisition. Wells of this type may include standard well screen and riser placed in boreholes created by hand augering, power augering, or by drilling. They may also consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval, such as a direct push Wellpoint®, a Geoprobe® Screen Point 15 sampler or a Hydropunch® sampler. As such, the efforts to remove several volumes of water to replace stagnant water do not necessarily apply because stagnant water is not present. It is important to note, however, that the longer a temporary well is in place and not sampled, the more stagnant the water column becomes and the more appropriate it becomes to apply, to the extent possible, standard permanent monitoring well purging criteria to it to re-achieve aquifer conditions.

In cases where the temporary well is to be sampled immediately after installation, purging is conducted primarily to mitigate the impacts of installation. In most cases, temporary well installation procedures disturb the existing aquifer conditions, resulting primarily in increased turbidity. Therefore, the goal of purging is to reduce the turbidity and remove the volume of water in the area directly impacted by the installation procedure. Low turbidity conditions in these types of wells that are completed within the limit of suction are typically and routinely achieved by the use of low-flow/low stress purging techniques using variable speed peristaltic pumps.

3.4.2 Purging When Water Level Is Within Limit of Suction

In situations where the elevation of the top of the water column is within the limit of suction (no greater than about 25 feet head difference between the pump and the water level), a variable speed peristaltic pump may be used to purge temporary wells. Enough tubing is deployed to reach the bottom of the temporary well screen. At the onset of purging, the tubing is slowly lowered to the bottom of the screen and is used to remove any formation material which may have entered the well screen during installation. This is critical to ensuring rapid achievement of low turbidity conditions. After the formation material is removed from the bottom of the screen, the tubing is slowly raised through the water column to near the top of the column. The tubing can be held at this level to determine if the pump rate is drawing down the water level in the well. If the water level remains the same, secure the tubing at the surface to maintain this pumping level.

If drawdown is observed on initiation of pumping, reduce the pump speed and attempt to match the drawdown of the well. Sustained pumping at these slow rates will usually result in a relatively clear, low turbidity sample. If the drawdown stabilizes, maintain that level, however, if it continues to lower, "chase" the water column until the well is evacuated. In this case, the recovered water column may be relatively free of turbidity and can be sampled. It may take several episodes of recovery to provide enough volume for a complete sample.

3.4.3 Purging When Water Level Is Greater Than Limit of Suction

In situations where the elevation of the water table is greater than the limit of suction, peristaltic pumps cannot be used to purge temporary wells. If the temporary well is a ScreenPoint15® sampler with small diameter probe rod riser, the only practical choices for water removal are a small diameter bailer, a small diameter bladder pump or an inertial pump. If the well is to be used strictly for VOC screening, it may be acceptable to use the bailer to bail as much sediment from the well as possible prior to sampling. If metals are the analytes of concern, the bladder pump is the best choice for lowering the turbidity of the water column prior to sampling, followed next by the inertial pump. For larger diameter temporary wells, two-inch diameter or greater, bailers and the Grundfos® RediFlo2 may be used although excessive silt or other "fines" may present problems with the operation of the pump.

3.4.4 Considerations for Direct Push Groundwater Sampling

With many of the direct push sampling techniques, purging is either not practical or possible, therefore, no purging is conducted. The sampling device is simply pushed or driven to the desired depth and opened and the sample is collected and retrieved. As a result, some samples collected in this way may not be satisfactory

or acceptable for certain analyses, i.e., the subject procedure may yield a turbid sample that is not appropriate for metals analyses.

3.5 Investigation Derived Waste

Purging generates quantities of purge water or investigation derived waste (IDW), the disposition of which must be considered. See SESD Operating Procedure for Management of Investigation Derived Waste (SESDPROC-202) for guidance on management or disposal of this waste.

4 Groundwater Sampling Methods – Sampling

4.1 General

Sampling is the process of obtaining, containerizing, and preserving (if required) a ground water sample after the purging process is complete. Non-dedicated pumps for sample collection generally should not be used. Many pumps are made of materials such as brass, plastic, rubber, or other elastomer products which may cause chemical interferences with the sample. Their principle of operation may also render them unacceptable as a sample collection device. It is recognized that there are situations, such as industrial or municipal supply wells or private residential wells, where a well may be equipped with a dedicated pump from which a sample would not normally be collected. Discretion should always be used in obtaining a sample.

4.2 Sampling Wells With In-Place Plumbing

Samples should be collected following purging from a valve or cold water tap as near to the well as possible, preferably prior to any storage/pressure tanks or physical/chemical treatment system that might be present. Remove any hose that may be present before sample collection and reduce the flow to a low level to minimize sample disturbance, particularly with respect to volatile organic constituents. Samples should be collected directly into the appropriate containers as specified in the ASBLOQAM. It may be necessary to use a secondary container, such as a clean 8 oz. or similar size sample jar or a stainless steel scoop, to obtain and transfer samples from spigots with low ground clearance. Also, refer to the discussion in the SESD Operating Procedure for Potable Water Supply Sampling (SESDPROC-305), Sec. 4.2, Potable Water Samples Collected from Wells with In-Place Plumbing. Potable well measurements for pH, specific conductance, temperature, and turbidity should be recorded at the time of sample collection.

4.3 Sampling Wells without Plumbing, Within the Limit of Suction

4.3.1 Equipment Available

The pump of choice for sampling ground water within the limit of suction is the variable-speed peristaltic pump. Its use is described in the following sections. Other acceptable alternatives that may be used under these conditions are the RediFlo2® electric submersible pump (with Teflon® tubing) and a closed-top Teflon® bailer

4.3.1.1 Peristaltic Pump, Direct from Pump Head Tubing

Samples for some constituents, primarily inorganic analytes such as metals and cyanide, may be collected directly from the pump head tubing. This method is acceptable under the following conditions:

- The pump head tubing must be changed between sampling locations;
- The pump head tubing must be either be certified clean according to SESD's internal quality control program described in Section 3.2 of the SESD Operating Procedure for Field Sampling Quality Control (SESDPROC-011) or
- An equipment rinsate blank is collected by pumping de-ionized water through a piece of the tubing.

4.3.1.2 Peristaltic pump/vacuum jug

It is not acceptable to collect samples for organic compounds analyses through the flexible tubing used in the pump head. When collecting samples for organic compound analyses it is necessary to use a vacuum container, placed between the pump and the well for sample collection. The following step-by-step procedures describe the process of sampling with a peristaltic pump and vacuum jug (see note following these procedures for collection of VOC samples):

1. Disconnect the purge tubing from the pump. Make sure the tubing is securely attached to the protective casing or other secure object.

2. Insert the tubing into one of the ferrule nut fittings of a Teflon® vacuum container transfer cap assembly.

3. Place a suitable length of Teflon® tubing between the remaining transfer cap assembly ferrule nut fitting and the vacuum side of the flexible tubing in the peristaltic pump head. Securely hand-tighten both fittings.

4. Turn the pump on. Water should begin to collect in the transfer container (typically a 1-liter sample container) within a few minutes. If water does not begin to flow into the container within several minutes, check the transfer cap fittings and make sure the assembly is tightly attached to the container. It may be necessary to tighten the ferrule nuts with a wrench or pliers to achieve a vacuum in the system, particularly when approaching the maximum head difference between the pump and water table (limit of suction).

5. When the transfer container is nearly full, turn off the pump, remove the transfer cap assembly, and pour the sample into the appropriate containers. Because the 1-liter containers used by the Branch are rinsed with nitric acid during cleaning, they cannot be used for collecting samples to be analyzed for nitrogen sensitive parameters.

6. If additional sample volume is needed, replace the transfer cap assembly, turn the pump on, and collect additional volume. The use of Teflon® valves or ball check devices to retain the water column in the sample delivery tubing during the transfer phase, when large volumes of sample are required, is acceptable. These devices, however, must be constructed so that they may be completely disassembled and cleaned according to the procedures in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).

7. When sampling is completed, all Teflon® tubing should be discarded.

NOTE: Samples for volatile organic compound analyses cannot be collected using this method. If samples for VOC analyses are required, they must be collected with a Teflon® or stainless steel bailer or by other approved methods, such as the "soda straw" method. The "soda straw" method involves allowing the tubing to fill, by either lowering it into the water column (A) or by filling it via suction applied by the pump head (B). If method (A) is used, the tubing is removed from the well after filling and the captured sample is allowed to drain into the sample vial. If method (B) is used, after running the pump and filling the tubing with sample, the pump speed is reduced and the direction reversed to push the sample out of the tubing into the vials. Avoid completely emptying the tubing when filling the sample vials when using method (B) to prevent introducing water that was in contact with the flexible pump head tubing. Either method is repeated, as necessary, until all vials are filled.

4.3.1.3 RediFlo2® Electric Submersible Pump (with Teflon® tubing)

After purging has been accomplished with RediFlo2® electric submersible pump, the sample may be obtained directly from the pump discharge, provided that Teflon® tubing was used for the sample delivery line. The discharge rate of the pump should be reduced during volatile organic compound sample collection to minimize sample disturbance. Note, if the RediFlo2® electric submersible pump is used for sampling, the water in the cooling chamber must be replaced with organic-free water between each well and the pump must undergo a full external and internal cleaning. In addition, pump rinsate blanks must be collected, at the appropriate frequency, to demonstrate that the pump has been adequately cleaned between wells.

4.3.1.4 Bailers

New bailer rope should be attached to the bailer via a Teflon® coated stainless steel wire. (If a bailer was used to purge the well, it may also be used to sample the well and new bailer rope is not required between purging and sampling). The bailer should be gently immersed in the top of the water column until just filled. At this point, the bailer should be slowly removed and the contents emptied into the appropriate sample containers.

4.4 Sampling Wells without Plumbing, Exceeding the Limit of Suction

All methods described previously in Section 4.3.2.1.3, RediFlo2® Electric Submersible Pumps, and Section 4.3.2.1.4, Bailers, are suitable sample methods where the water table is too deep to consider the use of a peristaltic pump for sampling.

4.5 Sample Preservation

After sample collection, all samples requiring preservation must be preserved as soon as practical. Consult the ASBLOQAM for the correct preservative for the particular analytes of interest. All samples preserved using a pH adjustment (except VOCs) must be checked, using pH strips, to ensure that they were adequately preserved. This is done by pouring a small volume of sample over the strip. Do not place the strip in the sample. Samples requiring reduced temperature storage should be placed on ice immediately.

4.6 Special Sample Collection Procedures

4.6.1 Trace Organic Compounds and Metals

Special sample handling procedures should be instituted when trace contaminant samples are being collected. All sampling equipment, including pumps, bailers, water level measurement equipment, etc., which comes into contact with the water in the well must be cleaned in accordance with the cleaning procedures described in the SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205 or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206). Pumps should not be used for sampling unless the interior and exterior portions of the pump and the discharge hoses are thoroughly cleaned. Blank samples should be collected to determine the adequacy of cleaning prior to collection of any sample using a pump other than a peristaltic pump.

4.6.2 Order of Sampling with Respect to Analytes

In many situations when sampling permanent or temporary monitoring wells, an adequate purge, with respect to turbidity, is often difficult to achieve. Removal

and insertion of equipment after the purge and prior to actual sampling may negate the low turbidities achieved during purging and elevate turbidity back to unacceptable levels. For this reason, it is important that special efforts be used to minimize any disturbance of the water column after purging and to collect the aliquot for metals first. Therefore, the preferred order of sampling is metals first, followed by other inorganic analytes, extractable organic compounds and volatile organic compounds.

4.6.3 Filtering

As a standard practice, ground water samples will not be filtered for routine analysis. Filtering will usually only be performed to determine the fraction of major ions and trace metals passing the filter and used for flow system analysis and for the purpose of geochemical speciation modeling. Filtration is not allowed to correct for improperly designed or constructed monitoring wells, inappropriate sampling methods, or poor sampling technique.

When samples are collected for routine analyses and are filtered, both filtered and non-filtered samples will be submitted for analyses. Samples for organic compounds analysis should not be filtered. Prior to filtration of the ground water sample for any reason other than geochemical speciation modeling, the following criteria must be demonstrated to justify the use of filtered samples for inorganic analysis:

1. The monitoring wells, whether temporary or permanent, have been constructed and developed in accordance with the SESD Guidance Document, Design and Installation of Monitoring Wells (SESDGUID-001).

2. The ground water samples were collected using sampling techniques in accordance with this section, and the ground water samples were analyzed in accordance with USEPA approved methods.

3. Efforts have been undertaken to minimize any persistent sample turbidity problems. These efforts may consist of the following:

- Redevelopment or re-installation of permanent ground water monitoring wells.
- Implementation of low flow/low stress purging and sampling techniques.

4. Turbidity measurements should be taken during purging and sampling to demonstrate stabilization or lack thereof. These measurements should be documented in the field notes. If the ground water sample appears to have either a chemically-induced elevated turbidity, such as would occur with precipitate formation, or a naturally elevated colloid or fine, particulate-related turbidity, filtration will not be allowed.

If filtration is necessary for purposes of geochemical modeling or other **pre-approved** cases, the following procedures are suggested:

1. Accomplish in-line filtration through the use of disposable, high capacity filter cartridges (barrel-type) or membrane filters in an in-line filter apparatus. The high capacity, barrel-type filter is preferred due to the higher surface area associated with this configuration. If a membrane filter is utilized, a minimum diameter of 142 mm is suggested.

2. Use a 5 μm pore-size filter for the purpose of determining the colloidal constituent concentrations. A 0.1 μm pore-size filter should be used to remove most non-dissolved particles.

3. Rinse the cartridge or barrel-type filter with 500 milliliters of the solute (ground water to be sampled) prior to collection of sample. If a membrane filter is used, rinse with 100 milliliters of solute prior to sample collection.

Potential differences could result from variations in filtration procedures used to process water samples for the determination of trace element concentrations. A number of factors associated with filtration can substantially alter "dissolved" trace element concentrations; these include filter pore size, filter type, filter diameter, filtration method, volume of sample processed, suspended sediment concentration, suspended sediment grain-size distribution, concentration of colloids and colloidally-associated trace elements, and concentration of organic matter. Therefore, consistency is critical in the comparison of short-term and long-term results. Further guidance on filtration may be obtained from the following: 1) Metals in Ground Water: Sampling Artifacts and Reproducibility; 2) Filtration of Ground Water Samples for Metals Analysis; and 3) Ground Water Sampling - A Workshop Summary. See Section 1.4, References, for complete citation for these documents.

Bacterial Sampling

Whenever wells (normally potable wells) are sampled for bacteriological parameters, care must be taken to ensure the sterility of all sampling equipment and all other equipment entering the well. Further information regarding bacteriological sampling is available in the following: 1) Sampling for Organic Chemicals and Microorganisms in the Subsurface; 2) Handbook for Evaluating Water Bacteriological Laboratories; and 3) Microbiological Methods for Monitoring the Environment, Water and Wastes. See Section 1.4, References, for complete citation for these documents.

4.7 Specific Sampling Equipment Quality Assurance Techniques

All equipment used to collect ground water samples shall be cleaned as outlined in the SESD Operating Procedure for Field Equipment Cleaning and Decontamination

(SESDPROC-205) or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) and repaired, if necessary, before being stored at the conclusion of field studies. Cleaning procedures utilized in the field or field repairs shall be thoroughly documented in field records.

4.8 Auxiliary Data Collection

During ground water sample collection, it is important to record a variety of ground water related data. Included in the category of auxiliary data are water levels measured according to the SESD Operating Procedure for Groundwater Level and Well Depth Measurement (SESDPROC-105), well volume determinations (Section 3.1.1, Purging and Purge Adequacy), pumping rates during purging (see below), and occasionally, drillers or boring logs. This information should be documented in the field records.

4.8.1 Well Pumping Rate - Bucket/Stop Watch Method

The pumping rate for a pump can be determined by collecting the discharge from the pump in a bucket of known volume and timing how long it takes to fill the bucket. The pumping rate should be in gallons per minute. This method shall be used primarily with pumps with a constant pump rate, such as gasoline-powered or electric submersible pumps. Care should be taken when using this method with some battery-powered pumps. As the batteries' charge decreases, the pump rate also decreases so that pumping rate calculations using initial, high pump rates may be erroneously high. If this method is used with battery-powered pumps, the rate should be re-checked frequently to ensure accuracy of the pumping rate calculations.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Soil Gas Sampling**

Effective Date: November 1, 2007 | **Number:** SESDPROC-307-R1

Authors

Name: Donald Hunter
Title: Environmental Scientist, Regional Expert
Signature: Donald Hunter Date: 11/02/07

Approvals

Name: Antonio Quinones
Title: Chief, Enforcement and Investigations Branch
Signature: [signature] Date: 11/02/07

Name: Laura Ackerman
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Laura Acker Date: 11/01/07

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-307-R1, *Soil Gas Sampling*, replaces SESDPROC-307-R0 **General** Updated referenced operating procedures due to changes in title names and/or to reflect most recent version. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Alphabetized and revised the referencing style for consistency. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual.	November 1, 2007
SESDPROC-307-R0, Soil Gas Sampling, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting soil gas samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling soil gas samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used to obtain a soil gas sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

Geoprobe® Systems Tools and Equipment Catalog, Kejr Engineering, Inc., Salinas, Kansas, 1997.

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-104, Most Recent Version)
SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

The Yellow Field Book©, Kejr Engineering, Inc., Salinas, Kansas, 2000.

US EPA. 1999. Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS); Center for Environmental Research Information, Office of Research and Development, Cincinnati, OH; EPA/625/R-96/010b

US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. April 13, 1981. Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples. Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273)

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting soil gas samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting soil gas samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) and/or International Air Transportation Association (IATA) hazardous materials shipping requirements.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader and stored in a secure place.

2 Special Sampling Considerations

2.1 Special Considerations for Sampling

The tubing used as part of either of the described sampling systems should be Teflon® or stainless steel. As most soil gas sampling will be conducted to investigate the presence or extent of organic compounds, Teflon® tubing is required to ensure the integrity of the sample.

2.2 Special Precautions for Soil Gas Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should be changed any time during sample collection when their cleanliness is compromised.
- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.

2.3 Sample Handling Requirements

1. Soil gas samples will typically be collected by directly filling evacuated, specially-prepared stainless steel canisters (SUMMA® or SilcoSteel™ canisters), after sample delivery line purging.

2. The SUMMA® canister will be labeled and identified according to SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples (SESDPROC-209).

2.4 Quality Control

If applicable to the study or investigation, a control sample should be collected from a location not affected by the possible contaminants of concern and submitted with the other samples. A canister field blank, prepared prior to the investigation by ASB personnel, should also be submitted with the sample set during the investigation. Equipment rinsate blanks should be collected if equipment, such as PRT adapters, probe rod or other sampling equipment is field cleaned and re-used to document that low-level contaminants were not introduced into the sample by the decontaminated equipment.

2.5 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in the SESD Operating Procedure for Control of Records (SESDPROC-002). Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation

according to the procedures found in SESD Operating Procedure Logbooks (SESDPROC-010) and SESD Operating Procedure for Sample and Evidence Management (SESDPROC-005).

3 Grab Sampling Using the Geoprobe® PRT System

3.1 General

Single event or grab sampling may be conducted using the Post-Run Tubing System (PRT). Using this system, soil gas samples can be collected quickly and with a high degree of assurance that the samples are representative of the targeted depth, i.e., using this method, there is no leakage at probe rod joints that will compromise the integrity of the sample.

The downhole components of the PRT system include:

- Sample delivery tubing
- Probe rods
- PRT Adapter
- Expendable point holder
- Expendable point

O-ring seals are used on the PRT Adapter and the expendable point holder to provide a leak-proof system that assures sample integrity.

3.2 PRT System Installation Procedures

The following procedures are used to collect soil gas samples using the Geoprobe® PRT system. The PRT system can be used with either the 1.0-inch or 1.25-inch diameter probe rod. All parts or accessories used in the PRT system must be selected with the appropriate diameter probe rod in mind to ensure compatibility of all components.

1. Place O-ring on PRT expendable point holder and attach to initial section of probe rod.

2. Place O-ring on expendable point and press into expendable point holder.

3. Add drive cap to probe rod and push PRT system into ground. Add additional probe rods, as needed, to push system to the desired sampling depth.

4. At the desired sampling depth, attach pull cap to probe rod and pull the rod back to disengage the expendable point and expose the soil interval for sampling. Remove the pull cap when this step is completed.

5. Secure the PRT adapter to a length of tubing sufficient to reach from the sampling interval to the surface, with several feet of excess tubing extending beyond the top of the probe rod to facilitate sampling. The adapter is secured tightly to the tubing using electrical tape. This will not compromise the integrity of the sample to be collected, as the sample is pulled directly through the adapter and is never

exposed to the tape.

6. Run the tubing and adapter into the probe rod and, using steady downward pressure, turn the tubing counter-clockwise to dock the adapter into the top of the expendable point holder. Tug gently on the tubing to ensure that the adapter docked firmly into the expendable point holder. Failure to dock could indicate that soil intruded during the push or that the expendable point was lost during the push.

7. At this point, the PRT system has been installed and is ready for sampling. If the sample can not be collected immediately, the end of the tubing should be capped with a stainless steel Swagelok® cap.

3.3 PRT System Sampling Methodology

Soil gas samples may be collected from the installed PRT system using several methods, listed below:

- Canister Sampling for Laboratory Analysis - After purging the PRT system tubing to introduce representative soil gas into the sampling system, an evacuated SUMMA® canister is attached using a Swagelok® or other suitable secure connection. After connection, the valve on the SUMMA® canister is opened, pulling soil gas from the exposed soil interval into the canister.

- Real-time Field Analytical Methods – Real-time analytical measurements may be obtained using appropriate instrumentation. Typically, a low flow rate pump is used to pull soil gas from the screened interval and through a properly calibrated instrument, such as the B and K Photoacoustic Analyzer, normally placed in-line between the implant tubing and the pump. Soil gas concentrations for selected compounds are read directly from the instrument and recorded.

4 Sampling Using Geoprobe® Permanent Soil Gas Implants

4.1 General

Long-term soil gas sampling may be conducted using permanent soil gas sampling implants installed with the Geoprobe®. Stainless steel implants may be installed at any depth achievable by the Geoprobe® and may be installed in 1.0-inch and 1.25-inch diameter probe rod in custom lengths, using 6-inch (152 mm) or 21-inch (533 mm) screens, which can be connected in any combination. The screens are double-woven stainless steel mesh with 0.0057-inch (0.15 mm) pore openings. A 14-inch long screen is available for use only with the 1.25-inch diameter probe rod.

4.2 Installation of Permanent Soil Gas Sampling Implants

The following procedures are used by to install a permanent soil gas sampling implant using the Geoprobe®. These are general procedures which are used with either 1.0-inch or 1.25-inch diameter probe rod. Attention should be given to rod diameter when ordering points and point holders.

1. Attach O-ring to implant point anchor.

2. Press implant point anchor into point holder and attach to first section of probe rod.

3. Push implant point anchor to the desired depth for implant installation.

4. When the desired depth has been reached, attach the implant to the sample delivery tubing. This is accomplished by loosening or removing the Swagelok® fitting and pressing the tubing into the implant. When the end of the tubing is sufficiently engaged in the end of the implant, the Swagelok® fitting is tightened to secure the tubing in the implant. It is critical that the tubing be securely attached to the implant so that it does not pull off during subsequent steps of the installation.

5. Feed the tubing into the probe rod until the implant reaches the implant point anchor. At this point, cut the tubing to allow enough tubing to remain for sampling, usually three to four feet.

6. Rotate the tubing and implant counter-clockwise, threading the implant into the anchor. If there was any soil intrusion during the push, the implant may not dock. If the implant does not dock, it is possible to salvage the installation by removing the implant and sealing the small hole on the bottom of the implant, if present, with foil or with a small sheet metal screw then returning the implant to the hole.

7. After the implant has been docked, use a pull cap and pull the probe rod

approximately one foot, exposing the implant. Observe the tubing to make sure that anchor remained in place and is not being pulled with the rod.

8. If the implant remained in place, slowly pour a measured amount of 60-100 mesh glass beads down the inside of the probe rod. The glass beads are used as a filter pack around the implant. Ideally, the implant should be covered with beads with approximately six inches of beads above the top of the implant. The volume of beads should be calculated based on the length of implant used. While pouring the beads, it is advisable to gently shake the tubing to prevent the beads from bridging inside the probe rod.

9. After placing the beads, the implant is sealed using a flowable mixture of the glass beads and fine-powdered bentonite. To accomplish this, two to three feet of rod is pulled and the mixture is slowly poured into the rod above the bead-packed implant. As with the bead placement, similar care should be taken to avoid bridging of this mixture.

10. If it is appropriate to grout the installation, grouting may be accomplished either through pressure grouting through the probe rod as the rods are pulled after placement of the seal or, if the hole remains open, the grout may be mixed and poured down the open hole after retrieval of the rods.

11. For permanent or long-term installations, efforts should be taken to protect the tubing at the surface using some type of surface completion and protective casing.

4.3 Sampling of Permanent Soil Gas Sampling Implants

Soil gas samples may be collected from the installed permanent soil gas implant using several methods. These are listed below:

- Canister Sampling for Laboratory Analysis - After purging implant tubing to introduce representative soil gas into the system, an evacuated SUMMA® canister is attached using a Swagelok® or other suitable secure connection. After connection, the valve on the SUMMA® canister is opened, pulling soil gas from the implant into the canister.
- Real-time Field Analytical Methods – Real-time analytical measurements may be obtained using appropriate instrumentation. Typically, a low flow rate pump is used to pull soil gas from the screened interval and through a properly calibrated instrument, such as the B and K Photoacoustic Analyzer, normally placed in-line between the implant tubing and the pump. Soil gas concentrations for selected compounds are read directly from the instrument and recorded.

BULK SAMPLE
CHAIN OF CUSTODY RECORD

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

POLARIZED LIGHT MICROSCOPY
PERFORMED BY EPA 600/R-93/116 METHOD

PROJECT NO.	PROJECT NAME	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
FACILITY		RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
SAMPLER(S)	DATE TAKEN	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:

SAMPLE #	LAB NUMBER	DATE ANALYZED	ANALYSTS INITIALS	ASBESTOS +	ASBESTOS N/D	ARCHIVE NUMBER	DATE ARCH	ARCHIVER INITIALS	SPECIAL INSTRUCTIONS

☐ Same Day ☐ 24 Hour ☐ 48 Hour ☐ 3-5 Day ☐ 6-10 Day

ALL SAMPLES WILL BE DISPOSED OF AFTER ANALYSIS UNLESS OTHERWISE REQUESTED

By signing below, I warrant that I am authorized to enter into this agreement for the client named below, and that I authorize the above analysis subject to the terms and conditions on the reverse hereof.

AUTHORIZED BY _____ (DATE & TITLE)

PRINT NAME _____

This agreement is governed by the terms and conditions on the reverse side hereof.

Analysis charges shall be as included in S&ME, Inc.'s fee schedule in effect at the time of the analysis.

CLIENT INVOICE INFORMATION		SEND COPIES OF RESULTS TO	
	ATTN:		Name, Dept.
Client Name		Co.	
Client PO#		Address	
Address		City, State, Zip	
City, State, Zip		Phone:	FAX:
Phone:	FAX:		

WHITE COPY-LABORATORY YELLOW COPY-ACCOUNTING PINK COPY-CLIENT

GORE-SORBER® Exploration Survey Chain of Custody

For W.L. Gore & Associates use only
Production Order # ______________

GORE Creative Technologies Worldwide

W. L. Gore & Associates, Inc., Survey Products Group

100 Chesapeake Boulevard • Elkton, Maryland 21921 • Tel: (410) 392-7600 • Fax (410) 505-4780

Instructions: Customer must complete *ALL* *shaded cells*

Customer Name: ______________	Site/Prospect Name: ______________
Address: ______________	Site Address: ______________
______________	______________
______________	Project Manager: ______________
Phone: ______________	Customer Project No.: ______________
FAX: ______________	Customer P.O. #: ______________ Quote #: ______________

Serial # of Modules Shipped						
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#	-	#		#	-	#

# of Modules for Grid Installation 0

# of Module for Models ______ # of Trip Blanks ______

Total Modules Shipped: 0 Pieces

Total Modules Received: ______ Pieces

Total Modules Installed: ______ Pieces

Serial # of Trip Blanks (*Client Decides*)		#
#	#	#
#	#	#
#	#	#
#	#	#
#	#	#
#	#	#
#	#	#

Prepared By: ______________

Verified By: ______________

Installation Performed/Supervised By:

Name (*please print*): ______________

Company/Affiliation: ______________

Installation Method(s) (*circle those that apply*):

Drive Point Hammer Drill Auger

Other: ______________

Installation Start Date and Time:	/ /	:	AM PM
Installation Complete Date and Time:	/ /	:	AM PM

Retrieval Performed/Supervised By:

Name (*please print*): ______________

Company/Affiliation: ______________

Total Modules Retrieved: ______ Pieces

Total Modules Lost in Field: ______ Pieces

Total Unused Modules Returned: ______ Pieces

Retrieval Start Date and Time:	/ /	:	AM PM
Retrieval Complete Date and Time:	/ /	:	AM PM

Relinquished By ______ Affiliation: W.L. Gore & Associates, Inc.	Date	Time	Received By: ______ Affiliation: ______	Date	Time
Relinquished By ______ Affiliation: ______	Date	Time	Received By: ______ Affiliation: ______	Date	Time
Relinquished By ______ Affiliation ______	Date	Time	Received By: ______ Affiliation: W.L. Gore & Associates, Inc.	Date	Time

GORE-SORBER® Screening Survey Installation and Retrieval Log

Page _____ of _____

SITE NAME & LOCATION

LINE #	MODULE #	INSTALLATION DATE/TIME	RETRIEVAL DATE/TIME	EVIDENCE OF LIQUID HYDROCARBONS (LPH) or HYDROCARBON ODOR *(Check as appropriate)*			MODULE IN WATER *(check one)*		COMMENTS
				LPH	ODOR	NONE	YES	NO	
1.									
2.									
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5.									
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CUSTODY SEAL
QEC
Quality Environmental Containers
800-255-3950 • 304-255-3900
DATE
SIGNATURE

Lead Chain-of-Custody

~For Lab Use Only ~

Environmental Hazards Services, LLC

www.leadlab.com *7469 Whitepine Rd*
(800) 347-4010 *Richmond, VA*
(804) 275-4907 (fax) *23237*

Company Name: _____ Address: _____ City/State/Zip: _____

Phone: ( ) _____ Fax: ( ) _____ E-mail: _____ Acct. Number: _____

Project Name / Testing Address: _____ **City/State (Required):** _____

Collected by: _____ Certification Number: _____ Purchase Order Number: _____

*** Do wipe samples submitted meet ASTM E1792 requirements? Yes ☐ No ☐**

Turn Around Time (TAT)

☐ **1-Day** ☐ **3-Day**

☐ **Same Day (Must Call Ahead)**

☐ **Weekend (Must Call Ahead)**

If no TAT is specified, sample(s) will be processed and charged as 3-Day TAT.

Sample Type

Single Dust Wipe	= DW	Soil	= S
Paint Chip	= PC	Air	= A
Composite Soil	= CS		

Abbreviations

FR	= Family Room	F	= Front	0	= Basement
LR	= Living Room	R	= Rear	KT	= Kitchen
DN	= Den	LT	= Left	BA	= Bath
DR	= Dining Room	RT	= Right	BR	= Bedroom
1	= 1st Fl	2	= 2nd Fl		

Surface Type for Dust Wipe

FL	=	Floor
CP	=	Carpet
SL	=	Window Sill
WW	=	Window Well

No.	Sample Type	Date Collected	Client Sample ID	Collection Location (LR, KT, LTFBR, RTRBR, etc.)	Surface Type	Area	Paint Chip			Air			Comments
						Length X Width in inches (Provide paint chip area only if requesting mg/cm2)	mg/cm²	PPM	%	Flow Rate (L/ min)	Total Time (minutes)	Volume (Total Liters)	
1						X							
2						X							
3						X							
4						X							
5						X							
6						X							
7						X							
8						X							
9						X							
10						X							

Released by:	Signature:	Date/Time:
Received by:	Signature:	Date/Time:

Billing Information:

Report to:

Email to:

Analysis/Container/Preservative

Chain of Custody
Page 1 of 1

ESC
L·A·B S·C·I·E·N·C·E·S

12065 Lebanon Road
Mt. Juliet, TN 37122

Phone: (800) 767-5859
Phone: (615) 758-5858
Fax: (615) 758-5859

Project Description:

City/Sate Collected

Phone:
FAX:

Client Project #:

ESC Key:

Collected by:

Site/Facility ID#:

P.O.#:

Collected by (signature):

Immediately Packed on Ice N ____ Y ___

Rush? (Lab MUST Be Notified)

____ Same Day. 200%
____ Next Day.. . . . . 100%
____ Two Day 50%
Three Day 25%

Date Results Needed:

Email? __No__Yes

FAX? __No__Yes

No. of Cntrs

CoCode (lab use only)

Template/Prelogin

Shipped Via:

Sample ID	Comp/Grab	Matrix*	Depth	Date	Time	No. of Cntrs	Remarks/Contaminant	Sample # (lab only)

*Matrix: **SS** - Soil/Solid **GW** - Groundwater **WW** - WasteWater **DW** - Drinking Water **OT** - Other_____

pH _____ Temp _____

Remarks:

Flow _____ Other _____

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Samples returned via: ☐ UPS ☐ FedEx ☐ Courier ☐ _____	Condition: (lab use only)	
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Temp:	Bottles Received:	CoC Seals Intact: ____ Y ____ N _____ NA
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)	Date:	Time:	pH Checked: / NCF:

FIELD PARAMETERS

Job Name :City of Knoxville, South Waterfront
Job Number : 1434-09-382

Location ID #:

Date: _____

1. Depth to top of Water:
_____ft.
2. Depth to top of product.
_____ft.

Prodct thickness = _____ft.

Date: _____

Well Diameter: _____in.
Well Depth: _____ ft.
Water Level: _____ft.
Depth of Water: _____ft.
Volume of Water in Well:_____gal.
Volume of Water to be Purged:_____gal.
Purge Start Time:_____
Purge Finish Time:_____
Actual Volume Purged:_____gal.

1 Well Volume in gallons =
0.016 x well diameter(squared) x depth of water

PARAMETER TESTING

Date: _____

Time (Standard) units					
ORP units					
pH units					
Conductivity units					
Turbidity units					
DO units					
Temperature (°c) units					
Salinity units					

* Indicates Sampling Data

Sampled at 13:45

S&ME Inc. – Knoxville TN.

Prepared by Environmental Science Corp.

Project: _____

Proj #: _____

Sample Location/ID: _____

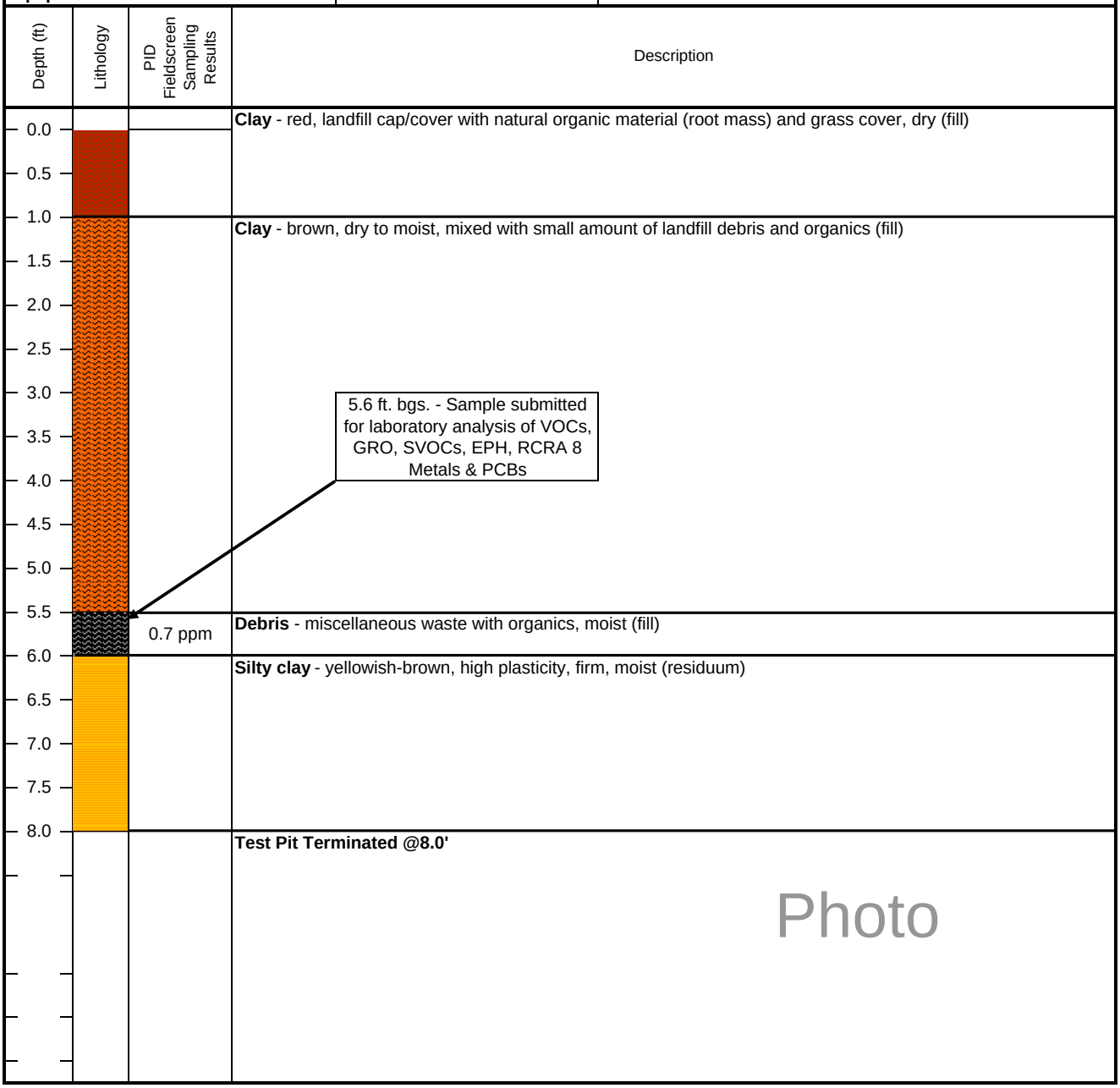
Analysis Reqd: _____

_____

Date: _____ Time: _____

Project:	South Waterfront Knoxville, Tennessee		SAMPLE S&ME TEST PIT RECORD:
Project No.:	*1434-09-382*	**Elevation:**	*Not Measured*
Logged by:	*S&ME's Nate Peterson, P.G.*	**Depth:**	*__ feet bgs*
Operator:		**Date:**	
Equipment:	*Backhoe*	**Water Encountered:**	

Notes:



S&ME Inc. – Knoxville TN.

Prepared by Environmental Science Corp.

Project: _____

Proj #: _____

Sample Location/ID: _____

Analysis Reqd: _____

_____

Date: _____ Time: _____

Billing Information:

Report to:

Email to:

Analysis/Container/Preservative

Chain of Custody
Page 1 of 1

ESC
L·A·B S·C·I·E·N·C·E·S

12065 Lebanon Road
Mt. Juliet, TN 37122

Phone: (800) 767-5859
Phone: (615) 758-5858
Fax: (615) 758-5859

Project Description:

City/Sate Collected

Phone:
FAX:

Client Project #:

ESC Key:

Collected by:

Site/Facility ID#:

P.O.#:

Collected by (signature):

Immediately Packed on Ice N ____ Y ___

Rush? (Lab MUST Be Notified)

____ Same Day. 200%
____ Next Day.. . . . . 100%
____ Two Day 50%
Three Day 25%

Date Results Needed:

Email? __No__Yes

FAX? __No__Yes

No. of Cntrs

CoCode (lab use only)

Template/Prelogin

Shipped Via:

Sample ID	Comp/Grab	Matrix*	Depth	Date	Time	No. of Cntrs	Remarks/Contaminant	Sample # (lab only)

*Matrix: **SS** - Soil/Solid **GW** - Groundwater **WW** - WasteWater **DW** - Drinking Water **OT** - Other_____

pH _____ Temp _____

Remarks:

Flow _____ Other _____

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Samples returned via: ☐ UPS ☐ FedEx ☐ Courier ☐ _____	Condition: (lab use only)	
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Temp:	Bottles Received:	CoC Seals Intact: ____ Y ____ N _____ NA
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)	Date:	Time:	pH Checked: / NCF:

Lead Chain-of-Custody

~For Lab Use Only ~

Environmental Hazards Services, LLC

www.leadlab.com *7469 Whitepine Rd*
(800) 347-4010 *Richmond, VA*
(804) 275-4907 (fax) *23237*

Company Name: _____ Address: _____ City/State/Zip: _____

Phone: ( ) _____ Fax: ( ) _____ E-mail: _____ Acct. Number: _____

Project Name / Testing Address: _____ **City/State (Required):** _____

Collected by: _____ Certification Number: _____ Purchase Order Number: _____

*** Do wipe samples submitted meet ASTM E1792 requirements? Yes ☐ No ☐**

Turn Around Time (TAT)

☐ **1-Day** ☐ **3-Day**

☐ **Same Day (Must Call Ahead)**

☐ **Weekend (Must Call Ahead)**

If no TAT is specified, sample(s) will be processed and charged as 3-Day TAT.

Sample Type

Single Dust Wipe	= DW	Soil	= S
Paint Chip	= PC	Air	= A
Composite Soil	= CS		

Abbreviations

FR	= Family Room	F	= Front	0	= Basement
LR	= Living Room	R	= Rear	KT	= Kitchen
DN	= Den	LT	= Left	BA	= Bath
DR	= Dining Room	RT	= Right	BR	= Bedroom
1	= 1st Fl	2	= 2nd Fl		

Surface Type for Dust Wipe

FL	=	Floor
CP	=	Carpet
SL	=	Window Sill
WW	=	Window Well

No.	Sample Type	Date Collected	Client Sample ID	Collection Location (LR, KT, LTFBR, RTRBR, etc.)	Surface Type	Area	Paint Chip			Air			Comments
						Length X Width in inches (Provide paint chip area only if requesting mg/cm2)	mg/cm²	PPM	%	Flow Rate (L/ min)	Total Time (minutes)	Volume (Total Liters)	
1						X							
2						X							
3						X							
4						X							
5						X							
6						X							
7						X							
8						X							
9						X							
10						X							

Released by:	Signature:	Date/Time:
Received by:	Signature:	Date/Time:


CUSTODY SEAL
QEC
Quality Environmental Containers
800-255-3950 • 304-255-3900
DATE
SIGNATURE

GORE-SORBER® Exploration Survey Chain of Custody

For W.L. Gore & Associates use only
Production Order # ______________

GORE Creative Technologies Worldwide

W. L. Gore & Associates, Inc., Survey Products Group

100 Chesapeake Boulevard • Elkton, Maryland 21921 • Tel: (410) 392-7600 • Fax (410) 505-4780

Instructions: Customer must complete ALL shaded cells

Customer Name: ______	Site/Prospect Name: ______
Address: ______	Site Address: ______
______	______
______	Project Manager: ______
Phone: ______	Customer Project No.: ______
FAX: ______	Customer P.O. #: ______ Quote #: ______

Serial # of Modules Shipped						# of Modules for Grid Installation 0		
#	-	#	#	-	#	# of Module for Models ______ # of Trip Blanks ______		
#	-	#	#	-	#	Total Modules Shipped: 0 Pieces		
#	-	#	#	-	#	Total Modules Received: ______ Pieces		
#	-	#	#	-	#	Total Modules Installed: ______ Pieces		
#	-	#	#	-	#	Serial # of Trip Blanks (*Client Decides*)		#
#	-	#	#	-	#	#	#	#
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#	-	#	#	-	#	#	#	#
Prepared By: ______						#	#	#
Verified By: ______						#	#	#

Installation Performed/Supervised By: Name (*please print*): ______ Company/Affiliation: ______	Installation Method(s) (*circle those that apply*): Drive Point Hammer Drill Auger Other: ______
Installation Start Date and Time: / /	: AM PM
Installation Complete Date and Time: / /	: AM PM
Retrieval Performed/Supervised By: Name (*please print*): ______ Company/Affiliation: ______	Total Modules Retrieved: ______ Pieces Total Modules Lost in Field: ______ Pieces Total Unused Modules Returned: ______ Pieces
Retrieval Start Date and Time: / /	: AM PM
Retrieval Complete Date and Time: / /	: AM PM

Relinquished By ______ Affiliation: W.L. Gore & Associates, Inc.	Date	Time	Received By: ______ Affiliation: ______	Date	Time
Relinquished By ______ Affiliation: ______	Date	Time	Received By: ______ Affiliation: ______	Date	Time
Relinquished By ______ Affiliation ______	Date	Time	Received By: ______ Affiliation: W.L. Gore & Associates, Inc.	Date	Time

GORE-SORBER® Screening Survey Installation and Retrieval Log

Page _____ of _____

SITE NAME & LOCATION

LINE #	MODULE #	INSTALLATION DATE/TIME	RETRIEVAL DATE/TIME	EVIDENCE OF LIQUID HYDROCARBONS (LPH) or HYDROCARBON ODOR *(Check as appropriate)*			MODULE IN WATER *(check one)*		COMMENTS
				LPH	ODOR	NONE	YES	NO	
1.									
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BULK SAMPLE
CHAIN OF CUSTODY RECORD

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

POLARIZED LIGHT MICROSCOPY
PERFORMED BY EPA 600/R-93/116 METHOD

PROJECT NO.	PROJECT NAME	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
FACILITY		RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
SAMPLER(S)	DATE TAKEN	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:

SAMPLE #	LAB NUMBER	DATE ANALYZED	ANALYSTS INITIALS	ASBESTOS +	ASBESTOS N/D	ARCHIVE NUMBER	DATE ARCH	ARCHIVER INITIALS	SPECIAL INSTRUCTIONS

☐ Same Day ☐ 24 Hour ☐ 48 Hour ☐ 3-5 Day ☐ 6-10 Day

ALL SAMPLES WILL BE DISPOSED OF AFTER ANALYSIS UNLESS OTHERWISE REQUESTED

By signing below, I warrant that I am authorized to enter into this agreement for the client named below, and that I authorize the above analysis subject to the terms and conditions on the reverse hereof.

AUTHORIZED BY _____ (DATE & TITLE)

PRINT NAME _____

This agreement is governed by the terms and conditions on the reverse side hereof.

Analysis charges shall be as included in S&ME, Inc.'s fee schedule in effect at the time of the analysis.

CLIENT INVOICE INFORMATION		SEND COPIES OF RESULTS TO	
	ATTN:		Name, Dept.
Client Name		Co.	
Client PO#		Address	
Address		City, State, Zip	
City, State, Zip		Phone:	FAX:
Phone:	FAX:		

WHITE COPY-LABORATORY YELLOW COPY-ACCOUNTING PINK COPY-CLIENT